UPSC Geophysics 2020-2026
Topic Wise PYQS

Topic: 1 Branches of Geophysics

Q:1
Rheology is the study of
(a) mountain building process
(b) deformation and flow of solid materials
(c) deformation and flow of liquid materials and gases
(d) gravity effect of the Sun and the Moon

Q:2
The branch of Geophysics which deals with the Earth's geometrical shape, orientation, mass distribution and their variations with time is known as
(a) Astrophysics
(b) Geomagnetic Studies
(c) Geodesy
(d) Seismology

Q:3
Which one of the following is not a principal subdivision of geophysics?
(a) Seismology
(b) Meteorology
(c) Terrestrial magnetism
(d) Petrology

Q:4
Which one of the following is NOT a branch of geophysics?
(a) Plutology
(b) Seismology
(c) Hydrology
(d) Topographic surveying and mapping

Q:5
Which branch of geophysics deals with the internal structure of earth?
(a) Active reflection seismics
(b) Active refraction seismics
(c) Passive seismology
(d) Magnetotellurics

Topic: 2 Solar System

Q:1
Which one of the following planets has no significant global magnetic field at present?
(a) Jupiter
(b) Uranus
(c) Mars
(d) Neptune

Q:2
The angle between the ecliptic plane and equatorial plane is known as
(a) angle of inclination
(b) angle of obliquity
(c) angle of declination
(d) angle of azimuth

Q:3
Bode's law gives the distance of a planet from the Sun. Which one of the following does not follow this relationship?
(a) Venus
(b) Asteroid belt
(c) Uranus
(d) Neptune

Q:4
What is the major constituent in the core of Vesta asteroid?
(a) Iron
(b) Nickel
(c) Aluminum
(d) Copper

Q:5
Which one of the following statements regarding the angle of obliquity and eccentricity of Earth's orbit is not correct?
(a) Eccentricity varies with a period of about 1,00,000 years.
(b) Obliquity varies with a period of about 41,000 years.
(c) The difference in insolation between summer and winter seasons is high for very small values of eccentricity.
(d) Obliquity is the main factor that determines the seasonal difference between summer and winter in each hemisphere.

Q:6
Which one of the following pairs of planets does not have any natural satellites?
(a) Mercury and Venus
(b) Mars and Mercury
(c) Mercury and Saturn
(d) Uranus and Venus

Q:7
Match List-I with List-II and select the correct answer using the code given below the Lists:

List-I Solar System Body	List-II Category
A. Uranus	1 Dwarf Planet
B. Pluto	2 Natural Satellite
C. Mercury	3 Jovian Planet

D. Moon	4 Terrestrial Planet

a. A-2, B-1, C-4, D-3
b. A-3, B-4, C-1, D-2
c. A-3, B-1, C-4, D-2
d. A-2, B-4, C-1, D-3

Q:8
According to the nebular hypothesis of the origin of the solar system, the sun, planets and other components of the solar system originated from
(a) objects in the Kuiper belt
(b) a white dwarf star
(c) a rotating cloud of hot, primordial gas and dust
(d) a red giant star

Q:9
When the mass of a star becomes more than 1.4 times the solar mass, it would cease to be a:
(a) White dwarf
(b) Neutron star
(c) Black hole
(d) Pulsar

Q:10
Bode's law is associated with:
(a) Distance between two planets
(b) Distance between sun and planets
(c) Distance between earth and moon
(d) Distance between two stars

Q:11
Which one amongst the following phenomena provides evidence that 'the universe is expanding'?
(a) Newton's law of gravitation
(b) Coloumb's law
(c) Green house effect
(d) Doppler effect

Q:12
The core of Jupiter is surrounded by the layers of:
(a) Liquid hydrogen and iron
(b) Liquid-metallic, non-metallic and gaseous hydrogen
(c) Gaseous hydrogen and gaseous helium only
(d) Gaseous hydrogen, gaseous helium and liquid helium

Q:13
Which one of the following statements is true for planets revolving around the Sun?
(a) Areal velocity of different planets is different
(b) Areal velocity of a planet is not constant
(c) Only Earth has areal velocity
(d) Jupiter has the largest areal velocity

Q:14
The most studied and largest fraction of the meteorites recovered on the earth is:
(a) Achondrites
(b) Chondrites
(c) Iron
(d) Iron-stony

Q:15
Which one of the following planets of the solar system has the highest mean orbital velocity?
(a) Mercury
(b) Venus
(c) Earth
(d) Mars

Q:16
The angle of obliquity of the Earth ranges from
(a) 21.1° to 25.3°
(b) 21.9° to 24.3°
(c) 21.9° to 25.3°
(d) 21.1° to 24.3°

Topic: 3 Earth Shape, Size and Rotation

Q:1
Consider the following statements regarding shape of the earth :
Statement 1: The ellipsoidal shape of the earth is a result of its rotation.
Statement 2: The ellipsoidal shape affects the rate of rotation and the orientation of rotational axis of the earth.Which one of the following is correct in respect of the above statements?
(a) Both Statement 1 and Statement 2 are true and Statement 2 is the consequence of Statement 1
(b) Both Statement 1 and Statement 2 are true and Statement 2 is not the consequence of Statement 1
(c) Statement 1 is true but Statement 2 is false
(d) Statement 1 is false but Statement 2 is true

Q:2
Consider the following statements:
Statement-1: The earth's gravity increases from equator to pole
Statement-2: The equatorial bulge places an excess mass at equator, which causes the decrease in gravity at the equator
Which one of the following is correct in respect of above statements?
(a) Both Statement-1 and Statement-2 are true and Statement-2 is the correct explanation of Statement-1
(b) Both Statement-1 and Statement-2 are true but Statement-2 is not the correct explanation of Statement-1
(c) Statement-1 is true but Statement-2 is false

(d) Statement-1 is false but Statement-2 is true

Q:3
Which one of the following statements regarding planet earth is NOT correct?
(a) Its shape is oblate spheroid
(b) Its polar radius is shorter than its equatorial radius
(c) Some of the oceanic islands are formed by the basalt volcanoes
(d) The deepest layer of the earth is core which is composed of liquid only

Q:4
The ratio of the centrifugal to gravitational acceleration is maximum at the equator. What would be its value, if the radius of the Earth is r_E, rotational angular velocity is ω, mass is M and gravitational constant is G ?
(a) $\frac{\omega^2 r_E^2}{M^2}$
(b) $\frac{G\omega^2}{Mr_E^2}$
(c) $\frac{r_E^3\omega^2}{GM}$
(d) $\frac{GM}{\omega^2 r_E^2}$

Topic: 4 Dynamics of Earth

Q:1
The Wadati-Benioff seismic zone is related to
(a) constructive plate margins
(b) destructive plate margins
(c) plate interiors
(d) conservative plate margins

Q:2
Which one of the following is the correct geomagnetic anomaly order across the Pacific-Antarctica ridge, starting from its ridge axis, as suggested by Vine-Matthews-Morley?
(a) Brunhes-Matuyama-Gilbert-Gauss
(b) Brunhes-Gilbert-Gauss-Matuyama
(c) Brunhes-Gauss-Matuyama-Gilbcrt
(d) Brunhes-Matuyama-Gauss-Gilbert

Q:3
The Wadati-Benioff zone is related to :
(a) Seismicity at subduction zone
(b) Seismicity at conservative plate boundary
(c) Seismicity at mid-oceanic ridge
(d) Seismicity in the plate interiors

Q:4
If the upper and lower mantle are convecting separately, what will happen to the temperature structure of the Earth's mantle compared to the whole mantle convection?
(a) Increase in temperature of lower mantle only
(b) Increase in temperature of upper mantle only
(c) Increase in temperature of both upper mantle and lower mantle
(d) Decrease in temperature of lower mantle only

Q:4
Consider the following statements regarding hotspot :
1. Hotspot is long-lasting centre of surface volcanism and locally high heat flow.
2. Hotspots occur only in the ocean basin, not on the continents.
3. The ocean hotspots are found in conjunction with intraplate island chain.
4. Hotspot creates mass anomaly and disturbs the geoids.
Which of the statements given above are correct?
(a) 1,2 and 3
(b) 2, 3 and 4
(c) 1, 3 and 4
(d) 1, 2 and 4

Q:5
Which one of the following types of triple junction is always stable?
(a) Ridge (R)-Trench (T)-Transform Fault(F)
(b) Ridge (R)-Ridge (R)-Transform Fault (F)
(c) Transform Fault (F)-Transform Fault (F)-Transform Fault (F)
(d) Ridge (R)-Ridge (R)-Ridge (R)

Q:6
Mid-Ocean Ridge Basalt (MORB) is produced at
(a) destructive margins
(b) conservative margins
(c) constructive margins
(d) coastal margins

Q:7
Which one of the following statements regarding Vine-Matthews-Morley hypothesis is not correct?
(a) It explains the seafloor spreading theory.
(b) It explains the polarity changes of geomagnetic field at irregular time intervals.
(c) It explains the remanent magnetization of basalts in the uppermost oceanic crust.
(d) It explains the solar wind interaction with the magnetic field of the earth.

Q:8
Which one of the following statements regarding the earth as a dynamic planet is not correct?

(a) The earth's surface is constantly altered by endogenic processes resulting in volcanism and tectonism.
(b) The earth's surface is altered by exogenic processes such as erosion and deposition.
(c) Europe and most of the Arabia plate formed a single continent called Laurasia.
(d) Laurasia and Gondwanaland split apart in the Early Mesozoic.

Q:9
During convergent motion of the oceanic and continental plates, continental plate rides higher because:
(a) It is denser and thinner than the oceanic crust
(b) It is less dense and thicker than oceanic crust
(c) It is denser and thicker than oceanic crust
(d) It is less dense and thinner than oceanic crust

Q:10
Which one of the following statements is correct with reference to the geosyncline?
(a) It is a linear part of the crust of earth that sagged widely through time
(b) It is a linear part of the crust of earth that sagged deeply through time
(c) It is not linked with the origin of mountains
(d) Generally, it is few kilometers long and hundreds of kilometers wide

Q:11
Plate recycling occurs below the surface of earth because of:
1. Pulling force of a sinking lithospheric slab
2. Pushing force of sliding off a mid oceanic ridge
3. Rising convection current at boundary regions
Select the correct answer using the code given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Q:12
Which one of the following statements regarding the radiogenic heat inside the Earth is correct?
(a) Radiogenic heat flow is more in upper crust than rest of lithosphere.
(b) Radiogenic heat flow is less in upper crust than rest of lithosphere.
(c) Radiogenic heat flow is same in upper crust and rest of lithosphere.
(d) No radiogenic heat flow occurs in crust.

Q:13
Which one of the following factors is responsible for different density values measured during in-situ and laboratory conditions?
(a) Surrounding rocks density
(b) Porosity
(c) Mineral constituents
(d) Measurement principle

Q:14
The average value of oceanic heat flow for an oceanic lithosphere of age 36 Ma is
(a) $65\ \mathrm{mW/m^2}$
(b) $75\ \mathrm{mW/m^2}$
(c) $85\ \mathrm{mW/m^2}$
(d) $105\ \mathrm{mW/m^2}$

Q:15
The phase boundary at 660 km depth in the mantle is due to
(a) exothermic transition
(b) endothermic transition
(c) entropy change being negative
(d) temperature change being positive

Q:16
What is the Reynolds' number for convection in the entire mantle having a thickness $= 2900$ km, speed of flow $= 1.5 \times 10^{-9}$ m/s, density $= 5000\ \mathrm{kg/m^3}$ and viscosity $= 1.5 \times 10^{21}$ Pa s?
(a) 1.45×10^{-20}
(b) 1.45×10^{-25}
(c) 3.5×10^{-30}
(d) 3.5×10^{-20}

Q:17
Geostrophic winds:
(a) Are real winds that blow parallel to the lines of equal temperature
(b) Exist betw Magnetotelluric een the horizontal components of the coriolis force and the vertical pressure gradient force
(c) Are hypothetical winds that blow parallel to the lines of equal pressure
(d) Represent to the actual winds at elevations lesser than 800 m

Q:18
What type of changes in the mineral phase takes place at 410 km discontinuity inside the Earth?
(a) Olivine-type to spinel-type lattice
(b) Graphite-type to γ-spinel-type lattice

(c) α-spinel-type to pyrite-type lattice
(d) γ-spinel-type to β-spinel-type lattice

Q:19
What is the approximate pressure at the centre of the Earth?
(a) 180 GPa
(b) 280 GPa
(c) 380 GPa
(d) 480 GPa

Q:20
Which one of the following is the correct epoch sequence from 0 to 4 Ma age as estimated from normal and reverse geomagnetic data?
(a) Brunhes, Gauss, Matuyama, Gilbert
(b) Brunhes, Matuyama, Gauss, Gilbert
(c) Brunhes, Matuyama, Gilbert, Gauss
(d) Brunhes, Gilbert, Matuyama, Gauss

Q:21
The geophysical methods used for investigating the shallow features of the Earth's crust are
(a) static methods only
(b) dynamic methods only
(c) static and dynamic methods both
(d) relaxation methods only

Topic: 5 Gravity of Earth and Gravitational Prospecting

Q:1
What will be the approximate value of gravity anomaly of an infinite horizontal sheet of density 2.62 g/cm^3 and thickness 132 cm lying in the surrounding material of density 2.43 g/ cm^3?
(a) 13274 X 10^{-8} gal
(b) 14489 X 10^{-8} gal
(c) 582 X 10^{-8} gal
(d) 1051 X 10^{-8} gal

Q:2
The latitude correction in gravity data is minimum at
(a) poles only
(b) equator only
(c) both poles and equator
(d) 45^o latitude

Q:3
The maximum tidal effect of the Sun in comparison to the Moon is only about
(a) 80 %
(b) 45 %
(c) 30 %
(d) 10 %

Q:4
Let sphere 'A' of mass excess (MA) in metric tons lying at a depth Z (Km) produce a maximum anomaly of g_A (mGal). Suppose sphere 'A' is now replaced by another sphere 'B ' at the same depth with its mass excess as 0.5 times M_A (metric tons) and produces a maximum anomaly of g_B (mGal). Which one of the following is the correct relation between g_A and g_B ?
(a) $g_A = 0.5\ g_B$
(b) $g_A = 2.0\ g_B$
(c) $g_B = 6.5\ g_A$
(d) $g_B = 2.0\ g_A$

Q:5
Match List-I with List-II and select the correct answer using the code given below the Lists :

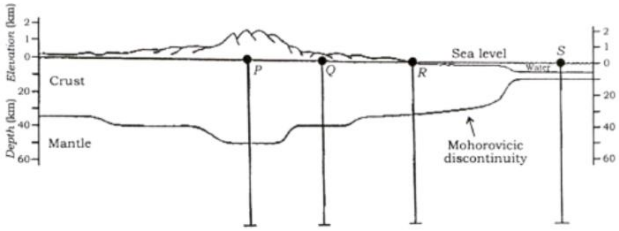
List-I (Gravity Correction)	List-II (Phenomenon)
A. Tidal correction	1. Accounts for the time dependent mechanical changes in the gravimeter
B. Drift correction	2. Accounts for time varying gravitational attraction of the Sun and the Moon
C. Free-air correction	3. Accounts for the speed and direction of moving vehicle containing gravimeter
D. Eötvös correction	4. Accounts for the elevation of the gravimeter station

(a) A-2, B-1, C-4, D-3
(b) A-3, B-4, C-1, D-2
(c) A-2, B-4, C-1, D-3
(d) A-3, B-1, C-4, D-2

Q:6
If gravity measuring station is located 50 m above the reference ellipsoid, what will be the free-air correction on the observed gravity data?
(a) 15.43 mGal
(b) 17.36 mGal
(c) 12.25 mGal
(d) 20.05 mGal

Q:7
The maximum gravity anomaly and the half-width of the gravity anomaly profile curve over a sphere are 0.1 mGal and 35 m , respectively. The depth to the centre of the sphere from surface and mass of the sphere are
(a) 32.5 m and 3000 tonnes, respectively
(b) 45.5 m and 3123.75 tonnes, respectively
(c) 25 m and 3197.25 tonnes, respectively
(d) 35 m and 1225 tonnes, respectively

Q:8



Assuming that the measured gravity is equal to the normal gravity value, which point in the above diagram has zero Bouguer gravity value?
(a) Point P
(b) Point Q
(c) Point R
(d) Point S

Q:9

Which one of the following statements regarding second vertical derivative of gravity data is correct?
(a) It enhances the deeper anomalies.
(b) It enhances the near surface anomalies.
(c) It increases the vertical resolution.
(d) It estimates the gravity at datum.

Q:10

In gravity method, the vertical fault block can be modeled as:
(a) Horizontal cylinder
(b) Vertical cylinder
(c) Infinite horizontal slab
(d) Semi-infinite horizontal slab

Q:11

Which one of the following correctly represents the relation between gravitational potential (U) and gravity attraction (g_r) at a distance r from the source mass?
(a) $g_r = -\frac{\partial U}{\partial r}$
(b) $g_r = r^2 \frac{\partial U}{\partial r}$
(c) $g_r = \frac{1}{r^2}\frac{\partial U}{\partial r}$
(d) $g_r = r^2 \frac{\partial^2 U}{\partial r^2}$

Q:12

Acceleration due to gravity g at a distance ($r > R_{earth}$) from the centre of earth is given by:
(a) $\frac{\partial g}{\partial r} + \frac{2}{r^2} g = 0$
(b) $\frac{\partial g}{\partial r} - \frac{g}{2r} = 0$
(c) $\frac{\partial g}{\partial r} - 2\frac{g}{r} = 0$
(d) $\frac{\partial g}{\partial r} + 2\frac{g}{r} = 0$

Q:13

Which one of the following relations is correct among the radius of sphere, R, and equatorial and polar radii of the international reference of ellipsoid, a and c, respectively, if the volumes of the sphere and ellipsoid are equal?
(a) $R - c \approx \frac{a-R}{2}$
(b) $R - c \approx a - R$
(c) $R - c \approx 2(a - R)$
(d) $R - c \approx 4(a - R)$

Q:14

The difference between geographic and geocentric latitudes is maximum at
(a) 0° latitude
(b) 23.5° latitude
(c) 45° latitude
(d) 90° latitude

Q:15

The acceleration of a point mass m_1 due to the attraction of another point mass m_2 at distance r is equal to
(a) $G\frac{m_1}{r^2}$
(b) $G\frac{m_2}{r^2}$
(c) $G\frac{m_1 m_2}{r^2}$
(d) $-G\frac{m_1}{r}$
(where G = universal gravitational constant)

Q:16

The approximate value of free-air correction at a station located at 1 m height above the datum plane at the equator is
(a) 0.3072 mGal
(b) 0.3388 mGal
(c) 0.3491 mGal
(d) 0.3516 mGal

Q:17

What is the ratio of maximum values of gravities directly above the centres of two spherical bodies of radii 1 m and 2 m situated in a homogeneous moraine having density contrast of 1 g/cc and 2 g/cc, respectively and depth to the centre of sphere as 2 m and 4 m , respectively?
(a) 1

(b) $\frac{1}{2}$
(c) $\frac{1}{4}$
(d) $\frac{1}{8}$

Q:18
The isostatic gravity anomaly is defined as the difference between
(a) Bouguer gravity anomaly and computed anomaly of the root zone
(b) free-air gravity anomaly and computed anomaly of the root zone
(c) Bouguer gravity anomaly and free-air gravity anomaly
(d) regional gravity anomaly and residual gravity anomaly

Q:19
The gravity value on the surface of the Earth at the equator is approximately
(a) $6.78\ m/s^2$
(b) $7.78\ m/s^2$
(c) $8.78\ m/s^2$
(d) $9.78\ m/s^2$

Q:20
The spherical shape model mass in the gravity method is particularly used as a first approximation in the interpretation of
(a) asymmetrical 2D anomalies
(b) approximately symmetrical 2D anomalies
(c) asymmetrical 3D anomalies
(d) approximately symmetrical 3D anomalies

Topic: 6 Earth Magnetism and Magnetic Prospecting

Q:1
The approximate ratio of the Earth's total magnetic field at the poles to that at the equator is
(a) 1: 4
(b) 1: 3
(c) 1: 2
(d) 2: 1

Q:2
The inclination of geocentric dipole to the Earth's rotation axis is about
(a) 8.2^o
(b) 11.2^o
(c) 18.2^o
(d) 23.5^o

Q:3
Which one of the following minerals has the highest magnetic permeability?
(a) Magnetite
(b) Pyrrhotite
(c) Hornblende
(d) Quartz

Q:4
The magnetism acquired over a short time in a strong magnetic field at a constant temperature is known as
(a) isothermal remanent magnetization
(b) viscous remanent magnetization
(c) chemical remanent magnetization
(d) anhysteretic remanent magnetization

Q:5
What will be the total magnetic field for a given Larmor frequency of 9/π kHz and gyromagnetic ratio for protons as
0.30 Hz /nT$?
(a) 25000 nT
(b) 65000 nT
(c) 56000 nT
(d) 60000 nT

Q:6
Which one of the following magnetometers has the highest precision?
(a) Fluxgate magnetometer
(b) Proton precision magnetometer
(c) Optically pumped magnetometer
(d) Torsion head magnetometer

Q:7
In local magnetic survey, the latitude correction at magnetic equator is
(a) zero
(b) 5 nT/km
(c) 0.5 nT/km
(d) 50 nT/km

Q:8
Secular variations in the geomagnetic field represent
(a) daily variations
(b) seasonal variations
(c) annual variations
(d) variations over decades or centuries

Q:9
After passing through the shock front, the solar wind is diverted around the Earth in a region of turbulent motion called :
(a) Magnetosheath
(b) Magnetosphere
(c) Magnetopause

(d) Van Allen belts

Q:10
The remanent magnetization related to the meteoritic impact is :
(a) Piezo remanent magnetization
(b) Shock remanent magnetization
(c) Anhysteretic remanent magnetization
(d) Isothermal remanent magnetization

Q:11
The horizontal component of Earth's magnetic field at a place on the Earth's surface is 1.5 times its vertical component. What is the inclination at the place?
(a) $\tan^{-1}(\frac{1}{1.5})$
(b) $\sin^{-1}(\frac{1}{1.5})$
(c) $\cos^{-1}(\frac{1}{1.5})$
(d) $\tan^{-1} 1.5$

Q:12
International Geomagnetic Reference Field (IGRF) correction removes :
(a) Effect of Earth's dipolar field only
(b) Effect of Earth's non-dipolar field only
(c) Effect of both, Earth's dipolar and non-dipolar fields
(d) Diurnal variations

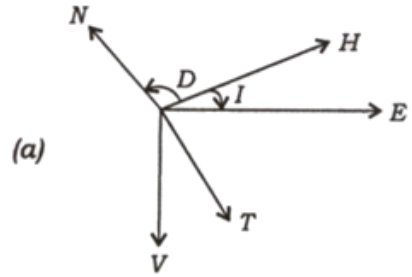
Q:13
Consider the following statements regarding remanent magnetization :
1. Thermoremanent magnetization results when magnetic material is cooled above the Curie point in the presence of external field.
2. Lightning strikes produce isothermal remanent magnetization over a very small area.

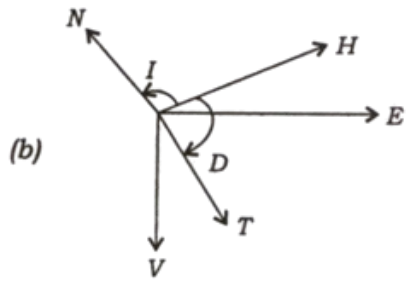
Which of the statement(s) given above is/are correct?
(a) 1 and 2 both
(b) 1 only
(c) 2 only
(d) Neither 1 nor 2

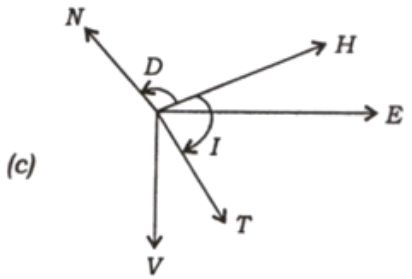
Q:14
In an aeromagnetic survey at a flight altitude of 1000 m above sea-level, the maximum total field anomaly over an ore body measured at centre was 160 nT . In a repeated measurement at 2500 m altitude, the maximum amplitude of the anomaly was 20 nT . What will be the depth of the ore body below sea-level assuming a monopole sphere source for the ore body?
(a) 375 m
(b) 500 m
(c) 625 m
(d) 750 m

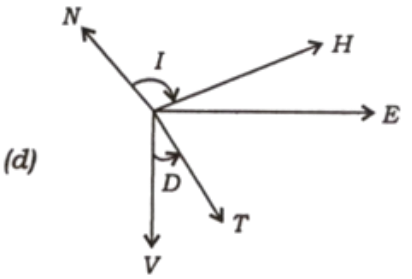
Q:15
Which one of the following rock types has the highest value of magnetic susceptibility?
(a) Granite
(b) Shale
(c) Gabbro
(d) Sandstone

Q:16
Which one of the following correctly represents the geomagnetic declination D, inclination I and total field direction T? Here, N= geographic north and H= magnetic north









Q:17
The susceptibility of paramagnetic material
(a) remains unchanged with increasing temperature
(b) decreases with increase in temperature
(c) increases with increase in temperature
(d) becomes zero with slight increase in temperature

Q:18
The regular diurnal variations in the Earth's magnetic field are caused by
(a) changes in strength and direction of ionospheric currents
(b) thunderstorm activities
(c) rotation of the Earth
(d) auroras

Q:19
In optically pumped magnetometer, the splitting of the energy levels in the presence of a magnetic field is called
(a) Doppler effect
(b) proton precession
(c) Zeeman effect
(d) magnetic saturation

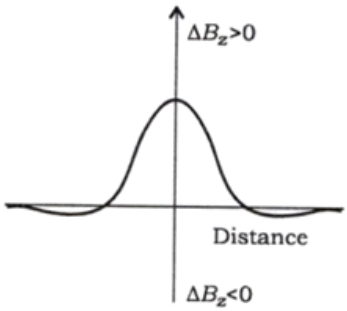
Q:20
Which one of the following magnetometers is used to study the remanent magnetization of rocks?
(a) Proton precession magnetometer
(b) Optically pumped magnetometer
(c) SQUID magnetometer
(d) Spinner magnetometer

Q:21
Which one of the following represents the correct order of magnetic susceptibilities of various rocks?
(a) Schist < Pegmatite < Peridotite
(b) Pegmatite < Schist < Peridotite
(c) Pegmatite < Peridotite < Schist
(d) Schist < Peridotite < Pegmatite

Q:22
What is the angle of inclination of the earth's magnetic field at 60° magnetic latitude?
(a) $\tan^{-1}(\frac{\sqrt{3}}{2})$
(b) $\tan^{-1}(2\sqrt{3})$
(c) $\tan^{-1}(\frac{1}{\sqrt{2}})$
(d) $\tan^{-1}\left(\frac{1}{2}\right)$

Q:23
The amplitude of magnetic diurnal variation is highest
(a) in the Equatorial regions
(b) in the Polar regions
(c) at 45^o latitude
(d) at 23.5^o latitude

Q:24
Consider the following schematic vertical component of the magnetic anomaly for a vertical dike with infinite horizontal extent :



Which one of the following statements regarding depth extent and induced magnetic field of the dike is correct with respect to the above diagram?
(a) The dike has infinite depth extent and is induced by the vertical component of the earth's magnetic field.
(b) The dike has finite depth extent and is induced by the vertical component of the earth's magnetic field.
(c) The dike has infinite depth extent and is induced by the horizontal component of the earth's magnetic field.
(d) The dike has finite depth extent and is induced by the horizontal component of the earth's magnetic field.

Q:25
Major component of earth's magnetic field comes from:
(a) Core
(b) Crust
(c) Mantle
(d) Ionosphere

Q:26
Which one of the following properties always exists in presence of magnetic field?
(a) Ferromagnetism
(b) Paramagnetism
(c) Antiferromagnetism
(d) Diamagnetism

Q:27
Which one of the following statements regarding earth's magnetism is true?
(a) A freely suspended magnet will be vertical at the equator
(b) Magnetic meridian at a place is a line passing through the axis of a freely suspended magnet
(c) At poles, the angle of dip is 0^o and horizontal component of earth's magnetic field is also zero
(d) Lines joining the points of same declination on the earth surface are called isogonic lines

Q:28
Consider the following statements regarding Magnetometer:
1. Proton Precession Magnetometer (PPM) is a total field magnetometer
2. PPM uses magnetizing solenoid
3. PPM can measure field components
4. Flux-gate Magnetometer measures components of the magnetic field along its axis Which of the statements given above are correct?
(a) 1, 2 and 4
(b) 1, 2 and 3
(c) 1, 3 and 4
(d) 2, 3 and 4

Q:29
The Earth's magnetic poles are shifting because of:
1. Shifts in the core's rate of spin
2. Changes in the convection of the core
3. Large earthquakes

Select the correct answer using the code given below:
(a) 1 and 3 only
(b) 1 and 2 only
(c) 2 only
(d) 1, 2 and 3

Q:30
Aurora Borealis occurs near the:
(a) Magnetic north pole of earth
(b) Equator of earth
(c) Sea shore
(d) Desert region

Q:31
The distance between south geographic pole and south magnetic pole is approximately:
(a) 4000 km
(b) 1500 km
(c) 1020 km
(d) 2860 km

Q:32
At neutral point of a bar magnet, a compass needle can stay in any position because:
(a) Magnetic declination at that point is zero
(b) Angle of dip at that point is zero
(c) Earth's magnetic field is zero
(d) Magnetic field of the bar magnet cancels the horizontal component of earth's magnetic field

Q:33
Match List-I with List-II and select the correct answer using the code given below:

List-I Mineral	List-II Magnetic property
A. Calcite	1. Diamagnetic
B. Magnetite	2. Paramagnetic
C. Ilmenite	3. Ferrimagnetic
D. Amphibole	4. Anti-ferromagnetic

Code

	A	B	C	D
(a)	1	3	4	2
(b)	1	4	3	2
(c)	2	3	4	1
(d)	2	4	3	1

Q:34
Which of the following has maximum Koenigsberger ratio?
(a) Igneous rock
(b) Sedimentary rock
(c) Metamorphic rock
(d) Depends only on temperature of rock

Q:35
Which one of the following is believed to be the cause of earth's magnetism?
(a) The earth has a large bar magnet at its centre
(b) The abundance of magnetic materials present in the crust of earth
(c) The electric currents conducting in the liquid core
(d) The magnetic fields produced by the magnetic materials present in the solid mantle

Q:36
The units of magnetic field strength and magnetic flux density, respectively are
(a) ampere metre $^{-1}$ and volt second metre $^{-2}$
(b) volt second metre $^{-2}$ and ampere metre $^{-1}$
(c) volt second and ampere metre $^{-1}$
(d) ampere metre $^{-1}$ and volt second

Q:37
A circular coil having axis length L and number of turns n is wound around a magnetic core. A current of I units passes through this coil. The magnetic excitation inside the core will be
(a) $\frac{nI}{L}$
(b) nIL
(c) $\frac{nL}{I}$
(d) $\frac{L}{I}$

Q:38
The angle between magnetic north and total magnetic field is
(a) magnetic declination
(b) magnetic inclination

(c) magnetic total angle
(d) magnetic vertical angle

Q;39
Which one of the following minerals has negative magnetic susceptibility?
(a) Pyrrhotite
(b) Ilmenite
(c) Sphalerite
(d) Quartz

Q:40
What is the approximate range of the Earth's magnetic field variation due to change in latitude value?
(a) $> 100\text{nT/km}$
(b) $50 - 100\text{nT/km}$
(c) $10 - 50\text{nT/km}$
(d) $< 6\text{nT/km}$

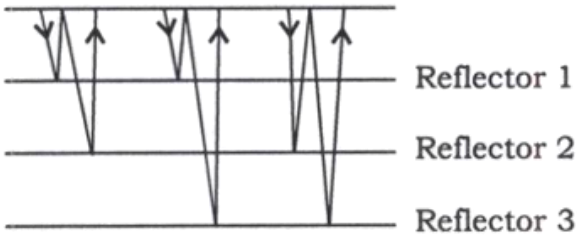
Q:41
What is the approximate direction of polarization of protons with respect to the Earth's magnetic field (F) due to applied external field in proton precession magnetometer?
(a) Parallel to F only
(b) Antiparallel to F only
(c) Normal to F
(d) Both parallel and antiparallel to F

Topic: 7 Seismology, Internal Structure of Earth and Seismic Methods

Q:1
Conservative plate margins are marked by abundance of
(a) normal fault
(b) reverse fault
(c) strike-slip fault
(d) oblique-slip fault

Q:2
The difference in travel time for a given reflection for two geophone locations, over a horizontal reflector is known as
(a) moveout
(b) checkout
(c) stacking
(d) dip correction

Q:3
Which type of reflection of seismic waves is shown in the diagram given below for ray paths in a model with three reflectors?



(a) Primary reflections
(b) First multiples
(c) Peg-leg multiples
(d) Inter-bed multiples

Q:4
Consider the following statements regarding seismic attributes analysis :
1. In clastic sections, the lowering of the acoustic impedance of a reservoir often produces a high amplitude reflection called as bright spot.
2. When the acoustic impedance of a water-filled reservoir is appreciably larger than that of the adjacent rock, the lowering of the acoustic impedance by hydrocarbon produces a dim spot.
3. A horizontal gas-oil, gas-water or oil-water contact may produce a distinct reflection, especially where the reservoir is thick, such reflection is called as flat spot.

Which of the statements given above are correct?
(a) 1,2 and 3
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1 and 3 only

Q:5
A seismic SH-wave is incident from medium-1 to medium-2 at the critical angle α. What is the ratio of wave speeds of medium-1 to medium-2?
(a) $\sin(\alpha)$
(b) $sin^2(\alpha)$
(c) $\sin(\frac{\pi}{2} - \alpha)$
(d) $1/\sin\alpha$

Q:6
A seismic ray traverses through a two-layered Earth medium. The velocity and density for the first layer are 2.7 km/s and 2400 kg/m^3, and those for the second layer are 3.0 Km/s and 2300kg/m^3 ,respectively. The reflection and transmission coefficients will be
(a) 0.03 and 0.97 , respectively
(b) 0.97 and 0.03 , respectively
(c) 0.15 and 0.85 , respectively
(d) 0.85 and 0.15 , respectively

Q:7

A layer with a seismic wave velocity of 1500 m/s and a thickness of 100 m lies above another layer with a velocity of 3000 m/s. What is the expected crossover distance for the critically refracted waves?
(a) 346.4 m
(b) 546.4 m
(c) 746.4 m
(d) 946.4 m

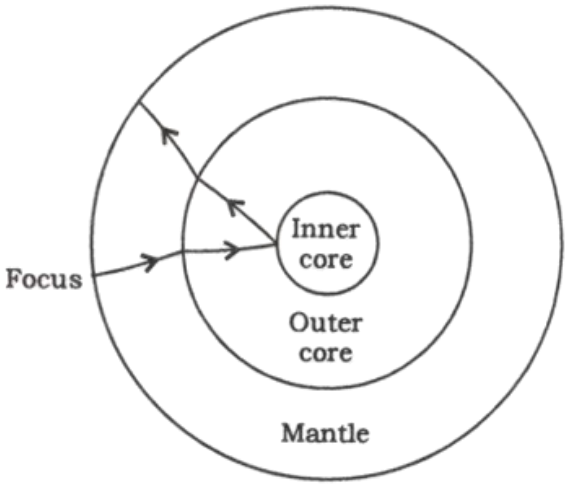
Q:8
The seismic phase PKP indicates
(a) P-wave refracted through the outer liquid core
(b) P-wave reflected from the outer liquid core
(c) P-wave reflected from the coremantle boundary
(d) P-wave reflected from the inner core

Q:9
Which one of the following statements is not correct?
(a) At the Lehmann discontinuity, an abrupt decrease of P- and S-wave velocities by 3-4% is observed.
(b) Below the Moho discontinuity, P-wave velocity exceeds 7.6km/s.
(c) In the low-velocity layer, the velocity decreases with increasing depth.
(d) The core-mantle boundary is called as Gutenberg discontinuity.

Q:10
The P-wave velocity becomes maximum inside the Earth near
(a) Mohoroviczić discontinuity
(b) Conrad discontinuity
(c) Gutenberg discontinuity
(d) Lehmann discontinuity

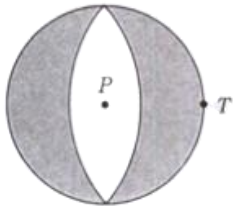
Q:11
The absence of S-waves beyond an epicentral distance of 105^{o} and existence of P -wave shadow zone in the epicentral distance range 105^{o}-143^{o} on the Earth indicates that the Earth has a/an
(a) mantle that creeps
(b) solid outer core
(c) silicate-rich crust
(d) inner core within a liquid outer core

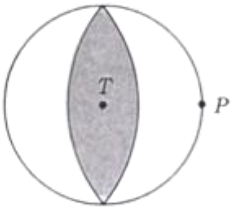
Q:12
The seismic wave path of reflected and refracted P - wave phases in the following diagram shows

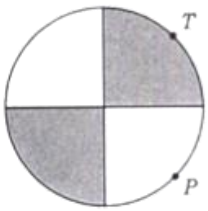


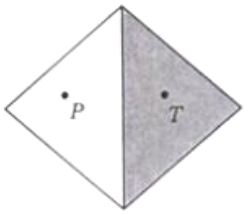
(a) PKCKP
(b) PKiKP
(c) PKIKP
(d) PKcKP

Q:13
Which one of the following is a correct representation of strike-slip tectonic fault?

(a) 

(b) 

(c) 

(d) 

Q:14
An intraplate earthquake in 2001 and reservoir-induced earthquake in 1967 occurred in which two States of India?
(a) Assam and Gujarat, respectively
(b) Arunachal Pradesh and Bihar, respectively
(c) Kerala and Uttar Pradesh, respectively
(d) Gujarat and Maharashtra, respectively

Q:15
The bulk modulus, shear modulus and bulk density of materials in a medium are 16 GPa, 13 GPa, 2.25 g /cm^3 , respectively. What would be the Poisson's ratio of the medium?
(a) 0.06
(b) 0.10
(c) 0.18
(d) 0.27

Q:15
What will be the intensity value on the European Macroseismic Scale (EMS) 1998 to describe the effects of earthquakes as 'very destructive'?
(a) IX
(b) X
(c) XI
(d) XII

Q:16
The empirical relationship of P -wave velocity V(ft/s) as a function of age (T) and depth z(ft) of the burial is $V=K(zT)^{1/6}$. This relationship is called
(a) Faust's equation
(b) Wyllie's equation
(c) Archie's law
(d) Hubble's law

Q:16
Consider the following statements regarding the different geophysical methods:
1. Seismic methods using ambient noise come under passive seismology.
2. Gravity and magnetic methods are wave field methods.
3. Seismic exploration methods investigate structures shallower than the earthquake seismology.
Which of the statement(s) given above is/are correct?
(a) 1 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1,2 and 3

Q:17
Consider the following statements regarding different geophysical methods:
1. The time variation of magnetic field is complex whereas the gravity field is smooth.
2. The study of the Earth's magnetism is the oldest branch of geophysics.
3. Exploration seismology is an offspring of earthquake seismology.

Which of the statements given above are correct?
(a) 1,2 and 3
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1 and 2 only

Q:3
Consider the following statements regarding passage of seismic waves during earthquakes :

Statement 1 :

Rocks and minerals in the Earth react differently to stresses that may be brief and sudden.

Statement 2 :
The stress response of rocks and minerals at depth in the Earth is affected by temperature, pressure and time of burial that exists at that depth.

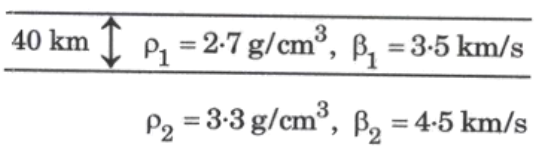
Which of the statement(s) given above is/are correct?
(a) 1 only
(b) Both 1 and 2
(c) 2 only
(d) Neither 1 nor 2

Q:4
The ground motion during an earthquake is recorded on a three-component seismometer. Which one of the following components will show the maximum amplitude of Rayleigh wave?
(a) Vertical (up-down) only
(b) East-West only
(c) North-South
(d) East-West and Vertical (up-down) both

Q:5
Consider the following statements regarding the phase and group velocities of surface waves:
1. For Earth, the phase velocity of both Love and Rayleigh waves generally increases with period.
2. Love waves are intrinsically dispersive even when the surface layer and underlying half-space are uniform.
3. Rayleigh waves over a uniform half-space are dispersive.

Which of the statements given above are correct?
(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1,2 and 3

Q:6
Consider a simple layer over a half-space model for the continental crust as shown in the diagram :



where ρ = density β = shear wave velocity; arctan 2.58 ~ 1.20 rad. What will be the period of fundamental Love wave travelling with a phase velocity of 3.8 Km/s?
(a) 12.2 s
(b) 23.4 s
(c) 38.1 s
(d) 42.6 s

Q:7
Which one of the following layers of the Earth has almost the same density as the average density of the Earth?
(a) Inner Core
(b) Upper Mantle
(c) Lower Mantle
(d) Outer Core

Q:8
What will be the value of Reynolds number for mantle layer with density, large scale of the flow, viscosity and velocity of flow as 5000 kg/m^3, 2900 Km, 1.5 X 10^{21} Pa.s and 5cm/year , respectively ?
(a) 1.5 X 10^{5}
(b) 1.5 X 10^{-10}
(c) 1.5 X 10^{-2}
(d) 1.5 X 10^{-20}

Q:9
What portion of the upper mantle appears to attenuate seismic waves the most?
(a) 40-60 Km
(b) 80-220 Km
(c) 240-410 Km
(d) 410-660 Km

Q:10
Which one of the following statements regarding the response function of an inertial seismometer is correct?
(a) It includes the effects of various forces that act on the suspended mass.
(b) It is independent of the forces acting on the suspended mass.
(c) It includes the effects of spring forces on the suspended mass only.
(d) It includes the effects of viscous damping force on suspended mass only.

Q:11
Consider the following statements regarding the earthquake seismology :
1. Long-period seismometers record the signals with periods in the range of 0.1 to 1.0 sec .
2. PKiKP is a P-wave that travels through mantle, outer core and inner core.
3. In the earthquake frequency (N), magnitude M_s relationship given by $\log N = a - bM_s$ the value of ' b ' varies between 8 and 9 from region to region.
Which of the statements given above are correct?
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1,2 and 3

Q:12
The special class of strike-slip fault that joins active segments of the ridge is known:
(a) Normal fault
(b) Reverse fault
(c) Transform fault
(d) Listric fault

Q:13
Which one of the following earthquake magnitude scales considers the wave amplitude around 0.8 sec and is highly useful in engineering seismology?
(a) Surface-wave magnitude scale
(b) Body-wave magnitude scale
(c) Local magnitude scale
(d) Moment magnitude scale

Q:14
What will be the ratio of critical distance X_{crit} to the crossover distance X_c for a model having a layer of velocity V_1 lying above another layer of velocity V_2 ?
(a) $\frac{V_1+V_2}{V_1}$
(b) $\frac{V_1}{V_2-V_1}$
(c) $\frac{V_1}{V_2+V_1}$
(d) $\frac{V_2}{V_2+V_1}$

Q:15
What is the P-wave velocity of a fully-fluid saturated formation having 25% porosity, if P-wave velocity in rock matrix and saturating fluid is 3000 ms^{-1} and 1500 ms^{-1} respectively?
(a) 2700 ms^{-1}
(b) 2400 ms^{-1}
(c) 2100 ms^{-1}
(d) 1800 ms^{-1}

Q:16
Consider the following statements regarding the shallow reflection technique:
1. Smaller energy sources with longer detector spreads are used in the survey.
2. Mapping of low velocity channels is possible.
3. Resolve the depositional features within the overburden material.
4. Appropriate for surveying when the surface layer is clay or silt with shallow water table.
Which of the statement(s) given above is/are correct?
(a) 1 and 2 only
(b) 2,3 and 4 only
(c) 1 only
(d) 1, 2, 3 and 4

Q:17
If ' d ' is the depth of shot below the reflector producing the ghost in seismic survey, what is the effective path difference between the direct wave and ghost wave ?
(a) $\frac{\lambda}{2}+d$
(b) $\lambda+\frac{d}{2}$
(c) $\lambda+d$
(d) $\frac{\lambda}{2}+2d$

Q:19
Brittle deformation is the main mechanism in the tectonic processes. It involves
(a) the uppermost 5-10 Km of the lithosphere
(b) the uppermost 10-20 Km of the lithosphere
(c) the boundary between lithosphere and asthenosphere
(d) the upper layer of the asthenosphere

Q:20
The equal values of Lamé constants λ and μ for a material make Poisson ratio 0.25 . Such material is called
(a) solid material
(b) semi-solid material
(c) Poisson solid material
(d) liquid material

Q:21
At the free surface of the Earth, the amplitude of SH - waves becomes
(a) 3 times
(b) 2 times
(c) 3/2 times
(d) 2/3 times

Q:22
The phase delay between the stress and strain of a material is 60 degree. The quality factor of the material will be
(a) 0.68
(b) 0.38
(c) 0.48
(d) 0.58

Q:23
When the undeformed strike is used as a reference, the Piola-Kirchhoff stress tensor is
(a) not symmetric
(b) symmetric only
(c) orthogonal only
(d) both orthogonal and symmetric

Q:24
Which one of the following seismic phases represents the P-wave conversion into S -wave during its passage through solid core?
(a) PKiKP
(b) PKJKP
(c) PKIKP
(d) PcS

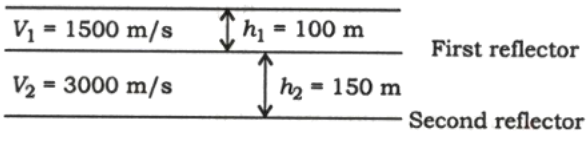
Q:25
For surface wave propagation, which one of the following relations among group velocity U, phase velocity c, wavelength λ frequency (f) and period (T) is correct?
(a) $U = c - \lambda \frac{\partial c}{\partial \lambda}$
(b) $U = c^2 \frac{\partial T}{\partial \lambda}$
(c) $U = -\lambda \frac{\partial c}{\partial \lambda}$
(d) $U = c + T \frac{\partial f}{\partial \lambda}$

Q:26
Which one of the following equations is utilized for modelling the density variation with depth inside the Earth?
(a) Adams-Williamson equation
(b) Eikonal equation
(c) Poisson equation
(d) Gardner equation

Q:27
The moment magnitude of a fault generating earthquake having seismic moment of 10^{20} N-m will be
(a) 7.27
(b) 6.27
(c) 8.27
(d) 5.27

Q:28
Which one of the following statements regarding the velocity of Tsunami is correct?
(a) It slows down as it approaches shore.
(b) It increases as it approaches shore.
(c) It remains constant as it approaches shore.
(d) It becomes zero as it approaches shore.

Q:29
What is the approximate average velocity V_{ave} along the zero-offset reflection path to the second reflector for the following model?

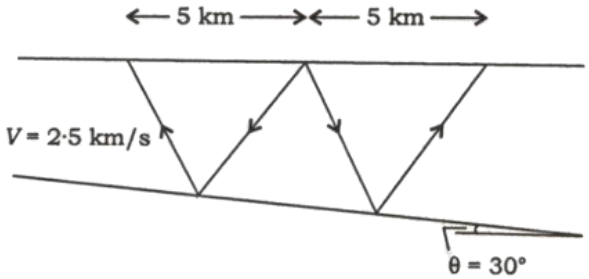


(a) 2250 m/s
(b) 2143 m/s
(c) 3143 m/s
(d) 2150 m/s

Q:30
Which of the following is/are type(s) of coherent seismic noise in a layered medium?
(a) Vehicular noise
(b) Ground roll only
(c) Multiple reflection only
(d) Ground roll and multiple reflection both

Q:31
A reflection survey indicates a depth of 750 m to the first reflector between the two layers, which have their velocities V_1=1500 m/s and V_2=2500 m/s. What will be the two-way reflection time at 1500 m offset?
(a) 2.414 s
(b) 3.414 s
(c) 4.414 s
(d) 1.414 s

Q:32
Consider the following basic geometry of the reflected ray path :



What will be the dip moveout for a single dipping reflector with $30^o dip a homogeneous top layer of velocity 2.5Km/s?
(a) 2 s
(b) 4 s
(c) 0.5 s
(d) 6 s

Q:33
If the travel time of a seismic wave at 10 m offset and zero-offset are 375 ms and 125 ms , respectively, the velocity in the medium will be
(a) 40 m/s
(b) 80 m/s
(c) 20 m/s
(d) 225 m/s

Q:34
For an earth material with both the Lamé parameters equal $\lambda = \mu$ the ratio of P -wave to S -wave velocities is

(a) 1/2
(b) 2
(c) 1/3
(d) $\sqrt{3}$

Q:35
The decrease in the intensity (energy density) of surface wave and body wave respectively, with distance r from the source, is proportional to
(a) 1/r , 1/r
(b) 1/r , $1/\sqrt{r}$
(c) 1/r, $1/r^2$
(d) $1/\sqrt{r}$, 1/r

Q:36
A class of seismic waves observed only on coastal and island seismic stations, which travel at very low phase velocities and correspond to sound waves trapped in the oceanic water layers, is known as
(a) primary waves
(b) Love waves
(c) tertiary waves
(d) Rayleigh waves

Q:37
Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I (Seismic phase)	List-II (Propagating medium)
A. P_g , S_g	1. Compressional and shear waves travelling along the Moho discontinuity
B. P^*,S^*	2. Compressional and shear waves reflected at Moho
C. P_n , S_n	3. Compressional and shear waves travelling along the Conrad discontinuity
D. PmP , SmS	4. Compressional and shear waves in the granitic layer of the crust

Code:

	A	B	C	D
(a)	4	3	1	2
(b)	2	3	1	4
(c)	2	1	3	4
(d)	4	1	3	2

Q:38
The seismological Moho is commonly defined as the depth at which P-wave velocity exceeds
(a) 8.4 Km/s
(b) 6.3 Km/s
(c) 7.6 Km/s
(d) 5.5 Km/s

Q:39
Which one of the following is the correct relation among the stresses for a strike-slip fault regime? (where σ_1= maximum principal stress, σ_2= intermediate principal stress and σ_3 =east principal stress in a region)
(a) $\sigma_1 > \sigma_2 > \sigma_3$
(b) $\sigma_2 > \sigma_3 > \sigma_1$
(c) $\sigma_3 > \sigma_2 > \sigma_1$
(d) $\sigma_2 > \sigma_3 > \sigma_1$

Q:40
The depth range of the transition zone associated with mineralogical phase changes in the mantle of the earth is
(a) 35-150 Km
(b) 150-410 Km
(c) 410-670 Km
(d) 720-860Km

Q:41
The surface wave magnitude of an earthquake was misreported as 5 with seismic energy E. If the correct magnitude of the earthquake is 7 , then the seismic energy generated by the earthquake will be
(a) 1024 E
(b) 3276 E
(c) 1000 E
(d) 3200 E

Q:42
The slope of the Wadati plot obtained using P -wave and S -wave arrival times for an earthquake is 0.77 . What will be the corresponding V_P/V_S ratio? (where V_P velocity of P -wave and V_s velocity of S -wave)
(a) 0.77
(b) 1.77
(c) 2.00
(d) 2.77

Q:43
Which one of the following statements regarding interplate events is not correct?
(a) Majority of seismic moment release occurs during interplate events.
(b) Recurrence interval of interplate events is generally much longer than intraplate events.
(c) Interplate events have much lower stress drops than intraplate events.
(d) Interplate faults are weaker in some sense than intraplate faults.

Q:44
Which one of the following is a source of coherent noise in the seismic data?
(a) Multiples or multiple reflections
(b) Wind blowing on trees near geophone locations in a seismic survey
(c) Passing traffic near geophone locations in a seismic survey
(d) Movement of streamers in a marine seismic survey

Q:45
Which one of the following statements regarding Gardner's equation for various rock types is correct?
(a) It relates P-wave velocity with density.
(b) It relates S-wave velocity with density.
(c) It relates P-wave velocity with porosity.
(d) It relates S-wave velocity with porosity.

Q:46
Which one of the following methods is not used for removing the effect of attenuation?
(a) Deconvolution
(b) Time-variant spectral whitening
(c) Migration
(d) Inverse Q filtering

Q:47
Which one of the following is a source of coherent noise in the seismic data?
(a) Multiples or multiple reflections
(b) Wind blowing on trees near geophone locations in a seismic survey
(c) Passing traffic near geophone locations in a seismic survey
(d) Movement of streamers in a marine seismic survey

Q:48
The foldage of a 2D common depth point (CDP) reflection profiling conducted using a 72 -channel digital recording unit with a geophone interval of 50 m and a shot interval of 100 m is
(a) 18
(b) 36
(c) 72
(d) 144

Q:49
In a seismic refraction survey, the inferred upper and lower layer velocities are 2 Km/s and 6 Km/s respectively. The depth of the refractor is 0.5 km . What will be the crossover distance?
(a) 2828 m
(b) 1414 m
(c) 707 m
(d) 353.5 m

Q:50
Which one of the following statements regarding longitudinal waves is NOT CORRECT?
(a) These can travel through fluids
(b) These are compressional waves
(c) These are also known as primary waves
(d) Motion of the particles is perpendicular to the direction of wave propagation

Q:51
The shear wave will be essentially elliptically polarized when:
(a) Both SH and SV motions have different frequencies
(b) Both SH and SV motions have varying phase difference
(c) Both SH and SV motions have same frequency and fixed phase difference
(d) Both SH and SV motions have same amplitude

Q:52
The P -wave velocities of more than 8 Km/s beneath Moho discontinuity indicate the presence of:
(a) Granite and gabbro
(b) Granite and basalt
(c) Basalt, gabbro and granite
(d) Rocks rich in dense minerals like olivine, pyroxene and garnet

Q:53
Which one of the following statements regarding velocity variations inside the earth is correct?
(a) Low velocity zone exists between 100-250 km depth
(b) Velocities decrease with depth
(c) Velocities decrease dramatically at 660 km depth
(d) P-wave velocities decrease at the boundary between liquid outer core and solid inner core

Q:54
The continuous movement of tectonic plates result in earthquakes. The point inside the earth from which earth shock waves generate is called:
(a) Seismic focus
(b) Epicentre
(c) Richter centre
(d) Trigger centre

Q:55
Which one of the following statements regarding tectonic earthquakes is correct?
(a) These are randomly distributed over the globe
(b) These are the abrupt release of strain within the earth
(c) They only occur on or near the plate boundaries and not within the lithospheric plates
(d) The result from the motion of underground magma

Q:56
Which one of the following statements is correct with reference to the geosyncline?
(a) It is a linear part of the crust of earth that sagged widely through time
(b) It is a linear part of the crust of earth that sagged deeply through time
(c) It is not linked with the origin of mountains
(d) Generally, it is few kilometers long and hundreds of kilometers wide

Q:57
Teleseismic events have an epicentral distance of:
(a) Greater than 20 °
(b) Less than 20 °
(c) Less than 5 °
(d) Less than 1 °

Q:58
The energy released by an earthquake of magnitude 7 will be approximately equal to energy released by:
(a) 1000 earthquakes of magnitude 5
(b) 100 earthquakes of magnitude 5
(c) 500 earthquakes of magnitude 5
(d) 110 earthquakes of magnitude 5

Q:59
A three component seismometer was installed at a granite site. The thickness of rock layer is 15 km . An earthquake occurred at a depth of 10 km with an epicentral distance of 30 km . The observed seismic moment is 6 X 10^{27} . Which one of the following is the correct relationship among body-wave magnitude m_b surface-wave magnitude M_s and moment magnitude M_w ?
(a) $m_b < M_s = M_w$
(b) $m_b = M_s < M_w$
(c) $m_b < M_s < M_w$
(d) $m_b > M_s > M_w$

Q:60
When an elastic wave propagates in a medium, its velocity depends on:
(a) Density of the medium only
(b) Elasticity of the medium only
(c) Both density and elasticity of the medium
(d) Neither density nor elasticity of the medium

Q:61
In travel time versus distance plot in seismic refraction, the slope of the segments depends on the:
(a) Impedance contrast between two layers
(b) Seismic velocity and dip in each layer
(c) Seismic velocity in each layer
(d) Thickness of each layer

Q:62
The most homogeneous layer of the earth is:
(a) Oceanic crust
(b) Mantle
(c) Outer core
(d) Inner core

Q:63
Two seismic recording stations receive data of S wave, P wave and PP wave consequently. On that basis, which of the following statements are correct?
1. The time difference of S wave and P wave determines the epicentral angle to the source
2. The time difference of S wave and PP wave determines the depth of the hypo centre
3. P-S arrival time difference from two stations determines the location of the earthquake Select the correct answer using the code given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Q:64
The power of an earthquake of magnitude 7 is higher than that of 5 on Richter scale by:
(a) 2 times
(b) 7 / 5 times
(c) 31 times
(d) 961 times

Q:65
The law of refraction for plane seismic waves can be written as:
(a) $\frac{\tan i}{\tan r} = \frac{\alpha_1}{\alpha_2}$

(b) $\frac{\sin i}{\sin r} = \frac{\alpha_2}{\alpha_1}$
(c) $\frac{\sin i}{\sin r} = \frac{\alpha_1}{\alpha_2}$
(d) $\frac{\tan i}{\tan r} = \frac{\alpha_2}{\alpha_1}$

Q:66
The presence of gas in sedimentary rocks reduces:
1. Elastic moduli
2. Poisson's ratio
3. Ratio of P and S wave velocities
4. Porosity
Select the correct answer using the code given below:
(a) 1, 2, 3 and 4
(b) 1 and 4 only
(c) 3 and 4 only
(d) 1, 2 and 3 only

Q:67
If the acoustic impedances offered by two successive layers are same, then all the incident energy will be:
(a) Reflected
(b) Transmitted
(c) Critically refracted
(d) Partly reflected and partly transmitted

Q:68
In a seismic refraction survey, if V_u and V_d are updip and downdip velocity, T_u and T_d are the intercept times, then which one of the following relationships between velocities and intercept times is true?
(a) $V_u > V_d$, $T_u < T_d$
(b) $V_u > V_d$, $T_u > T_d$
(c) $V_u < V_d$, $T_u < T_d$
(d) $V_u < V_d$, $T_u > T_d$

Q:69
The particle displacement (u) for a seismic wave travelling in the positive x-direction is $u = A\exp[i(kx - \omega t)]$. If there is no attenuation, the wave number k is given by
(a) ω/x
(b) ω/c
(c) $k + ix$
(d) ω/y
[where A = amplitude, ω = frequency and c = wave speed]

Q:70
The ratio of S -wave to P -wave velocities for zero Poisson's ratio value is
(a) $\sqrt{3}$
(b) $\frac{1}{\sqrt{3}}$
(c) $\sqrt{2}$
(d) $\frac{1}{\sqrt{2}}$

Q:71
What fraction of the normal incident wave energy will be transmitted into the second layer, if a layer with density 3 g/cc and wave velocity 4 km/s is overlain by a layer having density 2 g/cc and velocity 3 km/s ?
(a) 0.11
(b) 0.22
(c) 0.44
(d) 0.89

Q:72
Which one of the following seismic phases results from a P-wave turning within the crust?
(a) P_g
(b) $P_m P$
(c) P_n
(d) PP

Q:73

The slowness vector of a 1 Hz plane P -wave propagating at 6.5 km/s velocity in $+\boldsymbol{x}$ direction is
(a) $\left\{\frac{1}{6.5}, 0, 0\right\}$
(b) $\left\{0, \frac{1}{6.5}, 0\right\}$
(c) $\left\{0, 0, \frac{1}{6.5}\right\}$
(d) $\left\{\frac{1}{6.5}, 0, \frac{1}{6.5}\right\}$

Q:74
Which one of the following correctly describes the attenuation property of the Earth expressed in terms of quality factor (Q) ?
(a) The Q value is infinite for the Earth.
(b) The Q value is zero for the Earth.
(c) The Q value of P-wave is lower than the Q value of S -wave in the Earth's core.
(d) None of the above

Q:75
A weak P-wave diffraction is observed in the epicentral distance range of
(a) $0° - 30°$
(b) $30° - 90°$
(c) $90° - 102°$
(d) $103° - 120°$

Q:76
The scalar seismic moment (M_0) of an earthquake is related to density of medium ρ, seismic velocity c, hypocentral distance r and radiation pattern $U_{\phi\theta}$ as
(a) $\frac{\rho c^3}{rU_{\phi\theta}}$
(b) $\frac{\rho c^2}{rU_{\phi\theta}}$
(c) $\frac{\rho c^3 r}{U_{\phi\theta}}$
(d) $\frac{\rho c^2 r}{U_{\phi\theta}}$

Q:77
What approximate percentage of the total annually released seismic energy is due to the intermediate focal depth earthquakes at the global level?
(a) 85%
(b) 20%
(c) 12%
(d) 3%

Q:78
What is the ratio of the number of earthquakes having surface wave magnitudes greater than 5 and 7 occurring in a region, if the intercept, a and slope, b values of earthquake magnitude-frequency relation are 8 and 1 , respectively for that region?
(a) 1000
(b) 100
(c) 32
(d) 10

Q:79
What is the ratio of seismic velocities of the second layer to the first layer for a seismic wave incident on a horizontal interface at an angle of 30° to the normal in the first layer and refracted at 45° angle to the normal in the second layer?
(a) $\frac{1}{\sqrt{2}}$
(b) $\sqrt{2}$
(c) 2
(d) $2\sqrt{2}$

Q:80
The ground roll in seismic data can be attenuated by
(a) grouping of geophones
(b) reducing the number of geophones
(c) increasing geophone spacing
(d) decreasing geophone spacing

Q:81
What is the reflection coefficient for a seismic wave incident at normal to the interface between the first and second layers characterized by densities 3 g/cc and 2.5 g/cc, and velocities 5 km/s and 4 km/s, respectively?
(a) 0.2
(b) -0.2
(c) 1.2
(d) $-1 \cdot 2$

Q:82
A point scatterer is observed at 2.5 km depth within a layer with a uniform velocity of 4 km/s. What is the observed two-way travel time for the source and receiver with an offset of 3 km ?
(a) 1.25 s
(b) 1.35 s
(c) 1.60 s
(d) 1.95 s

Q:83
The phase shift between ghost multiple and primary reflection in seismic data is
(a) 90°
(b) 180°
(c) 270°
(d) 360°

Topic: 8 Electronic and Electromagnetic Prospecting, Well Logging

Q:1
Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I(Log type)	List-II (Formation property/ content)
A. Microlaterolog	1. The interval transit time of a sound wave
B. Neutron log	2. Primarily responds to the amount of hydrogen in the formation
C. Litho-Density log	3. Resistivity of the flushed zone
D. Sonic log	4. Bulk density and photoelectric absorption index of the formation

Code

	A	B	C	D
(a)	3	2	4	1
(b)	3	4	2	1
(c)	1	2	4	3

(d)	1	4	2	3

Q:2
The resistivity of a clean, consolidated hydrocarbon bearing sandstone formation is 10Ωm . The rock porosity and formation water resistivity are 15% and 0.05 Ωm, respectively. What will be the hydrocarbon saturation of the formation if the saturation exponent (n) is 2 ?
(a) 42 %
(b) 21 %
(c) 58 %
(d) 29 %

Q:3
Which one of the following electrode arrays is the best to determine the depth and resistivity for flat-lying layered sedimentary rock structures?
(a) Wenner
(b) Schlumberger
(c) Dipole-Dipole
(d) Pole-Dipole

Q:4
A hexagonal length of pipe used to convey the rotatory movement to the drill string and bit is called
(a) kelly bushing
(b) draw-works
(c) kelly
(d) riser

Q:5
What is the factor by which the true resistivity of 25% water saturated formation increases in comparison to fully water saturated formation according to Archie's equation? (Given saturation exponent =2)
(a) 2
(b) 8
(c) 16
(d) 0.062

Q:6
A plane electromagnetic wave of wavelength 2μm is being used to infer subsurface properties across a geological region. The land surface in the region consists of soil A and soil B with electrical conductivities as 10^{-3} $\Omega^{-1}m^{-1}$ and 10^{-1} $\Omega^{-1}m^{-1}$ respectively. Which one of the following statements regarding the wave penetration in soil A and soil B is correct ?
(a) The wave penetrates soil A up to 10 times greater depth than soil B .
(b) The wave penetrates soil B up to 10 times greater depth than soil A .
(c) The wave penetrates soil A up to 100 times greater depth than soil B .
(d) The wave penetrates soil B up to 100 times greater depth than soil A.

Q:7
Consider the following statements regarding geoelectrical methods :
1. Dipole-dipole array is least influenced by inductive coupling.
2. In Schlumberger gradient profiles obtained over faults, dikes/veins show gentler gradient than the Wenner profiling.
3. For resolution of horizontally layered structures, the Schlumberger and Wenner arrays are preferred over the other arrays.

Which of the statement(s) given above is/are not correct?
(a) 1 and 3
(b) 1 only
(c) 2 only
(d) 2 and 3

Q:8
Match List-I with List-II and select the correct answer using the code given below the lists :

List-I (Frequency range)	List-II (Geophysical method)
P. 10^{-4} Hz to 1 Hz	1. VLF
Q. 400 Hz to 2000 Hz	2. GPR
R. 20 kHz to 25 kHz	3. MT
S. 25 MHz to 1.2 GHz	4. Slingram

Code:

	A	B	C	D
(a)	1	1	4	3
(b)	3	1	4	2
(c)	2	4	1	3
(d)	3	4	1	2

Q:9
Which one of the following electrode arrays provides good vertical resolution but poor depth of penetration?
(a) Dipole-dipole
(b) Wenner
(c) Schlumberger
(d) Square

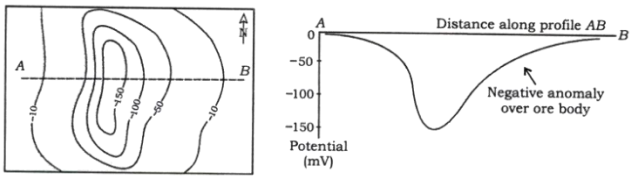
Q:10
An electromagnetic wave at 100 Hz can penetrate to a depth of 100 m . The depth of penetration in the same media for electromagnetic wave at 400 Hz will be
(a) 2.5 m
(b) 50 m
(c) 200 m
(d) 400 m

Q:11
Which one of the following boundary conditions in electromagnetic method is not correct?
(a) The electric field tangential to the interface is continuous
(b) The magnetic field tangential to the interface is continuous
(c) The current density normal to the interface is continuous
(d) The magnetic flux tangential to the interface is continuous

Q:12
What will be the approximate porosity of a formation, if the bulk, matrix and fluid densities of the formation are 2.50 g/cm^3 2.71 g/cm^3 and 1.10 g/cm^3 respectively?
(a) 13 %
(b) 20 %
(c) 22 %
(d) 25 %

Q:13
The relation between water saturation (S_w) and formation water resistivity (R_w) based on Archie's empirical equation is (where φ= porosity, R_t = true resistivity, a= constant, m= cementation factor, n= saturation exponent)
(a) $S_w = \left[\left(\frac{a}{\emptyset^m}\right)\left(\frac{R_w}{R_t}\right)\right]^{1/n}$
(b) $S_w = \left(\frac{a}{\emptyset}\right)\left(\frac{R_w}{R_t}\right)$
(c) $S_w = (a\emptyset)(R_t R_w)$
(d) $S_w = [(a\emptyset)(R_t R_w)]^{1/n}$

Q:14
Consider the following diagram with hypothetical contour lines of a negative self-potential anomaly over an ore body :



Which one of the following statements explains the asymmetry of the anomaly along the profile $A B$?
(a) The ore body dips perpendicular to the profile in the North direction.
(b) The ore body dips perpendicular to the profile in the South direction.
(c) The ore body dips towards B of the profile.
(d) The ore body dips towards A of the profile.

Q:15
Which one of the following logs is most reliable for coal identification?
(a) Gamma ray log
(b) Density log
(c) Neutron log
(d) NMR log

Q:16
Which one of the following electrode configurations produces the most pronounced peak in the resistivity curve over a thin dike?
(a) Full Wenner configuration
(b) Half Wenner configuration
(c) Double-dipole configuration
(d) Half Schlumberger configuration

Q:17
The Magnetotelluric (MT) sounding utilizing long period electromagnetic signals in the range of $10-$ 1000 seconds is very useful for structure investigations of:
(a) Lower mantle and outer core
(b) Crust and upper mantle
(c) Upper mantle and lower mantle
(d) Outer core and inner core

Q:18
Consider the following statements regarding Vertical Electric Sounding (VES) method:
1. It can reveal the resistivity profile with depth in the horizontal layered earth
2. It can detect the saline water 'pools' beneath few meters of dry sand
3. It can locate low resistivity layers at very small potential difference
4. It can reveal the lateral variation of resistivity profile inside the earth

Which of the statements given above are correct?
(a) 1, 2, 3 and 4
(b) 1 and 3 only
(c) 1 and 2 only
(d) 3 and 4 only

Q:19
Match the list-I with list-II and select the correct answer using the code given below the lists:

List-I (Electromagnetic method)	List-II (Source of primary field)
A. AFMAG	1. Transmitter coil
B. VLF	2. Straight wire or loop
C. Slingram	3. Thunderstorm
D. Turam	4. Radio station

Code:

	A	B	C	D
(a)	3	4	1	2
(b)	3	1	4	2
(c)	2	4	1	3
(d)	2	1	4	3

Q:20
Free fluid index (FFI) of a rock formation is estimated using:
(a) Neutron log
(b) Resistivity log
(c) SP log
(d) NMR log

Q:21
The Satellite Laser-Ranging (SLR) and Very Long Baseline Interferometry (VLBI) allow exceptionally accurate measurements of the distance between:
(a) Earth and Moon
(b) Two stations on the earth
(c) Two planets
(d) Two stars

Q:22
An electromagnetic wave of frequency ' ω ' and wave factor ' k ' impinges on the interface separating two media with different permittivity and permeability. If this wave gets partially reflected and partly refracted, then which one of the following statements regarding the magnitude of wave vector is correct?
(a) It changes for reflection but not for refraction
(b) It changes for refraction but not for reflection
(c) It changes for reflection and refraction both
(d) It doesn't change for reflection and refraction both

Q:23
Electromagnetic survey gives better results if the top surface layer is:
(a) More conductive
(b) Less conductive
(c) Highly magnetic
(d) Having same conductivity as sub-surface layers

Q:24
In TURAM method an anomaly is indicated by:
(a) Amplitude ratio of less than 1 and negative phase anomaly
(b) Amplitude ratio of more than 1 and negative phase anomaly
(c) Amplitude ratio of less than 1 and positive phase anomaly
(d) Amplitude ratio of more than 1 and positive phase anomaly

Q:25
In electrical resistivity methods, the coefficient of anisotropy λ is generally:
(a) Between 0 to 0.5
(b) Between 1 to 2
(c) More than 2
(d) Between 0.5 and 1

Q:26
Which one of the following statements regarding the plot of real and imaginary components of response function with response parameter (Q) in electromagnetic method is correct?
(a) The real component is greater than the imaginary component for Q<1.
(b) The imaginary component is greater than the real component for Q>1.
(c) The real component is greater than the imaginary component for Q>1.
(d) The real and imaginary components follow the same trend for all possible values of Q.

Q:27
Which of the following methods is/are appropriate for archaeological investigation?
1. Ground-penetrating radar method
2. Electrical resistivity method
3. Electromagnetic method
4. Gravity method
Select the correct answer using the code given below.
(a) 1 and 2 only
(b) 2 and 3 only
(c) 4

(d) 1, 2 and 3

Q:28
What is the nature of Magnetotelluric (MT) field?
(a) Plane wave
(b) Elliptically polarized wave
(c) Circularly polarized wave
(d) Spherically polarized wave

Q:29
What is the coefficient of anisotropy for a medium having vertical and horizontal resistivities ρ_v and ρ_h, respectively?
(a) $\left(\frac{\rho_v}{\rho_h}\right)^{\frac{1}{2}}$
(b) $\left(\frac{\rho_h}{\rho_v}\right)^{\frac{1}{2}}$
(c) $\frac{\rho_v}{\rho_h}$
(d) $\frac{\rho_h}{\rho_v}$

Q:30
What is the equivalent horizontal resistivity for a vertical stake of n beds with resistivities $\rho_1, \rho_2, \rho_3, ___ \rho_n$ and thicknesses $z_1, z_2, z_3, \ldots\ldots, z_n$ from top to bottom, respectively?
(a) $\left(\frac{\sum_{i=1}^{n} \rho_i z_i}{\sum_{i=1}^{n} z_i}\right)$
(b) $\left(\frac{\sum_{i=1}^{n} \frac{\rho_i}{z_i}}{\sum_{i=1}^{n} z_i}\right)$
(c) $\left(\frac{\sum_{i=1}^{n} z_i}{\sum_{i=1}^{n} \frac{z_i}{\rho_i}}\right)$
(d) $\left(\frac{\sum_{i=1}^{n} z_i}{\sum_{i=1}^{n} \frac{\rho_i}{z_i}}\right)$

Q:31
What is the ratio of effective resistivity of the rock (ρ_e) to the resistivity of the groundwater (ρ_w), if the formation has 1% porosity, water saturation constant $1 \cdot 0$, and parameters $a = 1, m = 2$ and $n = 2$ are constants of Archie's formula?
(a) 10^{-4}
(b) 10^{4}
(c) 10^{-2}
(d) 10^{2}

Q:32
Which one of the following potentials is relatively more variable electrical potential used in geophysical prospecting?
(a) Diffusion potential
(b) Nernst potential
(c) Electrokinetic potential
(d) Telluric potential

Topic: 9 Inverse Theory

Q:1
Weighted least-square method is used
(a) when all observations have same accuracy
(b) when some observations have more precision but errors are equal
(c) when some observations have more accuracy than others
(d) when all observations have same precision and errors are equal

Q:2
Consider the following statements regarding geophysical methods :
1. These methods are applied for geophysical fields, namely gravity, magnetic, electromagnetic and seismic waves field.
2. The forward problem solution makes possible to predict geophysical data for geological structures.
3. In inverse problems, model parameters are determined for a model using geographical data.

Which of the statements given above are correct?
(a) 1,2 and 3
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1 and 3 only

Q:3
The sensitivity of the geophysical method is determined by the
(a) ratio of the norm of the perturbation of the data to the norm of the perturbation of the model parameters
(b) ratio of the norm of the perturbation of the model parameters to the norm of the perturbation of the data
(c) norm of the perturbation of the model parameters
(d) norm of the perturbation of the data

Q:4
Consider a linear inverse problem G m=d, where G is a matrix of size N X M ; m and d are model and data vectors of lengths M and N, respectively. The least square solution for this problem is
(a) $[G^T G]^{-1} G d$
(b) $[G G^T]^{-1} G d$
(c) $[G^T G]^{-1} G^T d$
(d) $[G G^T]^{-1} G^T d$

Q:5
Consider the following group of equations:

$$y_1 = a_0 + a_1x_1 + a_2x_1^2$$
$$y_2 = a_0 + a_1x_2 + a_2x_2^2$$
$$y_3 = a_0 + a_1x_3 + a_2x_3^2$$
$$y_4 = a_0 + a_1x_4 + a_2x_4^2$$
$$y_5 = a_0 + a_1x_5 + a_2x_5^2$$

Which one of the following is correct regarding the solutions of the above equations?
(a) The solutions cannot be determined
(b) The solutions are overdetermined
(c) The solutions are exactly determined
(d) The solutions can be approximately determined

Q:6
In geophysical inverse problem, if the rank of a matrix is K, N is the number of data points and M is the number of unknown parameters, then the condition for over determined problem is:
1. N=M and K<M
2. N>M and K<M
3. N>M and K=M
4. N=M and K=M

Select the correct answer using the code given below:
(a) 1 and 4
(b) 2 and 3
(c) 1 and 3
(d) 2 and 4

Q:7
The regularization parameter in nonlinear least-squares inversion technique describes a trade-off between
(a) the best fitting and the most reasonable stabilization
(b) the worst fitting and the most reasonable stabilization
(c) the best fitting and the most unreasonable stabilization
(d) the worst fitting and the most unreasonable stabilization

Topic: 10 Vector Algebra and Vector Calculus

Q:1
Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I (Operation)	List-II (Naming/Result)
A. Vector product of two vectors vanishes	1. self-product
B. Scalar product of a vector with itself, is called	2. commutative
C. Vector product of two vectors is	3. when components of vectors are parallel
D. Scalar product of two vectors is	4. not commutative

Code:

	A	B	C	D
(a)	2	4	1	3
(b)	2	1	4	3
(c)	3	1	4	2
(d)	3	4	1	2

Q:2
Let the force $\vec{F} = \frac{-m}{r^3}(x\hat{\imath} + y\hat{\jmath} + z\hat{k})$. The curl of $\vec{F}$ is
(a) $-\frac{3m}{r^2}(x\hat{\imath} + y\hat{\jmath} + z\hat{k})$
(b) $+\frac{3m}{r^2}(x\hat{\imath} + y\hat{\jmath} + z\hat{k})$
(c) $-3mr^4(x\hat{\imath} + y\hat{\jmath} + z\hat{k})$
(d) zero

Q:3
Consider the following statements :
1. Gradient of a scalar function is a scalar.
2. Divergence of a vector field is a scalar quantity.
3. For solenoidal vector, the divergence of vector field is zero.

Which of the statements given above are correct?
(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Q:4
If $x = a\sin\theta\cos\phi$ and $y = a\sin\theta\sin\phi$, then the value of $a^2 - x^2 - y^2$ is :
(a) $a^2\sin^2\theta$
(b) $a^2\sin^2\phi$
(c) $a^2\cos^2\theta$
(d) $a^2\cos^2\phi$

Q:5
What is the value of $\phi(1,2,3)$ for a function defined as $\phi(x,y,z) = 3x^2z^2 - xy^3 - 15$?
(a) 2
(b) 4
(c) 8
(d) 12

Q:5

What is the value of $\int_1^2 \mathbf{F}(\mathbf{x})dx$, if $\mathbf{F}(x) = 3\hat{\imath} + \frac{4}{x^2}\hat{\jmath} + 2x\hat{k}$?
(a) $3\hat{\imath} - 2\hat{\jmath} + 4\hat{k}$
(b) $3\hat{\imath} - 2\hat{\jmath} + 3\hat{k}$
(c) $3\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$
(d) $3\hat{\imath} + 2\hat{\jmath} + 8\hat{k}$

Q:6
Which one of the following relations represents Stokes' theorem ?
(where all symbols have their usual meaning)
(a) $\iiint \vec{\nabla} \cdot \vec{A} dV = \oiint_S \vec{A} \cdot d\vec{S}$
(b) $\int_C \vec{A} \cdot d\vec{S} = \oiiint (\vec{\nabla} \times \vec{A}) \cdot d\vec{S}$
(c) $\oint_C \vec{A} \cdot d\vec{S} = \iiint \vec{\nabla} \cdot \vec{A} dV$
(d) $\oint_C \vec{A} \cdot d\vec{r} = \iint_S (\vec{\nabla} \times \vec{A}) \cdot d\vec{S}$

Q:7
Which one among the following defines the equation of a plane that is tangential to the surface $x^2 + y^2 - z^2 = 4$ at the point $(1,2,-1)$?
(a) $x^2 + y^2 - z^2 - 4 = 0$
(b) $x + y - z - 2 = 0$
(c) $x + 2y + z - 4 = 0$
(d) $x + y + z + 2 = 0$

Q:8
If $\vec{A} = x\hat{\imath} + y^2\hat{\jmath} + 2z\hat{k}$, then

$$\int_0^1 dx \int_0^1 dy \int_0^1 dz \vec{\nabla} \cdot \vec{A}$$

is
(a) 2
(b) -2
(c) zero
(d) 4

Q:9
Let $\vec{a} = (1,2,3), \vec{b} = (2,4,6)$ and $\vec{c} = (2,5,7)$. Then $(\vec{a} + \vec{b}) \cdot \vec{c}$ is
(a) 33
(b) 66
(c) 99
(d) 11

Q:10
Consider the vectors $\vec{a} = (1,1,1), \vec{b} = (1,2,-3), \vec{c} = (1,-4,3)$ in a vector space R^3 over a real field R.
Which one of the following is correct in this regard?
(a) $\vec{b}$ is orthogonal to $\vec{c}$
(b) $\vec{a}$ is not orthogonal to $(\vec{b} + \vec{c})$
(c) $\vec{a}$ is orthogonal to $\vec{b}$
(d) $\vec{a}$ is not orthogonal to $\vec{c}$

Q:11
Which one of the following equations is true, if a vector field $\vec{A}$ is irrotational?
(a) $\oint_{\partial S} \vec{A} \cdot d\vec{r} = 0$
(b) $\int_S \vec{A} \cdot d\vec{S} = 0$
(c) $\vec{\nabla} \cdot \vec{A} = 0$
(d) $\nabla^2 \vec{A} = 0$

Q:12
Consider the following vectors :

1. $\vec{A} = 3\hat{\imath} + 7\hat{\jmath} - 4\hat{k}$
2. $\vec{B} = 7\hat{\imath} - 4\hat{\jmath} + 3\hat{k}$
3. $\vec{C} = 4\hat{\imath} + 3\hat{\jmath} + 7\hat{k}$
4. $\vec{D} = 4\hat{\imath} - 7\hat{\jmath} + 3\hat{k}$

Which one of the following statements is true in respect of the above vectors?
(a) Vector $\vec{A}$ has a larger magnitude than the other three vectors.
(b) Vector $\vec{B}$ has a larger magnitude than the other three vectors.
(c) Vector $\vec{C}$ has a larger magnitude than the other three vectors.
(d) Vectors $\vec{A}, \vec{B}, \vec{C}$ and $\vec{D}$ have equal magnitudes.

Q:13
The components of a vector remain unchanged if
(a) it is rotated through an arbitrary angle
(b) it is multiplied by an arbitrary scalar
(c) its cross product with a unit vector is computed
(d) it is moved parallel to itself

Q:14
The three vectors $\vec{M} = (2\hat{\imath} + \hat{\jmath} + \hat{k}), \vec{N} = 2(\hat{\jmath} - \hat{k})$ and $\vec{P} = (\hat{\imath} + \hat{k})$ are
(a) linearly independent and $\vec{M}$ is perpendicular to $\vec{N}$
(b) linearly dependent and $\vec{M}$ is perpendicular to $\vec{N}$
(c) linearly dependent and $\vec{M}$ is perpendicular to $\vec{P}$
(d) linearly independent and $\vec{M}$ is perpendicular to $\vec{P}$

Q:15

If $\boldsymbol{r} = x\boldsymbol{i} + y\boldsymbol{j} + z\boldsymbol{k}$, then, what is the divergence of $(r^n \mathbf{r})$?
(a) $(3-n)r^n$
(b) $(3+n)r^{-n}$
(c) $(3+n)r^2$
(d) $(3+n)r^n$

Q:16
Two constant forces $\mathbf{F}_1 = (2\mathbf{i} + 3\mathbf{j} + 3\mathbf{k})$ Newton and $\mathbf{F}_2 = (5\mathbf{i} - 6\mathbf{j} - 2\mathbf{k})$ Newton act together on an object during its displacement from the point $(20\mathbf{i} + 15\mathbf{j})$ meter to a point $8\mathbf{k}$ meter. What is the amount of work done on the particle?
(a) - 28 Joule
(b) -87 Joule
(c) - 46 Joule
(d) - 62 Joule

Q:17
The directional derivative of $f(x,y,z) = 2x^2 + 3y^2 + z^2$ at a point P: (2,1,3) in the direction of $\vec{a} = \hat{\imath} - 2\hat{k}$ is:
(a) $\frac{4}{\sqrt{5}}$
(b) $\frac{-4}{\sqrt{5}}$
(c) $\frac{2}{\sqrt{5}}$
(d) $\frac{-2}{\sqrt{5}}$

Q:18
The divergence of the vector $e^{-x}\sin \mathrm{y}\hat{\imath} - e^{-x}\cos \mathrm{y}\hat{\jmath} + \mathrm{xy}\hat{k}$ is:
(a) $2e^{-x}\sin \mathrm{y}$
(b) $2e^{-x}\cos \mathrm{y}$
(c) xy
(d) 0 (zero)

Q:19
The two vectors $\mathbf{U} = (1,-3)$ and $\mathbf{V} = (-2,6)$ are:
(a) Linearly dependent
(b) Linearly independent
(c) **U** is subset of **V**
(d) **V** is subset of **U**

Q:20
A completely antisymmetric tensor $\varepsilon_{\mu\nu\lambda}$ in 3-space dimensions possesses
(a) rank = 3 and independent components = 3
(b) rank = 1 and independent components = 1
(c) rank = 1 and independent components = 3
(d) rank = 3 and independent components = 1

Q:21
Which one among the following pairs is not correctly matched?
(a) $\nabla \cdot (\nabla \times \vec{A})$: 0
(b) $\nabla \times (\nabla \times \vec{A})$: $\nabla(\nabla \cdot \vec{A}) - \nabla^2 \vec{A}$
(c) $\nabla \times (\nabla\phi)$: 0
(d) $\nabla \times (\phi\vec{A})$: $(\nabla\phi) \times \vec{A} - \phi(\nabla \times \vec{A})$
(Given : ϕ and $\vec{A}$ are differentiable scalar and vector functions, respectively)

Q:22
Let $P(4\cos t, 4\sin t, 4t)$ be a point on a curve, where t is some parameter. The magnitude of the tangent vector at point P is
(a) 4
(b) $2\sqrt{2}$
(c) 2
(d) $4\sqrt{2}$

Topic: 11 Matrices

Q:1
Let

$$A = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$$

If $A = (I-S)(I+S)^{-1}$, then the matrix S is [where I is identity matrix]
(a) $\begin{bmatrix} 0 & -\tan(\theta/2) \\ \tan(\theta/2) & 0 \end{bmatrix}$
(b) $\begin{bmatrix} 0 & -\cot(\theta/2) \\ \cot(\theta/2) & 0 \end{bmatrix}$
(c) $\begin{bmatrix} 0 & \tan(\theta/2) \\ \tan(\theta/2) & 0 \end{bmatrix}$
(d) $\begin{bmatrix} 0 & \cot(\theta/2) \\ \cot(\theta/2) & 0 \end{bmatrix}$

Q:2
The eigenvalues of the matrix

$$S = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$$

are
(a) $-1,0,2$
(b) $0,-1,2$
(c) $0,1,2$
(d) $1,1,2$

Q:3

The inverse of the matrix $A = \begin{bmatrix} 4 & 1 \\ 2 & 3 \end{bmatrix}$ is :

(a) $\frac{1}{10}\begin{bmatrix} 3 & 1 \\ 2 & 4 \end{bmatrix}$

(b) $\frac{1}{10}\begin{bmatrix} 3 & -1 \\ -2 & 4 \end{bmatrix}$

(c) $\frac{1}{10}\begin{bmatrix} 3 & 1 \\ -2 & 4 \end{bmatrix}$

(d) $\frac{1}{10}\begin{bmatrix} 3 & -1 \\ 2 & 4 \end{bmatrix}$

Q:4

The eigenvalues of the matrix $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ are :

(a) 1,2

(b) 0,2

(c) 2,1

(d) 0,1

Q:5

Three matrices M_x, M_y, M_z are given as

$$M_x = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}, M_y = \begin{pmatrix} 0 & -i & 0 \\ i & 0 & -i \\ 0 & i & 0 \end{pmatrix}$$

$$M_z = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

Then $[M_y, M_x]$ is

(a) $-2iM_z$

(b) $2iM_z$

(c) $-iM_z$

(d) iM_z

Q:6

What is the determinant of the following matrix?

$$A = \begin{bmatrix} 5 & 3 \\ 2 & 6 \end{bmatrix}$$

(a) 24

(b) -24

(c) 3

(d) -8

Q:7

Two functions $f(x)$ and $g(x)$ are related by a matrix (M) equation $Mf = g$. If $f(x)$ is an eigenfunction of M, then

(a) $g(x)$ should always be equal to $f(x)$

(b) $g(x)$ is directly proportional to $f(x)$

(c) $g(x)$ is inversely proportional to $f(x)$

(d) $g(x)$ is independent of $f(x)$

Q:8

Consider the following statements regarding eigenvalues of matrices :

1. The product of the eigenvalues of a matrix is equal to the determinant of the matrix.
2. A matrix has the same eigenvalues as its transpose.
3. A real symmetric matrix has real eigenvalues only.
4. The eigenvalues of a triangular matrix are equal to those of its equivalent diagonal matrix.

Which of the statements given above are correct?

(a) 1, 3 and 4 only

(b) 2 and 4 only

(c) 1,2 and 3 only

(d) 1, 2, 3 and 4

Q:9

Consider the following set of equations :

$$3x - 6y = -15$$
$$-x + 2y = 5$$

The number of solutions satisfying the above equations will be

(a) infinite

(b) zero

(c) three

(d) two

Q:10

The possible eigen values of given matrix M are:

$$\mathrm{M} = \begin{pmatrix} 1 & 0 & -i \\ 0 & 2 & 0 \\ i & 0 & -1 \end{pmatrix}$$

(a) $(1,2,-1)$

(b) $(1,0,-1)$

(c) $(1,-i,i)$

(d) $(2,\sqrt{2},-\sqrt{2})$

Q:11

Which one of the following correctly gives the value of determinant of a (4×4) diagonal matrix (1 , $2,4,-6$) ?

(a) 1

(b) 48

(c) -48

(d) -1

Q:12

The Eigen values of the matrix $A = \begin{bmatrix} 1 & 1 \\ 4 & 1 \end{bmatrix}$ are:

(a) $1,-1$

(b) $1,-4$

(c) $-1,3$
(d) $1,-3$

Q:13
Which one of the following matrices is an orthogonal matrix?
(a) $\begin{bmatrix}\cos\theta & \sin\theta \\ \sin\theta & \cos\theta\end{bmatrix}$
(b) $\begin{bmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{bmatrix}$
(c) $\begin{bmatrix}\sin\theta & -\sin\theta \\ \cos\theta & \cos\theta\end{bmatrix}$
(d) $\begin{bmatrix}\sin\theta & \cos\theta \\ \cos\theta & \sin\theta\end{bmatrix}$

Q:14
Characteristic polynomial $\Delta(t)$ of the matrix $\mathrm{A} = \begin{bmatrix}2 & 5 \\ 4 & 1\end{bmatrix}$ is:
(a) $t^2 - 5t + 1$
(b) $\mathrm{t}^2 + 9$
(c) $\mathrm{t}^2 - 3\mathrm{t} + 7$
(d) $\mathrm{t}^2 - 3\mathrm{t} - 18$

Q:15
What will be the approximate values of principal stresses in MPa for a 2D stress tensor $\tau = \begin{bmatrix}-3 & -1 \\ -1 & -5\end{bmatrix}$ MPa ?
(a) $-1{,}1 \cdot 2$
(b) $-2{,}4 \cdot 1$
(c) $-0.8, -3.1$
(d) $-2.6, -5.4$

Q:16

The eigenvalues of the matrix

$$A = \begin{pmatrix}5 & -2 \\ -2 & 2\end{pmatrix}$$

are
(a) 1, 2
(b) 5, 2
(c) 2,6
(d) 1,6

Q:17
For a matrix A, the diagonal matrix A' is obtained using the similarity transformation $A' = S^{-1}AS$, where S is a transformation matrix. If $A = \begin{pmatrix}0 & i \\ i & 0\end{pmatrix}$, then the diagonal matrix A' is
(a) $\begin{pmatrix}i & 0 \\ 0 & i\end{pmatrix}$
(b) $\begin{pmatrix}1 & 0 \\ 0 & -1\end{pmatrix}$
(c) $\begin{pmatrix}-1 & 0 \\ 0 & 1\end{pmatrix}$
(d) $\begin{pmatrix}i & 0 \\ 0 & -i\end{pmatrix}$

Q:18
Consider the following statements regarding a system of linear equations :
1. A system of linear equations is consistent if it has one or more solutions.
2. A system of linear equations is inconsistent if it has one or more solutions.
3. A system of linear equations is consistent if it has no solution.
4. A system of linear equations is inconsistent if it has no solution.

Which of the statements given above are correct?
(a) 1 and 3
(b) 2 and 4
(c) 2 and 3
(d) 1 and 4

Topic: 12 Differential Equations

Q:1
Which one of the following is a linear differential equation?
(a) $y' = \cot(y)$
(b) $yy' = 1$
(c) $y'^2 = xy$
(d) $y' = x$

Q:2
Consider the second-order linear differential equation

$$\frac{d^2y}{dx^2} + a_1\frac{dy}{dx} + a_2y = 0$$

where a_1 and a_2 are constants. The solution of this equation, when both roots of the auxiliary equation are real and equal, is
(a) $y = (Ax + B)e^{mx}, m$ is the root and A and B are constants
(b) $y = (Ax + Bx)e^{mx}, m$ is the root and A and B are constants
(c) $y = (Ax - B)e^{mx}, m$ is the root and A and B are constants
(d) $y = (Ax - Bx)e^{mx}, m$ is the root and A and B are constants

Q:3
Poisson partial differential equation is

(a) linear and homogeneous
(b) linear and inhomogeneous
(c) non-linear and homogeneous
(d) non-linear and inhomogeneous

Q:4
Match List-I with List-II and select the correct answer using the code given below the Lists (symbols have their usual meanings) :

List-I (Names)	List-II (Equations)
A. Diffusion equation	1. $\nabla^2\psi = \rho$
B. Laplace's equation	2. $\nabla^2\psi = \frac{1}{h^2}\frac{\partial\psi}{\partial t}$
C. Wave equation	3. $\nabla^2\psi = 0$
D. Poisson's equation	4. $\nabla^2\psi = \frac{1}{c^2}\frac{\partial^2\psi}{\partial t^2}$

Code:

	A	B	C	D
(a)	2	3	4	1
(b)	2	4	3	2
(c)	1	3	4	2
(d)	1	4	3	2

Q:5

The solution of the differential equation $\frac{\partial^2 \mathrm{y}}{\partial x^2} = \mathbf{y}$ which passes through the origin $(0,0)$ and the point $\left(\ln 2, \frac{3}{4}\right)$ is :
(a) $\frac{\mathrm{e^x + e^{-x}}}{2}$
(b) $\frac{\mathrm{e^{ix} - e^{-ix}}}{2}$
(c) $\frac{\mathrm{e^x - e^{-x}}}{2}$
(d) $\frac{\mathrm{e^{ix} - e^{-ix}}}{2}$

Q: 6
Consider the following differential equation :

$$\frac{\partial^2 y}{\partial x^2} - 6\frac{\partial y}{\partial x} + 9y = 0$$

The solution of the above equation can be written as :
(a) $(Ax + B)e^{3x}$
(b) $(\mathrm{Ax + B})\mathrm{e}^{-3\mathrm{x}}$
(c) $\mathrm{Ae^{i3x} + Be^{-3ix}}$
(d) $\mathrm{Ae^{3x} + Be^{-3x}}$

Q:7
The solution of the partial differential equation $x\frac{\partial u}{\partial x} + xy = u$ satisfying $u = 2y$ on the line $x = 1$ may be worked out to yield :
(a) $\mathrm{xy}(2 + \ln \mathrm{x})$
(b) $\mathrm{xy}(2 - \ln \mathrm{x})$
(c) $\mathrm{xy}(2 + \ln \mathrm{y})$
(d) $\mathrm{xy}(2 - \ln \mathrm{y})$

Q:8
Which one of the following statements is correct for the wave equation $\frac{\partial^2 u}{\partial x^2} - \frac{1}{c^2}\frac{\partial^2 u}{\partial t^2} = 0$?
(a) It is an elliptic equation.
(b) It is a parabolic equation.
(c) The appropriate boundary conditions are Cauchy conditions on an open boundary.
(d) The appropriate boundary conditions are Dirichlet or Neumann conditions on a closed boundary.

Q:9
Which one of the following equations is the correct representation of the heat equation?
(where symbols have their usual meaning)
(a) $\nabla^2 \mathrm{u} = 0$
(b) $\nabla^2 \mathrm{u} = \frac{1}{\alpha^2}\frac{\partial \mathrm{u}}{\partial \mathrm{t}}$
(c) $\nabla^2 u = \frac{1}{v^2}\frac{\partial^2 u}{\partial t^2}$
(d) $\frac{-\hbar^2}{2\,\mathrm{m}}\nabla^2\phi + \mathrm{V}\phi = +\mathrm{i}\hbar\frac{\partial}{\partial \mathrm{t}}\phi$

Q:10
Given $y_1 = a\sin z^3$ and $y_2 = b\cos z^3$, the value of the Wronskian $\mathrm{W}(\mathrm{y}_1, \mathrm{y}_2)$ is :
(a) $-abz^2$
(b) abz^2
(c) $-3abz^2$
(d) $3\mathrm{abz}^2$

Q:11
The particular solution for

$$\frac{dy}{dx} = -2xy$$

with $y(0) = 1.8$ is
(a) $1 \cdot 8e^{-4x^2}$
(b) $1.8e^{-3x^2}$
(c) $1.8e^{-2x^2}$
(d) $1.8e^{-x^2}$

Q:12

The Wronskian determinant for the two solutions $y_1 = e^{2x}$ and $y_2 = e^{3x}$, satisfying a differential equation, is
(a) e^{x}
(b) e^{2x}
(c) e^{3x}
(d) e^{5x}

Q:13
The function $f(r, \phi)$ is given by a partial differential equation

$$\frac{\partial^2 f}{\partial r^2} + \frac{1}{r^2}\frac{\partial^2 f}{\partial \phi^2} + \frac{2}{r}\frac{\partial f}{\partial r} = 0$$

This equation can precisely be identified with the Laplace equation in spherical coordinates (r, θ, ϕ), when
(a) $\theta = \pi$
(b) $\theta = \frac{\pi}{3}$
(c) $\theta = \frac{\pi}{4}$
(d) $\theta = \frac{\pi}{2}$

Q:14
The differential equation

$$\frac{\partial \vec{f}}{\partial t} + \vec{f} \cdot \vec{\nabla}\vec{f} = \frac{-\vec{\nabla}P}{\rho}$$

is
(a) first-order, linear and inhomogeneous
(b) first-order, non-linear and inhomogeneous
(c) first-order, non-linear and homogeneous
(d) second-order, linear and homogeneous

Q:15
A spring having stiffness 700 N/m hangs in a vertical position with its upper end fixed. A mass of 7 kg is attached to the lower end. The equation of motion is given by
(a) $\frac{d^2x}{dt^2} - 100x = 0$
(b) $\frac{d^2x}{dt^2} + 100x = 0$
(c) $\frac{d^2x}{dt^2} - \frac{x}{4900} = 0$
(d) $\frac{d^2x}{dt^2} + \frac{x}{4900} = 0$

Q:16
A possible solution of the differential equation

$$y\frac{d^2x}{dt^2} + x\frac{d^2y}{dt^2} + 2\frac{dx}{dt}\frac{dy}{dt} = -Q^2xy$$

(where Q is a non-zero constant) is
(a) $x = \sin Qt$ and $y = \cos Qt$
(b) $x = \sin Qt$ and $y =$ constant
(c) $x = e^{-Qt}$ and $y = e^{Qt}$
(d) $x = e^{-Qt}$ and $y = e^{-Qt}$

Q:17
The relation among total amount of heat flowing out of the earth per second $\left(\frac{dQ}{dt}\right)$, the mean heat flow per unit area per second (q) and the earth's surface area (A) is
(a) $\left(\frac{dQ}{dt}\right) = \frac{q}{A}$
(b) $\left(\frac{dQ}{dt}\right) = -qA$
(c) $\left(\frac{dQ}{dt}\right) = \frac{A}{q}$
(d) $\left(\frac{dQ}{dt}\right) = A - q$

Q:18
A standing wave $\psi(x, t)$ satisfies the wave equation $\frac{\partial^2\psi}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2\psi}{\partial t^2}$, which is a/an
(a) elliptic partial differential equation
(b) hyperbolic partial differential equation
(c) elliptic ordinary differential equation
(d) parabolic ordinary differential equation

Q:19
Consider the following Rodrigues' formula for a Hermite polynomial :

$$H_n(x) = (-1)^n e^{x^2}\left(\frac{d}{dx}\right)^n e^{-x^2}$$

What will be the second-order Hermite polynomial from the equation given above?
(a) $2x^2 - 4$
(b) $4x^2 - 2$
(c) $4x^2 - 1$
(d) $2x^2 - 1$

Q:20
A solution u $= \cos(\text{at})\sin(bx)$ satisfies the wave equation: $\frac{1}{c^2}\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}$. The value of constants (a, b and c) can be related as:
(a) $c^2 = a^2b^2$
(b) $a^2b^2c^2 = 1$
(c) $b^2 = a^2c^2$
(d) $a^2 = b^2c^2$

Q:21
At what value(s) the following differential equation possesses regular singularity?

$$(1 - x^2)\frac{d^2y}{dx^2} - x\frac{dy}{dx} + n^2y = 0$$

(a) $(1, -1)$
(b) ∞

(c) $(-1,1,\infty)$
(d) $(-1,\infty)$

Q:22
What is the possible partial differential equation responsible for the solution of the form $\psi(x,y,z,t) = a\sin(z-vt) + b\cos(x+iy)$, with $(a,b,v) > 0$?
(a) $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} - \frac{\partial^2\psi}{\partial z^2} - \frac{1}{v^2}\frac{\partial^2\psi}{\partial t^2} = 0$
(b) $\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} - \frac{1}{v^2}\frac{\partial^2\psi}{\partial t^2} = 0$
(c) $\frac{\partial^2\psi}{\partial x^2} - \frac{d^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} - \frac{1}{v^2}\frac{\partial^2\psi}{\partial t^2} = 0$
(d) $\frac{\partial^2\Psi}{\partial x^2} - \frac{\partial^2\Psi}{\partial y^2} - \frac{\partial^2\Psi}{\partial z^2} + \frac{1}{v^2}\frac{\partial^2\Psi}{\partial t^2} = 0$

Q:23
The solution of the differential equation $\frac{d^2y}{dx^2} + 8\frac{dy}{dx} + 15y = 0$ is:
(a) $y = C_1e^{3x} + C_2e^{5x}$
(b) $\mathrm{y = C_1e^{3x} + C_2e^{3x}}$
(c) $\mathrm{y = C_1 3x + C_2 5x}$
(d) $y = C_1e^{-3x} + C_2e^{-5x}$

Q:24
In Laplace equation $\nabla^2\boldsymbol{\Psi} = 0$, all the stationary points of $\boldsymbol{\Psi}$ must belong to:
(a) Maxima
(b) Minima
(c) Saddle points
(d) Zero

Q:25
Consider the following differential equation :

$$\frac{d^2y}{dx^2} = y$$

The solution of this equation $y(x)$ passing through the origin and through the point $\left(\ln 2, \frac{3}{4}\right)$ is
(a) $\sinh x$
(b) $\cosh x$
(c) $2\sinh x$
(d) $2\cosh x$

Q:26
The order and degree of the differential equation

$$\left[1 + \left(\frac{dy}{dx}\right)^2\right]^3 = \left(\frac{d^2y}{dx^2}\right)^2$$

are, respectively
(a) 1, 2
(b) 2, 2
(c) 3, 1
(d) 2,3

Q:27
Let $y_1 = e^{2x}$ and $y_2 = e^{3x}$ be two solutions of a linear second-order differential equation. Which one of the following is correct about the Wronskian (W), y_1 and y_2 ?
(a) $W = 0$; y_1 and y_2 are linearly dependent
(b) $W = e^{5x}$; y_1 and y_2 are linearly dependent
(c) $W = 0$; y_1 and y_2 are linearly independent
(d) $W = e^{5x}$; y_1 and y_2 are linearly independent

Q:28
Consider the second-order partial differential equation for a function $u(x,y)$, defined by

$$\frac{\partial^2u}{\partial x^2} + \frac{\partial^2u}{\partial y^2} = 0$$

Which one of the following is correct regarding the equation given above?
(a) Laplace equation, hyperbolic type
(b) Laplace equation, elliptic type
(c) Wave equation, parabolic type
(d) Wave equation, elliptic type

Q:29
Consider the heat flow in a two dimensional (x,y) metal plate. The temperature $u(x,y,t)$ at any point (x,y) at time t for diffusivity d^2 of the plate is governed by
(a) $\frac{\partial^2u}{\partial t^2} = d^2\frac{\partial^2u}{\partial x^2}$
(b) $\frac{\partial u}{\partial t} = d^2\left(\frac{\partial^2u}{\partial x^2} + \frac{\partial^2u}{\partial y^2}\right)$
(c) $\frac{\partial^2u}{\partial x^2} - \frac{\partial^2u}{\partial y^2} = d^2\frac{\partial u}{\partial t}$
(d) $\frac{\partial^2u}{\partial t^2} = d^2\left(\frac{\partial^2u}{\partial x^2} + \frac{\partial^2u}{\partial y^2}\right)$

Topic: 13 Numerical Methods

Q:1
Which one of the following is the correct relation for Newton-Raphson formula?
(a) $x_{n+1} = x_n + \frac{f(x_n)}{f'(x_n)}$
(b) $x_{n+1} = x_n + \frac{f'(x_n)}{f(x_n)}$
(c) $x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$
(d) $x_{n+1} = x_n - \frac{f'(x_n)}{f(x_n)}$

Q:2
Using the linear interpolation method, the root of the function
$$f(x) = x^2 - x - 2 = 0$$
in the range $1 < x < 3$ after the 2nd iteration is
(a) 1.6667
(b) 1.7778
(c) 1.909
(d) 2.121

Q:3
Consider
$$S_n = 1^3 + 2^3 + 3^3 + \cdots + n^3$$
The value of the third forward difference $\Delta^3 S_n$ using Newton's forward difference formula is
(a) $4n + 12$
(b) $6n + 18$
(c) $6n + 12$
(d) $4n + 8$

Q:4
The Euler method for solving ordinary differential equations uses the slope at the starting point of an interval to estimate the next value of the function. The Euler method is a
(a) first-order Runge-Kutta method
(b) second-order Runge-Kutta method
(c) third-order Runge-Kutta method
(d) fourth-order Runge-Kutta method

Q:5
Let $f(x) = x\sin x + \cos x$, then the iteration formula by the Newton-Raphson method is :
(a) $x_{n+1} = x_n + \frac{x_n \sin x_n + \cos x_n}{x_n \cos x_n}$
(b) $x_{n+1} = x_n - \frac{x_n \sin x_n + \cos x_n}{x_n \cos x_n}$
(c) $x_{n+1} = x_n + \frac{x_n \sin x_n - \cos x_n}{x_n \sin x_n}$
(d) $x_{n+1} = x_n - \frac{x_n \sin x_n + \cos x_n}{x_n \sin x_n}$

Q:6
Use Simpson's rule, given by the formula $I = \frac{1}{6}[y_0 + 4y_1 + y_2]$ in the usual notation, to evaluate $I = \int_0^1 \frac{dx}{1+x}$. Then I equals :
(a) 0.6970
(b) 0.7083
(c) 0.6945
(d) 0.6983

Q:7
The Taylor series method is applied to solve the equation $\frac{dy}{dx} = x^2 + y^2$ under the condition $y(x) = 1$ when $x = 0$. The first few terms in the series are :
(a) $1 + x + x^2 + \frac{8}{3!}x^3$
(b) $1 + x^2 + \frac{8}{3!}x^4$
(c) $1 - x + x^2 + \frac{8}{3!}x^3$
(d) $1 - x^2 - \frac{8}{3!}x^4$

Q:8
The root of the equation
$$f(x) = x^2 - 3x + 2$$
in the vicinity of $x = 0$ after 2 nd iteration using Newton-Raphson method is (use $x_1 = 0$ as the first approximation)
(a) 0.67
(b) 0.93
(c) 0.98
(d) 1.00

Q:9
Let $I = \int_{-1}^{1} e^x dx$. The value of I using Simpson's $\frac{1}{3}$ rd rule will be (where $e = 2 \cdot 7182$)
(a) 1.36
(b) 2.36
(c) 3.36
(d) 4.36

Q:10
Runge-Kutta methods are used to find numerical solution of ordinary differential equations. The approximation in the methods uses
(a) only the first-order derivative
(b) only the second-order derivative
(c) only the third-order derivative
(d) higher than third-order derivative

Q:11
A river is 80 m wide. The depth d at a distance x from the bank is given by the following table :

x	0	10	20	30	40	50	60	70	80
d	0	4	7	9	12	15	14	8	3

What will be the approximate area of the cross-section of the river by using Simpson's $\frac{1}{3}$ rd rule?
(a) 610 m^2
(b) 690 m^2
(c) 710 m^2
(d) 740 m^2

Q:12
What will be the Taylor series expansion of a polynomial $f(x) = x^4 + 1$, when expanded around $x = 0$ up to third order?
(a) 1
(b) 0
(c) -1
(d) ∞

Q:13
Heun's method for solving ordinary differential equations is an example of
(a) first-order Runge-Kutta method
(b) second-order Runge-Kutta method
(c) third-order Runge-Kutta method
(d) fourth-order Runge-Kutta method

Q:14
What is the value of following integral using the Simpson's $\frac{1}{3}$ rule?

$$\int_1^5 \frac{dx}{x+2}; (n = 4)$$

(a) 0.8476
(b) 1.4876
(c) 2.8276
(d) 0.6323

Q:15
Which one of the following numerical methods for solving the ordinary differential equations gives the solution in the form of a series?
(a) Taylor's method
(b) Runge-Kutta method
(c) Euler's method
(d) Adams-Bashforth method

Q:16 2021
Which one of the following expressions correctly describe the fourth forward differences in a set of values of $y = \{y_0, y_1, y_2, y_3 \dots \dots \dots y_n\}$?
(a) $y_n - 4y_{n-3} + 6y_{n-2} - 4y_{n-1} + y_{n-4}$
(b) $y_n - 4y_{n-1} + 6y_{n-2} - 4y_{n-3} + y_0$
(c) $y_n - 4y_{n-1} + 6y_{n-2} - 4y_{n-3} + y_{n-4}$
(d) $y_n + 4y_{n-1} - 6y_{n-2} - 4y_{n-3} + y_0$

Q:17
Interpolation is a method to:
(a) Solve differential equations numerically
(b) Find roots of a polynomial
(c) Find the value beyond the points in a data set
(d) Find the value of a point lying between known points

Q:18
We can find the value of the integral $\int_0^1 \left(\frac{x}{1+x}\right) dx$ by using Simpson's $3/8$ rule, if the interval number is:
(a) 7
(b) 6
(c) 8
(d) any positive integer

Q:19
The numerical value of the integral $\int_1^2 (x^3 + 1)dx$ using trapezoidal rule (considering only one interval between the end points) is
(a) 5.50
(b) 5.60
(c) 5.75
(d) 5.55

Q:20
The Newton-Raphson method is used in numerical analysis to
(a) solve a partial differential equation approximately
(b) find the root(s) of nonlinear equations approximately
(c) solve an ordinary differential equation exactly
(d) solve an algebraic equation exactly

Q:21
Which one of the following rules/ methods is used to numerically find the solutions of linear differential equations?
(a) Trapezoidal rule
(b) Boole's rule
(c) Newton-Raphson method
(d) Euler's method

Topic: 14 Probability

Q:1
For the binomial distribution and its normal approximation with $n = 100$ trials and probability of occurrence $p = 0 \cdot 5$, the values of mean and standard deviation are
(a) 50 and 10
(b) 60 and 10
(c) 50 and 5
(d) 60 and 5

Q:2

Which one of the following is not an example of discrete random variable?
(a) Outcomes of coin tosses
(b) Outcomes of tossing a die
(c) Outcomes of finding electron in atom
(d) Outcomes of measuring radioactive alpha decay

Q:3
For asymmetric distribution, mode and mean are 5 and 8 , respectively. The value of median is
(a) 5
(b) 6
(c) 7
(d) 8

Q:4
σ^{x} and σ^{y} are standard errors in the measurement of x and y respectively, and both x and y are independently measured quantities. If $\omega = x - y$, then standard error in ω is :
(a) $\sqrt{(\sigma^{x})^2 - (\sigma^{y})^2}$
(b) $\sqrt{(\sigma^{x})^2 + (\sigma^{y})^2}$
(c) $\sqrt{1 + (\sigma^{y})^2}$
(d) $\sqrt{(\sigma^{x})^2 - 1}$

Q:5 2024
Consider the following set of measurements
$$[7 \cdot 2{,}7 \cdot 0{,}7 \cdot 1]$$
The variance of all the measurements is :
(a) $0 \cdot 1$
(b) $0 \cdot 2$
(c) 0.01
(d) 0.02

Q:6
A Poisson distribution reduces to the binomial distribution when
(a) the number of trials is large and the probability of success in a given trial is also large
(b) the number of trials is small and the probability of success in a given trial is also small
(c) the number of trials is small and the probability of success in a given trial is large
(d) the number of trials is large and the probability of success in a given trial is small

Q:7
What will be the standard deviation, if the mean of a Poisson distribution is 9 ?
(a) 3
(b) 6
(c) 9
(d) 12

Q:8
Let X be described by a Gaussian distribution of mean μ and variance σ^2. Then the probability that X lies within 2σ of the mean is
(a) 50.0%
(b) 68.3%
(c) 95.4%
(d) 99.7%

Q:9
An unbiased single six-sided dise is rolled five times. The probability that a 'six' thrown exactly three times is
(a) 0.016
(b) 0.032
(c) 0.048
(d) 0.064

Q:10
Consider three identical boxes I, II and III, each containing two coins. In box I, both are gold coins, in box II, both are silver coins and in box III, there is one gold and one silver coin. A person chooses a box at random and takes out a coin. If the coin is of gold, what is the probability that the other coin in the box is also of gold?
(a) $\frac{1}{2}$
(b) $\frac{1}{4}$
(c) $\frac{4}{7}$
(d) $\frac{2}{3}$

Q:11
If the standard deviation of a data set is 3.28 , then what would be the approximate mean deviation assuming Gaussian distribution of the data?
(a) 1.08
(b) 2.61
(c) 3.08
(d) 4.61

Q:12
What is the probability that a red ball and a blue ball are respectively picked up in succession from a bag containing 6 red balls and 9 blue balls?

(a) $\frac{5}{18}$
(b) $\frac{1}{54}$
(c) $\frac{6}{25}$
(d) $\frac{9}{35}$

Q:13
Which one of the following is true for a sequence of random numbers generated by a digital computer?
(a) It is truly random
(b) It will repeat itself eventually
(c) It is useful only for playing games
(d) It is useful for traffic system

Q:14
A sample of 2 liters of water is collected from a pond that contains 40 mosquito larvae. From this pond a 100 mL sample was taken to carry out further analysis. The probability that this 100 mL sample has any mosquito larvae present in it is:
(where e = 2.718)
(a) 5.0%
(b) 13.5%
(c) 14.5%
(d) 86.5%

Q:15
Six cups are numbered 1 to 6 . Each cup can hold one marble. There are three red marbles and one blue marble. How many different ways are there to fill the cups with all four marbles?
(a) 12
(b) 24
(c) 30
(d) 60

Q:16
Which one of the following distributions is symmetric about its mean and has zero skewness?
(a) Laplacian distribution
(b) Gaussian distribution
(c) Poisson distribution
(d) Binomial distribution

Q:17
The probability of having at least two tails in 4 throws with a fair coin is:
(a) 1/8
(b) 3/4
(c) 3/8
(d) 11/16

Q:18
Which one of the following is the additive rule of probability $P(X \cup Y)$ for mutually exclusive events X and Y ?
(a) $P(X \cup Y) = P(X) - P(Y) - P(X \cap Y)$
(b) $P(X \cup Y) = P(X) - P(Y) + P(X \cap Y)$
(c) $P(X \cup Y) = P(X) - P(Y)$
(d) $P(X \cup Y) = P(X) + P(Y)$

Q:19
Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I (Distribution)	List-II (Probability distribution)
A. Binomial	$\frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$
B. Poisson	$q^{x-1}p$
C. Geometric	$\frac{\lambda^x}{x!} e^{-\lambda}$
D. Normal	${}^nC_x p^x q^{n-x}$

Code:

	A	B	C	D
(a)	4	2	3	1
(b)	4	3	2	1
(c)	1	2	3	4
(d)	1	3	2	4

Topic: 15 Basic Mechanics

Q:1
Theoretical physics has unified the combination of two/three fundamental interactions together. The term 'grand unified interaction' means
(a) unification of electromagnetic and weak forces
(b) unification of electromagnetic, weak and strong forces
(c) unification of electromagnetic and strong forces
(d) unification of all fundamental forces

Q:2
Which one among the following laws can be used to determine the mass of a planet?
(a) Kepler's first law
(b) Kepler's second law
(c) Kepler's third law
(d) Newton's first law

Q:3
The momentum of a free non-relativistic particle is
(a) directly proportional to square root of its energy
(b) inversely proportional to square root of its energy

(c) directly proportional to square of its energy
(d) inversely proportional to square of its energy

Q:4
Consider that a planet has radius four times the radius of the Earth. If this planet has the same surface gravity as the Earth, then its escape speed is
(a) equal to the escape speed of the Earth
(b) two times the escape speed of the Earth
(c) three times the escape speed of the Earth
(d) four times the escape speed of the Earth

Q:5
Consider the following statements regarding one-dimensional elastic collision of two particles with masses m_1 and m_2 :

1. When $m_1 = m_2$, the particles interchange their velocities on collision.
2. When $m_1 \ll m_2$ and the particle with mass m_2 is initially at rest, the latter begins to move and the particle with mass m_1 comes to rest.
3. When $m_1 \gg m_2$ and the particle with mass m_2 is initially at rest, the velocity of the particle with mass m_1 remains unchanged on collision.

Which of the statements given above is/are correct?
(a) 1 only
(b) 1 and 2
(c) 2 and 3
(d) 1 and 3

Q:6
A rigid body, in three space dimensions, is rotated by an angle $\frac{\pi}{2}$ in anticlockwise direction around the Z-axis. The same body is then rotated by $\frac{\pi}{3}$ in anti-clockwise direction around X-axis, subsequently the body is rotated by $\frac{\pi}{6}$ in anti-clockwise direction around X-axis. If the coordinates to begin with are represented by a column vector $\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$, then the transformed coordinates after all the above-mentioned rotations are represented as
(a) $\begin{pmatrix} -Z \\ Y \\ -X \end{pmatrix}$
(b) $\begin{pmatrix} Y \\ Z \\ X \end{pmatrix}$
(c) $\begin{pmatrix} -Z \\ X \\ -Y \end{pmatrix}$
(d) $\begin{pmatrix} -Z \\ X \\ Y \end{pmatrix}$

Q:7
In a solid sphere, the ratio of moment of inertia about its diameter to the moment of inertia about a tangent is
(a) 0.286
(b) 0.600
(c) 1.667
(d) 3.500

Q:8
The acceleration due to gravity at the Earth's surface is :
(where G is the gravitational constant, M_E is the mass of the Earth and R_E is the radius of the Earth)
(a) $\frac{GM_E}{R_E}$
(b) $\frac{GM_E}{R_E^2}$
(c) $\frac{GM_E}{R_E^3}$
(d) $\frac{R_E^2}{GM_E}$

Q:9
The time period of a satellite moving in a circular orbit of radius r around the Earth is proportional to :
(a) $r^{1/2}$
(b) $r^{3/2}$
(c) $r^{-3/2}$
(d) $r^{-1/2}$

Q:10
The spin of the graviton is :
(a) $\frac{1}{2}$
(b) 0
(c) 1
(d) 2

Q:11
Which one of the following statements regarding work done by a conservative force is not correct?
(a) It is given by the difference between the initial and final values of a potential-energy function.
(b) It is not reversible.
(c) It is independent of the path of the object and depends only on starting and ending points.
(d) The total work done is zero for a closed path.

Q:12
The moment of inertia of a rotating body is decreased to $\frac{1}{4}$ times and its angular velocity is increased to 4

times; then kinetic energy of the rotating body will :
(a) be decreased by a factor of $\frac{1}{4}$
(b) be increased by a factor of 4
(c) not change
(d) be increased by a factor of 2

Q:13
A rigid body rotation in (X, Y, Z) coordinates is given as :

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} \rightarrow \begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

then :
(a) Z -axis is the rotation axis and the angle of rotation is $\frac{\pi}{2}$
(b) Y -axis is the rotation axis and the angle of rotation is π
(c) Z -axis is the rotation axis and the angle of rotation is π
(d) Y -axis is the rotation axis and the angle of rotation is $\frac{\pi}{2}$

Q:14
A particle lying in the $x - y$ plane is acted upon by a force directed towards the origin whose magnitude is kr, where $r = \sqrt{x^2 + y^2}$ is the distance from the particle to the origin and k is a constant. The work that must be done to move the particle from the origin $(0,0)$ to the point $x = 1, y = 2$ along the direction to that point is
(a) $\frac{k}{2}$
(b) $\frac{3k}{2}$
(c) $\frac{5k}{2}$
(d) $\frac{7k}{2}$

Q:15
Comet A moves in an elliptical orbit around the Sun. Its distances from the Sun at perihelion and aphelion are 8.0×10^7 km and 4.0×10^9 km, respectively. The semi-major axis of the orbit is
(a) 6.63×10^9 km
(b) 2.04×10^9 km
(c) 6.63×10^7 km
(d) 2.04×10^7 km

Q:16
Imagine a potential

$$V(r) = \frac{c^2}{r - r_0}$$

where c and $r_0 > 0$ are constants. $V(r)$ is used to derive a conserved force $\vec{F}$. Then $\vec{F}$
(a) is only attractive
(b) is only repulsive
(c) can be either attractive or repulsive
(d) cannot be figured out from the available information

Q:17
Which one of the following is true for the range of the forces?
(a) Strong force is long-range, weak force is short-range
(b) Strong force is long-range, electromagnetic force is short-range
(c) Electromagnetic force is long range, strong force is short-range
(d) Electromagnetic force is long range, gravitational force is shortrange

Q:18
An object of mass 2 kg collides inelastically with another object of mass 8 kg , which was initially at rest. The two objects stick together after the collision. Then the ratio of final (after collision) to initial (before collision) kinetic energy is equal to
(a) 0.2
(b) 2.0
(c) 0.02
(d) 0.002

Q:19
Conservation of linear momentum
(a) does not ensure the conservation of its components and is valid even when the internal forces are non-conservative
(b) does ensure the conservation of its components and is valid even when the internal forces are nonconservative
(c) does not ensure the conservation of its components and is not valid when the internal forces are nonconservative
(d) does ensure the conservation of its components and is not valid when the internal forces are nonconservative

Q:20
The moment of inertia for a solid cylinder about its axis (passing through the centre of the circular sides) is (where M is the mass of the cylinder and R is the radius of the cylinder)

(a) MR^2
(b) $\frac{1}{2}MR^2$
(c) $\frac{2}{5}MR^2$
(d) $\frac{2}{3}MR^2$

Q:21
The number of degrees of freedom of a rigid rod of negligible thickness in three space dimensions is
(a) 3
(b) 4
(c) 5
(d) 6

Q:22
Which one of the following types of interactions is insignificant between elementary particles but becomes prominent in the study of astrophysics and cosmology?
(a) Strong interaction
(b) Weak interaction
(c) Electromagnetic interaction
(d) Gravitational interaction

Q:23
A disk of mass M and radius R rotates with an angular velocity $\overrightarrow{\omega_0}$. Another disk of equal mass M and radius r is placed on top of the rotating disk such that their centres coincide. Both the disks now rotate with an angular velocity $\vec{\omega}$ which is given by
(a) $\frac{r^2\overrightarrow{\omega_0}}{R^2+r^2}$
(b) $\frac{R^2\overrightarrow{\omega_0}}{R^2+r^2}$
(c) $\frac{(R^2+r^2)\overrightarrow{\omega_0}}{r^2}$
(d) $\frac{(R^2+r^2)\overrightarrow{\omega_0}}{R^2}$

Q:24
Two bodies of equal mass m are connected by a massless rigid rod of length $2l$ lying in the $x-y$ plane with the centre of the rod at the origin. If this system is rotating about the z-axis with an angular velocity $\vec{\omega}$, then its angular momentum is
(a) $4ml^2\vec{\omega}$
(b) $2ml^2\vec{\omega}$
(c) $0.5\text{ml}^2\vec{\omega}$
(d) $0.25\text{ml}^2\vec{\omega}$

Q:25
The moment of inertia I of a thick spherical shell of uniform density ρ, with internal radius r and external radius R, is given by
(a) $I = \left(\frac{2}{5}\right)\pi\rho(R^2-r^2)$
(b) $I = \left(\frac{8}{4}\right)\pi\rho(R^3-r^3)$
(c) $I = \left(\frac{8}{3}\right)\pi\rho(R^5-r^5)$
(d) $I = \left(\frac{8}{15}\right)\pi\rho(R^5-r^5)$

Q:26
Which one of the following statements regarding gravitational forces is NOT true?
(a) It is always attractive
(b) It is a conservative force
(c) It depends on the medium between the particles
(d) It is a long range force

Q:27
A satellite of mass m is in geosynchronous orbit around the earth of mass M and angular velocity ω. What is the radius of the geosynchronous orbit?
(a) $\sqrt{(GM/\omega^2)}$
(b) GM/ω^2
(c) $(GM/\omega^2)^{1/3}$
(d) $(GM/\omega^2)^{1/4}$

Q:28 2021
If strength of strong force is 1 , then what is the relative strength of electromagnetic force?
(a) 10^{-37}
(b) 10^{-2}
(c) 10^{2}
(d) 10^{37}

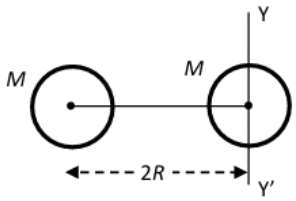
Q:29
The fundamental force(s) relevant for geophysical phenomena is/are:
(a) Gravitational force only
(b) Gravitational and electromagnetic forces
(c) Strong and gravitational forces
(d) Strong force only

Q:30
A particle is moving under a potential $V(r) = -(A/r)$, where the constant $A > 0$. Which one of the following statements is NOT true for the particle?
(a) Its angular momentum is always conserved
(b) Its kinetic energy is always conserved
(c) It always follows a closed path
(d) The force on it is always radial

Q:31

A bomb moving with velocity $(40\mathbf{i} + 50\mathbf{j} - 25\mathbf{k})$ explodes into two pieces of masses m and $4m$, respectively. After explosion, what would be the velocity of larger piece, if the smaller piece moves away with a velocity $(200\mathbf{i} + 70\mathbf{j} + 15\mathbf{k})$?
(a) $(45\mathbf{j} - 35\mathbf{k})$
(b) $(80\mathbf{j} - 35\mathbf{k})$
(c) $(80\mathbf{j} - 27.5\mathbf{k})$
(d) $(45\mathbf{j} - 27.5\mathbf{k})$

Q:32
Two spheres each of mass M and diameter R are connected with a massless rod of length $2R$ as shown in the figure. What will be the moment of inertia of the system about an axis passing through the centre of one of the sphere and perpendicular to the rod?

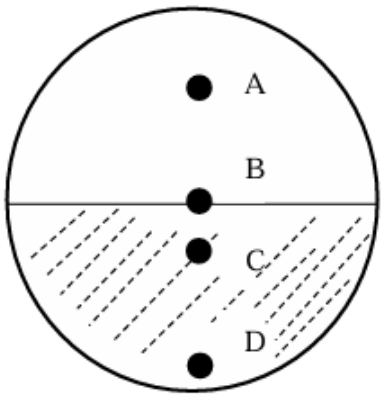


(a) $\frac{21}{5}MR^2$
(b) $\frac{2}{5}MR^2$
(c) $\frac{5}{2}MR^2$
(d) $\frac{5}{21}MR^2$

Q:33
A wheel is moving due to an external force **F**. The time rate of change of angular momentum of the wheel can be maximized by:
(a) Applying **F** near the axle of the wheel in radially outward direction to the axle
(b) Applying **F** near the rim of the wheel in radially outward direction to the axle
(c) Applying **F** near the axle of the wheel and parallel to a tangent at the rim
(d) Applying **F** near the rim of the wheel and tangent to the rim

Q:34
How does the angular momentum of a person changes when he spreads his arms horizontally while uniformly rotating on a frictionless turntable?
(a) It increases
(b) It remains the same
(c) It decreases
(d) It changes depending on the direction of rotational motion

Q:35
Consider a hollow metallic sphere partially filled with sand as shown in the figure:



Which one of the following points is likely to be the center of mass of the sphere?
(a) Point A
(b) Point B
(c) Point C
(d) Point D
Q:36 2020
If the gravitational potential on the surface of the earth is 6×10^{10}ergs/gm, then the gravitational potential at the center of the earth can be:
(a) 6×10^{10}ergs/gm
(b) 9×10^{10}ergs/gm
(c) 3×10^{10}ergs/gm
(d) 7.5×10^{10}ergs/gm

Q:37
Two spheres of equal mass are separated by a distance of 'r' and are subjected to their mutual gravitational attraction. Which of the following quantities must have the same magnitude for both the spheres?
1. Velocity
2. Kinetic energy
3. Gravitational force

Select the correct answer using the code given below:
(a) 1 only
(b) 2 and 3 only
(c) 1 and 2 only
(d) 1, 2 and 3

Q:38
Which one of the following systems shows an example of the presence of at least three fundamental forces?
(a) Pair of neutrons (n-n)
(b) Pair of electrons (e-e)

(c) Pair of protons (p-p)
(d) Neutron and proton (n-p)

Q:39
Which of the following quantities are conserved in a weak interaction?
1. Charge
2. Lepton number
3. Baryon number
4. Strangeness

Select the correct answer using the code given below:
(a) 1 and 2 only
(b) 1, 2 and 3 only
(c) 3 and 4 only
(d) 1, 2, 3 and 4

Q:40 α-decay and β-decay are due to:
(a) strong force and weak force respectively
(b) electromagnetic force and weak force respectively
(c) electrostatic force and weak force respectively
(d) electromagnetic force and strong force respectively

Q:41
A sphere, a cylinder and ring of same radius are allowed to roll down simultaneously on an inclined plane from the same height without slipping. Which of the following will reach the bottom first?
(a) Sphere
(b) Cylinder
(c) Ring
(d) All will reach simultaneously

Q:42
Two particles of equal mass travelling with velocities $2\ \mathrm{m/s}$ and $4\ \mathrm{m/s}$ collide and stick together. What would be the velocity of the combined mass?
(a) $2\ \mathrm{m/s}$
(b) $4\ \mathrm{m/s}$
(c) $3\ \mathrm{m/s}$
(d) $6\ \mathrm{m/s}$

Q:43
A slender uniform rod of total length ' L ' and total mass ' M ' has its rotational axis at the center of the length and perpendicular to length. Its moment of inertia can be given by:
(a) $\frac{1}{3}\mathrm{ML}^2$
(b) $\frac{1}{4}\mathrm{ML}^2$
(c) $\frac{1}{8}\mathrm{ML}^2$
(d) $\frac{1}{12}\mathrm{ML}^2$

Q:44
Total number of degrees of freedom for a rigid body around a fixed point is:
(a) Zero
(b) One
(c) Two
(d) Three

Q:45
Which of the following Kepler's laws of planetary motion is/are the result of conservation of angular momentum?
(a) Kepler's first law only
(b) Kepler's second law
(c) Kepler's third law only
(d) Kepler's first law and third law

Q:46
The centre of revolution of the Earth-Moon pair lies
(a) within the Earth
(b) within the Moon
(c) at the centre of the Earth-Moon distance
(d) very close to the Earth but outside of it

Q:47
A spaceship is moving in vacuum of outer space, which is far from any star or planet. When its engine dies, the spaceship will
(a) come to rest instantly
(b) move with an increasing velocity
(c) move with a decreasing velocity
(d) continue to move with a uniform velocity

Q:48
A particle with kinetic energy equal to $\frac{GMm}{R}$ on the surface of rotating earth will:
(a) Start rotating around the earth
(b) Escape from the earth
(c) Remain on the earth with maximum potential energy
(d) Reach the equator

Q:49
A satellite is revolving round the earth at a height of 600 km . Considering the radius of the earth as 6400 km , the mass of the earth as 6×10^{24} kg and gravitational constant (G) as $6.67 \times 10^{-11}\mathrm{Nm}^2/\mathrm{kg}^2$, the time period of the satellite will be:
(a) 4.8×10^3 s
(b) 4.8×10^6 s

(c) 5.8×10^3 s
(d) 4.2×10^2 s

Q:50 Which one of the following fundamental forces is mediated by massive particles?
(a) Strong force
(b) Electromagnetic force
(c) Weak force
(d) Gravitational force

Q:51 The range of weak interactions is
(a) 10^{-12} m
(b) 10^{-15} m
(c) 10^{-18} m
(d) 10^{-21} m

Q:52 The engine of a rocket in outer space, far from any planet, is turned on. The rocket rejects burned fuel at a constant rate. In the first second of firing, it ejects $\frac{1}{100}$ of its initial mass m_0 at a relative speed of 2000 m/s. The initial acceleration of the rocket is
(a) -20 m/s^2
(b) $+20$ m/s^2
(c) -2×10^5 m/s^2
(d) $+2 \times 10^5$ m/s^2

Q:53
In the centre of mass frame of reference, the magnitudes of the velocities of particles
(a) remain unchanged in an elastic collision
(b) remain unchanged in an inelastic collision
(c) remain unchanged in both elastic and inelastic collisions
(d) change in both elastic and inelastic collisions

Topic: 16 Special Theory of Relativity

Q:1
A beam of particles with a proper lifetime of 5 microsecond moves through the laboratory at a speed of 2×10^8 m s^{-1}. The average distance traversed by the particles before disintegration is
(a) $3\sqrt{5} \times 10^2$ m
(b) $5\sqrt{3} \times 10^2$ m
(c) $6\sqrt{5} \times 10^2$ m
(d) $10\sqrt{3} \times 10^2$ m

Q:2
The correct expression for time dilation is : (where γ is the Lorentz factor relating the two frames and Δt_0 is the proper time interval between two events measured in the rest frame of the clock)
(a) $\gamma^2 \Delta t_0$
(b) $\gamma \Delta t_0$
(c) $\Delta t/\gamma$
(d) $\Delta t_0/\gamma^2$

Q:3 What is the first-order correction to the non-relativistic kinetic energy for the relativistic energy of a particle given as $K = (\gamma - 1)mc^2$?
(here γ is the Lorentz factor, the particle has mass ' m ' and speed ' v ', and ' c ' is the speed of light)
(a) $\frac{3}{4}\frac{mv^2}{c^2}$
(b) $\frac{3}{8}\frac{mv^2}{c^2}$
(c) $\frac{3}{4}\frac{mv^4}{c^2}$
(d) $\frac{3}{8}\frac{mv^4}{c^2}$

Q:4
What is the speed of an electron accelerated from rest due to potential increase of $5 \cdot 11$MV of electric field? (where ' c ' is the speed of light)
(a) 0.096 c
(b) 0.816 c
(c) 0.996c
(d) 0.086 c

Q:5
The observed lifetime of π^+mesons travelling with speed $V = 0 \cdot 8c$ is (the proper lifetime of π^+mesons is 2.5×10^{-8} s and c is the speed of light)
(a) 2.5×10^{-8} s
(b) 3.2×10^{-8} s
(c) 4.2×10^{-8} s
(d) 5.2×10^{-8} s

Q:6
The percentage contraction in the length of a rod in a frame of reference, moving with velocity $0.8c$ in a direction parallel to its length, is
(a) 20
(b) 40
(c) 60
(d) 80

Q:7
Galilean transformations are
$$x' = x - vt, y' = y, z' = z, t' = t$$
Then t' in the corresponding Lorentz transformations is given by
(a) $t' = t$

(b) $t' = \frac{t-\frac{vx}{c^2}}{\sqrt{1+\frac{v^2}{c^2}}}$

(c) $t' = \frac{t+\frac{vx}{c^2}}{\sqrt{1+\frac{v^2}{c^2}}}$

(d) $t' = \frac{t-\frac{vx}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}$

Q:8 2022

The proper time interval $d\tau$ in special theory of relativity is expressed via a relation $d\tau^2 = -dt^2 + d\vec{x}^2$, where t is the time and $\vec{x}$ is the space vector. Then time-like and space-like separations between events are respectively given by

(a) $d\tau^2 > 0$ and $d\tau^2 < 0$

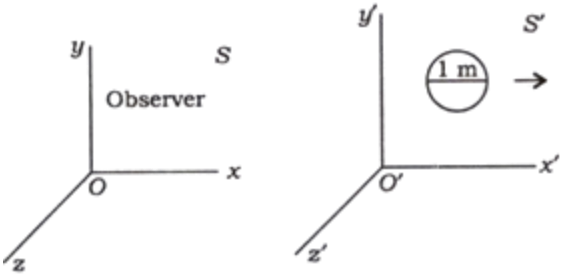
(b) $d\tau^2 < 0$ and $d\tau^2 > 0$

(c) $d\tau^2 > 0$ and $d\tau^2 = 0$

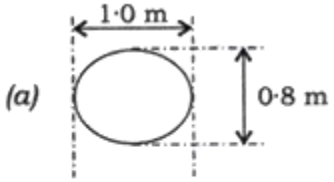
(d) $d\tau^2 < 0$ and $d\tau^2 = 0$

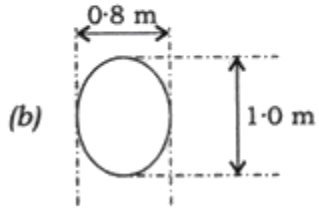
Q:9 2022

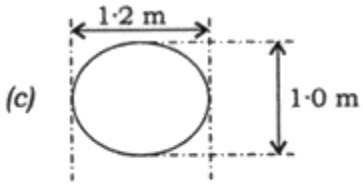
A sphere of 1 m diameter is in S' frame that is moving in x' direction with a speed of 0.6 times the speed of light in vacuum with respect to S frame :

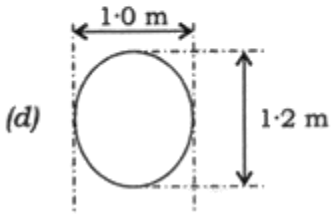


How will an observer at rest in frame S see the object?









Q:10

Two meteorites are moving towards each other with speeds of $0.9c$ and $0.3c$, respectively with respect to the laboratory frame of reference, where c is the speed of light in vacuum. Their relative speed is

(a) $0.49c$

(b) $0.94c$

(c) $0.74c$

(d) $0.67c$

Q:11

According to the special theory of relativity

(a) the speed of light in vacuum is dependent on the direction of propagation

(b) the speed of light in vacuum is dependent on the relative velocity of source and the observer

(c) the speed of light in vacuum is independent of the direction of propagation

(d) the laws of physics are dependent on the frame of reference

Q:12
A light beam is propagating through a block of glass with index of refraction ' n '. If the glass is moving at a uniform speed v in the same direction as the beam, what is the speed of light in the glass block as measured by an observer in the laboratory?
(a) V
(b) c
(c) $c + nv$
(d) $\frac{c+nv}{n+\frac{v}{c}}$

Q:13
An experiment is designed to measure the length of a rod. Initially the experimentalist and the rod are at rest with respect to the laboratory. Consider the following statements in this regard:
1. If the rod starts moving parallel to its length but the experimentalist stays at rest, the measured length would appear to be reduced to the experimentalist
2. If the rod stays at rest but the experimentalist starts moving parallel to the measured length of the rod, the length of the rod would appear to be reduced to the experimentalist
Which one of the following is correct in respect of above statements?
(a) Statement 1 is correct but statement 2 is wrong
(b) Statement 2 is correct but statement 1 is wrong
(c) Both the statements are correct
(d) Both the statements are wrong

Q:14 An observer measures the length 100 m of a space-craft moving with a speed 0.8 c , where c is the speed of light in vacuum. What is the length of the space-craft as measured by a pilot in the same space-craft?
(a) 100 m
(b) 60 m
(c) 30 m
(d) 10 m

Q:15
The speed of an electron in a uniform electric field changes from 0.95 c to 0.98 c , where c is the velocity of light. Change in the mass of electron will be:
(Rest mass of electron $= 9.11 \times 10^{-31}$ kg)
(a) 1.8×10^{-31} kg
(b) 16.4×10^{-27} kg
(c) 1.8×10^{-27} kg
(d) 16.4×10^{-31} kg

Q:16
What will be the speed of a proton, whose kinetic energy is double to its rest mass energy?
(a) $\frac{2\sqrt{2}}{3}$ c
(b) $\frac{c}{\sqrt{2}}$
(c) $\frac{c}{\sqrt{3}}$
(d) $\frac{c}{2}$

Q:17 If the kinetic energy of a proton is 3752 MeV , then its Lorentz (relativistic) factor is approximately
(a) 5
(b) 4
(c) 3
(d) 2

Q:18 The total energy of a 3.53 MeV electron is
(a) 3.02 MeV
(b) 3.53 MeV
(c) 4.04 MeV
(d) 4.55 MeV

Topic: 17 Signals and Systems

Q:1 A geophysical signal is being recorded at a sampling rate of 1 sample per 2 millisecond. The temporal variations in the signal occurring at frequency around 625 Hz will be
(a) faithfully reproduced from the sampled data
(b) reproduced with aliasing of higher frequencies down to lower frequencies
(c) reproduced but at a higher frequency
(d) non-reproducible from sampled data

Q:2
Which one of the following conditions is correct for exhibiting aliasing effect in a signal?
(a) Sampling rate > Nyquist rate
(b) Sampling rate =0
(c) Sampling rate < Nyquist rate
(d) Nyquist rate =0

Q:3 Which of the following pairs are not correctly matched?

(Filter)	(Filtering)
1 Low-pass filters	Reject high frequencies
2 High-pass filters	Pass high frequencies
3 Band-pass filters	Pass all the frequencies
4 Band-reject filters	Reject all the frequencies

Select the answer using the code given below.
(a) 1,3 and 4
(b) 3 and 4 only

(c) 1 and 2 only
(d) 1, 2 and 3

Q:4 The Fourier transform of the rectangular function $\Pi\left(\frac{x-3}{2}\right)$ is
(a) $\frac{2}{3}e^{-31\omega}\cdot\sin\left(\frac{2\omega}{3}\right)$
(b) $2e^{-31\omega}\cdot\sin(2\omega)$
(c) $2e^{-31\omega}\cdot\sin\left(\frac{2\omega}{3}\right)$
(d) $3e^{-31\omega}\cdot\sin(2\omega)$

Q:5
The convolution of two finite length sequences $x_n=\{1,0,-2\}$ and $y_n=\{1,-1\}$ is
(a) $\{-1,1,2,-2\}$
(b) $\{1,-1,-2,2\}$
(c) $\{1,0,-2,2\}$
(d) $\{1,-2,-1,2\}$

Q:6
The function

$$\delta(t)=\begin{cases}1, & t=0\\ 0, & t\neq 0\end{cases}$$

is known as
(a) unit-step function
(b) Dirac-delta function
(c) unit rectangular function
(d) ramp function

Q:7
The minimum frequency at which a signal comprising of 30Hz, 50 Hz and 70 Hz frequencies should be sampled to avoid aliasing is :
(a) 25 Hz
(b) 35 Hz
(c) 70 Hz
(d) 140 Hz

Q:8 The band-limited signal is uniquely represented by its samples. In practice, however, narrow, large amplitude pulses, which approximate impulses, are also relatively difficult to generate and transmit. What is the convenient form of sampled signal generated ?
(a) Zero-order hold
(b) First-order hold
(c) Ideal low-pass filter
(d) Cascade combination

Q:9 A wave filtered at 200 Hz is aliased due to the sampling process. The sampling rate of the signal is 350 Hz . What is the output frequency?
(a) 175 Hz
(b) 150 Hz
(c) 125 Hz
(d) 100 Hz

Q:10
Consider the following statements regarding the Fourier Transformation (FT) of a time series ' g(t) ' :
1. FT converts g(t) into its equivalent amplitude and phase spectra.
2. FT converts g(t) into a complex function of frequency.
3. FT converts g(t) into its equivalent phase spectra only.
4. FT converts g(t) into a real function of frequency.
Which of the statements given above are correct?
(a) 1 and 3
(b) 1 and 2
(c) 2 and 3
(d) 3 and 4

Q:11 Consider the following statements regarding the scaling of a signal in time and frequency domains :
1. Linear expansion in time domain gives rise to linear contraction in frequency domain.
2. Linear contraction in time domain gives rise to linear expansion in frequency domain.
3. Linear expansion in time domain gives rise to linear expansion in frequency domain.
Which of the statement(s) given above is/are correct?
(a) 1 and 2
(b) 2 and 3
(c) 3 only
(d) 1 only

Q:12 The Fourier series expansion for $\cos^2(x)-4\sin^4(x)-3\cos^3(2x)$ contains :
(a) Sine terms only
(b) Constant terms only
(c) Both non-zero cosine and sine terms
(d) Cosine terms only

Q:13 Consider a two-dimensional function $f(x_1,x_2)$ in the spatial domain and $F(\varepsilon_1,\varepsilon_2)$ be its Fourier transform. Identify the correct relation between $f(x_1,x_2)$ and $F(\varepsilon_1,\varepsilon_2)$ if x_1 and x_2 are scaled independently by a factor of a_1 and a_2, respectively :
(a) $f(a_1x_1,a_2x_2)\leftrightarrow a_1a_2\ F\left(\frac{\varepsilon_1}{a_1},\frac{\varepsilon_2}{a_2}\right)$
(b) $f(a_1x_1,a_2x_2)\leftrightarrow\frac{1}{a_1a_2}F\left(\frac{\varepsilon_1}{a_1},\frac{\varepsilon_2}{a_2}\right)$
(c) $f(a_1x_1,a_2x_2)\leftrightarrow a_1a_2F(a_1\varepsilon_1,a_2\varepsilon_2)$
(d) $f(a_1x_1,a_2x_2)\leftrightarrow\frac{1}{a_1a_2}F(a_1\varepsilon_1,a_2\varepsilon_2)$

Q:14
The axis of complex plane at which the Laplace and Fourier transforms converge is :
(a) Real axis
(b) Imaginary axis
(c) Positive side of real axis only
(d) Positive side of imaginary axis only

Q:15
In an eight-bit remote sensing image, the digital number (DN) value lies between 64 and 128. After doing linear contrast enhancement of the whole data, what will be the value of DN=98 after transformation?
(a) 34
(b) 64
(c) 135
(d) 168

Q:16
Cross-correlate the wavelet g[n] $= \{2,5,-2,1\}$ with another wavelet f]n] $= \{6,-1,-1\}$. For what shift are these functions being mostly alike?
(a) 0
(b) -1
(c) +1
(d) -2

Q:17
The value of $\sum_{n=0}^{\infty} \delta(n+1)4^n$ is : (where, $\delta(\mathbf{n})$ is delta function)
(a) 4
(b) -1
(c) 1
(d) 0

Q:18
The near field displacement record of an earthquake was found to be closely approximated as the function

$$f(t) = \begin{cases} 0, & t \le t_0 \\ 1, & t > t_0 \end{cases}$$

What would be the velocity record look like? (δ represents a Dirac-Delta function)
(a) 0 (Zero)
(b) $\delta(\mathrm{t} - \mathrm{t}_0)$
(c) 1
(d) $\delta(\mathrm{t})$

Q:19
To prevent aliasing, a filter must be applied before sampling or resampling to a larger sample period, and a filter must be applied to limit frequencies
(a) to above Nyquist
(b) to below Nyquist
(c) equal to Nyquist
(d) twice of Nyquist

Q:20
The spectra cross at the frequency

$$\frac{F_s}{2} = \frac{1}{2T} \text{ Hz}$$

is known as (where F_s is the sampling frequency)
(a) dominant frequency
(b) resonance frequency
(c) folding frequency
(d) Nyquist frequency

Q:21
The Fourier transform of a boxcar function is
(a) boxcar function
(b) square function
(c) step function
(d) sinc function

Q:22
What will be the Fourier transform of the derivative of $x(t)$, if the Fourier transform of a function $x(t)$ is $X(\omega)$?
(a) $\frac{X(f)}{jf}$
(b) $j\omega X(\omega)$
(c) $-\frac{1}{j\omega}X(\omega)$
(d) if $X(\mathrm{f})$

Q:23
The Fourier transform of the Gaussian function is
(a) sinc function
(b) boxcar function
(c) Gaussian function
(d) delta function

Q:24
Consider the following statements regarding convolution operation :
1. The effect of a filter is mathematically described by convolution operation.
2. Convolution operation does not convolve the input signal and impulse response.
3. Convolution operation convolves the input signal and impulse response.
4. Convolution operation describes output of a Linear Time Invariant (LTI) system.

Which of the statements given above are correct?
(a) 1 and 3 only
(b) 3 and 4 only

(c) 1,2 and 4
(d) 1, 3 and 4

Q:25 What will be the complementary error function $\text{erfc}(x)$, if the error function

$$\text{erf}(x) = \left(1/\pi^{1/2}\right)\int_0^x e^{-u^2}du?$$

(a) $\text{erfc}(x) = 1 - \text{erf}(x)$
(b) $\text{erfc}(x) = 1 + \text{erf}(x)$
(c) $\text{erfc}(x) = \frac{1}{\text{erf}(x)}$
(d) $\text{erfc}(x) = 2\text{erf}(x)$

Q:26 For convolution of two functions in time domain, the effect in the frequency domain is to
(a) multiply their amplitude spectra and add their phase spectra
(b) divide their amplitude spectra and add their phase spectra
(c) multiply their amplitude spectra and subtract their phase spectra
(d) multiply their phase spectra and add their amplitude spectra

Q:27
The value of Dirac delta $\delta(t)$ at $t = 0$ will be
(a) zero
(b) +1
(c) -1
(d) ∞

Q:28 A unit step function u(t) is discontinuous at
(a) t=0
(b) t=-1
(c) t=1
(d) t=∞

Q:29 The spectrum of a harmonic signal in the time and frequency domain is
(a) square wave
(b) triangular wave
(c) spike wave
(d) cosine wave

Q:30
Which one of the following statements regarding linear, time-invariant system is not correct?
(a) It follows commutative property.
(b) It follows distributive property.
(c) It follows associative property.
(d) It follows non-causality property.

Q:31 Which one of the following is a minimum phase wavelet?
(a) $\{6, -1, -1\}$
(b) $\{3, -5, -2\}$
(c) $\{-2, -5, 3\}$
(d) $\{-1, -1, 6\}$

Q:32 A signal with input frequency 625 Hz is sampled at every two milliseconds. What will be the folding-back frequency in the output after aliasing?
(a) 100 Hz
(b) 125 Hz
(c) 250 Hz
(d) 370 Hz

Q;33 Match List-I with List-II and select the correct answer using the code given below the Lists:

List-I (Functions)	List-II (Fourier transform)
A. Real and even	Imaginary
B. Real and odd	Imaginary and odd
C. Real even plus imaginary odd	Real
D. Real odd plus imaginary even	Real and even

Code:

	A	B	C	D
(a)	4	3	2	1
(b)	4	2	3	1
(c)	1	3	2	4
(d)	1	2	3	4

Q:34 Consider the following statements regarding Fourier transformation :
1. It may be used to convert a time function into its amplitude and phase spectra.
2. The Fourier transform of impulse response is known as transfer function.
3. Fast Fourier transform (FFT) is used to transform continuous waveform in time domain to its equivalent frequency domain.
4. The Fourier transform of Dirac function consists a continuous frequency spectrum from zero to infinity.

Which of the statements given above are correct?
(a) 1,2 and 4
(b) 1,2 and 3
(c) 1, 3 and 4
(d) 2, 3 and 4

Q:35
The discrete-time Fourier transform (DTFT) of a discrete-time signal $x[n]$ is represented as $X\left(e^{j(1)}\right)$.

What will be the DTFT for $x[n-n_0]$
(a) $e^{-j\omega n_0}X(e^{j\omega})$
(b) $e^{-j\omega n_0/n}X(e^{j\omega})$
(c) $\frac{X(e^{j\omega})}{e^{-j\omega n_0}}$
(d) $\frac{X(e^{j\omega})}{e^{-j\omega n_0/n}}$

Q:36 The Laplace transform of unit step function?
(a) 1
(b) 1 / s
(c) 1 / s^2
(d) 1 / s^3

Q:37 Which one of the following statements regarding convolution operator is not correct?
(a) It describes the change of shape of waveform while passing through a filter.
(b) Convolution in time domain is equivalent to multiplication in frequency domain.
(c) Convolved waveform output is shorter than the input waveform.
(d) Convolution involves both folding and shifting of one waveform while keeping other waveform fixed.

Q:38 Consider the following statements regarding autocorrelation function (ACF) :
1. The ACF of a periodic waveform is also periodic.
2. The ACF of a cosine wave is a cosine wave.
3. The ACF contains all the amplitude information of the original waveform.
4. The ACF contains all the phase information of the original waveform.
Which of the statements given above are correct?
(a) 1,2 and 4
(b) 1,3 and 4
(c) 2 and 4 only
(d) 1,2 and 3

Q:39 The frequency domain of a time domain delta function contains
(a) zero frequency range
(b) unit frequency range
(c) -1 Hz to +1 Hz frequency range
(d) infinite frequency range

Q:40 The derivative of unit step function is
(a) sinc function
(b) comb function
(c) unit step function
(d) impulse function

Q:41 The input of a digital system $x(t)$ is related to output $y(t)$ as $y(t) = tx(t)$. The system is:
(a) Linear
(b) Non-linear
(c) Stable
(d) Time invariant

Q:42 Let $x_1(t)$ and $x_2(t)$ be two periodic signals with fundamental periods T_1 and T_2, respectively. For $x_1(t) + x_2(t)$ to be periodic, which one of the following should be a rational number?
(a) $T_1 + T_2$
(b) $T_1 - T_2$
(c) $\frac{T_1}{T_2}$
(d) $T_1 \times T_2$

Q:43 Which one of the following applications does NOT signify the use of Hilbert Transform in digital signal processing?
(a) Automatic gain control
(b) Time difference of arrival measurements
(c) Audio and color image compression
(d) Linear and stationary system analysis

Q:44 Which of the following conditions make digital signal processing beneficial over analog signal processing?
1. Flexibility
2. Accuracy
3. Storage

Select the correct answer using the code given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Q:45 The required condition(s) for a signal to be represented as Fourier series is/are:
(a) Dirichlet's conditions
(b) Periodicity condition
(c) Stability and Zero phase condition
(d) Discontinuity condition

Q:46 In the Fourier transform of a Gaussian function e^{-at^2}, with a > 0, an increase in 'a' will make the original Gaussian:
(a) Wider
(b) Narrower
(c) Flat
(d) Oval

Q:47

If $f(x) = \begin{cases} 1 & -\pi < x < 0 \\ 0 & 0 < x < \pi \end{cases}$ and has a period of 2π.
The value of the series $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots$ would be:
(a) $\frac{\pi^2}{12}$
(b) $\frac{\pi^2}{4}$
(c) $\frac{\pi}{2}$
(d) $\frac{\pi}{4}$

Q:48 Fourier cosine transform of the function $f(x) = \begin{cases} k & 0 < x < a \\ 0 & x > a \end{cases}$ is:
(a) $\frac{k\sin\omega a}{a}$
(b) $ka\sin\omega a$
(c) $\frac{-k\sin\omega a}{\omega}$
(d) $\frac{k\sin\omega a}{\omega}$

Q:49
The auto-correlation function of a complex valued signal exhibits:
(a) Commutative property
(b) Distributive property
(c) Associative property
(d) Conjugate property

Q:50 In Laplace transform, two very different signals may have identical algebraic expressions for $X(s)$. Which one of the following can distinguish them?
(a) Region of convergence
(b) Length of the convergence
(c) Property of the first signal
(d) Property of the second signal

Q:51 The Laplace transform of given unit step function $u(t-a)$ is:
(a) e^{-as}
(b) e^{as}
(c) $\frac{e^{-as}}{s}$
(d) $\frac{e^{as}}{s}$

Q:52 If $f(s)$ be the Laplace transform of a function $f(t)$, then $\lim_{s\to\infty} f(s)$ will be equal to:
(a) Zero
(b) 1
(c) -1
(d) ∞

Q:53 According to Parseval's theorem, the energy spectral density curve is equal to the area under:
(a) Magnitude of the signal
(b) Square root of the magnitude of the signal
(c) Square of the magnitude of the signal
(d) Independent of the magnitude of the signal

Q:54 Which one of the following processes does NOT use the power spectrum in digital signal processing?
(a) Pattern recognition
(b) Signal coding
(c) Signal reconstruction
(d) Data forecasting

Q:55
The continuous time unit step function is defined as $(x) = \begin{cases} 1 & x > 0 \\ 0 & x < 0 \end{cases}$, then $\frac{du(x)}{dx}$ will be:
(a) 1
(b) Zero
(c) $\delta(x)$
(d) -1

Q:56 A signal has a frequency spectrum of $0 - 5$kHz. If f_s is the sampling frequency of a data processing system then aliasing will arise when:
(a) $f_s > 10$kHz
(b) $f_s = 10$kHz
(c) $f_s < 10$kHz
(d) $f_s = 20$kHz

Q:57 The spectrum of a signal contains minimum and maximum frequency of 1 kHz and 100 kHz respectively. To avoid aliasing effect, the signal must be sampled at:
(a) more than 2 kHz
(b) more than 200 kHz
(c) more than 100 kHz
(d) more than 1000 kHz

Q:58 The input signal I(t) and Output signal g(t) are said to be linear, only if:
(a) g(t)I(t)
(b) $g(t)\frac{1}{I(t)}$
(c) $g(t) = I(t) \cdot g(t)$
(d) $I(t) = g(t) \cdot I(t)$

Q:59
The Fourier transform of the function $f(t) = \begin{cases} 2 & -3 \le t \le 3 \\ 0, & \text{otherwise} \end{cases}$ is:

(a) $\frac{4}{\omega}\sin 3\omega$
(b) $\frac{4}{\omega}\cos 3\omega$
(c) $\frac{2\sin 2\omega}{\omega}$
(d) $\frac{e^{i\omega t}}{\omega}$

Q:60 Transformation of a time domain signal to frequency domain is accomplished by:
(a) Fourier transform
(b) Laplace transform
(c) Fourier series
(d) Hilbert transform

Q:61 The two dimensional Fourier transform of a gravity data makes it possible to digitally filter the gravity anomalies. When the function representing gravity data is multiplied by the Fourier filter function, a new function is produced. This process is called:
(a) De-convolution
(b) Convolution
(c) Digitization
(d) Transformation

Q:62 If the Laplace transform of $2\sqrt{\frac{t}{\pi}}$ is $\frac{1}{s^{\frac{3}{2}}}$, then the Laplace transform of $\frac{1}{\sqrt{\pi t}}$ would be:
(a) $s^{-\frac{3}{2}}$
(b) $\sqrt{s}$
(c) $s^{-\frac{1}{2}}$
(d) $s^{\frac{3}{2}}$

Q:63 Relationship between Power Spectral Density (PSD) and autocorrelation of a real, stationary signal is:
(a) PSD is the Fourier transform of autocorrelation
(b) PSD is the Z transform of autocorrelation
(c) PSD is the Laplace transform of autocorrelation
(d) PSD is the Hilbert transform of autocorrelation

Q:64 The Laplace transform of a function f(t) is $L\{f(t)\} = F(s)$. Let $f(t) = e^{at}$, when $t \geq 0$ and ' a ' is a constant and ' a ' $< s$ then the value of $L\{f(t)\}$ is:
(a) $\frac{1}{s-a}$
(b) $\frac{1}{s+a}$
(c) $\frac{1}{s^2+a^2}$
(d) $\frac{1}{s^2-a^2}$

Q:65 If two functions have lengths of 4 and 3 respectively then their convolved output has a length of:
(a) 7
(b) 6
(c) 1
(d) -1

Q:66
Autocorrelation function of a wave form contains information on:
(a) Phase only
(b) Phase and amplitude
(c) Amplitude only
(d) Noise

Q:67
Cross correlation function measures the:
(a) Degree of dissimilarity in wave forms
(b) Degree of similarity in wave forms
(c) Impulse response
(d) De-convolution response

Q:68 The value of integral $\int_{-\infty}^{\infty} \delta(x^2 - 4\pi^2)\cos x dx$ is:
(a) π
(b) $-\pi$
(c) $\frac{1}{2\pi}$
(d) 0 (zero)

Q:69 Consider the unit-step function $\mathbf{u(t-a)} = \begin{cases} 0 \text{ if } t < a \\ 1 \text{ if } t > a \end{cases}$
If $f(t)$ be a function then the product function $f(t)u(t-a)$ will produce:
(a) Rotation effect
(b) Damping effect
(c) No change
(d) Switching off and on effect

Q:70
The Laplace transform of a delta function at time $t = 1$ is:
(a) 1
(b) e^{-s}
(c) e^{-t}
(d) $1/t$

Q:71 The value of $\int_{-\infty}^{+\infty} t^3\delta(1-2t)dt$ will be:
(a) 1
(b) 8
(c) $\frac{1}{8}$
(d) $\frac{1}{16}$

Q:72 What is the Nyquist frequency for a seismic data recorded with a sampling rate of 100 Hz ?
(a) 250 Hz
(b) 200 Hz
(c) 100 Hz
(d) 50 Hz

Q:73 Which one of the following filters is used to avoid the aliasing problem in seismic data processing?
(a) Low-pass filter
(b) High-pass filter
(c) Band-pass filter
(d) Notch filter

Q:74 The convolution of a signal with a delta function
(a) alters the shape of the signal only
(b) does not alter the shape of the signal but produces a time shift in the original signal
(c) makes the signal zero at all times
(d) alters the shape of the signal as well as produces a time shift in the original signal

Q:75 The only non-zero Fourier series coefficients for the signal $x(t) = \sin\omega_0 t$, having fundamental frequency ω_0, are
(a) $\pm\frac{1}{8i}$
(b) $\pm\frac{1}{6i}$
(c) $\pm\frac{1}{4i}$
(d) $\pm\frac{1}{2i}$
(where $i = \sqrt{-1}$)

Q:76 The radix-2 fast Fourier transform requires the sequence length of the input time-domain signal to be an integral power of
(a) 2
(b) 3
(c) 4
(d) 5

Q:77 The Laplace transform of a function $f(t)$ is given as $F(s)$. The Laplace transform of a time-domain signal $f(t) = Ae^{-at}$ (A = constant, $a > 0$) is
(a) $\frac{A}{s}$
(b) $\frac{A}{s^2}$
(c) $\frac{A}{s+a}$
(d) $\frac{A}{(s+a)^2}$

Q:78 What would be the length of the output signal, generated after convolution of two signals of lengths D_1 and D_2 ?
(a) $D_1 + D_2 - 1$
(b) $D_1 + D_2 + 1$
(c) $D_1 + D_2 - 2$
(d) $D_1 + D_2 + 2$

Q:79 Which one of the following is not correct about the Dirac delta function?
(a) The Fourier transform of a Dirac function is equal to a nonzero constant.
(b) The Dirac function can be used to delay a time series function.
(c) The product of a function with a Dirac function gives a Dirac function of amplitude equal to the sample of that function.
(d) The Fourier transform of a Dirac function is equal to zero.

Q;80 With the increase in number of input data points, the difference between the number of complex multiplications required by the radix- 2 fast Fourier transform (FFT) and the discrete Fourier transform (DFT)
(a) remains constant
(b) increases
(c) decreases
(d) becomes zero

Topic: 18 Remote Sensing and Black Body

Q:1
Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I [Microwave band]	List-II [Frequency (in GHz)]
1. C-band	A. 0.3-1
2. K-band	B. $1-2$
3. Ka-band	C. 2-4
4. Ku-band	D. 4-8
5. L-band	E. $8-12\cdot5$
6. P-band	F. $12\cdot5-18$
7. S-band	G. $18-26\cdot5$
8. X-band	H. $26\cdot5-40$

Code:

	C	D	E	F
(a)	2	5	6	8
(b)	3	7	2	5
(c)	7	1	8	4
(d)	4	2	1	3

Q:2 Which one of the following parameters does not govern the texture in an optical image?
(a) Scale
(b) Shadow
(c) Spatial resolution
(d) Dielectric constant

Q:3 Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I [Electromagnetic radiation]	List-II [Frequency range (in Hz)]
A. Gamma rays	$10^9 - 10^{12}$
B. Infrared	$10^{12} - 10^{14}$
C. Microwave	$10^{15} - 10^{17}$
D. Ultraviolet	$10^{19} - 10^{22}$

Code:

	A	B	C	D
(a)	3	1	2	4
(b)	3	1	1	4
(c)	4	1	2	3
(d)	4	2	1	3

Q:4 In an atom, a photon is emitted during a transition from energy level E_1 to energy level E_2. If the difference between E_1 and E_2 is 4.136 eV , then the corresponding photon wavelength is approximately given, the Planck's constant is 4.136×10^{-15}eVs and the speed of light is 3×10^8 m/s
(a) 300 nm
(b) 30.0 nm
(c) 3.00 nm
(d) 0.30 nm

Q:5 For blackbody radiation, the pressure (P) is given by the relation
(a) $P = \frac{4\sigma T^4}{c}$
(b) $P = \frac{4\sigma T^4}{3c}$
(c) $P = \frac{3\sigma T^4}{4c}$
(d) $P = \frac{\sigma T^4}{3}$
[where T is temperature, σ is Stefan's constant and c is the distance travelled by radiation in unit time]

Q:6 Consider the following statements regarding spectral distribution of energy for blackbody radiation :
1. For given wavelength, the energy density decreases with increase in temperature.
2. At each temperature, the distribution of energy shows a maximum, which shifts to longer wavelength as temperature increases.
3. At each temperature, the distribution of energy shows a maximum, the product of wavelength and temperature at the maximum is constant value.

Which of the statements given above is/are correct?
(a) 1 only
(b) 1 and 2
(c) 3 only
(d) 1 and 3

Q:7 For shorter wavelength limit, the Planck's radiation law becomes
(a) Rayleigh-Jeans law
(b) Wien's radiation law
(c) Stefan's law
(d) Kirchhoff's law

Q:8 A nuclear fission explosion produces a fireball which can be approximated as a blackbody having electromagnetic radiation power 12.56 MW . The electromagnetic radiation intensity at 5 km distance is
(a) 25MW/m^2
(b) 0.04MW/m^2
(c) $25\ \text{W/m}^2$
(d) $0.04\ \text{W/m}^2$

Q:9 Ratio of radiating capability or exitance of a surface to that of a black body is defined as
(a) Emissivity
(b) Reflectivity
(c) Reflectance
(d) Radiance

Q:10 Which one of the following parameters does not govern the spatial resolution of an optical remote sensing image ?
(a) Modulation Transfer Function (MTF)
(b) Signal to Noise Ratio (SNR)
(c) Object Contrast
(d) Object Temperature

Q:11
Which colour of the visible light has the highest sensitivity for the human eye ?
(a) Violet
(b) Yellow-Green

(c) Blue
(d) Orange-Red

Q:12 Sunlight strikes the surface of the Earth with an average intensity of $1400\ \mathrm{W/m^2}$. The maximum value of the electric field associated with electromagnetic radiations is approximately :
(a) $1060\ \mathrm{V/m}$
(b) $1400\ \mathrm{V/m}$
(c) $2800\ \mathrm{V/m}$
(d) $700\ \mathrm{V/m}$

Q:13 The radiant emittance of a blackbody at a temperature of 400 K is :
(a) $1452 \times 10^0 \mathrm{Watts/m^2}$
(b) $1452 \times 10^1 \mathrm{Watts/m^2}$
(c) $1452 \times 10^2 \mathrm{Watts/m^2}$
(d) $1452 \times 10^3 \mathrm{Watts/m^2}$

Q:14 The entropy for a black body radiation is :
(where T = temperature, V = volume and ' a ' is the constant which appears in the expression for radiation energy density u: $\mathrm{u} = \mathrm{aT}^4$)
(a) $\frac{4}{3}aT^3V$
(b) $\frac{4}{3}aT^5V$
(c) $\frac{2}{3}aT^3V$
(d) $\frac{2}{3}\mathrm{aT}^5\ \mathrm{V}$

Q:15 When size of particles is very small compared to the wavelength of the radiation, which of the following scattering processes is/are expected to occur?
(a) Mie only
(b) Non-selective only
(c) Rayleigh
(d) Mie and non-selective

Q:16 The apparent change in frequency due to motion of the source and/or observer is known as
(a) dispersion effect
(b) scattering effect
(c) Doppler effect
(d) path attenuation effect

Q:17 If the frequency of an electromagnetic radiation is doubled, its wavelength becomes
(a) 1/2 of original
(b) 2 times of original
(c) 1/4 of original
(d) 4 times of original

Q:18 Which one of the following regions of the electromagnetic spectrum enables us to see through clouds?
(a) Visible region
(b) Shortwave infrared region
(c) Microwave region
(d) Ultraviolet region

Q:19 What kind of electromagnetic waves would dominantly reach the Earth surface, if the temperature of the Sun reduces by half?
(a) Infrared
(b) Ultraviolet
(c) Green light
(d) Visible

Q:20 The ratio of the energy of a photon of 2000Å wavelength to that of 4000Å wavelength is
(a) $\frac{1}{2}$
(b) $\frac{1}{4}$
(c) 2
(d) 4

Q:21 Total radiation emitted by a black-body depends upon the temperature of the emitting surface (fourth power of its absolute temperature). This corresponds to
(a) Stefan-Boltzmann law
(b) Planck's law
(c) Wien's displacement law
(d) Debye's law

Q:22 The Planck's black-body radiation graph at sufficient long wavelengths can be approximated with a line of slope
(a) -2
(b) -3
(c) -4
(d) -5

Q:23 Non-selective scattering occurs if the size of effective atmospheric particles is
(a) smaller than the wavelength of radiation
(b) of same size as the wavelength of radiation
(c) larger than the wavelength of radiation
(d) independent of the wavelength of radiation

Q:24 Which band of the electromagnetic spectrum can penetrate the clouds?
(a) Infrared wave band
(b) Thermal infrared wave band
(c) Microwave band
(d) Ultraviolet band

Q:25 What is the approximate value of impedance of free space (Z_0) required to calculate flux density of electromagnetic waves?
(a) 170Ω
(b) 377Ω
(c) 445Ω
(d) 520Ω

Q:26 What percent of the incident radiant flux is reflected back by the earth?
(a) 17
(b) 25
(c) 35
(d) 46

Q:27 A blackbody is at a temperature of 5796 K . What will be the wavelength at which the peak spectral radiance occurs?
(where displacement constant $= 2.898 \times 10^{-3}$ m K)
(a) 0.3μ m
(b) 0.5μ m
(c) 1.0μ m
(d) 1.5μ m
Q:28 2022
The relative magnetic permeability of water is close to
(a) 1
(b) 9
(c) 83
(d) 377

Q:29 Which one of the following statements is correct according to Planck's radiation law?
(a) Cold bodies emit more energy at shorter wavelengths.
(b) Warm bodies emit more energy at shorter wavelengths.
(c) Cold bodies emit more energy at longer wavelengths.
(d) Warm bodies emit more energy at longer wavelengths.

Q:30 The ozone layer termed as protector of blanket of earth's atmosphere. It protects earth from harmful radiations and converts ultraviolet radiation into:
(a) Visible radiation
(b) Microwave radiation
(c) Infra red radiation
(d) X-rays radiation

Q:31
A goniometer is used for measurement of bidirectional reflectance distribution function (BDRF) of the surface for the purpose of:
(a) Measuring reflectance for all combinations of illumination and viewing angles at a particular wavelength
(b) Illuminations parallel to the surface only
(c) Illuminations in the perpendicular direction only
(d) Illuminations at $45°$ from the surface only

Q:32 The absorption band at $9.2 - 10.2\mu$ m in the thermal-infrared region is due to:
(a) Presence of carbon dioxide in the atmosphere
(b) Presence of ozone in the upper atmosphere
(c) Presence of water vapors in the lower atmosphere
(d) Presence of suspended particulate matter

Q:33 The part of the signal emanating from the atmosphere is called:
(a) Path length
(b) Path radiance
(c) Ground radiance
(d) Back scattering

Q:34 Light enters a denser medium B from a rarer medium A . Which one among the following relation is true (where λ is the wavelength and v is the frequency in respective media)?
(a) $\lambda_A = \lambda_B$ and $v_A = v_B$
(b) $\lambda_A > \lambda_B$ and $v_A = v_B$
(c) $\lambda_A < \lambda_B$ and $v_A = v_B$
(d) $\lambda_A > \lambda_B$ and $v_A < v_B$

Q:35 Which one of the following pairs of electric field vector **E** and magnetic field vector **B** may represent a plane electromagnetic wave propagating along z direction?
(a) (E_x and B_y) and (E_x and B_z)
(b) (E_y and B_x) and (E_x and B_y)
(c) (E_x and B_z) and (E_z and B_x)
(d) (E_y and B_x) and (E_y and B_y)

Q:36 What is the wavelength range of the visible spectrum of electromagnetic wave?
(a) 0.5 nm to 0.7 nm
(b) 0.9 nm to 0.11 nm
(c) 0.2 mm to 0.4 mm
(d) 0.4μ m to 0.7μ m

Q:37
What will happen to the maximum value of spectral energy density of a blackbody when its temperature is

doubled?
(a) It becomes 32 times of its initial value
(b) It becomes 8 times of its initial value
(c) It becomes 2 times of its initial value
(d) It becomes 16 times of its initial value

Q:38 A hot body at 2000 K emits maximum energy at a wavelength of 15,000 angstrom. If Sun emits a maximum energy at 5000 angstrom, what would be the approximate temperature of the Sun?
(a) 6000 K
(b) 600 K
(c) 8000 K
(d) 5000 K

Q:39 The radiant power emitted by a body depends on the emissivity of the body. Which one of the following relations correctly describe the value of emissivity?
(a) It is always more than 1 for a black body while it is less than 1 for a gray body
(b) It is always equal to 1 for a black body while it is zero for a gray body
(c) It is always equal to 1 for a black body while it is less than 1 for a gray body
(d) It is always positive for a black body while for a gray body it is negative

Q:40 With the increase in temperature of a blackbody, what is the wavelength shift in the emitted radiation of highest intensity?
(a) Blue shift
(b) Red shift
(c) No shift and no change in intensity
(d) No shift but change in intensity

Q:41 Which one of the following laws gives the distribution of radiation energy over wavelength for a blackbody at a given temperature?
(a) Kirchhoff's law
(b) Planck's law
(c) Snell's law
(d) Lambert's law

Q:42 The ratio of total solar radiant energy returned by a body to the total radiant energy incident on the body is called:
(a) Reflectance
(b) Transmittance
(c) Albedo
(d) Reflection Coefficient

Q:43 Which of the following is NOT used as principle of remote sensing?
(a) Interaction of electromagnetic radiation with atmosphere
(b) Interaction of electromagnetic radiation with earth surface
(c) Interaction of electromagnetic radiation with satellites
(d) Interaction of electromagnetic radiation with clouds and aerosols

Q:44 Which one of the following statement is correct for remote sensing techniques?
(a) They use both sonic and electromagnetic waves for investigation
(b) They use entire range (radio waves to gamma-rays) of the electromagnetic spectrum for investigation
(c) They use microwave, infrared and visual portions of the electromagnetic spectrum for investigation
(d) They gather the information with or without actual contact with the object or area under investigation

Q:45 What is the refractive index of air at Standard Temperature Pressure (STP) for sodium yellow light?
(a) Exactly 1.0
(b) About 0.03% higher than that of vacuum
(c) About 0.03% lower than that of vacuum
(d) It depends on the location

Q:46 Which one of the following colours of light travel fastest through a transparent glass sheet?
(a) Red
(b) Yellow
(c) Green
(d) Violet

Q:47 The planet Saturn has a surface temperature 80 K . The wavelength corresponding to maximum radiation that can be detected from it is:
(a) 330 nm
(b) 330Å
(c) 33μ m
(d) 33 mm

Q:48
The total radiant emittance is given by $u = \sigma AT^4$. This equation represents:
(a) Planck's radiation law
(b) Wein's Law
(c) Stefan-Boltzmann law
(d) Kirchhoff's law

Q:49 The surface temperature of the sun is 6000 K and it emits maximum energy at a wavelength of 4753Å. If the moon emits maximum energy at a wavelength 15×10^{-6} m, then what would be the surface temperature of the moon?
(a) 180 K
(b) 190 K
(c) 200 K
(d) 210 K

Q:50 What is the most probable energy ' E ' for photons emitted by a black body of temperature T, assuming that the intensity $I(E) \sim E^5 e^{-E/kT}$?
(where k is Boltzmann constant)
(a) kT
(b) 2 kT
(c) $1/2kT$
(d) 4 kT

Q:51 The ratio of photons presents in 1 cm^3 of radiation in thermal equilibrium at 1000 K to the photons present in the same volume of radiation in thermal equilibrium at 8000 K is:
(a) 1: 2
(b) 2: 1
(c) 1: 64
(d) 1: 512

Q:52 Planck's formula for black body radiation reduces to Rayleigh and Wien's formulae respectively for:
(a) Small and large wavelength
(b) Large and small wavelength
(c) Large and complex wavelength
(d) Complex and large wavelength

Q:53 Which one of the following represents the active remote sensing system?
(a) Aerial photography
(b) Visible/near infrared imaging
(c) Thermal infrared imaging
(d) Real aperture radar

Q:54 The geostationary orbit of a satellite around the earth is such that the satellite remains stationary with respect to the earth. It requires that the orbit must be:
a) Geosynchronous, elliptical with height from the surface of earth nearly 36,000Km
b) Geosynchronous, circular with height from the surface of earth nearly 36,000Km
c) Geosynchronous, circular and stays over the geographical poles of earth at a height of nearly 36,000km
d) Geosynchronous, orthogonal above the south pole at a height of nearly 36,000Km

Q:55 Which one of the following microwave bands will have the maximum penetration in dry sand?
(a) P
(b) S
(c) X
(d) K

Q:56
Which of the following ground parameters are measured during field survey using thermal infrared region of electromagnetic spectrum?
(a) Ground temperature and spectral emissivity
(b) Rainfall pattern and backscattering coefficient
(c) Spectral emissivity and backscattering coefficient
(d) Ground temperature and rainfall pattern

Q:57 Which one of the following statements is not correct regarding body's emissivity?
(a) The spectral emissivity values range from 0-1.
(b) Blackbody radiates a continuous spectrum.
(c) The Sun and the Earth as whole bodies radiate a near-continuous spectrum.
(d) The spectral emissivity values of a gray body are not constant at all wavelengths.

Q:58 Consider the following statements :
1. Stefan-Boltzmann relation applies to all wavelengths of the spectrum shorter than microwaves.
2. Rayleigh-Jeans law is valid for longer wavelengths such as microwaves.
Which of the statements given above is/are correct?
(a) Both 1 and 2
(b) 1 only
(c) 2 only
(d) Neither 1 nor 2

Q:59 Which one of the following is the correct sequence of the electromagnetic waves in the order of their increasing frequencies?
(a) Radio wave, Microwave, Infrared, Visible, Ultraviolet, X-ray
(b) Radio wave, Infrared, Microwave, Visible, Ultraviolet, X-ray
(c) Microwave, Radio wave, Infrared, Visible, X-ray, Ultraviolet

(d) Infrared, Visible, Ultraviolet, Microwave, Radio wave, X-ray

Q:60 A hot blackbody emits energy at the rate of $25\ \text{J m}^{-2}\ \text{s}^{-1}$ with most intense radiation corresponding to wavelength of 20000Å. If the temperature of the body is further raised, its most intense radiation corresponds to wavelength of 10000Å. Then the rate at which energy is emitted is
(a) $100\ \text{J m}^{-2}\ \text{s}^{-1}$
(b) $200\ \text{J m}^{-2}\ \text{s}^{-1}$
(c) $400\ \text{J m}^{-2}\ \text{s}^{-1}$
(d) $800\ \text{J m}^{-2}\ \text{s}^{-1}$

Q:61 The correct value of the StefanBoltzmann constant is
(a) $5.6704 \times 10^{-7}\ \text{W m K}^{-4}$
(b) $5.6704 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$
(c) $4.6704 \times 10^{-8}\ \text{W m K}^{-4}$
(d) $4.6704 \times 10^{-7}\ \text{W m}^{-2}\ \text{K}^{-4}$

Topic: 19 Thermodynamics

Q:1 Consider the following thermodynamic relation :

$$dU = TdS - PdV$$

[where $U =$ internal energy, $S =$ entropy, $T =$ temperature, $P =$ pressure and $V =$ volume
Which one of the following pairs is correct, as obtained from the above thermodynamic relation?
(a) $T = -(\partial U/\partial S)_V$ and $P = -(\partial U/\partial V)_S$
(b) $T = +(\partial U/\partial S)_V$ and $P = +(\partial U/\partial V)_S$
(c) $T = +(\partial U/\partial S)_V$ and $P = -(\partial U/\partial V)_S$
(d) $T = -(\partial U/\partial S)_V$ and $P = +(\partial U/\partial V)_S$

Q:2 Which one of the following functions is defined by the 2nd law of thermodynamics?
(a) Enthalpy
(b) Entropy
(c) Internal energy
(d) Pressure

Q:3 2025
A heat pump uses 2 kW of electrical power supply to heat a house at $25°\text{C}$ when the outside temperature is $0°\text{C}$. The maximum heat flow rate is
(a) 23.84 kJ/s
(b) 11.92 kJ/s
(c) 2.0 kJ/s
(d) 0.17 kJ/s

Q:4 What is the temperature at which the Kelvin and Fahrenheit scales coincide?
(a) 274.25
(b) 574.25
(c) 374.25
(d) -40

Q:5 A Carnot engine absorbs 200 J of heat from a reservoir at the temperature of $273 \cdot 17°\text{C}$. What is the work done by the engine, if it rejects heat to the reservoir at a temperature of triple point of water?
(a) 300 J
(b) 400 J
(c) 150 J
(d) 100 J

Q:6 Which one of the following statements regarding molar heat capacities for all ideal gases is true ? (where T is temperature and other symbols have their usual meaning)
(a) C_v is not a function of T .
(b) C_P is a function of T only and is less than C_v.
(c) $\text{C}_\text{P} - \text{C}_\text{v}$ is not a function of T .
(d) The ratio $\text{C}_\text{P}/\text{C}_\text{v}$ is not a function of T and is less than 1 .

Q:7 A system experiences a change of temperature from T_i to T_f during the heat transfer of Q units. What would be the average heat capacity of the system?
(a) $\frac{T_f - T_i}{Q}$
(b) $\frac{Q}{T_f - T_i}$
(c) $\frac{T_i - T_f}{Q}$
(d) $\frac{Q}{T_i - T_f}$

Q:8 When 26,400 J of energy is supplied to a 2.0 kg block of aluminum, its temperature rises from $20°\text{C}$ to $35°\text{C}$. The block is well insulated so that there is no energy loss to the surroundings. What is the specific heat capacity of aluminum?
(a) $480\ \text{J kg}^{-1}\ \text{K}^{-1}$
(b) $880\ \text{J kg}^{-1}\ \text{K}^{-1}$
(c) $180\ \text{J kg}^{-1}\ \text{K}^{-1}$
(d) $1880\ \text{J kg}^{-1}\ \text{K}^{-1}$

Q:9
A heat engine operates between a cold reservoir at temperature $T_2 = 360$ K and a hot reservoir at temperature T_1. It takes 100 J of heat from the hot reservoir and delivers 60 J of heat to the cold reservoir in a cycle. What could be the minimum temperature of the hot reservoir?
(a) 800 K
(b) 900 K

(c) 600 K
(d) 1000 K

Q:10 There are four dishes (i) a ladoo (spherical) with a radius of 4 cm ; (ii) another ladoo with a radius of 8 cm ; (iii) a pizza (disc) with a radius of 10 cm ; and a pizza of same thickness with a radius of 20 cm . All the four dishes are simultaneously heated in an oven. Which one of them will be heated first?
(a) Smaller ladoo will be heated first
(b) Both the ladoos will be heated in the same time and prior to pizzas
(c) Both the pizzas will be heated in the same time and prior to ladoos
(d) All the four dishes will be heated in the same time

Q:11 For a reversible isothermal process, the work done by the system is equal to:
(a) Decrease in Helmholtz function
(b) Increase in Helmholtz function
(c) Decrease in Gibb's free energy
(d) Increase in Gibb's free energy

Q:12 A resistor immersed in running water carries an electric current. Considering the resistor as the system, which of the following holds true?
(a) $\mathrm{Q}=0, \mathrm{W}=-\mathrm{ve}, \Delta \mathrm{U}=-\mathrm{ve}$
(b) $\mathrm{Q}=0, \mathrm{W}=-\mathrm{ve}, \Delta \mathrm{U}=+\mathrm{ve}$
(c) $\mathrm{Q}=0, \mathrm{W}=+\mathrm{ve}, \Delta \mathrm{U}=-\mathrm{ve}$
(d) $Q=0, W=+\mathrm{ve}, \Delta U=+\mathrm{ve}$

Q:13 The difference of Helmholtz free energy F and Gibbs free energy G, (that is F-G) for an ideal gas sample of one mole is:
(a) RT
(b) -RT
(c) T
(d) -T

Q:14 The energy of an oscillator of frequency v is equal to
(a) $\frac{h}{v}$
(b) hv
(c) $h^2v^{2/3}$
(d) $h^{2/3}v^2$
(where h is Planck's constant)

Q:15 The Kelvin-Planck statement of the second law of thermodynamics deals with
(a) conservation of energy
(b) conservation of mass
(c) conversion of work into heat
(d) conversion of heat into work

Q:16 Which one of the following thermodynamic laws relates the change in internal energy of a system with the heat supplied to the system and the work done by the system on its surroundings?
(a) Zeroth law
(b) First law
(c) Second law
(d) Third law

Topic: 20 Nuclear Properties, Nuclear Models, Nuclear Force and Particle Physics

Q:1 Consider the following nuclear electric quadrupole moments (Q) of the nuclei :

Nuclide	Q (in barn)
^{133}Cs	-0.003
^{161}Dy	+2.401
^{63}Cu	-0.209

Which one of the following statements regarding the shape of these nuclei is correct?
(a) ^{63}Cu is prolate, ^{133}Cs is near spherical and ^{161}Dy is oblate.
(b) ^{63}Cu and ^{133}Cs are prolate and ^{161}Dy is oblate.
(c) ^{63}Cu and ^{161}Dy are oblate and ^{133}Cs is prolate.
(d) ^{63}Cu is oblate, ^{133}Cs is near spherical and ^{161}Dy is prolate.

Q:2 The ratio of the nuclear magneton and Bohr magneton is
(a) 1836
(b) $1/1836$
(c) 3672
(d) $1/3672$

Q:3 Which one of the following has maximum binding energy per nucleon?
(a) $^{4}_{2}$He
(b) $^{12}_{6}$C
(c) $^{58}_{28}$Ni
(d) $^{208}_{82}$ Pb

Q:4
A heavy nucleus goes to spontaneous symmetric fission. The energy released using the Bethe-Weizsãcker mass formula (neglecting pairing term) is given by

(a) $a_s A^{\frac{2}{3}}\left(1-2^{1/3}\right)+a_c \frac{Z^2}{A^{\frac{1}{3}}}\left(1-2^{-2/3}\right)$
(b) $a_s A^{\frac{2}{3}}\left(1+2^{1/3}\right)+a_c \frac{Z^2}{A^{\frac{1}{3}}}\left(1-2^{2/3}\right)$
(c) $a_s A^{\frac{2}{3}}\left(1+2^{1/3}\right)+a_c \frac{Z^2}{A^{\frac{1}{3}}}\left(1+2^{-2/3}\right)$
(d) $a_s A^{\frac{2}{3}}\left(1-2^{1/3}\right)+a_c \frac{Z^2}{A^{\frac{1}{3}}}\left(1-2^{2/3}\right)$

Q:5 The electric quadrupole moment for a spherical nucleus is :
(a) Positive
(b) Negative
(c) Zero
(d) Dependent on the atomic number of the nucleus

Q:6 Which one among the following best describes nuclear force?
(a) A strong long-range force between two nucleons which depends on their electric charges
(b) A weak short-range force between two nucleons which depends on their electric charges
(c) A strong short-range force which is responsible for the attraction between a proton and a neutron
(d) A weak long-range force which is responsible for the attraction between a proton and a neutron

Q:7
Which one of the following set of charges can be possessed by quarks present in a nucleon?
(a) $-2/3$ and $-1/3$ times the electron charge
(b) $+2/3$ and $-1/3$ times the electron charge
(c) $-2/3$ and $+1/3$ times the electron charge
(d) $+2/3$ and $+1/3$ times the electron charge

Q:8 The binding energy is often expressed in mass units. One atomic mass unit is equivalent to: (where c is the speed of light in vacuum)
(a) $931.494\text{MeV}/c^2$
(b) $93 \cdot 1494\text{MeV}/c^2$
(c) $9 \cdot 31494\text{MeV}/c^2$
(d) $9314.94\text{MeV}/c^2$

Q:9 In a scattering experiment, the atomic mass of the target nucleus is 27 times the atomic mass of the projectile nucleus. The ratio of the radius of the target nucleus to the radius of the projectile nucleus is
(a) 27
(b) 81
(c) 9
(d) 3

Q:10 Which one of the following experimental methods is not used to measure nuclear matter distribution?
(a) Rutherford scattering
(b) Electron scattering
(c) Alpha decay
(d) π-Mesic X-rays

Q:11 Which one of the following statements is true about the nuclear density of $^{12}_{6}\text{C}$ and $^{238}_{92}\text{U}$ nucleus?
(a) $^{238}_{92}\text{U}$ is more dense than $^{12}_{6}\text{C}$.
(b) $^{12}_{6}\text{C}$ is more dense than $^{238}_{92}\text{U}$.
(c) Both the nuclei have the same nuclear density.
(d) Nuclear density depends on the abundance of the element.

Q:12 Which one of the following represents a pair of mirror nuclei?
(a) $^{15}_{7}$ N and $^{15}_{8}\text{O}$
(b) $^{16}_{8}\text{O}$ and $^{17}_{8}\text{O}$
(c) $^{60}_{27}\text{Co}$ and $^{66}_{30}\text{Zn}$
(d) $^{14}_{6}\text{C}$ and $^{16}_{8}\text{O}$

Q:13 The total angular momentum of a nucleus is a
(a) scalar quantity and is the sum of the angular momenta of all the nucleons
(b) vector quantity and is the vector sum of the angular momenta of all the charged nucleons only
(c) vector quantity and is the vector sum of the angular momenta of all the nucleons
(d) scalar quantity and is the sum of the angular momenta of all the charged nucleons only

Q:14 Among the protium, deuterium and tritium isotopes of hydrogen, which one has the largest value of the ratio of binding energy to rest mass energy?
(a) Protium
(b) Deuterium
(c) Tritium
(d) Same for all the three isotopes of hydrogen

Q:15 Consider ^{3}He and ^{3}H nuclei which have equal number of nucleons. Which one of the following energy terms will not be the same for both the nuclei in the semi-empirical mass formula?
(a) Volume energy term
(b) Surface energy term
(c) Coulomb energy term
(d) Pairing energy term

Q:16

What is the approximate mass A of a nucleus having radius 2.71 fm ? (where $r_0 = 1.5\text{fm}$)
(a) 4
(b) 8
(c) 7
(d) 6

Q:17 What will be the radius of the nucleus with atomic mass 216 , if nuclear radius parameter is $r_0 = 1.5$ fm ?
(a) 9.0 fm
(b) 54.0 fm
(c) 6.0 fm
(d) 324 fm

Q:18 Two spherical nuclei have mass numbers 216 and 64 with their radii a_1 and a_2 respectively. The ratio a_1/a_2 is:
(a) 1.5
(b) 3
(c) 2.5
(d) 6

Q:19 Mass of a helium nucleus is 4.0028 amu , where as the mass of a proton is 1.00758 amu and that of neutron is 1.00897 amu. The biding energy of alpha particle in MeV unit will be: $(1\text{amu} \equiv 931\text{Mev})$
(a) 21.5 MeV
(b) 0.0303 MeV
(c) 28.21 MeV
(d) $28.21 \times 10^{-6}\text{MeV}$

Q:20 Which one of the following properties of the nuclear force is correct?
(a) It depends on the charge of the nucleons
(b) It depends on the directions of the spins of the nucleons
(c) It does not depend on the directions of the spins of the nucleons
(d) It depends on the mass of the nucleons

Q:20 Which one of the following pairs is an example of mirror nuclei?
(a) ^{14}C and ^{13}C
(b) ^{13}C and ^{14} N
(c) ^{13}C and ^{13} N
(d) ^{13}C and ^{12} B

Q:21 The ground-state spin (J) and parity (P) of most of the even-even (even protons, even neutrons) nuclei, i.e., J^P, is
(a) 3^-
(b) 0^+
(c) $5/2^+$
(d) 0^-

Q:22 The approximate radius R of ^{125}Sn nucleus is
(a) 1.2 fm
(b) 12.5 fm
(c) 6 fm
(d) 10 fm

Q:23 According to the liquid drop model, when a nucleus is bombarded by neutrons, the compound nucleus before undergoing fission attains the shapes in the sequence of
(a) ellipsoidal, spherical, dumbbell
(b) spherical, ellipsoidal, dumbbell
(c) spherical, dumbbell, ellipsoidal
(d) dumbbell, ellipsoidal, spherical

Q:24 The total binding energy of $^{20}_{10}\text{Ne}$ nucleus is 160.647 MeV . The binding energy per nucleon for $^{20}_{10}\text{Ne}$ is
(a) 160.647 MeV
(b) 16.064 MeV
(c) 8.032 MeV
(d) 5.354 MeV

Topic: 21 Radioactivity

Q:1 In the Sun, the fusion process generates energy using proton-proton cycle. Which one of the following reactions is dominating in the ^3_2He burning process?
(a) $^3_2\text{He} + {}^4_2\text{He} \rightarrow {}^7_4\text{Be} + \gamma$
(b) $^3_2\text{He} + {}^2_1\text{H} \rightarrow {}^4_2\text{He} + p$
(c) $^3_2\text{He} + {}^3_1\text{H} \rightarrow {}^4_2\text{He} + d$
(d) $^3_2\text{He} + {}^3_2\text{He} \rightarrow {}^4_2\text{He} + 2p$

Q:2 When the ^{22}Na nucleus decays to ^{22}Ne, both electron capture decay and positive beta decay processes are energetically possible. If the Q-value of electron capture decay of ^{22}Na is 2.254 MeV , then the Q-value of positive beta decay of ^{22}Na is
(a) 3.276 MeV
(b) 2.254 MeV
(c) 1.743 MeV
(d) 1.232 MeV

Q:3 The maximum Coulomb repulsive potential that the α-particle experiences in the α-decay of $^{212}_{84}\text{Po}$ is [given, $R_0 = 1.20\text{fm}$]
(a) 22.24 MeV
(b) 26.21 MeV
(c) 30.24 MeV
(d) 34.24 MeV

Q:4
Consider that two isotopes of uranium $^{238}_{92}\mathrm{U}$ and $^{235}_{92}\mathrm{U}$ have abundance 93.0% and 7.0%, respectively in a planet. If these two isotopes were equal at the time of planet formation, then the age of the planet (in years) is
[given, the half-lives of $^{235}_{92}\mathrm{U}$ and $^{238}_{92}\mathrm{U}$ are 7×10^8 years and 4.5×10^9 years, respectively; $\ln 93 = 4.533$ and $\ln 7 = 1.946$]
(a) 3.1×10^9
(b) 5.9×10^8
(c) 3.1×10^8
(d) 5.9×10^9

Q:5 Naturally occurring radioactive isotope, which has only beta decay as primary mode of decay, is
(a) $^{186}\mathrm{Os}$
(b) $^{232}\mathrm{Th}$
(c) $^{235}\mathrm{U}$
(d) $^{176}\mathrm{Lu}$

Q:6 The activity of 2.0 g of $^{226}\mathrm{Ra}$ is [given, the half-life of $^{226}\mathrm{Ra}$ is 1600 years]
(a) $3.7 \times 10^{10}\mathrm{Ci}$
(b) $7.4 \times 10^{10}\mathrm{Ci}$
(c) 2×10^{10} Bq
(d) 7.4×10^{10} Bq

Q:7 Which of the following moderator(s) can be used in fission reactors fuelled by natural uranium?
(a) Beryllium
(b) Boron
(c) Cadmium
(d) $^{12}\mathrm{C}$ in the form of graphite or $\mathrm{D_2O}$

Q:8 Among the stable nuclei, the ratio of neutron number (N) to proton number (Z) increases with atomic mass (A) because of
(a) Large Coulombic repulsion among protons as Z increases.
(b) Increase in pairing effect between neutrons and protons.
(c) Magic number of neutrons, provides more stability as A increases.
(d) Large surface energy of the nucleus as Z increases.

Q:9 Decay of $^{137}_{55}\mathrm{Cs}$ radioactive source is an example of :
(a) Alpha decay
(b) Beta plus decay
(c) Beta minus decay
(d) Neutron decay

Q:10 Which one of the following radioactive minerals has Thorium (Th) radioactivity?
(a) Alunite
(b) Carnotite
(c) Monazite
(d) Muscovite

Q:11 The daughter nucleus produced after beta-plus decay of $^{107}_{48}\mathrm{Cd}$ is :
(a) $^{107}_{49}\mathrm{In}$
(b) $^{108}_{48}\mathrm{Cd}$
(c) $^{107}_{47}\mathrm{Ag}$
(d) $^{107}_{46}\mathrm{Pd}$

Q:12 $^{238}_{92}\mathrm{U}$ cannot spontaneously emit a proton as :
(a) $^{238}_{92}\mathrm{U}$ is not a radioactive element
(b) $^{238}_{92}\mathrm{U}$ is a heavy element
(c) The proton is a stable particle
(d) The process has a negative Q value

Q:13
The fission chain reaction will be subcritical when multiplication factor k is
(a) equal to zero
(b) equal to one
(c) greater than one
(d) less than one

Q:14 Consider the following equation for a fission process :
$$^1_0n + {}^{235}\mathrm{U} \rightarrow [{}^{236}\mathrm{U}] \rightarrow {}^{94}_{38}\mathrm{Sr} + Y + 2\,{}^1_0n + Q$$
where Q is the energy released in the fission process. Then the nucleus Y is
(a) $^{140}_{54}\mathrm{Xe}$
(b) $^{140}_{56}\mathrm{Ba}$
(c) $^{136}_{54}\mathrm{Xe}$
(d) $^{136}_{56}\mathrm{Ba}$

Q:15 According to the Geiger-Nuttall law, the range of an α-particle is proportional to
(a) square of its initial velocity
(b) square root of its initial velocity
(c) cube of its initial velocity
(d) cube root of its initial velocity

Q:16
The mass of $^{60}_{27}\mathrm{Co}$ required to produce an activity of 10 Ci is (given, the half-life of $^{60}_{27}\mathrm{Co}$ is 5.26 years)

(a) 0.08 mg
(b) 0.88 mg
(c) 8.8 mg
(d) 88 mg

Q:17 What will be the half-life of a radioactive substance whose activity drops to $\frac{1}{16}$ th of its initial value in 40 years?
(a) 2 years
(b) 8 years
(c) 10 years
(d) 16 years

Q:18 Which one of the following rocks has maximum ^{40} K background activity?
(a) Basalt
(b) Ultramafic
(c) Chondrite
(d) Granite

Q:19
The actinium series for natural radioactivity starts from
(a) $^{232}_{90}$Th
(b) $\frac{227}{89}$Ac
(c) $^{238}_{92}$U
(d) $^{235}_{92}$U

Q:20 Which one of the following statements best describes the Q-value of a nuclear reaction?
(a) It is the energy required to start the reaction.
(b) It is the difference in the total kinetic energies of the system after and before a reaction.
(c) It is defined only for β-decay.
(d) It is the kinetic energy of a neutron which is produced in a nuclear reaction.

Q:21 Consider the following nuclear reactions :
1. $p \rightarrow n + e^- + \bar{\nu}_e$
2. $n \rightarrow p + e^- + \bar{\nu}_e$
3. $p \rightarrow n + e^+ + \bar{\nu}_e$
4. $n \rightarrow p + e^+ + \bar{\nu}_e$

Which of the nuclear reactions given above represent(s) a β-decay?
(a) 1 only
(b) 2 only
(c) 1 and 2
(d) 3 and 4

Q:22 The half-life of a radioactive element
(a) does not depend on the time elapsed but depends on the quantity of the element
(b) depends both on the time elapsed and on the quantity of the element
(c) increases with time but is independent of the quantity of the element
(d) is independent of both the elapsed time and the quantity of the element

Q:23 $^{238}_{92}$U nucleus decays into $^{234}_{90}$Th through alpha particle emission. The atomic masses of $^{238}_{92}$U, $^{234}_{90}$ Th and $^{4}_{2}$He atoms are $238 \cdot 05079\text{u}, 234 \cdot 04363\text{u}$ and 4.00260 u , respectively. The energy released during the decay is
(where $1\text{u} \equiv 931.5\text{MeV}/c^2, c$ is the speed of light in vacuum)
(a) 7.76 MeV
(b) 4.25 MeV
(c) 6.67 MeV
(d) 3.73 GeV

Q:24 Which one of the following statements is best suited with regard to carbon dating technique, used to determine the time of death of an organism?
(a) ^{14} N converts into ^{14}C through β^+decay with a half-life of 5730 years.
(b) ^{14} N converts into ^{14}C through β^-decay with a half-life of about 375 years.
(c) ^{14}C converts into ^{14} N through β^+decay with a half-life of about 375 years.
(d) ^{14}C converts into ^{14} N through β^-decay with a half-life of 5730 years.

Q:25 A radioactive material decays with time with a certain half-life. Which one of the following laws is generally followed in this decay?
(a) Inverse-cube law
(b) Linear law
(c) Exponential law
(d) Inverse-square law

Q:26 ^{17} N undergoes a β-decay to an X isotope. The ground state spin and parity of ^{17} N is $\frac{1^-}{2}$. Which of the following is a possible value for ground state spin and parity of X isotope?
(a) $\frac{1^+}{2}$
(b) $\frac{5^-}{2}$
(c) $\frac{5^+}{2}$
(d) $\frac{1^-}{2}$.

Q:27
Why fusion reactions take place at very high temperature?
(a) The atoms are ionized at high temperature
(b) The molecules break up at high temperature
(c) The nuclei break up at high temperature
(d) The kinetic energy is high enough to overcome the repulsion between nuclei

Q:28 The energy released per fission of $_{92}U^{235}$ is 200 MeV . What is the number of fission processes that should occur per second in a nuclear reactor to operate at a power of 20,000 kW ?
(a) 6.25×10^{7}
(b) 6.25×10^{17}
(c) 6.25×10^{13}
(d) 6.25×10^{23}

Q:29
The number of alpha and beta particles emitted when uranium nucleus ($_{92}U^{238}$) decays to lead ($_{82}$ Pb^{206}) are:
(a) 6 and 8 respectively
(b) 8 and 6 respectively
(c) 6 and 6 respectively
(d) 8 and 8 respectively

Q:30 Consider the following statements with respect to the role of neutrino in a nuclear reaction of β-decay:

$$zX^{A} \longrightarrow z-1Y^{A} + e^{+} + v$$

1. It explains the sharp energy line spectra in β-decay
2. It explains the continuous energy spectra in β-decay
3. It satisfies the linear and angular momenta conservation in β-decay
4. It explains the interaction with matter during β-decay

Which of the statements correctly describe the role of neutrino in the above reaction?
(a) 1 and 3
(b) 2 and 3
(c) 1 and 4
(d) 2 and 3

Q:31 A certain radioisotope has a half-life of 5 hours. Consider the following statements with respect to its decay:

1. Every nucleus of this isotope has a 50% change of decaying in every 5 hours period
2. There is 100% probability of decaying in 10 hours

Which of the statement(s) given above is/are true?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q:32 Which one of the following statements regarding β-decay is correct?
(a) α-particles have a greater range than β-particles
(b) Parity is not conserved in β-decay
(c) The longest lived nuclei emit the most energetic particles
(d) β-particles emitted by a radioactive element have same energy and range

Q:33
A certain radioactive material has a life time of 30 days in which it reduces half to its amount that is $t_{1/2} = 30$ days. What will be its mean life?
(a) 20.79 days
(b) 15 days
(c) 43.29 days
(d) 231 days

Q:34 Radon environmental hazard is associated with the radioactive decay of:
(a) Rubidium (Rb-87)
(b) Potassium (K-40)
(c) Carbon (C-14)
(d) Uranium (U-238)

Q;35 Which one of the following statements regarding age determination of rocks using radioisotopes is not correct?
(a) Sr/Rb method is useful in determining the age of Precambrian rocks.
(b) ^{40} K measurements determine the age since the temperature of the rock dropped below $50°C$.
(c) ^{18}O to ^{16}O ratio is indicator of paleo-temperatures in oceans.
(d) K/Ar method is useful in determining age from about 50 thousand years to about $3 \cdot 5$ billion years.

Q:36 In the asymmetric fission of $^{235}_{92}U$, the maximum energy appears as
(a) kinetic energy of the emitted neutrons
(b) energy of the emitted gamma rays
(c) kinetic energy of the lighter fission fragments
(d) kinetic energy of the heavier fission fragments

Q:37
Which one of the following nuclear fusion reactions has the highest release of energy?
(a) Proton-proton reaction
(b) Proton-deuteron reaction
(c) Deuteron-deuteron reaction
(d) Deuteron-triton reaction

Q:38 The half-life of a radioactive nucleus is 6 nanosecond (ns). The decay constant of this nucleus is
(a) $1.16 \times 10^9\ s^{-1}$
(b) $1.16 \times 10^8\ s^{-1}$
(c) $1.60 \times 10^9\ s^{-1}$
(d) $1.60 \times 10^8\ s^{-1}$

Q:39 $^{99}_{43}$Tc nucleus decays to $^{99}_{44}$Ru nucleus by a radioactive decay process. This radioactive decay is an example of
(a) alpha decay
(b) positive beta decay
(c) negative beta decay
(d) orbital electron capture

Q:40 Which one of the following statements is correct for a nucleus undergoing gamma decay?
(a) The number of neutrons increases by one.
(b) The number of protons increases by one.
(c) Neither the number of protons nor the number of neutrons changes.
(d) Each of the proton and neutron numbers increases by one.

Q:41 Which one of the following radioactive minerals has thorium (Th) element?
(a) Alunite
(b) Carnotite
(c) Monazite
(d) Muscovite

Q:42 A radioactive source having a half-life of 5 years has an initial activity of 400 kBq . The activity (in kBq) after 15 years will be
(a) 200
(b) 100
(c) 50
(d) 25

Q:43 The parent nuclide of the $(4n + 2)$ radioactive series is
(a) ^{232}Th
(b) ^{238}U
(c) ^{210}Bi
(d) ^{227}Ra

Topic: 22 Radiation Detectors

Q:1 A 2.556 MeV photon interacts with a medium via pair-production process. The energy of the single escape peak detected by the NaI(Tl) scintillation detector is
(a) 2.045 MeV
(b) 1.534 MeV
(c) 1.022 MeV
(d) 0.511 MeV

Q:2 Which one of the following detectors is coupled with photomultiplier tube?
(a) Proportional counter
(b) GM counter
(c) Ionization counter
(d) NaI(TI) Scintillator

Q:3 Geiger-Müller counter is used to measure :
1. Energy of the incident radiation
2. Charge of the incident radiation
3. Number count of the incident radiation
Select the correct answer using the code given below :
(a) 1 and 2
(b) 2 and 3
(c) 1 only
(d) 3 only

Q:4 In a typical gamma-ray detector, what processes occur for an incident high-energy photon?
1. It undergoes Compton scattering a few times and may leave the detector before depositing all its energy.
2. It undergoes multiple Compton scattering, followed by photoelectric absorption and complete energy deposition.
3. It produces an e^+e^-, followed by positron annihilation, Compton scattering and photoelectric absorption and complete energy deposition.
4. It produces an e^+e^- pair, followed by positron annihilation, and one or both annihilation photons escape.

Select the correct answer using the code given below:
(a) 1 and 3 only
(b) 2 and 4 only
(c) 1, 3 and 4 only
(d) 1, 2, 3 and 4

Q:5 2023
Which one of the following radiation detectors provides the best energy resolution to measure the energy of gamma rays?
(a) Geiger-Müller counter
(b) Scintillator detector
(c) Ionization chamber
(d) Germanium detector

Q:6 2023
In a scintillation detector, the role of the photocathode is
(a) to amplify the number of scintillation photons produced by the scintillator
(b) to amplify the number of electrons produced in the photomultiplier tube
(c) to convert the scintillation light emitted from the scintillator to photoelectrons
(d) to convert the electrons of the scintillator to scintillation light

Q:7 2022
Alkali metals are generally preferred to be used as photosensitive metals as
(a) they have low work functions
(b) they have very low rest mass
(c) they have low stopping potential
(d) they are shiny

Q:8 2022
Which of the following nuclear detectors are based on the principle of ionization of a gas when radioactive radiation passes through it?
(a) Scintillation and proportional counters only
(b) Geiger-Müller and proportional counters only
(c) Scintillation and Geiger-Müller counters only
(d) Geiger-Müller, proportional and scintillation counters

Q:9 2021
The background gamma-ray spectrum inside massive concrete shielding shows a prominent 2.22 MeV line because of:
(a) Neutron capture in hydrogen atom
(b) Decay of ^{40}K
(c) Decay of ^{22}Na
(d) Annihilation radiation

Q:10 2021
A GM-counter has a 'dead-time' of 400μ s. What is the true counting rate when the observed counting rate is 100 per minute?
(a) 1000 per minute
(b) 100.07 per minute
(c) 1000.07 per minute
(d) 100 per minute

Q:11 2021
In a scintillation counter, a gamma-ray peak of 40 keV energy is observed at a pulse height of 32 V . The full width at half maxima (FWHM) is 4 keV . What is the percentage resolution of the counter?
(a) 10%
(b) 20%
(c) 32%
(d) 3.2%

Q:12 2020
Which one of the following statements regarding scintillation counter is correct?
(a) It makes use of very fine drops of oil
(b) It is not used for counting alpha particles
(c) It uses a material which emits light when a charged particle strikes it
(d) It cannot be used for detection of radiations but for scintillating the screen of a detector

Q:13 2020
Which one of the following instruments separates the characteristic γ-rays of ^{40}K, ^{238}U and ^{232}Th ?
(a) Geiger Muller Counter
(b) Scintillation Detector
(c) Pulse-height analyzer
(d) Radiation Counter

Q:14 2020
Which one of the following statement regarding Geiger-Muller Tube is correct?
(a) It has a metallic casing filled with a high pressure gas
(b) Both the ends of its tube are fixed with thin mica sheets
(c) It has a metallic casing filled with low pressure gas
(d) It can detect all radiations emerging out from a radioactive source

Q:15 2026
Which one of the following inorganic scintillators has the maximum light yield per MeV ?
(a) BaF_2
(b) BGO
(c) NaI(Tl)
(d) $LaBr_3(Ce)$

Q:16 The different regions of operation of gas-filled detectors are ion saturation, proportional region, limited proportional region and Geiger-Müller region. The region not used for detector operation is
(a) Geiger-Müller region
(b) ion saturation region
(c) proportional region
(d) limited proportional region

Topic: 23 Modern Physics

Q:1 The Compton scattering interaction of photon with matter results the creation of recoil electron and scattered gamma-ray photon. Which one of the following statements is correct about this process?
(a) Maximum kinetic energy of the recoil electron can be equal to the energy of initial photon.
(b) Maximum energy of the scattered photon can be greater than the energy of initial photon.
(c) Minimum kinetic energy of the recoil electron can be zero.
(d) Minimum energy of the scattered photon is much greater than $\frac{m_e c^2}{2}$.

Q:2 The wavelength of electron having kinetic energy 100 eV is
(a) 0.123 nm
(b) 0.132 nm
(c) 0.231 nm
(d) 0.312 nm

Q:3
Electromagnetic waves are travelling in vacuum. The relationship between group velocity (v_g) and phase velocity (v_p) is
(a) $v_g < v_p$
(b) $v_g = v_p^2$
(c) $v_g > v_p$
(d) $v_g = v_p$

Q:4 Which one of the following electron experiments does not confirm the wave nature of the electron?
(a) Davisson and Germer experiment
(b) G. P. Thomson's experiment
(c) Photoelectric effect
(d) Young's double-slit experiment

Q:5 When gamma-rays are scattered by an electron at rest then :
(a) The wavelength of the scattered gamma-ray is less than that of the incident ray and it does not depend on the angle of scattering.
(b) The wavelength of the scattered gamma-ray is greater than that of the incident ray and it depends on the angle of scattering.
(c) The wavelength of the scattered gamma-ray is less than that of the incident ray and it depends on the angle of scattering.
(d) The wavelength of the scattered gamma-ray is greater than that of the incident ray and it does not depend on the angle of scattering.

Q:6 The probability of photoelectric absorption for gamma rays incident on a medium depends on :
(a) Energy of the gamma rays and atomic mass of the absorber medium
(b) Energy of the gamma rays and atomic number of the absorber medium
(c) Atomic mass of the absorber medium but not on the energy of the gamma rays
(d) Atomic number of the absorber medium but not on the energy of the gamma rays

Q:7 In which one of the following situations will a proton and an alpha particle have the same de Broglie wavelength ?
(Assume the non-relativistic approximation holds)
(a) The velocity of the proton is four times the velocity of the alpha particle.
(b) The velocity of the alpha particle is four times the velocity of the proton.
(c) Both the particles move with the same velocity.
(d) Both the particles move with the same kinetic energy.

Q:8
Consider a particle of mass ' m ' enclosed in a box of length ' L ' with impenetrable walls. The longest wavelength of the particle trapped in the box is:
(a) $\frac{L}{2}$
(b) 2 L
(c) $\frac{L}{3}$
(d) $\frac{2\,L}{3}$

Q:9 An incident gamma ray interacts with a nearly free electron only during
(a) Compton scattering
(b) pair production
(c) photoelectric effect
(d) Auger effect

Q:10

The kinetic energy of a proton, whose de Broglie wavelength is about 1 fm , is approximately (where proton rest mass energy $= 938\text{MeV}$ and $h = 6.63 \times 10^{-34}$ J $-$ s)
(a) 600 MeV
(b) 1200 MeV
(c) 938 MeV
(d) 1836 MeV

Q:11 Davisson and Germer experiment on electron scattering from a solid surface confirms the
1. particle nature of the electron
2. variation of number of scattered electrons with the angle between the incoming beam and the direction of scattering
3. existence of de Broglie waves

Select the correct answer using the code given below.
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Q:12 Consider the following statements regarding pair-production process :
1. A third body is necessarily required for momentum conservation.
2. A third body is necessarily required for energy conservation.
3. The threshold energy for pairproduction is less when a gamma ray interacts with a heavy target nucleus and is more when it interacts with a light target nucleus.
Which of the statements given above is/are correct?
(a) 1 only
(b) 2 only
(c) 1 and 3
(d) 2 and 3

Q:13 The wavelength of a neutron with kinetic energy 1 eV is closest to
(where Planck's constant $h = 6.626 \times 10^{-34}$ J s and mass of neutron $= 1.674 \times 10^{-27}$ kg)
(a) 10^{-2} cm
(b) 10^{-4} cm
(c) 10^{-6} cm
(d) 10^{-9} cm

Q:14 If pair production were to take place in empty space, then which one of the following sets of physical quantities could NOT be conserved?
(a) Energy and linear momentum
(b) Energy and angular momentum
(c) Mass and linear momentum
(d) Energy and parity

Q:15 In Compton effect, for what angle between the directions of the initial and scattered photons, the wavelength change will be twice the Compton wavelength?
(a) $0°$
(b) $90°$
(c) $60°$
(d) $180°$

Q:16 Which one of the following statements is NOT correct?
(a) A bright light yields more photoelectrons than a dim one of the same frequency
(b) Red light produces faster photoelectrons than blue light
(c) Pair production cannot occur in empty space
(d) Compton shift is maximum for scattering angle of 180^0

Q:17 For pair production to take place γ-ray energy should be greater than:
(a) 1.02 MeV
(b) 2.56 MeV
(c) 2.05 MeV
(d) 0.78 MeV

Q:18 A particle of mass 10 gram is moving with velocity 10 m/sec. What will be the De Broglie wavelength associated with the particle?
(Plank's constant $= 6.62 \times 10^{-34}$Js)
(a) 6.62×10^{-32} m
(b) 6.62×10^{-33} m
(c) Zero
(d) Infinity

Q:19 An excited atom de-excites through the emission of photon with a lifetime of 10^{-8}sec. The inherent uncertainty in the frequency of the photon is about :
(a) 10^{7} Hz
(b) 10^{-26} Hz
(c) 10^{11} Hz
(d) 10^{-19} Hz

Q:20
A photon and an electron have same De Broglie wavelength. Which one of the following is correct?
(a) Electron moves faster than photon
(b) Photon moves faster than electron
(c) Both move with same speed
(d) Cannot be predicted

Q:21
The minimum photon energy required for a pair production by a gamma ray, in the presence of a nucleus, is
(a) 0.511 MeV
(b) 1.022 MeV
(c) 937 MeV
(d) 4.0 MeV

Q:22
For an incident gamma-ray energy of 1 MeV , which one of the following absorbers has the highest probability of photoelectric absorption?
(a) $^{12}_{6}\mathrm{C}$
(b) $^{28}_{14}\mathrm{Si}$
(c) $^{60}_{28}\mathrm{Ni}$
(d) $^{76}_{32}\mathrm{Ge}$

Q:23
The maximum energy that can be transferred by an incident photon of energy $h\nu$ to an electron in a single Compton interaction is
(a) $h\nu\left(\frac{2\alpha}{1+2\alpha}\right)$
(b) $h\nu\left(\frac{1}{1+2\alpha}\right)$
(c) $h\nu\left(\frac{1}{1-2\alpha}\right)$
(d) $h\nu\left(\frac{2\alpha}{1-2\alpha}\right)$
(where $\alpha = \frac{h\nu}{m_0c^2}$; m_0c^2 is the rest mass energy of the electron)

Q:24
Which one of the following is the correct equation to represent a pair-production process of gamma-ray interaction?
(a) $h\nu - m_0c^2 = E_{e^-} + E_{e^+}$
(b) $h\nu + m_0c^2 = E_{e^-} + E_{e^+}$
(c) $h\nu + 2m_0c^2 = E_{e^-} + E_{e^+}$
(d) $h\nu - 2m_0c^2 = E_{e^-} + E_{e^+}$
(where $h\nu$ is the energy of incident gamma ray; $E_{e^-}$and $E_{e^+}$are the electron and positron kinetic energies, respectively; m_0c^2 is the rest mass energy of the electron)

Q:25
The de Broglie wavelength associated with an alpha particle emitted with a kinetic energy of 1 MeV by the nucleus of an atom of radon is of the order of
(a) 10^{-14} cm
(b) 10^{14} cm
(c) 10^{-12} cm
(d) 10^{12} cm

Topic: 24 Atomic Physics

Q:1 The Balmer series of hydrogen spectrum is labelled as $\mathrm{H}_\alpha, \mathrm{H}_\beta, \mathrm{H}_\gamma, \mathrm{H}_\delta$, ... for $n = 3,4,5,6$, ..., respectively. The spectrum line that has blue colour is
(a) H_α line
(b) H_β line
(c) H_γ line
(d) H_δ line

Q:2
The wave number of singly ionized helium atom for the first spectral line of Balmer series is
(a) $0.0381 \times 10^7\ \mathrm{m}^{-1}$
(b) $0.1524 \times 10^7\ \mathrm{m}^{-1}$
(c) $0.3048 \times 10^7\ \mathrm{m}^{-1}$
(d) $0.6096 \times 10^7\ \mathrm{m}^{-1}$

Q:3 The magnitude of spin angular momentum of the electron is:
(a) $\sqrt{\frac{1}{2}}\hbar$
(b) $\sqrt{\frac{1}{4}}\hbar$
(c) $\sqrt{\frac{3}{4}}\hbar$
(d) $\sqrt{\frac{4}{3}}\hbar$

Q:4
Which one of the following radiations takes place in the visible region?
(a) Lyman Series
(b) Paschen Series
(c) Pfund Series
(d) Balmer Series

Q:5
According to Bohr Model, the potential energy $(\mathrm{U_n})$ for an electron in $\mathrm{n^{th}}$ orbit is :
(a) $-\frac{\mathrm{me}^4}{2\varepsilon_0^2\mathrm{n}^2\ \mathrm{h}^2}$
(b) $-\frac{me^4}{4\varepsilon_0^2n^2h^2}$
(c) $-\frac{2me^4}{\varepsilon_0^2n^2h^2}$
(d) $-\frac{4me^4}{\varepsilon_0^2n^2h^2}$

Q:5

For $n = 4$ states of hydrogen atom, the maximum value of L_z (z-component of orbital angular momentum $\vec{L}$) is
(a) $1\hbar$
(b) $2\hbar$
(c) $3\hbar$
(d) $4h$

Q:6
Which one of the following could be the possible reason of helium atom having more spectral transitions than hydrogen atom?
(a) Helium atom is smaller in size as compared to hydrogen atom
(b) Helium is inert while hydrogen is not
(c) Helium atom has more number of electrons than hydrogen atom
(d) Helium is less abundant than hydrogen

Q:7
The electrons in an atom are bound to the nucleus due to
(a) weak nuclear force
(b) electrostatic force
(c) strong nuclear force
(d) gravitational force

Q:8
The magnitude of angular momentum due to spin of an electron is:
(a) $\frac{\sqrt{3}\,\mathrm{h}}{2\pi}$
(b) $\frac{\mathrm{h}}{4\pi}$
(c) $1/2$
(d) $\frac{\sqrt{3}\,\mathrm{h}}{4\pi}$

Q:9
What is the ratio of the wavelengths for Lyman series spectrum ($n = 2$ to $n = 1$ transition) to Balmer series spectrum ($n = 3$ to $n = 2$ transition) in the hydrogen spectrum?
(a) $\frac{4}{3}$
(b) $3\frac{6}{5}$
(c) $4/9$
(d) $\frac{5}{27}$

Q:10
Which one of the following hydrogen spectrum lines is blue in colour?
(a) H_α
(b) H_β
(c) H_γ
(d) H_δ

Q:11
Which of the following particle always obey Pauli exclusion principle?
(a) All charged particles
(b) All particles
(c) All particles that have spin quantum numbers as multiples of $\frac{1}{2}$
(d) All particles that have spin quantum numbers as multiples of 1

Q:12
The Balmer lines of hydrogen (transition to $\mathrm{n} = 2$) span the visible frequency range. What is the maximum energy of the balmer line photons?
(a) 3.4 eV
(b) 1.9 eV
(c) 13.6 eV
(d) 7.5 eV

Q:13
Which one of the following statement is NOT correct?
(a) The longest wavelength line of Lyman series is the resonance line of hydrogen spectrum
(b) Balmer series contains only those spectral lines of hydrogen atom, which occur in the visible part of the spectrum
(c) In spectrum of helium, for each singlet energy state there is a corresponding triplet energy state
(d) The sharp and diffuse series of spectra of alkali atoms have a common convergence limit

Q:14
The magnitudes of total angular momentum given by $\vec{J} = \vec{L} + \vec{S}$ for $l = 1$ and $s = 1/2$ are
(a) $\frac{\sqrt{3}}{4}\hbar$ and $\frac{\sqrt{15}}{4}\hbar$
(b) $\frac{\sqrt{3}}{2}\hbar$ and $\frac{\sqrt{1}}{2}\hbar$
(c) $\frac{\sqrt{3}}{2}\hbar$ and $\frac{\sqrt{15}}{2}\hbar$
(d) $\frac{\sqrt{3}}{2}\hbar$ and $\frac{\sqrt{4}}{3}\hbar$
(where the symbols have their usual meanings)

Q:15
In the X-ray spectra, the K_β line originates
(a) when an $n = 4$ electron undergoes a transition to a vacant $n = 2$ state
(b) when an $n = 3$ electron undergoes a transition to a vacant $n = 2$ state

(c) when an $n = 3$ electron undergoes a transition to a vacant $n = 1$ state
(d) when an $n = 2$ electron undergoes a transition to a vacant $n = 1$ state

Topic: 25 Electrostatics

Q:1 Consider two isolated protons at a distance d apart. Suppose their electrostatic force of repulsion is equal in magnitude to the gravitational force acting on either proton at the surface of the Earth. In terms of the charge and mass of a proton, e and m, respectively, the free space permittivity ε_0, and the acceleration due to gravity on the Earth's surface, g, the value of d is
(a) $e/\left(mg\sqrt{4\pi\varepsilon_0}\right)$
(b) $mge/\sqrt{4\pi\varepsilon_0}$
(c) $e/\sqrt{4\pi\varepsilon_0 mg}$
(d) $\left(mg\sqrt{4\pi\varepsilon_0}\right)/e$

Q:2 An electric dipole consists of charges of magnitude 2.0 nC , separated by 6.0μ m. It is placed in an electric field of magnitude 1000 N/C. The magnitude of difference between the potential energies for dipole orientations parallel and anti-parallel to the electric field is
(a) 1.2×10^{-10} joule
(b) 2.8×10^{-12} joule
(c) 1.4×10^{-12} joule
(d) 2.4×10^{-11} joule

Q:3 Two identical spherical water droplets, each of radius a and carrying charge q, combine to form a single spherical water drop, the electric potential at the surface of which is V. In terms of q, a and the free space permittivity ε_0, the value of V is
(a) $2^{-4/3}q/(\pi\varepsilon_0 a)$
(b) $2^{-2/3}\pi q/(\varepsilon_0 a)$
(c) $2^{2/3}q/(\pi\varepsilon_0 a)$
(d) $2^{4/3}\pi q/(\varepsilon_0 a)$

Q:4
A point charge q is imbedded at the centre of a sphere of linear dielectric material of dielectric constant K. The total bound charge on the surface of the sphere is
(a) $Q_b = q/K$
(b) $Q_b = q(1-K)/K$
(c) $Q_b = q/(K-1)$
(d) $Q_b = q(K-1)/K$

Q:5
Suppose that a portion q of the total charge Q on a sphere is transferred to a nearby sphere which has been electrically neutral initially. If the two spheres are tiny enough to be treated almost as particles, then the electrostatic force between them, after the charge transfer, would be maximum when
(a) $q = Q/4$
(b) $q = Q^2/8$
(c) $q = Q/2$
(d) $q = 2Q^2/9$

Q:6
An unknown charge sits on a conducting solid sphere of radius $L/(2\pi)$. If the magnitude of the electric field at a distance L/π from the centre of the sphere is E, then the net charge on the sphere is
(a) $4\pi\varepsilon_0 L^2 E$
(b) $4\varepsilon_0 L^2 E/\pi$
(c) $\varepsilon_0 L^2 E/\pi^2$
(d) $\pi\varepsilon_0 E/L^2$

Q:7
Which one of the following statements regarding equipotential surfaces is correct?
(a) The electric field lines and equipotential surfaces are always in the same direction.
(b) The electric field lines and equipotential surfaces are always mutually perpendicular.
(c) The angles between the electric field lines and equipotential surfaces depend on the potential on the surface.
(d) The directions of electric field lines and equipotential surfaces are unrelated.

Q:8
Consider a particle of charge $q = -2 \times 10^{-9}$C placed in an electric field produced due to a charged cloud near the Earth's surface. If the electrostatic force acted on the particle is downward (i.e. towards the centre of the Earth), and of magnitude 3×10^{-6} N, then the magnitude and direction of the electric field $\vec{E}$ are given by :
(a) 15 N/C, upward
(b) 1500 N/C, upward
(c) 15 N/C, downward
(d) 1500 N/C, downward

Q:9 2024
Consider a charge Q on a tiny sphere. Let a portion of it, say q , be transferred to a nearby tiny sphere. If both the spheres are treated as particles, then the

electrostatic force of repulsion between them would be maximum for :
(a) $q = Q/4$
(b) $q = Q/8$
(c) $q = Q/2$
(d) $q = 3Q/4$

Q:10
Consider an electric field in a certain region of the Earth's atmosphere. Let the electric field be directed vertically down, and have magnitude $100\ N/C$ at an altitude 200 m and $60\ N/C$ at an altitude 300 m . In terms of the free space permittivity ε_0, the net amount of charge contained in a cube of sides 100 m , and with horizontal faces at altitudes of 200 m and 300 m , would be :
(a) $q = 2 \times 10^4 \varepsilon_0$
(b) $q = 4 \times 10^5 \varepsilon_0$
(c) $q = 2 \times 10^6 \varepsilon_0$
(d) $q = 6 \times 10^5 \varepsilon_0$

Q:11
Consider two metal plates, each having an area A, parallel to the xy plane and separated by a distance d along z . If the upper plate is held at a fixed potential V_0 and the lower plate $(z = 0)$ is grounded, then the potential distribution along the z-direction is given by :
(a) $V = V_0(2xy + z)/d$
(b) $V = 2\ V_0 z/d$
(c) $V = V_0(xy + 2z)/d$
(d) $V = V_0 z/d$

Q:12
Consider two positive charges q and $2q$ at a distance L apart. Let there be another charge Q placed in between q and $2q$, on the line joining them. For the net electrostatic force on Q to be zero, the distance of Q from the charge q should be
(a) $\frac{L}{\sqrt{2}}$
(b) $\frac{L}{\sqrt{2}-1}$
(c) $\frac{L}{\sqrt{2}+1}$
(d) $\sqrt{2}L - 1$

Q:13
A proton (of charge e and mass m_p) travelling a distance l, after being accelerated from rest by an electric field (of magnitude E), would attain a speed
(a) $\sqrt{2elE/m_p}$
(b) $2l\sqrt{eE/m_p}$
(c) $2l^2 eE/m_p$
(d) $\sqrt{2l^3 eE/m_p}$

Q:14
A spherical conductor, carrying a charge Q, is covered by a concentric spherical shell of a linear dielectric material of permittivity ε. If the spherical conductor is of radius a and the spherical shell is of thickness b, then the total energy of the configuration would be
(a) $\frac{Q^2}{8\pi\varepsilon b}\left(\frac{b}{a} + \frac{\varepsilon}{\varepsilon_0} - 1\right)$
(b) $\frac{Q^2}{8\pi\varepsilon b}\left(\frac{b}{a} - \frac{\varepsilon}{\varepsilon_0} - 1\right)$
(c) $\frac{Q^2}{8\pi\varepsilon b}\left(\frac{b}{a} - \frac{\varepsilon}{\varepsilon_0} + 1\right)$
(d) $\frac{Q^2}{8\pi\varepsilon b}\left(\frac{b}{a} + \frac{\varepsilon}{\varepsilon_0} + 1\right)$

Q:15
Consider a very long cylindrical conductor of charge per unit length λ. Let E be the magnitude of the electric field due to the cylinder at a perpendicular distance r from its axis. What would be the perpendicular distance at which the electric field would be reduced to $E/2$?
(a) $2r$
(b) $4r$
(c) $r/2$
(d) $r/4$

Q:16
Suppose that the electric field due to a spherical distribution of charge is purely radial and is given by
$$E = E_0 r^{-2}\left(1 - e^{-\lambda r}\right)$$
where E_0, λ are constants. Which one of the following is the correct relationship of r and λ for which the volume charge density would be minimum?
(a) $r = -2/\lambda$
(b) $r = 2\lambda$
(c) $r = 3/\lambda$
(d) $r = 3\lambda$

Q:17
The general solution for a radial potential $V(r)$, obtained by solving the corresponding Lapla-ce equation in spherical polar coordinates, is given by
(a) $V(r) = \alpha + \beta r^2$, where α, β are constants
(b) $V(r) = \alpha + \beta r^2 + \gamma r^4$, where α, β, γ are constants
(c) $V(r) = \alpha + \beta r^{-1}$, where α, β are constants
(d) $V(r) = \alpha \ln r + \beta r^{-1} + \gamma r^{-2}$, where α, β, γ are constants

Q:18 A rectangular pipe, running parallel to the z-axis (from $-\infty$ to ∞), has three grounded metallic sides at $x = 0, y = 0$ and $y = a$. The fourth side, at $x = b$, is maintained at a specific potential $V_0(y)$. Which one of the following can be taken as a suitable trial solution for the overall potential $V(x, y)$, to be determined by solving the corresponding two-dimensional Laplace equation?
(a) $\left(Ae^{ikx} + Be^{-ikx}\right)\cos(ky + \delta)$, where A, B, k, δ are constants
(b) $\left(Ae^{ikx} + Be^{iky}\right)(C\sin kx + D\cos ky)$, where A, B, C, D, k are constants
(c) $\left(Ae^{kx} + Be^{-kx}\right)(C\sin ky + D\cos ky)$, where A, B, C, D, k are constants
(d) $\left(Ae^{ikx} + Be^{-ikx}\right)\sin(ky + \delta)$, where A, B, k, δ are constants

Q:19 The process of inducing a charge on a metal ball by bringing an electrically charged plastic rod near it, without actually touching it, is called
(a) electrostatic friction
(b) electrostatic induction
(c) electrostatic conduction
(d) charge transfer

Q:20 Two point charges of equal mass m and charge Q are suspended at a common point by two threads of negligible mass and length l. At equilibrium, if α is the angle of each thread to the vertical, the charge Q is given by the relation
(a) $Q = 16\pi\varepsilon_0 mgl\sin^2\alpha$
(b) $Q = \sqrt{16\pi\varepsilon_0 mgl^2\sin^2\alpha\tan\alpha}$
(c) $Q = \sqrt{4\pi\varepsilon_0 mgl\tan\alpha}$
(d) $Q = 2\pi\varepsilon_0 mgl^2\cos\alpha$

Q:21 Consider the following four surfaces placed in uniform electric fields :

1. A flat oval surface with vector area $\vec{A} = (8.0\ \text{m}^2)\hat{\jmath} + (17\ \text{cm}^2)\hat{k}$ in a uniform electric field $\vec{E} = (4 \cdot 2\ \text{N/C})\hat{\imath}$
2. A flat circular surface with vector area $\vec{A} = (8.0\ \text{m}^2)\hat{\imath} - (17\ \text{cm}^2)\hat{k}$ in a uniform electric field $\vec{E} = (4 \cdot 2\ \text{N/C})\hat{\imath}$
3. A flat rectangular surface with vector area $\vec{A} = (8.0\ \text{m}^2)\hat{\imath} + (17\ \text{cm}^2)\hat{\jmath}$ in a uniform electric field $\vec{E} = (2.4\ \text{N/C})\hat{\imath} - (7.6\ \text{N/C})\hat{\jmath}$
4. A flat square surface with vector area $\vec{A} = (8.0\ \text{m}^2)\hat{\jmath} + (17\ \text{m}^2)\hat{k}$ in a uniform electric field $\vec{E} = (7.6\ \text{N/C})\hat{k} + (3.4\ \text{N/C})\hat{\jmath}$

Rank these surfaces in increasing order of electric flux through them.
(a) $1 < 2 < 3 < 4$
(b) $2 < 4 < 1 < 3$
(c) $1 < 3 < 2 < 4$
(d) $4 < 2 < 3 < 1$

Q:22 2022
Which one of the following expressions of a scalar function V satisfies the Laplace equation?
(a) $V = x^2 + y^2 - 2z^2$
(b) $V = x^2 + y^2 - z^2$
(c) $V = x^2 + y^2 + 2z^2$
(d) $V = x^2 + y^2 + z^2$

Q:23 The electrostatic energy stored in the space outside of a metal sphere of radius R , carrying a total charge Q is given by:
(a) $\frac{1}{8\pi\varepsilon_0}\frac{Q^2}{R}$
(b) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{R}$
(c) $\frac{1}{2\pi\varepsilon_0}\frac{Q^2}{R}$
(d) $\frac{1}{\pi\varepsilon_0}\frac{Q^2}{R}$

Q:24 A right angled triangle DAB , with angle $\text{A} = 90°$, $\text{AB} = 3$ m and $\text{AD} = 4$ m, possesses two equal charges +2 C each at the vertices A and B . A third charge +4 C is placed at the vertex D . What is the approximate electrostatic energy of the configuration?
(a) $\frac{1}{\pi\varepsilon_0}$ units
(b) $\frac{1}{2\pi\varepsilon_0}$ units
(c) $\frac{3}{4\pi\varepsilon_0}$ units
(d) $\frac{5}{4\pi\varepsilon_0}$ units

Q:25 2021
Which one among the following statements is true for the Laplacian or the Laplace operator?
(a) It represents the gradient of the divergence of a vector
(b) It represents the divergence of the gradient of a function
(c) It represents the divergence of a vector
(d) It represents the gradient of a scalar

Q:26
The relation between electric displacement **D**, electric field **E** and electric polarization **P** in electrostatic units

is given by:
(a) $\mathbf{D} = \mathbf{E} + 4\pi\mathbf{P}$
(b) $\mathbf{E} = \mathbf{D} + 4\mathbf{P}$
(c) $\mathbf{P} = \mathbf{D} + 4\pi\mathbf{E}$
(d) $\mathbf{E} = 2\pi\mathbf{D} + 4\mathbf{P}$

Q:27 Two charges +2 C and +3 C are placed at the end points of a straight line AB . The point P at which the electric field is zero, when P lies in between A and B is:
(Given AB = 4 m)
(a) at a distance 1.8 m from point B
(b) at a distance 1.8 m from point A
(c) at a distance 2.5 m from point B
(d) at a distance 2.5 m from point A

Q:28 The electrostatic force between two charged particles separated by a distance ' d ' and placed in a medium having dielectric constant ' K ' is 8 Newton. If the medium is replaced by another medium having dielectric constant ' 2 K ' and in the new medium, if the distance between two charged particles is increased to ' 2 d ', then the electrostatic force becomes:
(a) 1 Newton
(b) 2 Newton
(c) 4 Newton
(d) 8 Newton

Q:29 If the potential in a certain medium is given by $\emptyset(r) = \frac{q}{4\pi\epsilon_0}\frac{e^{-r/\lambda}}{r}$ where ' λ ' is a constant, the total charge associated with the medium is:
(a) q
(b) $2q$
(c) 0 (zero)
(d) q/λ

Q:30 2020
Consider the following equations:
1. $\vec{D} = \epsilon_0\vec{E} + \vec{P}$
2. $\vec{\nabla} \cdot \vec{D} = 0$

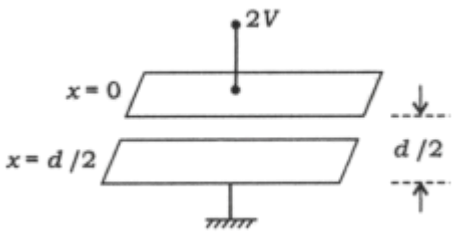
Gauss law for free ions embedded in dielectric material follows which of the above equations?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q:31 The solution of the differential equation $\frac{d^2V}{dx^2} = 0$ with the boundary conditions $V(2) = 3$ and $V(5) = 0$ is:
(a) $-x + 5$
(b) $-x - 5$
(c) $x + 5$
(d) $x - 5$

Q:32 An infinite plane carries a uniform surface charge σ. Its electric field is
(a) $\frac{\sigma}{2\varepsilon_0}\hat{n}$
(b) $\frac{\sigma}{\varepsilon_0}\hat{n}$
(c) $\frac{\sigma}{4\varepsilon_0}\hat{n}$
(d) $\frac{\sigma}{8\varepsilon_0}\hat{n}$
(where $\hat{n}$ is a unit normal vector pointing away from the surface)

Q:33 The electric field in polystyrene (relative permittivity $= 2.55$) filling the space between the plates of a parallel-plate capacitor is 10kV/m. The distance between the plates is 1.5 mm . The potential difference between the plates is
(a) 4 V
(b) 10 V
(c) 60 V
(d) 15 V

Q:34 Two parallel plates are separated by a distance $d/2$ as shown in the figure below :



The surface charge density at $x = 0$ is
(a) $\frac{4V\varepsilon_0}{d}$
(b) $\frac{V\varepsilon_0}{d}$
(c) $\frac{V\varepsilon_0}{4d}$
(d) $\frac{2V\varepsilon_0}{d}$

Q:35
Which one of the following boundary conditions is not satisfied by the electric potential (V) while solving Laplace's equation $\nabla^2 V = 0$ in electromagnetic method?
(a) V is continuous.
(b) The component of current density normal to the boundary is continuous.
(c) The component of current density normal to the

boundary is discontinuous.
(d) V is finite at any point where there is no source or sink of current.

Topic: 26 Magnetism

Q:1 A long straight wire, carrying a steady current I, lies on the surface of the Earth. The Earth's magnetic field, at the location of the wire, has a value 40μ T, and is horizontal and due North. Given the free space permeability $\mu_0 = 4\pi \times 10^{-7}\text{H/m}$, the resultant magnetic field would vanish 8 cm above the wire, if
(a) $I = 16$ A
(b) $I = 12$ A
(c) $I = 40$ A
(d) $I = 20$ A

Q:2
A particle of charge q and mass m, moving with an initial speed v in the yz-plane, is subjected to uniform electric and magnetic fields of magnitudes E and B, respectively. If the magnetic field is in the x-direction, and the particle accelerates in the x-direction as well, then the magnitude of the acceleration is
(a) $q(E - vB)/m$
(b) $q\sqrt{E^2 - v^2B^2}/m$
(c) $q(E + vB)/m$
(d) $q\sqrt{E^2 + v^2B^2}/m$

Q:3
A particle of charge q and mass m is circulating in a plane which is at an angle of $45°$ to a uniform magnetic field of magnitude B. The frequency of the revolution is
(a) $qB/(\sqrt{8}\pi m)$
(b) $4qB/(\pi m)$
(c) $2qB/(\sqrt{3}\pi m)$
(d) $qB/(2\pi m)$

Q:4
A long cylindrical wire of radius R carries a current I distributed uniformly over the cross-section. Let the magnetic field, due to the current I, be of magnitude B at the surface of the wire. The distances from the surface, outside and inside the wire, at which the magnetic field is of magnitude $B/4$, are respectively
(a) $4R$ and $R/4$
(b) $2R$ and $3R/4$
(c) $2R$ and $R/2$
(d) $3R$ and $3R/4$

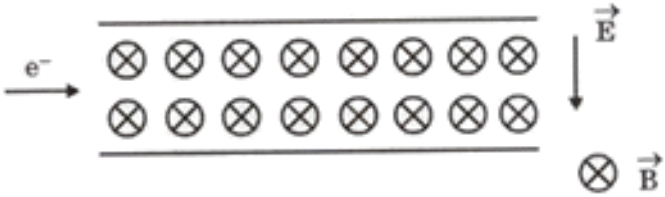
Q:5
A surveyor is using a magnetic compass at a distance d below a power line in which there is a steady current of 100 A . The free space permeability is $\mu_0 = 4\pi \times 10^{-7}\ \text{T} - \text{m/A}$, and the horizontal component of the Earth's magnetic field at the site is given to be 20μ T. The deflection of the compass needle due to power line would be as large as 9 degrees, if d is equal to

$$\left[\text{Deflection } = \frac{\text{Magnetic field due to power line}}{\text{Earth's magnetic field}}\right]$$

(a) $(2/\pi)$m
(b) 2π m
(c) $(20/\pi)$m
(d) 20π m

Q:6 Suppose that at a certain location on the globe, the Earth's magnetic field of 40μ T is horizontal and directed northward. Let there be a long, straight, horizontal wire, carrying a uniform current I. If the Earth's magnetic field be cancelled by the magnetic field due to the wire at a distance 8 cm above it, then what would be the magnitude of the current I in ampere?
(The free space permeability $\mu_0 = 4\pi \times 10^{-7}\text{H/m}$)
(a) 4
(b) 2
(c) 24
(d) 16

Q:7 An electron is allowed to transit through a region of space in which there is an electric field of magnitude 1.5kV/m and a magnetic field 0.25 T is applied as shown in the figure. If the electron leaves the region without being deflected, then it would have entered the region with speed :



(a) 1.5 km/s
(b) 3.5 km/s
(c) 4.5 km/s
(d) 6.0 km/s

Q:8 Consider a particle of mass 100 mg and charge $-5 \times 10^{-8}\text{C}$ moving in the Earth's gravitational field. Let the particle's initial velocity be horizontal, due north, and of magnitude 40 km/s. A horizontal, eastward magnetic field will keep the particle moving (under the influence of gravity) in the same horizontal,

northward direction, if the magnitude of such a field has the minimum value:
(taking the acceleration due to gravity $g = 9.8\ m/s^2$)
(a) 0.98 T
(b) 0.49 T
(c) 1.96 T
(d) 1.47 T

Q:9 A uniformly charged solid sphere, of radius R and total charge Q , is centered at the origin and spinning at a constant angular velocity $\vec{\omega}$ about the z-axis. The magnitude of the curl of the magnetic field $\vec{\mathbf{B}}$ at a point (r, θ, ϕ) within the sphere is :
(a) $\frac{\mu_0}{4\pi}\frac{Q}{R^4}|\vec{\omega}|r^2 \sin 2\theta$
(b) $\frac{\mu_0}{4\pi}\frac{3Q}{R^3}|\vec{\omega}|r \sin\theta$
(c) $\frac{\mu_0}{4\pi}\frac{Q}{R^4}|\vec{\omega}|r^2 \sin\theta$
(d) $\frac{\mu_0}{4\pi}\frac{3Q}{R^3}|\vec{\omega}|r \sin 2\theta$

Q:10
Consider the circular acceleration of singly charged ions (of mass number A) that are projected perpendicularly into a magnetic field of magnitude B. When the ions are accelerated to a kinetic energy E_k, the radius of their circular orbit, assuming non-relativistic motion, can be expressed in terms of the charge and mass of a proton, e and m_p, as :
(a) $r = \frac{E_k\sqrt{Am_p}}{eB}$
(b) $r = \frac{\sqrt{AE_k m_p}}{2eB}$
(c) $r = \frac{\sqrt{2AE_k m_p}}{eB}$
(d) $r = \frac{E_k\sqrt{2Am_p}}{eB}$

Q:11 Consider an electric field in a certain region of the Earth's atmosphere. Let the electric field be directed vertically down, and have magnitude $100\ N/C$ at an altitude 200 m and $60\ N/C$ at an altitude 300 m . In terms of the free space permittivity ε_0, the net amount of charge contained in a cube of sides 100 m , and with horizontal faces at altitudes of 200 m and 300 m , would be :
(a) $q = 2 \times 10^4 \varepsilon_0$
(b) $q = 4 \times 10^5 \varepsilon_0$
(c) $q = 2 \times 10^6 \varepsilon_0$
(d) $q = 6 \times 10^5 \varepsilon_0$

Q:12 A long, cylindrical wire carries a current I distributed uniformly over its cross-sectional area A . Let B_0 be the magnitude of the magnetic field strength, due to the current I, at the surface of the wire. The magnetic field strength is half of B_0 (in magnitude) at a distance (from the axis of the wire) :
(a) $\sqrt{2\ A/\pi}$
(b) $\sqrt{2\ A}/\pi$
(c) $2\sqrt{A/\pi}$
(d) $2\sqrt{2\ A/\pi}$

Q:13 Consider a short current element $\vec{dl} = b\ \hat{y}$, and a point P located at $\vec{r} = b(\hat{x} + \sqrt{3}\hat{z})$ where b is a constant, and $\hat{x}, \hat{y}, \hat{z}$ denote the unit vectors along the x, y, z directions, respectively. The magnetic field at P , due to the current I carried by the element dl along the **y** direction, can be expressed in terms of the free space permeability μ_0 as :
(a) $\frac{\mu_0 I}{16\pi b}(\hat{x} + \sqrt{3}\hat{z})$
(b) $\frac{\mu_0 I}{32\pi b}(\sqrt{3}\hat{x} + \hat{z})$
(c) $\frac{\mu_0 I}{16\pi b}(\hat{x} - \sqrt{3}\hat{z})$
(d) $\frac{\mu_0 I}{32\pi b}(\sqrt{3}\hat{x} - \hat{z})$

Q:14 Consider two particles with the same mass m, and charges q_1 and q_2. They traverse identical helical paths in completely opposite senses in a uniform magnetic field $\vec{B} = B_0\hat{k}$, where $\hat{k}$ is the unit vector along the z-axis and B_0 is a constant quantity. Which one of the following is true in this regard?
(a) Both the charged particles have equal momenta along the z-axis
(b) $q_1 = q_2$
(c) $q_1 = -q_2$
(d) No conclusion can be drawn regarding the signs of q_1 and q_2

Q:15 Consider two circular coils of currentcarrying wire, having the same magnetic moment. The first coil is of radius 10 cm , has 120 turns, and carries a current of 2.0 A . If the second coil has 150 turns and carries a current of 6.4 A , then what is its radius?
(a) 8.5 cm
(b) 2.5 cm
(c) 5.0 cm
(d) 2.0 cm

Q:16 The magnetic field inside a uniformly magnetized sphere is
(a) radial, unlike the electric field inside a uniformly polarized sphere
(b) uniform, unlike the electric field inside a uniformly polarized sphere

(c) radial, like the electric field inside a uniformly polarized sphere
(d) uniform, like the electric field inside a uniformly polarized sphere

Q:17 An electron moving with a uniform speed enters into a long current-carrying solenoid along its axis. Which one of the following statements is correct in this regard?
(a) The electron will be repelled back.
(b) The electron will be deflected by an angle of 45^{o} from the axis of the solenoid.
(c) The electron will continue moving with the same speed along the axis of the solenoid.
(d) The electron's path will become circular about the axis of the solenoid.

Q:18 A cubical region of space, with an edge l, is filled with uniform electric and magnetic fields. Now an electron enters into this region across one of its faces with a certain velocity $\vec{v}$. At the same instant, a positron enters the cubical region via the opposite face with velocity $-\vec{v}$. The following statements are given in this regard for the instant when both the particles enter the cubical space :

1. Both the particles will experience the same accelerations due to the electric force.
2. Both the particles will experience the same accelerations due to the magnetic force.
3. Both the particles will gain (or lose) energy at the same rate.
4. The magnetic field alone will determine the motion of centre of mass of the two particles.

Which of the statements given above are correct?
(a) 1,3 and 4
(b) 1 and 4 only
(c) 2 and 3 only
(d) 2,3 and 4

Q:19 A charged particle moves with a uniform speed of 4 m/s along the x-axis in a region of uniform electromagnetic field with $\vec{E} = 28\hat{j}$ V/m and $\vec{B} = B_0\hat{k}$.
If the particle keeps on moving with the same uniform speed in the field, then the value of (B_0 in $\mathrm{Wb/m^2}$) is
(a) 5
(b) 7
(c) 10
(d) 15

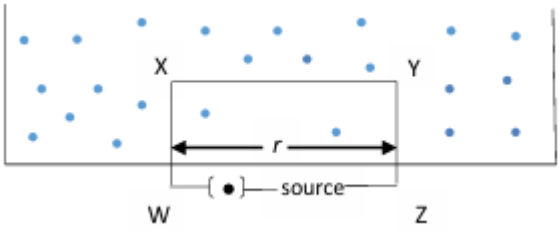
Q:20 A 0.20 m long current-carrying solenoid has 4.0 cm inner diameter. It consists of four close-packed layers of 100 turns along its length. What is the magnetic field strength at the centre of the solenoid, if the current through it is 5 A ? ($\mu_0 = 4\pi \times 10^{-7}$ T m/A)
(a) 3.14×10^{-3} T
(b) 3.14×10^{-5} T
(c) 12.6×10^{-7} T
(d) 12.6×10^{-3} T

Q:21 Two parallel plane current sheets placed at planes given by $z = 0$ and $z = 4$ carry currents with densities equal to $-10\hat{\imath}$ A/m^2 and $10\hat{\imath}$ A/m^2, respectively. What is the magnetic field strength $\vec{H}$ at the point (1,1,1)
(All distances are in metres)?
(a) 0 A/m
(b) $10\hat{\jmath}$ A/m
(c) $5\hat{\jmath}$ A/m
(d) $-5\hat{\jmath}$ A/m

Q:22 Which one of the following could be a primary reason for magnetism?
(a) Pauli exclusion principle and intrinsic spin of electrons
(b) Atomic currents and intrinsic spin of electrons
(c) Polar nature of molecules and atomic currents
(d) Polar nature of molecules and Pauli exclusion principle

Q:23 What is the total force experienced by a charge q, in presence of both electric field **E** and magnetic field **B**, and moving parallel to the magnetic field with velocity **v** ?
(a) $\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$
(b) $\mathbf{F} = q\mathbf{E}$
(c) $\mathbf{F} = q(\mathbf{v} \times \mathbf{B})$
(d) $\mathbf{F} = q(\mathbf{E} \times \mathbf{B})$

Q:24 A current carrying wire in rectangular shaped WXYZ supports a non-metallic bob of mass m. It is hanged vertically with its one edge XY $= r$ in an uniform magnetic field **B** into the page as shown in the figure:
What is the current that must be set in circuit WXYZ such that the gravitational force is exactly be balanced by the magnetic force?

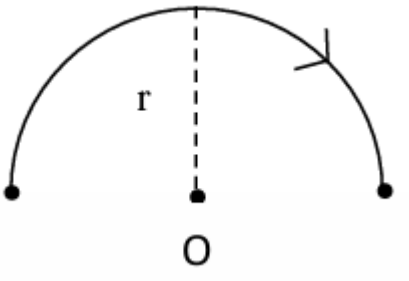


(a) $\frac{rB}{mg}$ and in the clockwise direction

(b) $\frac{mg}{rB}$ and in the anti-clockwise direction
(c) $\frac{mg}{rB}$ and in the clockwise direction
(d) $\frac{rB}{mg}$ and in the anti-clockwise direction

Q:25 Which one of the following statements about the magnetic forces is NOT CORRECT?
(a) The forces between two parallel current-carrying wires are not electrostatic in nature
(b) The magnetic forces do not work
(c) The magnetic force between two infinitely long current-carrying wires is always attractive
(d) The magnetic force can change the directions of both a moving proton or a moving electron

Q:26 A current carrying wire is bent to a half circle detour of radius r around its center. It carries current I in clockwise direction. What will be the magnetic field at the center of detour?



(a) $\frac{\mu_0 I}{2r}$ and in a direction out of the paper
(b) $\frac{\mu_0 I}{2r}$ and in a direction into the paper
(c) $\frac{\mu_0 I}{4r}$ and in a direction out of the paper
(d) $\frac{\mu_0 I}{4r}$ and in a direction into the paper

Q:27
What is the nature of the force between two parallel current-carrying wires of fixed lengths, if the currents in both the wires are alternating having equal frequency, equal amplitude but opposite in phase?
(a) Attractive
(b) Repulsive
(c) Zero
(d) Cannot be determined

Q:28 A steady current I flows around a hollow cylindrical tube of base radius a. If r be the distance of a given point from the cylindrical axis of symmetry, what will be the magnitude of the magnetic field **B** at a point inside the cylinder?
(a) Zero
(b) $\frac{\mu_0 I}{2\pi r}$
(c) $\frac{\mu_0 I}{\pi r^2}$
(d) $\frac{2\mu_0 I}{r^2}$

Q:30 A magnetic field B is produced by a very long solenoid of radius R and having n turns per unit length with a steady current I. Consider the following statements in this regard:
Statement 1: B $= \mu_0 nI$ inside the solenoid
Statement 2: B $= 0$ outside the solenoid
Which of the statements given above is/are correct?
(a) 1 and 2
(b) 1 only
(c) 2 only
(d) Neither 1 nor 2

Q:31 Which one of the following can be explained using Lenz's law?
(a) Only paramagnetism
(b) Only diamagnetism
(c) Only ferromagnetism
(d) All types of magnetism

Q:32 What is the magnetic force per unit length between two parallel wires separated by a distance ' d ' each carrying a current 'I' in the same direction?
(a) $\frac{\mu_0 I}{2\pi d}$,attractive
(b) $\frac{\mu_0 I}{2\pi d}$, repulsive
(c) $\frac{\mu_0 I^2}{2\pi d}$,attractive
(d) $\frac{\mu_0 I^2}{2\pi d}$, repulsive

Q:33
A thin disc of radius ' R ' carrying a uniform surface charge density ' σ ' rotates with a constant angular velocity ' ω ' about its axis (z -axis). The torque on the disc if placed in a uniform magnetic field $\vec{B}$ acting along **x**-direction would be:
(a) $\frac{\pi}{4}\omega\sigma BR^4$ along +y direction
(b) $\frac{\pi}{4}\omega\sigma BR^4$ along -y direction
(c) $\frac{\pi}{4}\omega\sigma BR^3$ along +y direction
(d) $\frac{\pi}{4}\omega\sigma BR^3$ along -y direction

Q:34 If in a cyclotron, a particle of charge ' q ' and mass ' m ' with a speed ' v ' follows a circular path of radius ' R ', because of a centripetal force ' F ' exerted upon it by a magnetic field ' B ', the radius of the path may be determined by using the equation:

(a) $R = \frac{qvB}{m}$
(b) $R = \frac{mv}{qB}$
(c) $R = \frac{m}{qvB}$
(d) $R = \frac{Bv}{qm}$

Q:35
The magnetic field corresponding to the vector potential $\vec{A}(\vec{r}) = 0.25(\vec{C} \times \vec{r}) + 0.7r^{-2}\hat{r}$ (where $\vec{C}$ is a constant vector) is:
(a) $0.175\vec{r}$
(b) $0.175\vec{C}$
(c) $2\vec{C}$
(d) $0.5\vec{C}$

Q:36
A particle of charge Q moves with speed v, in a circle of radius R, in a uniform magnetic field of magnitude B perpendicular to the plane of the circle. The momentum of the particle is
(a) QvB
(b) $\frac{QB}{R}$
(c) $\frac{QB}{v}$
(d) QBR

Q:37 Which one of the following laws describes the force $(\vec{F})$ experienced by a charged particle of charge q, while moving through a magnetic field $\vec{B}$ with velocity $\vec{v}$?
(a) Faraday's law
(b) Biot-Savart law
(c) Coulomb's law
(d) Lorentz's law

Q:38 Which one of the following statements regarding solenoid is not correct?
(a) The wire is wound closely in the form of a helix.
(b) The wire is coated with a conducting material.
(c) Adjacent turns of the wire physically touch each other.
(d) Ampere's law is valid.

Q:39 According to Biot-Savart law, the magnitude of the magnetic field due to a current element is
(a) directly proportional to the square of the distance between the current element and the point where the field is calculated
(b) directly proportional to the cube of the distance between the current element and the point where the field is calculated
(c) inversely proportional to the square of the distance between the current element and the point where the field is calculated
(d) inversely proportional to the cube of the distance between the current element and the point where the field is calculated

Topic: 27 Electrodynamics, EM Waves and Advanced EM Topics

Q:1
The magnetic flux through a coil is given as a function of time t as

$$\Phi_B(t) = \alpha t - \beta t^3$$

where α and β are certain constants. If the induced e.m.f. is zero at an instant of time T, then at a later instant $3T$, this e.m.f. would be
(a) 3α
(b) 8α
(c) 4α
(d) 9α

Q:2 A generator consists of 100 turns of wire, which is formed into a square loop of side 30 cm , and placed entirely in a uniform magnetic field of 4 T in magnitude. The maximum e.m.f. induced when the loop is spun at 1000 revolutions per minute, about an axis perpendicular to the magnetic field, is
(a) 1200π V
(b) 600π V
(c) 6π V
(d) 12π V

Q:3 Consider a point charge Q moving in a straight line, with a constant speed v, towards a small loop of area α which is perpendicular to the direction of motion of the charge. The magnitude of displacement current through the loop, when it is at a very short distance x from the charge, can be expressed as
(a) $Q\alpha v/(2\pi x^3)$
(b) $Qx^2v/(4\alpha)$
(c) $Qx^3v/(2\pi\alpha)$
(d) $Q\alpha v/(4\pi x)$

Q:4 A conducting loop of wire of resistance R and enclosing an area α is placed perpendicular to a magnetic field B for a short time interval T and then removed far away. The charge that flows through any cross-section of the wire, during the process, is
(a) $Q = \alpha B/(RT)$

(b) $Q = BT/(\alpha R)$
(c) $Q = \alpha BT/R$
(d) $Q = \alpha B/R$

Q:5 In a region of space, consider a square loop of wire with vertices at $(x = 0, y = 0), (x = a, y = 0), (x = a, y = a)$ and $(x = 0, y = a)$. If there is a magnetic field in this region, given by $\vec{B} = \beta t^2 y^3 \hat{z}$, where β is a constant and $\hat{z}$ is the unit vector along the z-direction, then the e.m.f. induced in the loop would be
(a) $\varepsilon = -\beta t a^5/2$
(b) $\varepsilon = -\beta t a^4/4$
(c) $\varepsilon = -\beta t^3 a^5/5$
(d) $\varepsilon = -\beta t^3 a^3/3$

Q:6 A parallel-plate capacitor of plate area A and plate separation d is charged by a time-varying current. Suppose there is a plane surface of area $A/2$, parallel to the plates, and situated symmetrically between them. If the charge on the capacitor varies as $Q = Q_0 \exp[-t/\tau]$, where Q_0 and τ are constants, then the displacement current through this surface is
(a) $-(2Q_0/\tau)\exp[-t/\tau]$
(b) $-(Q_0/2\tau)\exp[-t/\tau]$
(c) $-2Q_0\tau\exp[-2t/\tau]$
(d) $-(Q_0/\tau)\exp[-2t/\tau]$

Q:7 Consider the propagation of an electromagnetic wave with a frequency v in a certain piece of glass. Let the peak amplitude of the electric field in the wave be given by

$$E_0 = (2 + \mu_r)cB_0/2$$

where B_0 is the peak amplitude of the corresponding magnetic field, μ_r is the relative permeability, and c is the speed of light in vacuum. The dielectric constant for glass at the frequency v is
(a) $\frac{4}{\mu_r(\mu_r+2)^2}$
(b) $\frac{2}{\mu_r(\mu_r+2)}$
(c) $\frac{\mu_r}{2(\mu_r+2)}$
(d) $\frac{4\mu_r}{(\mu_r+2)^2}$

Q:8 An electromagnetic wave from a radio station passes perpendicularly through an open window of area 0.5sq. m. Suppose that at the window, the electric field of the wave has a peak amplitude 0.02 V/m. The energy the wave would carry through the window during a 20 -second commercial can therefore be expressed in terms of the free space permittivity ε_0 and the speed of light in free space, c, as
(a) $5\varepsilon_0 c \times 10^{-3}$ J
(b) $2\varepsilon_0 c \times 10^{-6}$ J
(c) $2\varepsilon_0 c \times 10^{-3}$ J
(d) $5\varepsilon_0 c \times 10^{-6}$ J

Q:9 The electric flux through a certain area of a dielectric varies with time as $\Phi \propto t^{1/3}$. If at a time $t = 3$sec, the displacement current through that area is 24 A , then its value is 6 A at a time :
(a) 15 sec
(b) 24 sec
(c) 1 sec
(d) 6 sec

Q:10 An electrical circuit is placed in a magnetic field. An emf can be induced in the circuit by changing :
(a) The magnetic field only
(b) The area of cross-section only
(c) The electric current in the given electric circuit only
(d) The magnetic field or the area of cross-section or the angle between the magnetic field and the plane of the circuit

Q:11 Suppose that magnetic charges $q_{m1}, q_{m2}, \ldots$ exist, and there is a Coulomb's law for such charges, given by $\vec{F} = \frac{\mu_0}{4\pi}\frac{q_{m1}q_{m2}}{r^2}\hat{r}$, then, for a given magnetic charge q_m moving with a velocity $\vec{v}$, through electric and magnetic fields, $\vec{E}$ and $\vec{B}$ respectively the force law using the principle of electromagnetic duality can correspondingly be expressed as :
(a) $\vec{F} = q_m\left(\vec{B} + \vec{v} \times \vec{E}/c^2\right)$
(b) $\vec{F} = q_m\vec{v} \times \vec{E}/c^2$
(c) $\vec{F} = q_m\left(\vec{B} - \vec{v} \times \vec{E}/c^2\right)$
(d) $\vec{F} = q_m\vec{B}$

Q:12 If the peak magnetic field in a plane electromagnetic wave is 2×10^{-4} T, then the average energy density corresponding to the electromagnetic wave is :
(a) $\frac{1}{20\pi}$ J/m^3
(b) $\frac{20}{\pi}$ J/m^3
(c) $\frac{1}{2\pi}$ J/m^3
(d) $\frac{2}{\pi}$ J/m^3

Q:13 A source of sinusoidal electromagnetic waves radiates in all directions. If at a distance 15 m from this source, the amplitude of the electric field of the wave is 2 N/C, then at a distance 30 cm from the source, the electric field amplitude would be

(a) $60\ \mathrm{N/C}$
(b) $0.1\ \mathrm{N/C}$
(c) $100\ \mathrm{N/C}$
(d) $6\ \mathrm{N/C}$

Q:14
The total intensity of electromagnetic radiation from a star, as measured by a space probe at a distance 2×10^{10} m away from it, is $5000\ \mathrm{W/m^2}$. If the star radiates uniformly in all directions, then its total average power output is :
(a) $8\pi \times 10^{24}$ W
(b) $2\pi \times 10^{24}$ W
(c) $8\pi \times 10^{22}$ W
(d) $2\pi \times 10^{25}$ W

Q:15 A rotor generates a maximum induced emf of 50 V , while rotating at a rate of 120 rpm . What should be the rate of rotation in order that a maximum induced emf of 75 V is generated?
(a) 240 rpm
(b) 360 rpm
(c) 320 rpm
(d) 180 rpm

Q:15 Consider a parallel-plate capacitor with a 2.0μ F capacitance. At what rate should the potential difference between the plates of the capacitor be changed to produce a displacement current of 1.5 A ?
(a) 7.5×10^5 V/s
(b) 9.25×10^4 V/s
(c) 5.25×10^4 V/s
(d) 4.5×10^5 V/s

Q:17
A battery of fixed emf ε and internal resistance R_B is connected to a variable load of resistance R_L. The power delivered to the load will be maximum for
(a) $R_L = 0.5R_B$
(b) $R_L = 0.25R_B$
(c) $R_L = R_B$
(d) $R_L = 2R_B$

Q:18 Which one of the following is correct for a current of finite density $\vec{J}$ flowing through a perfect conductor?
(a) The magnetic field vanishes
(b) The magnetic field is in general non-zero, but irrotational
(c) The magnetic field decays exponentially with time
(d) The magnetic field is timeindependent

Q:19 A current I flows down a wire of uniform cross-sectional area α and length l. If the potential difference at the ends of the wire is V, then the magnitude of the Poynting vector would be
(a) $\frac{2lVI}{\sqrt{3\pi\alpha}}$
(b) $\frac{VI}{2l\sqrt{\pi\alpha}}$
(c) $\frac{IVI}{2\sqrt{\pi\alpha}}$
(d) $\frac{VI}{l\sqrt{3\pi\alpha}}$

Q:20 A monochromatic plane electromagnetic wave of amplitude E_0, frequency ω and zero phase angle travels in the negative x-direction and is polarized in the z-direction. The electric and magnetic field vectors for the wave can be expressed as
(a)
$$\vec{E}(\vec{x},t) = E_0\hat{z}\sin\left[\omega\left(t-\frac{x}{c}\right)\right]$$
$$\vec{B}(\vec{x},t) = \frac{E_0}{c}\hat{y}\cos\left[\omega\left(t-\frac{x}{c}\right)\right]$$
(b)
$$\vec{E}(\vec{x},t) = E_0\hat{z}\sin\left[\omega\left(t+\frac{x}{c}\right)\right]$$
$$\vec{B}(\vec{x},t) = \frac{E_0}{c}\hat{x}\cos\left[\omega\left(t+\frac{x}{c}\right)\right]$$
(c)
$$\vec{E}(\vec{x},t) = E_0\hat{z}\cos\left[\omega\left(t-\frac{x}{c}\right)\right]$$
$$\vec{B}(\vec{x},t) = \frac{E_0}{c}\hat{x}\cos\left[\omega\left(t-\frac{x}{c}\right)\right]$$
(d)
$$\vec{E}(\vec{x},t) = E_0\hat{z}\cos\left[\omega\left(t+\frac{x}{c}\right)\right]$$
$$\vec{B}(\vec{x},t) = \frac{E_0}{c}\hat{y}\cos\left[\omega\left(t+\frac{x}{c}\right)\right]$$

Q:21
The frequency of oscillation of the current in an $L-C$ circuit is given by
$$v = \frac{1}{2\pi\sqrt{LC}}$$
where L and C denote the inductance and capacitance, respectively. What inductance should be connected to a 20 pF capacitor in an oscillator capable of generating 600 nm electromagnetic waves?
(a) $\frac{3}{\pi^2} \times 10^{-21}$H
(b) $\frac{5}{\pi^2} \times 10^{-21}$H
(c) $\frac{5}{\pi^2} \times 10^{-20}$H
(d) $\frac{3}{\pi^2} \times 10^{-20}$H

Q:22
The electric and magnetic fields derived respectively from the scalar and vector potentials

$$\phi(\vec{r},t)=\phi_0, \vec{A}(\vec{r},t)=\frac{A_0t^2}{r^3}\vec{r}$$

are given by (where ϕ_0, A_0 are constants)
(a) $\vec{E}(\vec{r},t)=-\frac{3A_0t^2}{r^4}\vec{r}$,

$$\vec{B}(\vec{r},t)=\frac{A_0t^2}{r^4}\vec{\nabla}\times\vec{r}$$

(b) $\vec{E}(\vec{r},t)=-\frac{2A_0t}{r^3}\vec{r}, \vec{B}(\vec{r},t)=0$
(c) $\vec{E}(\vec{r},t)=\left(\phi_0 r-\frac{A_0t^2}{2r^4}\right)\vec{r}, \vec{B}(\vec{r},t)=0$
(d) $\vec{E}(\vec{r},t)=\phi_0\vec{r}+\frac{2A_0t}{r^3}\vec{\nabla}r$,

$$\vec{B}(\vec{r},t)=-\frac{3A_0t^2}{r^4}\vec{\nabla}\times\vec{r}$$

Q:23 The magnitude of magnetic field for a plane electromagnetic wave is

$$B=(200\mu\text{ T})\sin\left[(4\times10^{15}\text{ s}^{-1})\left(t-\frac{x}{c}\right)\right]$$

What would be the average energy density corresponding to the electric field of the wave, in terms of the permittivity of free space ε_0, in SI units?
(a) $(2.7\times10^8)\varepsilon_0$
(b) $(1.8\times10^9)\varepsilon_0$
(c) $(2.7\times10^9)\varepsilon_0$
(d) $(1.8\times10^8)\varepsilon_0$

Q:24
A light beam travelling in the x-direction is described by the electric field

$$E_y=(300\text{Vm}^{-1})\sin\omega\left(t-\frac{x}{c}\right)$$

An electron is constrained to move along the y-direction with a speed of 2.0×10^7 m/s. The maximum magnetic force on the electron is
(a) 4.8×10^{-17} N
(b) 3.2×10^{-18} N
(c) 7.8×10^{-15} N
(d) 8.2×10^{-12} N

Q:25
A parallel-plate capacitor with plate area of 10 cm^2 and plate separation of 3 mm has a voltage $30t$ V applied to its plates. What will be the displacement current, if the permittivity of the medium $\varepsilon=2\varepsilon_0$? $\left(\frac{1}{4\pi\varepsilon_0}=9\times10^9\text{ N m}^2\text{C}^{-2}\right)$
(a) 1.47 nA
(b) 1.77×10^{-10} A
(c) 50×10^{-5} A
(d) 8×10^{-7} A

Q:26
The existence of displacement current in a capacitive circuit is due to an inconsistency in
(a) Ampere's law
(b) Faraday's law
(c) Gauss' law
(d) Coulomb's law

Q:27 Which of the following circuit elements oppose(s) any change in the current through it?
(a) Resistor only, as it offers resistance to the flow of charges in the conductor
(b) Inductor only, by developing a voltage across it proportional to the rate of change of the current
(c) Capacitor only, as it stores energy by maintaining a voltage between the two plates
(d) Both inductor and capacitor

Q:28
Match List-I with List-II and select the correct answer using the code given below the Lists :

List-I (Law)	List-II (Explanation)
A. Gauss' law for electricity	1 Relates induced electric field to changing magnetic flux
B. Gauss' law for magnetism	2 Relates net magnetic flux to net enclosed magnetic charge
C. Faraday's law	3 Relates induced magnetic field to changing electric flux and to current
D. Ampere-Maxwell law	Relates net electric flux to net enclosed electric charge

Code:
(a) A B C D
4 1 2 3
(b) A B C D
3 1 2 4
(c) A B C
3 2 1
(d) A B C D
4 2 1 3

Q:29
The intensity of an electromagnetic radiation at a point is
(a) the instantaneous value of the electromagnetic

energy flow rate ($= \vec{E} \times \vec{B}$) at that point
(b) the average value of the electromagnetic energy flow rate ($= \vec{E} \times \vec{B}$) at that point
(c) the average value of the electromagnetic energy flow rate $\left(= \frac{1}{\mu_0} \vec{E} \times \vec{B}\right)$ at that point
(d) the instantaneous value of the electromagnetic energy flow rate $\left(= \frac{1}{\mu_0} \vec{E} \times \vec{B}\right)$ at that point

Q:30 In an electronic communication system, which one of the following correctly represents the sequence of phenomena taking place?
(a) The generation of waves, their propagation, their reception and their reflection
(b) The propagation of waves, their generation, their reflection and their reception
(c) The generation of waves, their propagation, their reflection and their reception
(d) The generation of waves, their reflection, their propagation and their reception

Q:31 An electromagnetic radiation having an energy flux of 20 W/cm^2 falls on a completely absorbing surface, having 25 cm^2 area, at an incidence angle of 0°. What is the total momentum delivered to the surface in 10 minutes?
(a) 3.60×10^{-3} kg m/s
(b) 3.00×10^{-3} kg m/s
(c) 1.00×10^{-3} kg m/s
(d) 1.80×10^{-2} kg m/s

Q:32
Which one of the following statements is true about Maxwell's equations?
(a) These equations can be used to show that a point charge at rest produces static electric and magnetic fields.
(b) There are exceptions, where these equations are not able to explain the behaviour of electromagnetic waves.
(c) With the help of these equations, the entire electromagnetic theory can be explained.
(d) These equations explain the existence of electric as well as magnetic monopoles.

Q:33
What will be the approximate skin depth of electromagnetic waves of frequency 1 kHz in a conductor having conductivity 100 S/m?
(a) 16 metres
(b) 1.6 metres
(c) 0.16 metre
(d) 0.016 metre

Q:34
What will be the nature of induced electromotive force (emf) if a rectangular-shaped current-carrying wire is moved back-and-forth parallel to the direction of a uniform magnetic field?
(a) It will continuously increase with time
(b) It will have the non-zero constant value throughout
(c) It will be zero
(d) It will decrease with time

Q:35
What is the cause of the displacement current in an electric circuit?
(a) It is due to the variation of magnetic field
(b) It is due to the flow of steady current
(c) It is due to the variation of electric field
(d) It is due to the magnetic flux linked with the circuit

Q:36
A uniform magnetic field **B** along a vertically upward direction passes through a circular area of radius r. If the magnetic field varies with time t, then what will be the induced electric field **E** ?
(a) $\mathbf{E} = -\pi r^3 \frac{d\mathbf{B}}{dt}$
(b) $\mathbf{E} = -\pi r^2 \frac{d\mathbf{B}}{dt}$
(c) $\mathrm{E} = -\pi r^4 \frac{d\,\mathrm{B}}{dt}$
(d) $\mathbf{E} = -\pi r^{1/2} \frac{d\mathbf{B}}{dt}$

Q:37 Which one of the following statements is true for Maxwell's equations?
(a) They delve with the conduction current
(b) They delve with the conduction current density
(c) They delve with the convection current
(d) They delve with the displacement current

Q:38
If magnetic monopole exists, then which of the following equations will get modified?
1. $\nabla . \mathbf{B} = 0$
2. $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$
3. $\nabla . \mathbf{E} = \frac{\rho}{\varepsilon_0}$

Select the correct answer using the code given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Q:39 What is the number of coupled Maxwell's equations between electric field and magnetic field?
(a) One
(b) Two
(c) Three
(d) Four

Q:40 A wave of 1 MHz is propagating in sea water having attenuation coefficient $0.1258\ \text{m}^{-1}$. How far does the wave will propagate before it is attenuated to 50% of its original intensity?
($\ln 2 = 0.693$)
(a) 1 mm
(b) 1 m
(c) 5.5 m
(d) 100 m

Q:41
A circular loop of wire of radius ' a ' and resistance ' R ' is oriented in the xy-plane. A uniform magnetic field of magnitude ' B ' points in the $+\hat{Z}$-direction. If the loop of wire is rotated about the x -axis with an angular frequency ' ω ', what is the average power dissipated by the joule heating in the loop?
(a) $\frac{\pi^2 a^4 B^2 \omega^2}{2R}$
(b) $\frac{\pi^2 a^4 B^2 \omega^2}{R}$
(c) $\frac{\pi^2 a^4 B^2 \omega^2}{3R}$
(d) 0 (zero)

Q:42
Consider the following statements regarding displacement current:
1. It is not linked with the motion of charges
2. It has finite value even in a perfect vacuum

Which of the statements given above is/are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q:43
Which one of the following statements is correct with reference to Faraday's law of electromagnetic induction?
(a) Magnetic field produces electric field
(b) Time varying electric field produces magnetic field
(c) Time varying magnetic field produces conservative electric field
(d) Time varying magnetic field produces non-conservative time varying electric field

Q:44
If a magnetic monopole existed, which one of the following expressions would be proportional to the "magnetic charge" of the monopole? (Assuming that there are no other sources of electric or magnetic fields present)
(a) $\int\ (\vec{\nabla} \cdot \vec{E}) dV$
(b) $\int\ (\vec{\nabla} \cdot \vec{B}) dV$
(c) $\int\ (\vec{\mathrm{E}} \cdot \vec{B}) dV$
(d) $\int\ |E|^2 dV$

Q:45
Which one of the following equations will remain the same while changing the medium?
(a) $\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$
(b) $\vec{\nabla} \cdot \vec{B} = 0$
(c) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$
(d) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$

Q:46
An electromagnetic wave crossing from one medium to other (if there is no free charge or free current at interface), then:
(a) Parallel component of $\vec{E}$ and $\vec{B}$ are continuous
(b) Perpendicular component of $\vec{E}$ and $\vec{B}$ are continuous
(c) Perpendicular component of $\vec{E}$ and parallel component of $\vec{B}$ are continuous
(d) Parallel component of $\vec{E}$ and perpendicular component of $\vec{B}$ are continuous

Q:47
Consider the following statements with regard to boundary condition:
1. The tangential component of electric field is zero along the perfectly conducting surface
2. The boundary condition for electric field vector is found from the fact that no work is done in taking a unit test charge around a closed path

Which of the above statements is/are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q:48

Electromagnetic induction method of geophysics obeys:
(a) Wave equation
(b) Diffusion equation
(c) Laplace equation
(d) Poisson equation

Q:49 Consider the following statements with regard to propagation of electromagnetic wave in a conducting medium:

1. The field vectors $\vec{E}$ and $\vec{H}$ are not in phase; but $\vec{H}$ lags behind $\vec{E}$
2. The field vectors $\vec{E}$ and $\vec{H}$ are not in phase; but $\vec{E}$ lags behind $\vec{H}$

Which of the above statement is/are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Q:50
If the electrical permittivity of certain non-magnetic medium is 140 times higher than the electrical permittivity of space, the speed of electromagnetic wave in this medium would be approximately:
(a) $2142.9\ \mathrm{km/s}$
(b) $25354.6\ \mathrm{km/s}$
(c) $3 \times 10^5\ \mathrm{km/s}$
(d) $3.6 \times 10^5\ \mathrm{km/s}$

Q:51
According to Faraday's law of electromagnetic induction, the magnetic flux through a coil can be changed by
1. changing the magnitude of the magnetic field within the coil
2. changing the portion of the area of the coil that lies within the magnetic field
3. changing the temperature of the experimental setup
4. changing the angle between the direction of the magnetic field and the plane of the coil

Select the correct answer using the code given below.
(a) 1,2 and 4
(b) 2, 3 and 4
(c) 1 and 4 only
(d) 2 and 4 only

Q:52
The equation

$$\frac{d}{dx}\left(\frac{1}{\rho}\frac{dV}{dx}\right)+\frac{d}{dy}\left(\frac{1}{\rho}\frac{dV}{dy}\right)+\frac{d}{dz}\left(\frac{1}{\rho}\frac{dV}{dz}\right)=0$$

(where $V =$ electric potential, $\rho =$ resistivity)
reduces to Laplace's equation for
(a) a homogeneous and anisotropic medium
(b) a homogeneous and isotropic medium
(c) an inhomogeneous and anisotropic medium
(d) an inhomogeneous and isotropic medium

Q:53 2
A uniform magnetic field B exists in a direction perpendicular to the plane of a square frame made of copper wire. The wire has a diameter of 2 mm and a total length of 40 cm . The magnetic field changes with time at a steady rate $\frac{dB}{dt} = 0.02\mathrm{Ts}^{-1}$. The current induced in the frame is
(a) 4.5×10^{-2} A
(b) 9.3×10^{-2} A
(c) 2.5×10^{-1} A
(d) 8.5×10^{-3} A
(Given : Resistivity of copper$= 1.7 \times 10^{-8}\Omega$ m)

Q:54
Which one of the following Maxwell's equations is generalized due to displacement current?
(a) Gauss's law for electricity
(b) Gauss's law for magnetism
(c) Faraday's law
(d) Ampere's law

Q:55
"The parallel components of $\vec{H}$ are discontinuous by an amount proportional to the free surface current density."
For a linear medium, which one of the following relations is the correct boundary condition for the statement given above?
(a) $\frac{1}{\mu_1}\mathbf{B}_1^{\parallel}-\frac{1}{\mu_2}\mathbf{B}_2^{\parallel}=\mathbf{K}_f\times\hat{n}$
(b) $\mathbf{E}_1^{\parallel}-\mathbf{E}_2^{\parallel}=0$
(c) $\frac{1}{\mu_1}\mathbf{B}_1^{\parallel}-\frac{1}{\mu_2}\mathbf{B}_2^{\parallel}=0$
(d) $\frac{1}{\mu_1}\mathbf{B}_1^{\parallel}+\frac{1}{\mu_2}\mathbf{B}_2^{\parallel}=\mathbf{K}_f\times\hat{n}$
(where the symbols have their usual meanings)

Q:56
An electromagnetic wave propagates through a linear homogeneous medium. The speed of the wave in this medium is
(a) $c\sqrt{\frac{\varepsilon_0\mu_0}{\varepsilon\mu}}$
(b) $c\sqrt{\frac{\varepsilon\mu}{\varepsilon_0\mu_0}}$

(c) $c\sqrt{\frac{\varepsilon_0\mu}{\varepsilon\mu_0}}$
(d) $c\sqrt{\frac{\varepsilon\mu_0}{\varepsilon_0\mu}}$
(where the symbols have their usual meanings)

Q:57
Consider the following statements regarding skin depth of electromagnetic waves in conductors :
1. It is the distance taken by the electromagnetic wave to reduce the amplitude by a factor of half.
2. It measures how far the electromagnetic wave penetrates into the conductor.
3. It is determined by the real part of the wave number.
4. It is determined by the imaginary part of the wave number.
Which of the statements given above are correct?
(a) 1 and 3
(b) 1 and 4
(c) 2 and 3
(d) 2 and 4

Q:58
The number of inhomogeneous Maxwell's equations for a good conductor is
(a) one
(b) two
(c) three
(d) zero