JEE (Main) PHYSICS SOLVED PAPER

2023

25th Jan Shift 2

Section A

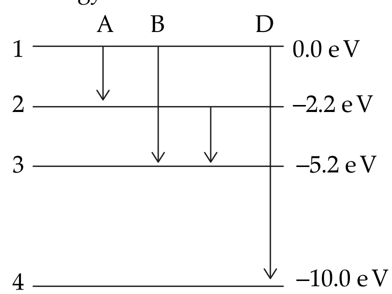
Q. 1. According to law of equipartition of energy the molar specific heat of a diatomic gas at constant volume where the molecule has one additional vibrational mode is:

(1) $\frac{5}{2}R$ **(2)** $\frac{9}{2}R$ **(3)** $\frac{7}{2}R$ **(4)** $\frac{3}{2}R$

Q. 2. A wire of length 1 m moving with velocity 8 m/s at right angles to a magnetic field of 2 T. The magnitude of induced emf, between the ends of wire will be

(1) 20 V **(2)** 8 V **(3)** 12 V **(4)** 16 V

Q. 3. The energy levels of an atom is shown in figure.



Which one of these transitions will result in the emission of a photon of wavelength 124.1 n m? Given ($h = 6.62 \times 10^{-34}$ J s)

(1) D **(2)** B **(3)** C **(4)** A

Q. 4. Given below are two statements :

Statement I: Stopping potential in photoelectric effect does not depend on the power of the light source.

Statement II: For a given metal, the maximum kinetic energy of the photoelectron depends on the wavelength of the incident light.

In the light of above statements, choose the most appropriate answer from the options given below:

(1) Statement I is incorrect but statement II is correct

(2) Statement I is correct but statement II is incorrect

(3) Both Statement I and statement II are correct

(4) Both Statement I and Statement II are incorrect

Q. 5. The distance travelled by a particle is related to time t as $x = 4t^2$. The velocity of the particle at $t = 5$ s is:

(1) 40 ms^{-1} **(2)** 20 ms^{-1} **(3)** 8 ms^{-1} **(4)** 25 ms^{-1}

Q. 6. Match List I with List II

LIST I		LIST II	
A.	Young's Modulus (Y)	I.	$[ML^{-1}T^{-1}]$
B.	Co-efficient of Viscosity (η)	II.	$[ML^2T^{-1}]$
C.	Planck's Constant (h)	III.	$[ML^{-1}T^{-2}]$
D.	Work Function (ϕ)	IV.	$[ML^2T^{-2}]$

Choose the correct answer from the options given below:

(1) A-I, B-II, C-III, D-IV
(2) A-II, B-III, C-IV, D-I
(3) A-I, B-III, C-IV, D-II
(4) A-III, B-I, C-II, D-IV

Q. 7. Match List I with List II

LIST I		LIST II	
A.	Troposphere	I.	Approximate 65 – 75 km over Earth's surface
B.	E- Part of Stratosphere	II.	Approximate 300 km over Earth's surface
C.	F2- Part of Thermo-sphere	III.	Approximate 10 km over Earth's surface
D.	D- Part of Stratosphere	IV	Approximate 100 km over Earth's surface

Choose the correct answer from the options given below:

(1) A-III, B-IV, C-II, D-I
(2) A-III, B-II, C-I, D-IV
(3) A-I, B-IV, C-III, D-II
(4) A-I, B-II, C-IV, D-III

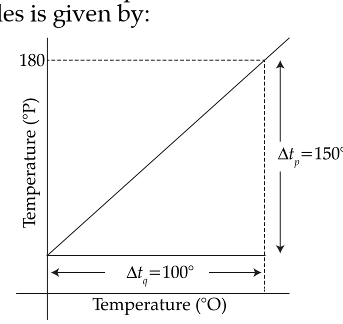
Q. 8. The light rays from an object have been reflected towards an observer from a standard flat mirror, the image observed by the observer are:

A. Real
B. Erect
C. Smaller in size than object
D. Laterally inverted

Choose the most appropriate answer from the options given below:

(1) A, C, and D Only **(2)** B and D Only
(3) A and D Only **(4)** B and C Only

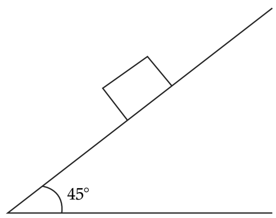
Q. 9. The graph between two temperature scales P and Q is shown in the figure. Between upper fixed point and lower fixed point there are 150 equal divisions of scale P and 100 divisions on scale Q. The relationship for conversion between the two scales is given by:



(1) $\frac{t_p}{100} = \frac{t_Q - 180}{150}$ **(2)** $\frac{t_Q}{150} = \frac{t_P - 180}{100}$

(3) $\frac{t_P}{180} = \frac{t_Q - 40}{100}$ **(4)** $\frac{t_Q}{100} = \frac{t_P - 30}{150}$

10. Consider a block kept on an inclined plane (inclined at 45°) as shown in the figure. If the force required to just push it up the incline is 2 times the force required to just prevent it from sliding down, the coefficient of friction between the block and inclined plane (μ) is equal to:



(1) 0.25 **(2)** 0.50
(3) 0.60 **(4)** 0.33

Q. 11. Every planet revolves around the sun in an elliptical orbit:

A. The force acting on a planet is inversely proportional to square of distance from sun.

B. Force acting on planet is inversely proportional to product of the masses of the planet and the sun.

C. The Centripetal force acting on the planet is directed away from the sun.

D. The square of time period of revolution of planet around sun is directly proportional to cube of semi-major axis of elliptical orbit.

Choose the correct answer from the options given below:

(1) B and C only **(2)** A and C Only
(3) A and D only **(4)** C and D only

Q. 12. For a moving coil galvanometer, the deflection in the coil is 0.05 rad when a current of 10 mA is passed through it. If the torsional constant of suspension wire is 4.0×10^{-5} N m rad^{-1}, the magnetic field is 0.01 T and the number of turns in the coil is 200 , the area of each turn (in cm^2) is:

(1) 1.0 **(2)** 2.0 **(3)** 1.5 **(4)** 0.5

Q. 13. Match List I with List II

LIST I		LIST II	
A.	Gauss's Law in Electrostatics	I.	$\oint \vec{E}.d\vec{l} = -\frac{d\phi_B}{dt}$
B.	Faraday's Law	II.	$\oint \vec{B}.d\vec{A} = 0$
C.	Gauss's Law in Magnetism	III.	$\oint \vec{B}.d\vec{l} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$
D.	Ampere-Maxwell Law	IV.	$\oint \vec{E}.d\vec{s} = \frac{q}{\varepsilon_0}$

Choose the correct answer from the options given below:

(1) A-IV, B-I, C-II, D-III
(2) A-II, B-III, C-IV, D-I
(3) A-III, B-IV, C-I, D-II
(4) A-I, B-II, C-III, D-IV

Q. 14. Two objects are projected with same velocity 'u' however at different angles α and β with the horizontal. If $\alpha + \beta = 90°$, the ratio of horizontal range of the first object to the 2nd object will be:

(1) 2 : 1 **(2)** 1 : 2
(3) 1 : 1 **(4)** 4 : 1

Q. 15. A particle executes simple harmonic motion between $x = -$ A and $x = +$ A. If time taken by particle to go from $x = 0$ to $\frac{A}{2}$ is 2 s; then time taken by particle in going from $x = \frac{A}{2}$ to A is:

(1) 4 s **(2)** 1.5 s
(3) 2 s **(4)** 3 s

Q. 16. Match List I with II

List I		List II	
A.	Isothermal Process	I.	Work done by the gas decreases internal energy
B.	Adiabatic Process	II.	No change in internal energy
C.	Isochoric Process	III.	The heat absorbed goes partly to increase internal energy and partly to do work
D.	Isobaric Process	IV.	No work is done on or by the gas

Choose the correct answer from the options given below:

(1) A-I, B-II, C-III, D-IV
(2) A-II, B-I, C-IV, D-III
(3) A-II, B-I, C-III, D-IV
(4) A-I, B-II, C-IV, D-III

Q. 17. **Statement I:** When a Si sample is doped with Boron, it becomes p-type and when doped by Arsenic it becomes n-type semi conductor such that p-type has excess holes and n-type has excess electrons.

Statement II: When such p-type and n-type semi-conductors, are fused to make a junction, a current will automatically flow which can be detected with an externally connected ammeter.

In the light of above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and statement II are correct
(2) Statement I is incorrect but statement II is correct
(3) Both Statement I and Statement II are incorrect
(4) Statement I is correct but statement II is incorrect

Q. 18. A point charge of 10 μC is placed at the origin. At what location on the x-axis should a point charge of 40 μC be placed so that the net electric field is zero at $x = 2$ cm on the x-axis?

(1) $x = -4$ cm **(2)** $x = 6$ cm
(3) $x = 4$ cm **(4)** $x = 8$ cm

Q. 19. The resistance of a wire is 5 Ω. Its new resistance in ohm if stretched to 5 times of its original length will be :

(1) 25 **(2)** 125
(3) 5 **(4)** 625

Q. 20. A body of mass is taken from earth surface to the height h equal to twice the radius of earth (R_e), the increase in potential energy will be:

(g = acceleration due to gravity on the surface of Earth)

(1) $3mgR_e$ **(2)** $\frac{1}{3}mgR_e$
(3) $\frac{2}{3}mgR_e$ **(4)** $\frac{1}{2}mgR_e$

Section B

Q. 21. Two long parallel wires carrying currents 8 A and 15 A in opposite directions are placed at a distance of 7 cm from each other. A point P is at equidistant from both the wires such that the lines joining the point P to the wires are perpendicular to each other. The magnitude of magnetic field at P is _____ $\times 10^{-6}$ T

(Given : $\sqrt{2} = 1 \cdot 4$)

Q. 22. A spherical drop of liquid splits into 1000 identical spherical drops. If U_i is the surface energy of the original drop and U_f is the total surface energy of the resulting drops, the (ignoring evaporation), $\frac{U_f}{U_i} = \left(\frac{10}{x}\right)$, then value of x is _______.

Q. 23. A nucleus disintegrates into two smaller parts, which have their velocities in the ratio 3 : 2. The ratio of their nuclear sizes will be $\left(\frac{x}{3}\right)^{1/3}$. The value of '$x$' is _______.

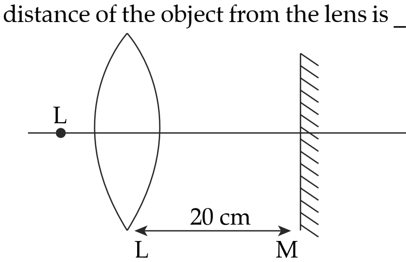
Q. 24. A train blowing a whistle of frequency 320 Hz approaches an observer standing on the platform at a speed of 66 m/s. The frequency observed by the observer will be (given speed of sound = 330 ms^{-1}) _______ Hz.

Q. 25. A body of mass 1 kg collides head on elastically with a stationary body of mass 3 kg. After collision, the smaller body reverses its direction of motion and moves with a speed of 2 m/s. The initial speed of the smaller body before collision is ________ ms^{-1}.

Q. 26. A series LCR circuit is connected to an AC source of 220 V, 50 Hz. The circuit contains a resistance R = 80 Ω, an inductor of inductive reactance $X_L = 70\ \Omega$, and a capacitor of capacitive reactance $X_C = 130\ \Omega$. The power factor of circuit is $\frac{x}{10}$. The value of x is ________ .

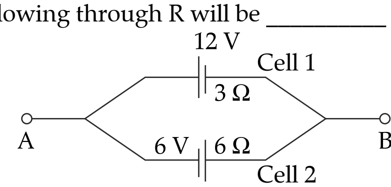
Q. 27. If a solid sphere of mass 5 kg and a disc of mass 4 kg have the same radius. Then the ratio of moment of inertia of the disc about a tangent in its plane to the moment of inertia of the sphere about its tangent will be $\frac{x}{7}$, The value of x is _________.

Q. 28. An object is placed on the principal axis of convex lens of focal length 10 cm as shown. A plane mirror is placed on the other side of lens at a distance of 20 cm. The image produced by the plane mirror is 5 cm inside the mirror. The distance of the object from the lens is _______ cm.



Q. 29. A capacitor has capacitance 5 μF when its parallel plates are separated by air medium of thickness d. A slab of material of dielectric constant 1.5 having area equal to that of plates but thickness $\frac{d}{2}$ is inserted between the plates. Capacitance of the capacitor in the presence of slab will be _______ μ

Q. 30. Two cells are connected between points A and B as shown. Cell 1 has emf of 12 V and internal resistance of 3 Ω. Cell 2 has emf of 6 V and internal resistance of 6 Ω. An external resistor R of 4 Ω is connected across A and B. The current flowing through R will be __________ A.



Answer Key

Q. No.	Answer	Topic Name	Chapter Name
1	(3)	Specific Heat of Gases	Kinetic Theory of Gases
2	(4)	Motional emf	Electromagnetic Induction
3	(1)	Photoelectric Effect	Dual Nature of Radiation and Matter
4	(3)	Stopping Potential	Dual Nature of Radiation and Matter

5	**(1)**	Velocity	Motion in a Straight Line
6	**(4)**	Dimensions	Units and Dimensions
7	**(1)**	Atmospheric Layers	Communication Systems
8	**(2)**	Image Formation by a Plane Mirror	Ray Optics
9	**(4)**	Temperature Scale	Heat
10	**(4)**	Motion on an Inclined Plane	Laws of Motion
11	**(3)**	Kepler's Laws	Gravitation
12	**(1)**	Moving Coil Galvanometer	Moving Charges and Magnetism
13	**(1)**	Maxwell's Equations	Electromagnetic Waves
14	**(3)**	Projectile Motion	Motion in a Plane
15	**(1)**	SHM	Oscillations and Waves
16	**(2)**	Thermodynamical Processes	Thermodynamics
17	**(4)**	Extrinsic Semiconductors	Semiconductor Electronics
18	**(2)**	Electric Fields	Electric Charges and Fields
19	**(2)**	Resistivity	Current Electricity
20	**(3)**	Gravitational Potential Energy	Gravitation
21	**[68]**	Force Between Two Parallel Current Carrying Conductors	Moving Charges and Magnetism
22	**[1]**	Surface Tension	Mechanical Properties of Fluids
23	**[2]**	Nuclear Disintegration	Nuclei
24	**[400]**	Sound	Oscillations and Waves
25	**[4]**	Momentum	Work, Energy and Power
26	**[8]**	RLC Circuit	Alternating Current
27	**[5]**	Moment of Inertia	System of Particles and Rotational Motion
28	**[30]**	Image Formation due to Combination of Lens and Mirror	Ray Optics
29	**[6]**	Parallel Plate Capacitor	Electrostatic Potential and Capacitance
30	**[1]**	Combination of Cells	Current Electricity

SOLUTIONS

Section A

1. Option (3) is correct.

Molar heat capacity at constant volume $C_v = \frac{1}{2}fR$
where, f = degrees of freedom
For a diatomic gas
$f = 3\,(\text{translational}) + 2\,(\text{Rotational}) + 2\,(\text{vibrational})$
$= 7$

$$C_v = \frac{7R}{2}$$

2. Option (4) is correct.

Given, B = 2 T, l = 1 m , v = 8 m/s
Induced emf, $e = Blv = 2 \times 1 \times 8 = 16$ V

3. Option (1) is correct.

$$\Delta E = \frac{hc}{\lambda e}\text{ (e V)} = \frac{1241}{\lambda(\text{nm})}\text{ (e V)}$$

Given λ = 124.1 hm

$\Delta E = \frac{1241}{124.1} = 10$ which corresponds to the transition of electron from level 1 to 4 i.e line D in given diagram

4. Option (3) is correct.

Stopping potential depends on the frequency of the incident radiation not on the intensity of power of the source. Statement I is correct.

Maximum K.E. of the emitted photoelectrons depends on the wavelength of the incident radiation. Hence, statement II is correct.

5. Option (1) is correct.

Given $x = 4t^2$

$$\text{Velocity } v = \frac{dx}{dt} = 8t$$

at $t = 5$ s, $\mu = 8 \times 5 = 40$ m/s

6. Option (4) is correct.

Young's modulus, $Y = \frac{F}{A}.\frac{l}{\Delta l}$

$$[Y] = [M^1L^{-1}T^{-2}]$$

Coefficient of viscosity, $\eta = \frac{F}{A\frac{dv}{dy}}$

$$[\eta] = [M^1L^{-1}T^{-1}]$$

Planck's constant, $h = \dfrac{E}{f}$

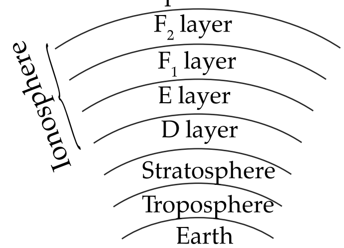
$$[h] = [M^1L^2T^{-1}]$$

Work functions, ϕ = Energy

$$[\phi] = [M^1L^2T^{-2}]$$

7. Option (1) is correct.

Different layers of the atmosphere are:



8. Option (2) is correct.

Image formed by a plane (flat) mirror is erect, virtual, laterally inverted and having the same size as the object.

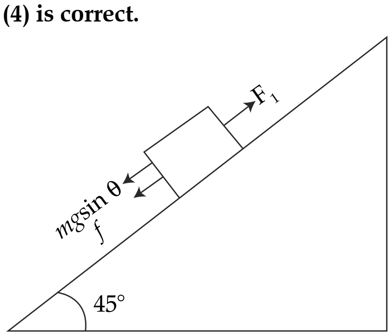
9. Option (4) is correct.

For the P scale upper fixed point = 180°
and lower fixed point = 180 – 150
= 30°
For the Q scale upper fixed point = 100°
and lower fixed point = 100 – 100
= 0°

Hence, $$\frac{t_P - 30}{180 - 30} = \frac{t_Q - 0}{100 - 0}$$

$\rightarrow$ $$\frac{t_P - 30}{150} = \frac{t_Q}{100}$$

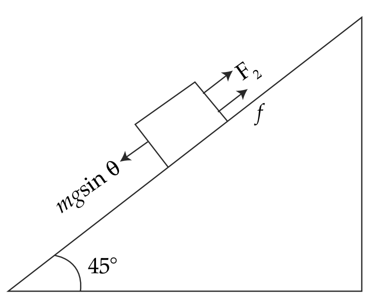
10. Option (4) is correct.



In order to just push the block up (acceleration = 0),

$$F_1 = mg\sin\theta + \mu mg\cos\theta$$

$$F_1 = \frac{mg}{12} + \frac{\mu mg}{12} = \frac{mg}{\sqrt{2}}(1+\mu)$$



In order to just prevent it from sliding down,

$$F_2 = mg\sin\theta + \mu mg\cos\theta$$

$$F_2 = \frac{mg}{\sqrt{2}} - \frac{\mu mg}{\sqrt{2}} = \frac{mg}{\sqrt{2}}(1-\mu)$$

Given that $F_1 = 2F_2$

$$\frac{mg}{\sqrt{2}}(1+\mu) = 2 \times \frac{mg}{\sqrt{2}}(1-\mu)$$

$$1 + \mu = 2(1-\mu)$$

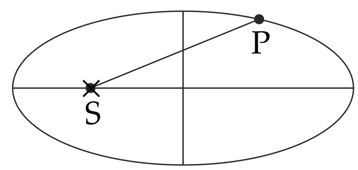
$$3\mu = 1$$

$$\mu = \frac{1}{3} = 0.33$$

11. Option (3) is correct.

For elliptical orbit,

$$F = \frac{GM_s m}{m^2} \rightarrow F \propto \frac{1}{r^2} \rightarrow F \propto M_s m$$



Centripetal force acting on the planet is always directed towards the sun.

From Kepler's third law, $F^2 \propto a^3$

where, T is the time period of revolution and 'a' is the semi major axis of the elliptical path.

(A) and (D) are correct statements.

12. Option (1) is correct.

For a moving coil galvanometer

$$\phi = \frac{NBA}{C}i$$

Where C = torsional constant of suspension wire.
ϕ = angular deflection.

$$A = \frac{\phi}{i}\left(\frac{C}{NB}\right) = \frac{0.05 \times 4 \times 10^{-5}}{10 \times 10^{-3} \times 200 \times 0.01}$$

$$= 0.05 \times 2 \times 10^{-3}$$

$$= 10^{-4}\,\text{m}^2$$

$$= 1\,\text{cm}^2$$

13. Option (1) is correct.

Gauss's law in electrostatic, $\oint \vec{E}.\,d\vec{s} = \dfrac{q}{\varepsilon_0}$

Faraday's law, $\oint \vec{E}.\,d\vec{l} = \dfrac{-dF_B}{dt}$

Gauss's law in magnetism, $\oint \vec{B}.d\vec{A} = 0$

Ampere's Maxwell law, $\oint \vec{B}.d\vec{l} = \mu_0 i_c + \mu_0\varepsilon_0 \dfrac{d\phi_E}{dt}$

14. Option (3) is correct.

$$R_1 = \frac{u^2 \sin 2\alpha}{g}$$ = Range of an oblique projectile

$$R_2 = \frac{u^2 \sin 2\beta}{g}$$

$$= \frac{u^2 \sin 2(90^\circ - \alpha)}{g}$$
$$= \frac{u^2 \sin(180^\circ - 2\alpha)}{g}$$
$$= \frac{u^2 \sin 2\alpha}{g}$$
$$= R_1$$

Since $R_2 = R_1$

$$\frac{R_1}{R_2} = 1:1$$

15. Option (1) is correct.

Let the particle executes SHM according to

$x = a\sin \omega t$

Let t_1 = time taken from $x = 0$ to $x = \frac{a}{2} = 2$ s

$$\frac{a}{2} = a\sin\omega(2)$$
$$2\omega = \frac{\pi}{6}$$
$$\omega = \frac{\pi}{12} = \frac{2\pi}{T}$$

$\Rightarrow$ T = 24 s

Time taken from $x = 0$ to $x = a = \frac{T}{4} = 6$ s

Hence time taken from $x = \frac{a}{2}$ to $x = \omega$ is t_2

where, $t_2 = 6 - 2 = 4$ s

16. Option (2) is correct.

For isothermal process T = const, $\Delta U = nC_v\Delta T = 0$

For adiabatic process, $\Delta Q = 0 = \Delta U + \Delta W$

$\Delta U = -\Delta W$

When gas does work, $\Delta W > 0$ so $\Delta U < 0$

i.e., work done by gas decreases internal energy. For, isochoric process, V = constant.

Hence, $\Delta W = P\Delta V = 0$

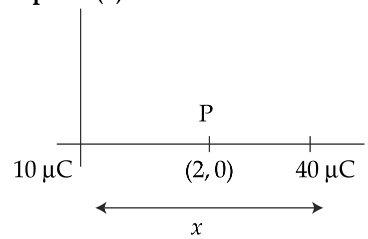
For isobaric process $\Delta Q = \Delta U + \Delta W$

17. Option (4) is correct.

Trivalent impurities like Boron makes a pure semiconductor p–type with excess holes while pentavalent impurities like Arsenic makes it an n-type semiconductor with excess electrons. Statement–I is correct.

For a p–n junction, current never flows due to the presence of a potential barrier at the junction. Current starts to flow only when the barriers is overcome by forward biasing the diode. So, statement–II is incorrect.

18. Option (2) is correct.



Let $q = 40\,\mu C$ be placed at a distance x from the origin

for $\vec{E_p} = 0, \vec{E_{10}} = -\vec{E_{40}}$

$$\left|\vec{E_{10}}\right| = \left|\vec{E_{40}}\right|$$
$$\frac{K(10)}{(2)^2} = \frac{K(40)}{(x-2)^2}$$
$$16 = (x-2)^2$$
$$x - 2 = 4$$
$$x = 6 \text{ cm}$$

19. Option (2) is correct.

When a wire is stretched, its volume remains conserved

$$Al = A'(nl)$$
$$A' = \frac{A}{W}$$

Initially $R = \rho\frac{l}{A} = 5$

After stretching $R' = \frac{\rho(5l)}{A/5}$

$= 25R = 25 \times 5$

$= 125\ \Omega$

20. Option (3) is correct.

Potential energy at the earth's surface

$$= U_1 = \frac{-GM_m}{R_e}$$

At $h = 2R_e, U_2 = \frac{-GM_m}{R_e + h} = \frac{-GM_m}{3R_e}$

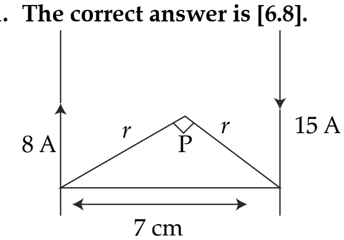
$$\Delta U = U_2 - U_1$$
$$= \frac{GM_m}{3R_e} - \left(\frac{-GM_m}{R_e}\right) = \frac{2}{3}\frac{GM_m}{R_e}$$

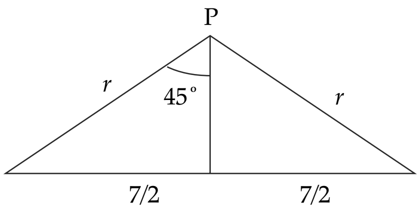
Since $GM = gR_e^2$

$$\Delta U = \frac{2}{3}mgR_e$$

Section B

21. The correct answer is [6.8].





$$r = \frac{7/2}{\cos 45^\circ} = \frac{7}{\sqrt{2}}$$

$$\overrightarrow{B_8} = \left(\frac{\mu_0 8}{2\pi \times \frac{7}{\sqrt{2}}}\right) \times 10^2$$

$$\bar{B}_{15} = \frac{\mu_0 15}{2\pi \times \left(\frac{7}{\sqrt{2}}\right)} \times 10^2$$

$$\bar{B}_p = \bar{B}_8 + \bar{B}_{15} \rightarrow \left|\bar{B}_P\right| = \sqrt{\left|\bar{B}_8\right|^2 + \left|\bar{B}_{15}\right|^2}$$

$$= \frac{\mu_0}{2\pi\left(\frac{7}{\sqrt{2}}\right)}\left(\sqrt{8^2 + 15^2}\right) \times 10^2$$

$$= \frac{4\pi \times 10^{-7} \times \sqrt{2} \times \sqrt{289} \times 10^2}{2\pi \times 7}$$

$$= \frac{2 \times 10^{-7} \times 1.4 \times 17 \times 10^2}{7}$$

$= 68 \times 10^{-5}$ T

$= 6.8 \times 10^{-6}$ T

22. The correct answer is [1].

When a liquid drop of radius R splits into n identical drops, each of radius r, volume of the system is conserved.

$$R^3 = nr^3$$

Hence $\quad r = 1000$

$$R = 10r$$

Initial surface energy $U_i = S\,(4\pi R^2)$

where, S = surface tension

Final surface energy, $U_f = S[1000 \times 4\pi r^2]$

$$\frac{U_f}{U_i} = \frac{S\left[1000 \times 4\pi r^2\right]}{5.4\pi R^2} = \frac{1000 r^2}{(10r)^2} = 10 = \frac{10}{x}$$

$\therefore \quad x = 1$

23. The correct answer is [2].

When a nucleus disintegrates ($F_{ext} = 0$)
Momentum of the system remain conserved.

$$\vec{0} = \vec{p}_1 + \vec{p}_2$$

$$\bar{p}_2 = -\bar{p}_1$$

$$\left|\bar{p}_2\right| = \left|\bar{p}_1\right|$$

$$m_2 v_2 = m_1 v_1$$

$$\frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{3}{2}$$

Mass = volume × density

Since nuclear density is constant, irrespective of the nuclear size.

$$m \propto V$$

$$\frac{m_1}{m_2} = \frac{V_1}{V_2} = \frac{R_1{}^3}{R_2{}^3} = \frac{2}{3}$$

$$\frac{R_1}{R_2} = \left(\frac{2}{3}\right)^{1/3} = \left(\frac{x}{3}\right)^{1/3} \quad \text{(given)}$$

$\therefore \quad x = 2$

24. The correct answer is [400].

When a source of sound approaches an observer at rest, frequency perceived by the observer is

$$n' = \frac{n\bar{v}}{v - \bar{v}_s} \quad \text{where, } \bar{v} = \text{velocity of sound}$$

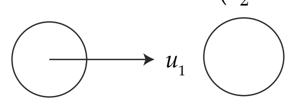
$$= \frac{320 \times 330}{330 - 66}$$

$$= \frac{320 \times 330}{264}$$

$= 400$ Hz

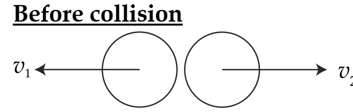
25. The correct answer is [4].

rest ($u_2 = 0$)



m_1=1 kg $\quad m_2 = 3$ kg

<u>**Before collision**</u>



$v_1 = 2$ m s^{-1}

<u>**After collision**</u>

For elastic collision with $u_2 = 0$

$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) u_1$$

$$-2 = \left(\frac{1-3}{1+3}\right) u_1$$

$$-8 = -2u_1$$

$u_1 = 4$ m s^{-1}

26. The correct answer is [8].

For a series R - L - C circuit

$$\cos\theta = \frac{R}{Z} = \frac{R}{\sqrt{R_2 + (X_L - X_C)^2}}$$

Putting for $R = 80\ \Omega$, $X_L = 70\ \Omega$ and $X_c = 130\ \Omega$

$$\text{We get, } \cos\phi = \frac{80}{\sqrt{80^2 + (70 - 130)^2}} = \frac{80}{\sqrt{80^2 + 60^2}}$$

$$= \frac{4}{5}$$

$$= \frac{x}{10} \quad \text{(given)}$$

$x = 8$

27. The correct answer is [5].

Applying parallel axis theorem

$$I = I_{CM} + MR^2$$

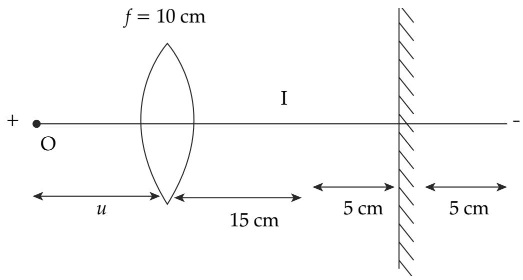
For a disc, $I_{\tan g_D} = \frac{MR^2}{4} + MR^2 = \frac{5MR^2}{4}$

For a sphere, $I_{\tan g_S} = \frac{2}{5}M^1R^2 + M^1R^2 = \frac{7}{5}M^1R^2$

$$\frac{I_{\tan g_D}}{I_{\tan g_S}} = \frac{\frac{5}{4}MR^2}{\frac{7}{5}M^1R^2} = \frac{25}{28} \times \frac{4}{5} = \frac{5}{7} = \frac{x}{7} \text{ (given)}$$

on comparison $x = 5$

28. The correct answer is [30].



Since the image is formed at 5 cm inside the mirror, object should lie 5 cm in front of it; which implies that the image formed by the convex lens is at 20 – 5 = 15 cm on the other side of the lens as shown.

Applying lens formula,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{15} - \frac{1}{u} = \frac{1}{10}$$

$$\frac{1}{u} = \frac{1}{15} - \frac{1}{10} = -\frac{1}{30}$$

$$u = -30 \text{ cm.}$$

Object is placed at 30 cm away from the lens away.

29. The correct answer is [6].

For a partially filled dielectric slab of thickness t and dielectric constant K, capacitance is given by

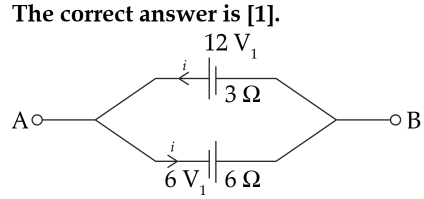
$$C = \frac{C_0}{1 - \frac{t}{d}\left(1 - \frac{1}{K}\right)} = \frac{5}{1 - \frac{d/2}{d}\left(1 - \frac{1}{1.5}\right)}$$

$$= \frac{5}{1 - \frac{1}{2}\left(\frac{1}{3}\right)}$$

$$= \frac{30}{5}$$

$$= 6\ \mu\text{F}$$

30. The correct answer is [1].

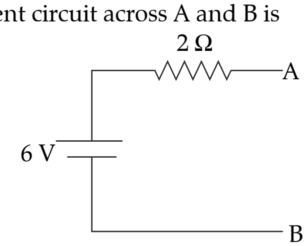


$$i = \frac{12+6}{9} = 2\text{ A}$$

$$V_{AB} = 12 - i(3) = 12 - (2 \times 3) = 6\text{ V}$$

$$R_{AB} = \frac{r_1 r_2}{r_1 + r_2} = \frac{3 \times 6}{3 + 6} = 2\ \Omega$$

Equivalent circuit across A and B is



When $R = 4\ \Omega$ is connected across A and B

$$\lambda_R = \frac{6}{2+4} = 1\text{ A}$$