JEE (Main) PHYSICS SOLVED PAPER

2023
11th April Shift 1

Section A

Q. 1. The radii of two planets 'A' and 'B' are 'R' and '4R' and their densities are ρ and $\frac{\rho}{3}$ respectively. The ratio of acceleration due to gravity at their surfaces ($g_A : g_B$) will be:

(1) 1 : 16 **(2)** 3 : 16 **(3)** 3 : 4 **(4)** 4 : 3

Q. 2. A coin placed on a rotating table just slips when it is placed at a distance of 1 cm from the center. If the angular velocity of the table is halved, it will just slip when placed at a distance of ______ from the centre:

(1) 8 cm **(2)** 4 cm **(3)** 2 cm **(4)** 1 cm

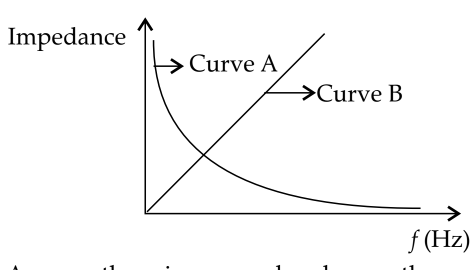
Q. 3. Three vessels of equal volume contain gases at the same temperature and pressure. The first vessel contains neon (monoatomic), the second contains chlorine (diatomic) and third contains uranium hexafluoride (polyatomic). Arrange these on the basis of their root mean square speed (v_{rms}) and choose the correct answer from the options given below:

(1) v_{rms} (mono) > v_{rms} (dia) > v_{rms} (poly)
(2) v_{rms} (dia) < v_{rms} (poly) < v_{rms} (mono)
(3) v_{rms} (mono) < v_{rms} (dia) < v_{rms} (poly)
(4) v_{rms} (mono) = v_{rms} (dia) = v_{rms} (poly)

Q. 4. Two radioactive elements A and B initially have same number of atoms. The half life of A is same as the average life of B. If A λ_A and λ_B are decay constants of A and B respectively, then choose the correct relation from the given options:

(1) $\lambda_A = 2\lambda_B$ **(2)** $\lambda_A = \lambda_B$
(3) $\lambda_n \ln 2 = \lambda_B$ **(4)** $\lambda_A = \lambda_B \ln 2$

Q. 5.



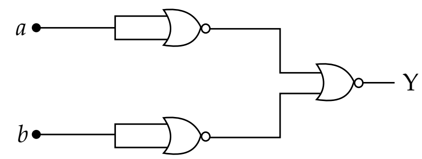
As per the given graph, choose the correct representation for curve A and curve B.
(where, X_C = reactance of pure capacitive circuit connected with A.C. source
X_L = reactance of pure inductive circuit connected with A.C. source
R = impedance of pure resistive circuit connected with A.C. source.
Z = impedance of the LCR series circuit)

(1) $A = X_L, B = R$ **(2)** $A = X_L, B = Z$
(3) $A = X_C, B = R$ **(4)** $A = X_C, B = X_L$

Q. 6. A transmitting antenna is kept on the surface of the earth. The minimum height of receiving antenna required to receive the signal in line of sight at 4 km distance from it is $x \times 10^{-2}$ m. The value of x is ______.
(Let, radius of earth, R = 6400 km)

(1) 125 **(2)** 12.5 **(3)** 1250 **(4)** 1.25

Q. 7. The logic performed by the circuit shown in figure is equivalent to:



(1) NAND **(2)** NOR **(3)** AND **(4)** OR

Q. 8. The electric field in an electromagnetic wave is given as:

$$\vec{E} = 20 \sin \omega \left(t - \frac{x}{c}\right) \vec{J} \text{ N C}^{-1}$$

where, ω and c are angular frequency and velocity of electromagnetic wave respectively. The energy contained in a volume of 5×10^{-4} m^3 will be: (Given $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2 N^{-1} m^{-2})

(1) 88.5×10^{-13} J **(2)** 17.7×10^{-13} J
(3) 8.85×10^{-13} J **(4)** 28.5×10^{-13} J

Q. 9. Two identical heater filaments are connected first in parallel and then in series. At the same applied voltage, the ratio of heat produced in same time for parallel to series will be:

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

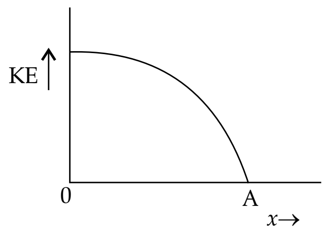
Q. 10. A parallel plate capacitor of capacitance 2 F is charged to a potential V. The energy stored in the capacitor is E_1. The capacitor is now connected to another uncharged identical capacitor in parallel combination. The energy stored in the combination is E_2. The ratio E_2/E_1 is:

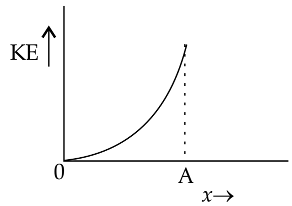
(1) 2 : 3 **(2)** 1 : 2 **(3)** 1 : 4 **(4)** 2 : 1

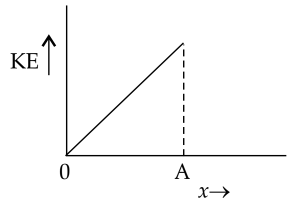
Q. 11. An average force of 125 N is applied on a machine gun firing bullets each of mass 10 g at the speed of 250 m s^{-1} to keep it in position. The number of bullets fired per second by the machine gun is:

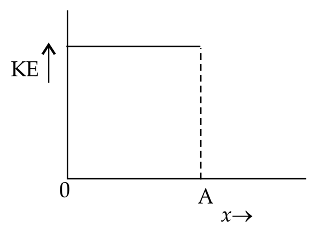
(1) 25 **(2)** 5 **(3)** 100 **(4)** 50

Q. 12. The variation of kinetic energy (KE) of a particle executing simple harmonic motion with the displacement (x) starting from mean position to extreme position (A) is given by:

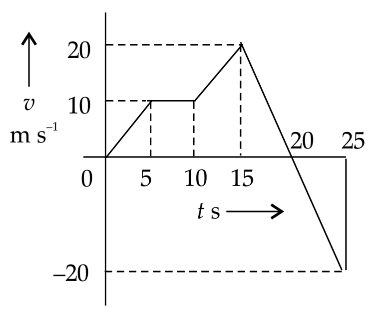
(1) 

(2) 

(3) 

(4) 

Q. 13. From the v-t graph shown, the ratio of distance to displacement in 25 s of motion is:



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

Q. 14. On a temperature scale 'X', the boiling point of water is 65°X and the freezing point is –15°X. Assume that the X scale is linear. The equivalent temperature corresponding to –95°X on the Farenheit scale would be:

(1) –63°F **(2)** –148°F **(3)** –48°F **(4)** –112°F

Q. 15. The free space inside a current carrying toroid is filled with a material of susceptibility 2×10^{-2}. The percentage increase in the value of magnetic field inside the toroid will be:

(1) 0.2% **(2)** 1% **(3)** 2% **(4)** 0.1%

Q. 16. The critical angle for a denser-rarer interface is 45°. The speed of light in rarer medium is 3×10^{8} m s^{-1}. The speed of light in the denser medium is:

(1) 2.12×10^{8} m s^{-1} **(2)** 5×10^{7} m s^{-1}
(3) 3.12×10^{7} m s^{-1} **(4)** $\sqrt{2} \times 10^{8}$ m s^{-1}

Q. 17. Given below are two statements:
Statements I: Astronomical unit (Au), Parsec (Pc) and Light year (ly) are units for measuring astronomical distances.
Statements II: Au < Parsec (Pc) < ly
In the light of the above statements, choose the most appropriate answer from the options given below :
(1) Both Statements I and Statements II are incorrect.
(2) Both Statements I and Statements II are correct.
(3) Statements I is incorrect but Statements II are correct
(4) Statements I is correct but Statements II are incorrect.

Q. 18. The current sensitivity of moving coil galvanometer is increased by 25%.This increase is achieved only by changing in the number of turns of coils and area of cross section of the wire while keeping the resistance of galvanometer coil constant. The percentage change in the voltage sensitivity will be:

(1) +25% **(2)** –25% **(3)** –50% **(4)** Zero

Q. 19. A metallic surface is illuminated with radiation of wavelength λ , the stopping potential is V_0. If the same surface is illuminated with radiation of wavelength 2λ , the stopping potential becomes $\frac{V_0}{4}$. The threshold wavelength for this metallic surface will be:

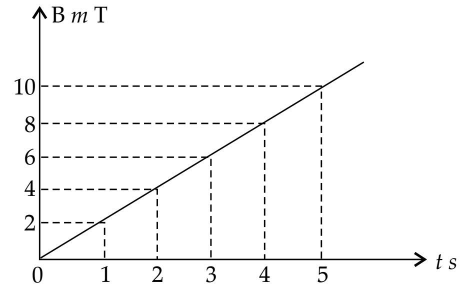
(1) $\frac{3}{2}\lambda$ **(2)** 4λ **(3)** 3λ **(4)** $\frac{\lambda}{4}$

Q. 20. 1 kg of water at 100°C is converted into steam at 100°C by boiling at atmospheric pressure. The volume of water changes from 1.00×10^{-3} m^3 as a liquid to 1.671 m^3 as steam. The change in internal energy of the system during the process will be:
(Given latent heat of vaporisation = 2257 kJ/kg, Atmospheric pressure = 1×10^5 Pa)
(A) + 2476 kJ **(B)** –2426 kJ
(3) –2090 kJ **(4)** +2090 kJ

Section B

Q. 21. The radius of curvature of each surface of a convex lens having refractive index 1.8 is 20 cm. The lens is now immersed in a liquid of refractive index 1.5. The ratio of power of lens in air to its power in the liquid will be x : 1. The value of x is _________ .

Q. 22. The magnetic field B crossing normally a square metallic plate of area 4 m^2 is changing with time as shown in figure. The magnitude of induced emf in the plate during t = 2 s to t = 4 s, is ______ mV.



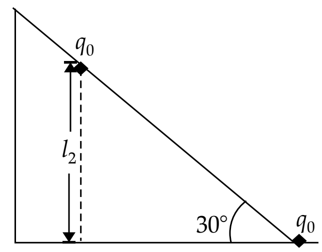
Q. 23. The length of a wire becomes l_1 and l_2 when 100 N and 120 N tensions are applied respectively. If $10\ l_2 = 11\ l_1$, the natural length of wire will be $\frac{1}{x}\ l_1$. Here the value of x is _______ .

Q. 24. A monochromatic light is incident on a hydrogen sample in ground state. Hydrogen atoms absorb a fraction of light and subsequently emit radiation of six different wavelengths. The frequency of incident light is $x \times 10^{15}$ Hz. The value of x is _______.
(Given: $h = 4.25 \times 10^{-15}$ e V)

Q. 25. A force $\vec{F} = (2 + 3x)\hat{i}$ acts on a particle in the x direction where F is in newton and x is in metre. The work done by this force during a displacement from $x = 0$ to $x = 4$ m, is ______ J.

Q. 26. As shown in the figure, a configuration of two equal point charges ($q_0 = +2\ \mu$ C) is placed on an inclined plane. Mass of each point charge is 20 g. Assume that there is no friction between charge and plane. For the system of two point charges to be in equilibrium (at rest) the height, $h = x \times 10^{-3}$ m. The value of x is _________.

(Take $\frac{1}{4\pi\varepsilon_0}$ 9×10^9 N m^2 C^{-2}, $g = 10$ m s^{-2})



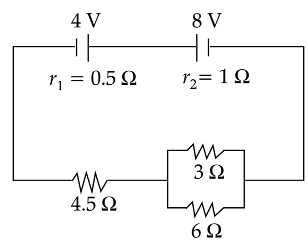
Q. 27. A solid sphere of mass 500 g and radius 5 cm is rotated about one of its diameter with angular speed of 10 rad s^{-1}. If the moment of inertia of the sphere about its tangent is $x \times 10^{-2}$ times its angular momentum about the diameter. Then the value of x will be ____________.

Q. 28. The equation of wave is given by

$$Y = 10^{-2} \sin 2\pi\ (160t - 0.5x + \frac{\pi}{4})$$

where x and y are in m and t in s. The speed of the wave is _________ km h^{-1}.

Q. 29. In the circuit diagram shown in figure given below, the current flowing through resistance 3 Ω is $\frac{x}{3}$ A. The value of x is _________.



Q. 30. A projectile fired at 30° to the ground is observed to be at same height at time 3 s and 5 s after projection, during its flight. The speed of projection of the projectile is ________ m s^{-1}.
(Given g = 10 m s^{-2})

Answer Key

Q. No.	Answer	Topic name	Chapter name
1	(3)	Acceleration due to gravity	Gravitation
2	(2)	Friction	Laws of motion
3	(1)	r.m.s. speed	Kinetic theory of gases
4	(4)	Half life	Nuclei
5	(4)	Impedance	Alternating current
6	(1)	Range of transmission	Communication systems
7	(3)	Logic gates	Semiconductor & Electronics
8	(3)	Energy density	Electromagnetic waves
9	(2)	Heating effect of electric current	Current electricity
10	(2)	Parallel plate capacitor	Electrostatic potential and capacitance
11	(4)	Momentum	Laws of motion
12	(1)	Kinetic energy	Oscillations
13	(3)	Graphical representation of motion	Motion in a straight line
14	(3)	Temperature scale	Thermal properties of matter
15	(3)	Solenoid	Moving charges and magnetism

16	**(1)**	Total internal reflection	Ray optics
17	**(4)**	Units	Units and dimesnions
18	**(1)**	Moving coil galvanometer	Moving charges and magnetism
19	**(3)**	Photoelectric effect	Dual nature of radiation and matter
20	**(4)**	First law of thermodynamics	Thermodynamics
21	**[4]**	Lens maker's formula	Ray optics
22	**[8]**	Induced EMF	Electromagnetic induction
23	**[2]**	Young's modulus of elasticity	Mechanical properties of solids
24	**[3]**	Atomic spectrum	Atoms
25	**[32]**	Force	Laws of motion
26	**[300]**	Electrostatic force	Electric charges and fields
27	**[35]**	Moment of inertia	System of particles and rotational motion
28	**[1152]**	Speed of EMW	Electromagnetic waves
29	**[1]**	Circuit diagram	Current electricity
30	**[80]**	Projectile motion	Motion in a plane

SOLUTIONS

Section A

1. Option (3) is correct.

We know that, $g = \frac{GM}{R^2} = \frac{4}{3}\pi G\rho R$

Clearly, $g \propto \rho R$ $\frac{g_A}{g_B} = \frac{\rho_A R_A}{\rho_B R_B} = \frac{\rho R}{\frac{\rho}{3} \times 4R} = 3:4$

2. Option (2) is correct.

In balanced condition,

friction = centripetal force

$\Rightarrow$ $\mu mg = m\omega^2 r$ = const.

Here, $r_1 = 1\ cm$, $\omega_1 = \omega$

$r_2 = ?$, $\omega_2 = \frac{\omega}{2}$

$\Rightarrow$ $m\omega_2^2 r_2 = m\omega_1^2 r_1 \Rightarrow \frac{\omega^2}{4} r_2 = \omega^2 1 \Rightarrow r_2 = 4$ cm

3. Option (1) is correct.

$v_{rms} = \sqrt{\frac{3kT}{m}}$

$\Rightarrow v_{rms} \propto \frac{1}{\sqrt{m}}$ $(\because T = \text{constant})$

$\because$ m (neon) < m (oxygen) < m (hexa floride)

$\therefore$ v_{rms} (neon) > v_{rms} (oxygen) > v_{rms} (hexa floride)

4. Option (4) is correct.

Given, $T_{1/2}(A) = T_{av}(B)$

$\frac{\ln 2}{\lambda_A} = \frac{1}{\lambda_B} \Rightarrow \lambda_A = \lambda_B \ln 2$

5. Option (4) is correct.

Resistance of a circuit does not change with frequency, hence option 1 and 3 are wrong

$X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C} \Rightarrow X_c \propto \frac{1}{f}$

On increasing f, Z decrease,hence $A \rightarrow X_c$

$X_L = \omega L = 2\pi f L$

$\Rightarrow$ $X_c \propto f$

On increasing f, Z increase,hence $B \rightarrow X_L$

6. Option (1) is correct.

Given, Radius of earth, R = 6400 km

Range of transmission, d = 4 km

Range of transmission, $d = \sqrt{2hR}$

$\Rightarrow$ $h = \frac{4 \times 4}{2 \times 6400} = \frac{1}{800}$ km

or $h = \frac{1000}{800}\text{m} = 125 \times 10^{-2}\text{m}$

On comparing, we get x = 125

7. Option (3) is correct.

Inputs		$Y' = \overline{A + A} = \overline{A}$	$Y'' = \overline{B + B} = \overline{B}$	Output $Y = \overline{Y' + Y''}$
A	**B**			
0	0	1	1	0
0	1	1	0	0
1	0	0	1	0
1	1	0	0	1

From above table we can see final output is similar to that of AND gate.

8. Option (3) is correct.

Given, Volume, $V = 5 \times 10^{-4}\ \text{m}^3$

$E_0 = 20\ \text{NC}^{-1}$

Energy density is given by, $u = \frac{1}{2}\varepsilon_0 E_0^2$

$\Rightarrow u = \frac{1}{2} \times 8.85 \times 10^{-12} \times 400$

$\Rightarrow U = u \times$ volume

$U = 8.85 \times 10^{-10} \times 2 \times 5 \times 10^{-4}$

$= 8.85 \times 10^{-13}$ J

9. Option (2) is correct.

Let the resistance of each filament be 'R'

In parallel, $R_p = \frac{R}{2}$

In series, $R_s = R + R = 2R$

At constant voltage, $H = \frac{V^2 t}{R}$

$$\because \quad \frac{H_p}{H_s} = \frac{R_s}{R_p} = \frac{2R}{\frac{R}{2}} = \frac{4}{1}$$

10. Option (2) is correct.

Energy stored in capacitor, $E_1 = \frac{1}{2}CV^2$

When charged capacitor is connected to uncharged capacitor, flow of charges will take place until both capacitors are at same potential. New potential

$$V' = \frac{C_1V_1 + C_2V_2}{C_1 + C_2} = \frac{CV + 0}{2C} = \frac{V}{2}$$

$C' = C + C = 2C$

Energy stored in combination, $E_2 = \frac{1}{2}C'V'^2$

$$\Rightarrow \quad E_2 = \frac{1}{2} \times 2C \times \left(\frac{V}{2}\right)^2 = \frac{1}{4}CV^2$$

Now $\frac{E_2}{E_1} = \frac{\frac{1}{4}CV^2}{\frac{1}{2}CV^2} = \frac{1}{2}$

11. Option (4) is correct.

Given, Average force, $F = 125$ N

Mass of each bullet, $m = 10$ g

Velocity of each bullet, $v = 250$ m s^{-1}

As per 2nd law of motion, $F = \frac{dp}{dt}$

Or $F = \frac{d(nmv)}{dt} = mv\frac{dn}{dt}$

$$\Rightarrow \frac{dn}{dt} = \frac{F}{mv}$$

$$\Rightarrow \frac{dn}{dt} = \frac{125}{10 \times 10^{-3} \times 250} = 50$$

12. Option (1) is correct.

K.E. of particle in SHM is given by,

$$\text{KE} = \frac{1}{2}KA^2 - \frac{1}{2}Kx^2$$

From above equation we can say, as $x \to$ (0 to A), KE changes non linearly.

So KE in max at mean position and least at extreme positions, hence option (1) is correct.

13. Option (3) is correct.

Displacement = Area under v-t graph

$$= \frac{1}{2} \times 10 \times 5 + 5 \times 10 + \frac{1}{2} \times 5 \times (10 + 20) + \frac{1}{2} \times 5 \times 20 - \frac{1}{2} \times 5 \times 20$$

$= 25 + 50 + 75 + 50 - 50 = 150$ m

Distance $= 25 + 50 + 75 + 50 + 50 = 250$ m

Now, $\frac{\text{distance}}{\text{displacement}} = \frac{250}{150} = \frac{5}{3}$

Alternative: If motion is not in a straight line then $\frac{\text{distance}}{\text{displacement}} > 1$,

Only option (3) is satisfying this condition.

14. Option (3) is correct.

$$\frac{X - X_L}{X_U - X_L} = \frac{F - F_L}{F_U - F_L}$$

$$\Rightarrow \frac{-95 - (-15)}{65 - (-15)} = \frac{F - 32}{212 - 32}$$

$$\Rightarrow \quad -\frac{80}{80} = \frac{F - 32}{180}$$

$$\Rightarrow \quad F = -180 + 32 = -148°F$$

15. Option (3) is correct.

$B_{toroid} = \mu_0 nI$ (without material)

$B'_{toroid} = \mu_0\mu_r nI$ (with material)

$$\%\Delta B = \frac{B' - B}{B} \times 100$$

$$= \frac{\mu_0\mu_r nI - \mu_0 nI}{\mu_0 nI} \times 100$$

$$= (\mu_r - 1) \times 100 = 2 \times 10^{-2} \times 100 = 2\%$$

16. Option (1) is correct.

We know that, $n = \frac{1}{\sin C}$

$$n = \frac{1}{\sin 45} = \sqrt{2}$$

Now, $n = \frac{v_1}{v_2}$

$$\sqrt{2} = \frac{3 \times 10^8}{v_2}$$

$$\Rightarrow \quad v_2 = \frac{3}{\sqrt{2}} \times 10^8 = 2.12 \times 10^8 \text{ m s}^{-1}$$

17. Option (4) is correct.

1 Parsec $= 3.0857 \times 10^{16}$ m $= 3.26$ ly

1 ly $= 9.5 \times 10^{15}$ m

1 AU $= 1.49 \times 10^{11}$ m

All three units are used to measure astronomical distances. Parsec is the biggest unit to measure length. Hence, statement II is wrong

18. Option (1) is correct.

Current sensitivity, $i_s = \frac{\alpha}{I} = \frac{BNA}{k}$

Voltage sensitivity, $V_S = \frac{\frac{BNA}{k}}{R} = \frac{i_s}{R}$

If R is constant, $V_S \propto i_S$

Hence voltage sensitivity will also change by 25%.

19. Option (3) is correct.

Energy of photon = K.E. + work function

$$\Rightarrow \frac{hc}{\lambda} = eV_0 + \phi_0 \quad \text{...(i)}$$

$$\text{Now, } \frac{hc}{2\lambda} = \frac{eV_0}{4} + \phi_0 \quad \text{...(ii)}$$

Substituting value of eV_0 from eq. (i) in eq (ii),

$$\frac{hc}{2\lambda} = \frac{1}{4}\left(\frac{hc}{\lambda} - \phi_0\right) + \phi_0$$

$$\Rightarrow \quad \frac{hc}{2\lambda} = \frac{hc}{4\lambda} + \frac{3}{4}\phi_0$$

$$\Rightarrow \quad \frac{3}{4}\phi_0 = \frac{hc}{4\lambda}$$

$$\Rightarrow \quad \frac{3}{4}\frac{hc}{\lambda_0} = \frac{hc}{4\lambda}$$

$$\Rightarrow \quad \lambda_0 = 3\lambda$$

20. Option (4) is correct.

Given, $m_w = 1$ kg, $P = 1.013 \times 10^5$ Pa

$V_w = 0.001$ m^3, $V_s = 1.671$ m^3

$\Delta Q = \Delta U + W$

$\Rightarrow \quad mL_V = \Delta U + P\Delta V$

$\Rightarrow 2257 \times 1 = \Delta U + (1.013 \times 10^5) \times 1.67$

$\Rightarrow \quad \Delta U = 2090$ kJ

Section B

21. The correct answer is (4).

Given, First radius of curvature, $R_1 = +20$ cm

second radius of curvature, $R_2 = -20$ cm

Refractive index of lens, $\mu_g = \mu_2 = 1.8$

Refractive index of air, $\mu_a = \mu_1 = 1$

From lens maker's formula $\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$\Rightarrow P = \frac{1}{f} = \left(\frac{1.8}{1} - 1\right)\left(\frac{1}{20} - \frac{1}{-20}\right)$$

$$\Rightarrow P = \frac{1}{f} = \frac{0.8}{10} \quad \text{...(i)}$$

When immersed in liquid

$$P' = \left(\frac{1.8}{1.5} - 1\right)\left(\frac{1}{20} - \frac{1}{-20}\right)$$

$$\Rightarrow P' = \frac{0.2}{10} \quad \text{...(ii)}$$

On dividing eq. (i) and (ii), we get

$$\frac{P}{P'} = \frac{0.8}{0.2} = 4:1$$

22. The correct answer is (8).

Given, Area of plate $A = 4$ m^2

$$E = \frac{d\phi}{dt} = \frac{d(BA)}{dt} = A\frac{dB}{dt}$$

$$E = 4 \times \left(\frac{8-4}{4-2}\right) = 8 \text{ volt}$$

23. The correct answer is (2).

Given, $F_1 = 100$ N, $F_2 = 120$ N

$11l_1 = 10l_2$

As per young's modulus,

$$Y = \frac{F}{A} \cdot \frac{l}{\Delta l}$$

$$\Rightarrow \quad F = \frac{AF(l_1 - l)}{l}$$

$$100 = k(l_1 - l) \quad \text{...(i)}$$

$$120 = k(l_2 - l) \quad \text{...(ii)}$$

On dividing eq. (ii) by eq. (i), we get

$$\frac{120}{100} = \frac{l_2 - l}{l_1 - l}$$

$\Rightarrow \quad 1.2l_1 - 1.2l = l_2 - l$

$\Rightarrow \quad 1.2l_1 - 1.2l = 1.1l_1 - l$

$\Rightarrow \quad l_1 = 2l$

Hence, $l = \frac{l_1}{2}$, on comparing with $\frac{l_1}{x}$, we get

$x = 2$

24. The correct answer is (3).

Here, $n_1 = 1$

For 6 wavelengths $n_2 = 4$

Energy absorbed by electrons,

$$\Delta E = 13.6\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$hv = 13.6\left(\frac{1}{1^2} - \frac{1}{4^2}\right) \text{ e V}$$

$$\Rightarrow \upsilon = \frac{13.6}{4.25 \times 10^{-15}} \times \frac{15}{16} = 3 \times 10^{15}$$

On comparing with $x \times 10^{15}$, we get

$x = 3$

25. The correct answer is (32).

Work done $W = \int_0^4 F.dx$

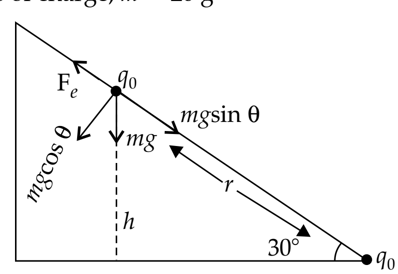
$$W = \int_0^4 (2 + 3x).dx$$

$$= \left[2x + \frac{3x^2}{2}\right]_0^4 = 8 + 24 = 32 \text{ J}$$

26. The correct answer is (300).

Given, $q_1 = q_2 = 2$ μC

Mass of charge, $m = 20$ g



At equilibrium, $F_e = mg\sin\theta$

$$\Rightarrow \quad \frac{kq_1q_2}{r^2} = mg\sin 30$$

$$\Rightarrow \quad \frac{kq_1q_2}{\left(\frac{h}{\sin 30}\right)^2} = mg\sin 30$$

$$\Rightarrow \frac{(9\times10^9\times2\times10^{-6}\times2\times10^{-6})}{4h^2} = 20\times10^{-3}\times10\times\frac{1}{2}$$

$$\Rightarrow \quad h = 300\times10^{-3}\text{ m}$$

On comparing with $h = x \times 10^{-3}$, we get $x = 300$

27. The correct answer is (35).

About axis : $I_{sphere} = \frac{2}{3}mR^2$

About diameter:

$$I'_{sphere} = \frac{2}{5}mR^2 + mR^2 = \frac{7}{5}mR^2$$

Given,

$MI_{tangent}$ = Angular momentum$_{diameter}$ $\times x \times 10^{-2}$

$$\Rightarrow \frac{7}{5}mR^2 = \frac{2}{5}mR^2\omega\times x\times10^{-2}$$

$$\Rightarrow \quad x = \frac{7}{20}\times100 = 35$$

28. The correct answer is (1152).

Comparing given eq. with standard equation

$Y = A\sin\pi(\omega t - kx + \phi)$, we get

$\omega = 160$, $k = 0.5$, $A = 0.01$

Speed of wave,

$$v = \frac{w}{k}$$

$$\Rightarrow v = \frac{160}{0.5} = 320\text{ m s}^{-1} = 1152\text{ km h}^{-1}$$

29. The correct answer is (1).

Net resistance of circuit,

$$R_{net} = 0.5 + 1 + \frac{3\times6}{9} + 4.5$$

$$R_{net} = 6 + 3\times\frac{6}{9} = 8\ \Omega$$

$$V_{net} = V_1 + V_2 = 8 + (-4) = 4\text{ V}$$

$$I_{net} = \frac{V_{net}}{R_{net}} = \frac{4}{8} = 0.5\text{ A}$$

Now, $I_3 = I_{net}\times\frac{6}{3+6} = \frac{1}{3}$ A

Comparing with $\frac{x}{3}$ A, we get $x = 1$

30. The correct answer is (80).

Height of projectile is same, hence total time of flight $= 3 + 5 = 8$ s

Now, $\quad T = \frac{2u\sin\theta}{g}$

$$\Rightarrow \quad u = 8\times\frac{10}{2\sin 30} = 80\text{ m s}^{-1}$$

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