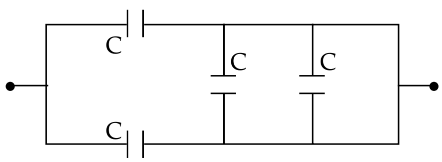
JEE (Main) PHYSICS SOLVED PAPER

2023
10^{th} April Shift 1

Section A

Q. 1. The equivalent capacitance of the combination shown is:



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

Q. 2. Match List I with List II :

	List I		List II
(A)	3 Translational degrees of freedom	**(I)**	Monoatomic gases
(B)	3 Translational, 2 rotational degrees of freedom	**(II)**	Polyatomic gases
(C)	3 Translational, 2 rotational and 1 vibrational degrees of freedom	**(III)**	Rigid diatomic gases
(D)	3 Translational, 3 rotational and more than one vibrational degrees of freedom	**(IV)**	Nonrigid diatomic gases

Choose the correct answer from the options given below:

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

Q. 3. Given below are two statements:
Statements I: If the number of turns in the coil of a moving coil galvanometer is doubled then the current sensitivity becomes double.
Statements II: Increasing current sensitivity of a moving coil galvanometer by only increasing the number of turns in the coil will also increase its voltage sensitivity in the same ratio.
In the light of the above statements, choose the correct answer from the options given below:
(1) Both Statement I and Statement II are true
(2) Both Statement I and Statement II are false
(3) Statement I is true but Statement II is false
(4) Statement I is false but Statement II is true

Q. 4. Given below are two statements:
Statement I: Maximum power is dissipated in a circuit containing an inductor, a capacitor and a resistor connected in series with an AC source, when resonance occurs.
Statement II: Maximum power is dissipated in a circuit containing pure resistor due to zero phase difference between current and voltage.
In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is true but Statement II is false
(2) Both Statement I and Statement II are false
(3) Statement I is false but Statement II is true
(4) Both Statement I and Statement II are true

Q. 5. The range of the projectile projected at an angle of 15° with horizontal is 50 m. If the projectile is projected with same velocity at an angle of 45° with horizontal, then its range will be:

(1) $100\sqrt{2}$ m **(2)** 50 m
(3) 100 m **(4)** $50\sqrt{2}$ m

Q. 6. A particle of mass m moving with velocity v collides with a stationary particle of mass $2m$. After collision, they stick together and continue to move together with velocity:

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

Q. 7. Two satellites of masses m and $3m$ revolve around the earth in circular orbits of radii r & $3r$ respectively. The ratio of orbital speeds of the satellites respectively is:

(1) 3 : 1 **(2)** 1 : 1
(3) $\sqrt{3}:1$ **(4)** 9 : 1

Q. 8. Assuming the earth to be a sphere of uniform mass density, the weight of a body at a depth $d = \frac{R}{2}$ from the surface of earth, if its weight on the surface of earth is 200 N, will be:

(1) 500 N **(2)** 400 N **(3)** 100 N **(4)** 300 N

Q. 9. The de-Broglie wavelength of a molecule in a gas at room temperature (300 K) is λ_1. If the temperature of the gas is increased to 600 K, then the de-Broglie wavelength of the same gas molecule becomes:

(1) $2\lambda_1$ **(2)** $\frac{1}{\sqrt{2}}\lambda_1$
(3) $\sqrt{2}\lambda_1$ **(4)** $\frac{1}{2}\lambda_1$

Q. 10. A physical quantity P is given as $P = \frac{a^2 b^3}{c\sqrt{d}}$

The percentage error in the measurement of a, b, c and d are 1%, 2%, 3% and 4% respectively. The percentage error in the measurement of quantity P will be:

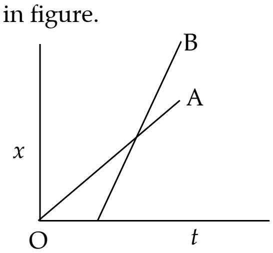
(1) 14% **(2)** 13%
(3) 16% **(4)** 12%

Q. 11. Consider two containers A and B containing monoatomic gases at the same Pressure (P), Volume (V) and Temperature (T). The gas in A is compressed isothermally to $\frac{1}{8}$ of its original volume while the gas in B is compressed adiabatically to $\frac{1}{8}$ of its original volume. The ratio of final pressure of gas in B to that of gas in A is:

(1) 8 **(2)** 4
(3) $\frac{1}{8}$ **(4)** $8^{3/2}$

Q. 12. Given below are two statements:
Statements I: Pressure in a reservoir of water is same at all points at the same level of water.
Statements II: The pressure applied to enclosed water is transmitted in all directions equally.
In the light of the above statements, choose the correct answer from the options given below:
(1) Both Statement I and Statement II are false
(2) Both Statement I and Statement II are true
(3) Statement I is true but Statement II is false
(4) Statement I is false but Statement II is true

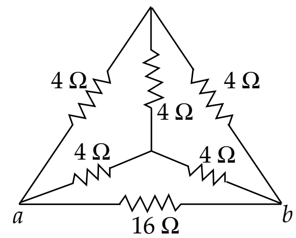
Q. 13. The positon-time graphs for two students A and B returning from the school to their homes are shown in figure.



(A) A lives closer to the school
(B) B lives closer to the school
(C) A takes lesser time to reach home
(D) A travels faster than B
(E) B travels faster than A
Choose the correct answer from the options given below:
(1) (A) and (E) only **(2)** (A), (C) and (E) only
(3) (B) and (E) only **(4)** (A), (C) and (D) only

Q. 14. The energy of an electromagnetic wave contained in a small volume oscillates with
(1) double the frequency of the wave
(2) the frequency of the wave
(3) zero frequency
(4) half the frequency of the wave

Q. 15. The equivalent resistance of the circuit shown below between points a and b is:



(1) 20 Ω **(2)** 16 Ω **(3)** 24 Ω **(4)** 3.2 Ω

Q. 16. A carrier wave of amplitude 15 V is modulated by a sinusoidal base band signal of amplitude 3 V. The ratio of maximum amplitude to minimum amplitude in an amplitude modulated wave is:

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

Q. 17. A particle executes S.H.M. of amplitude A along x-axis. At $t = 0$, the position of the particle is $x = \frac{A}{2}$ and it moves along positives x-axis. The displacement of particle in time t is $x = A\sin(\omega t + \delta)$, then the value δ will be:

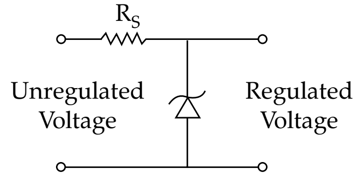
(1) $\frac{\pi}{4}$ **(2)** $\frac{\pi}{2}$ **(3)** $\frac{\pi}{3}$ **(4)** $\frac{\pi}{6}$

Q. 18. The angular momentum for the electron in Bohr's orbit is L. If the electron is assumed to revolve in second orbit of hydrogen atom, then the change in angular momentum will be:

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

Q. 19. An object is placed at a distance of 12 cm in front of a plane mirror. The virtual and erect image is formed by the mirror. Now the mirror is moved by 4 cm towards the stationary object. The distance by which the position of image would be shifted, will be:
(1) 4 cm towards mirror
(2) 8 cm away from mirror
(3) 2 cm towards mirror
(4) 8 cm towards mirror

Q. 20. A zener diode of power rating 1.6 W is to be used as voltage regulator. If the zener diode has a breakdown of 8 V and it has to regulate voltage fluctuating between 3 V and 10 V. The value of resistance R_S for safe operation of diode will be:



(1) 13.3 Ω **(2)** 13 Ω
(3) 10 Ω **(4)** 12 Ω

Section B

Q. 21. Unpolarised light of intensity 32 W m^{-2} passes through the combination of three polaroids such that the pass axis of the last polaroid is perpendicular to that of the pass axis of first polaroid. If intensity of emerging light is 3 W m^{-2}, then the angle between pass axis of first two polaroids is _______°.

Q. 22. If the earth suddenly shrinks to $\frac{1}{64}$th of its original volume with its mass remaining the same, the period of rotation of earth becomes $\frac{24}{x}h$. The value of x is _________.

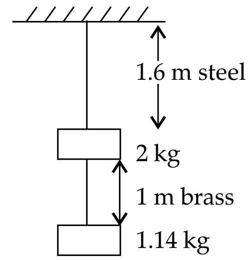
Q. 23. Three concentric spherical metallic shells X, Y and Z of radius a, b and c respectively [$a < b < c$] have surface charge densities σ, $-\sigma$ and σ, respectively. The shells X and Z are at same potential. If the radii of X & Y are 2 cm and 3 cm, respectively. The radius of shell Z is __________ cm.

Q. 24. A transverse harmonic wave on a string is given by $y(x, t) = 5\sin(6t + 0.003x)$
where x and y are in cm and t in sec. The wave velocity is _________ m s^{-1}.

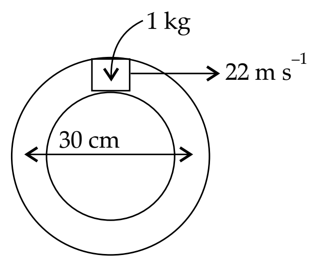
Q. 25. 10 resistors each of resistance 10 Ω can be connected in such as to get maximum and minimum equivalent resistance. The ratio of maximum and minimum equivalent resistance will be ______.

Q. 26. The decay constant for a radioactive nuclide is 1.5×10^{-5} s^{-1}. Atomic weight of the substance is 60 g $mole^{-1}$, ($N_A = 6 \times 10^{23}$). The activity of 1.0 μg of the substance is _________ $\times 10^{10}$ Bq.

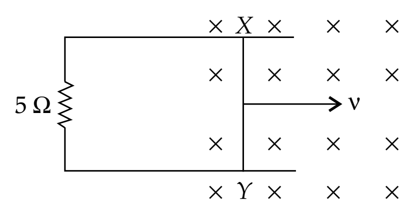
Q. 27. Two wires each of radius 0.2 cm and negligible mass, one made of steel and the other made of brass are loaded as shown in the figure. The elongation of the steel wire is _______ $\times 10^{-6}$ m. (Young's modulus for steel = 2×10^{11} N m^{-2} and $g = 10$ m s^{-2})



Q. 28. A closed circular tube of average radius 15 cm, whose inner walls are rough, is kept in vertical plane. A block of mass 1 kg just fit inside the tube. The speed of block is 22 m s^{-1}, when it is introduced at the top of tube. After completing five oscillations, the block stops at the bottom region of tube. The work done by the tube on the block is ____ J. (Given : g = 10 m/s^2)



Q. 29. A 1 m long metal rod XY completes the circuit as shown in figure. The plane of the circuit is perpendicular to the magnetic field of flux density 0.15 T. If the resistance of the circuit is 5 Ω, the force needed to move the rod in direction, as indicated, with a constant speed of 4 m s^{-1} will be _______ 10^{-3} N.



Q. 30. The current required to be passed through a solenoid of 15 cm length and 60 turns in order to demagnetize a bar magnet of magnetic intensity 2.4×10^3 A m^{-1} is ________A.

Answer Key

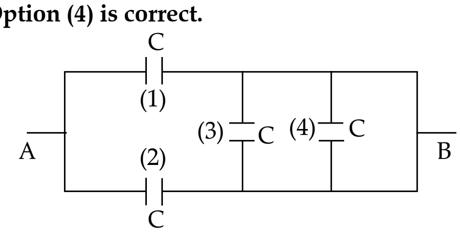
Q. No.	Answer	Topic Name	Chapter Name
1	(4)	Capacitor	Electrostatics
2	(1)	Degree of freedom	Kinetic theory of gases
3	(3)	Moving coil galvanometer	Magnetic effect of current
4	(4)	RLC circuit	Alternating current
5	(3)	Projectile motion	Motion in a plane
6	(2)	Collision	Work, Energy & Power
7	(3)	Orbital speed of satellite	Gravitation
8	(3)	Variation in g	Gravitation
9	(2)	de-Broglie wavelength	Dual nature of matter and radiation

10	**(2)**	Error in measurement	Units & Dimensions
11	**(2)**	Thermodynamic processes	Thermodynamics
12	**(2)**	Pascal's law	Fluid mechanics
13	**(1)**	Displacement-time graph	Motion in a straight line
14	**(1)**	Energy density	Electromagnetic waves
15	**(4)**	Combination of resistors	Electric current
16	**(4)**	Modulation	Communication system
17	**(4)**	Equation of SHM	Oscillation and waves
18	**(3)**	Angular momentum	Atoms
19	**(4)**	Plane mirror	Ray optics
20	**(3)**	Zener diode	Semiconductors
21	**[30 & 60]**	Polarisation	Wave optics
22	**[16]**	Angular momentum	Rotational motion
23	**[5]**	Electric potential	Electrostatics
24	**[20]**	Velocity of wave	Waves
25	**[100]**	Combination of resistance	Electric current
26	**[15]**	Radioactive decay	Nuclear Physics
27	**[20]**	Hook's law	Properties of solid
28	**[245]**	Work energy theorem	Work, Energy & Power
29	**[18]**	Force on current carrying conductor in a uniform magnetic field	Magnetic effect of current & Magnetism
30	**[6]**	Solenoid	Magnetic effect of current & Magnetism

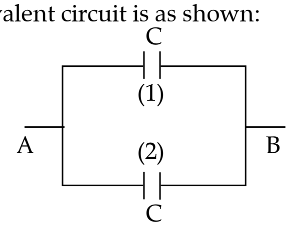
SOLUTIONS

Section A

1. Option (4) is correct.



Capacitors numbered (3) and (4) are short circuit as their both plates are connected to terminal B which makes the potential difference across both to be zero. The equivalent circuit is as shown:



Hence $C_{AB} = 2C$ as capacitors numbered (1) and (2) are connected in parallel.

2. Option (1) is correct.

Degrees of freedom possessed by various gases depends on their atomicities

Monoatomic $\rightarrow$ 3 translational degrees

Rigid diatomic $\rightarrow$ 3 translational + 2 rotational degrees.

Non rigid diatomic $\rightarrow$ 3 translational, 2 rotational and 1 vibrational degrees.

Polyatomic $\rightarrow$ 3 translational, 3 rotational and more than one vibrational degrees.

3. Option (3) is correct.

Current sensitivity, $S_i = \frac{\phi}{i} = \frac{NAB}{C}$

where ϕ = angular deflection

N = number of turns

C = torsional constant

$S_i \propto N$

Therefore, on increasing the no. of turns the current sensitivity increases.

Voltage sensitivity $S_V = \frac{\phi}{V} = \frac{S_i}{R}$

where, R = resistance of the coil.

On increasing N, resistance of the coil increases in the same proportion, hence S_V remains same.

4. Option (4) is correct.

At resonance $X_L = X_C$

Hence impedance $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$= R$ (Minimum)

i.e. R–L–C series circuit behaves as purely resistive, in which case power factor is 1. So power dissipated is maximum.

5. Option (3) is correct.

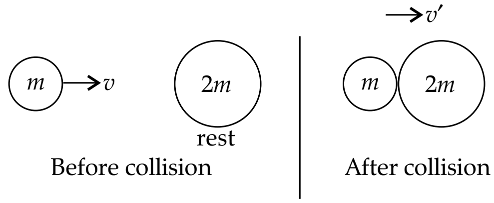
Range R of a projectile is given by

$$R = \frac{u^2 \sin 2\theta}{g}$$

Where, $\theta = 15°$, $R = \frac{u^2 \sin 30°}{g} = \frac{u^2}{2g} = 50$ (m)

When, $\theta = 45°$, $R' = \dfrac{u^2 \sin 90°}{g} = \dfrac{u^2}{g} = 100 \text{ (m)}$

6. Option (2) is correct.



Let v' be the velocity of the combined mass after collision

COM gives,

$$mv + 2m \times 0 = (m + 2m)\, v'$$
$$mv = 3mv'$$
$$v' = \frac{v}{3}$$

7. Option (3) is correct.

Orbital speed of a satellite,

$$v_0 = \sqrt{\frac{GM}{r}}$$

where, M = mass of earth.

$$\frac{v_{01}}{v_{02}} = \sqrt{\frac{r_2}{r_1}} = \sqrt{\frac{3r}{r}} = \sqrt{3}$$

8. Option (3) is correct.

At $d = \dfrac{R}{2}, g' = g\left(1 - \dfrac{d}{R}\right) = \dfrac{g}{2}$

Weight W' at $d = \dfrac{R}{2}$ will be hence $\dfrac{W}{2}$

$\therefore\ W' = \dfrac{W}{2} = \dfrac{200}{2} = 100 \text{ (N)}$

9. Option (2) is correct.

de-Broglie wavelength of a gaseous molecule is given by, $\lambda = \dfrac{h}{\sqrt{3mK_bT}}$

where, K_b = Boltzmann's constant

$$\lambda \propto \frac{1}{\sqrt{T}}$$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{600}{300}} = \sqrt{2} \Rightarrow \lambda_2 = \frac{\lambda_1}{\sqrt{2}}$$

10. Option (2) is correct.

$$P = \frac{a^2 b^3}{c\sqrt{d}}$$

Maximum percentage error in P is given by

$$\frac{\Delta P}{P} \times 100 = \left(2\frac{\Delta a}{a} + 3\frac{\Delta b}{b} + \frac{\Delta c}{c} + \frac{1}{2}\frac{\Delta d}{d}\right) \times 100$$

$$= (2 \times 1\%) + (3 \times 2\%) + 3\% + \frac{1}{2} \times 4\%$$

$$= (2 + 6 + 3 + 2)\% = 13\%$$

11. Option (2) is correct.

For container A, compression is isothermal

$$P_1V_1 = P_2V_2$$
$$PV = P'\left(\frac{V}{8}\right)$$
$$P' = 8P$$

For container B, compression is adiabetic

$$P_1V_1^r = P_2V_2^r$$

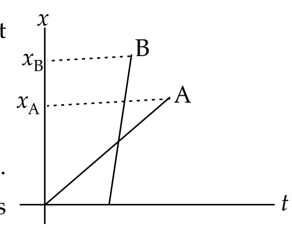
where, $r = \dfrac{5}{3}$ for monoatomic gas

$$PV^{5/3} = P''\left(\frac{V}{8}\right)^{5/3}$$
$$P'' = (8)^{5/3} \times P = (2)^5 P = 32\text{P}$$
$$\frac{P''}{P'} = \frac{32\text{P}}{8\text{P}} = 4$$

12. Option (2) is correct.

Both the statements refer to Pascal's law in hydrostatics.

13. Option (1) is correct.



From the given graphs, it can be seen

slope$_B$ > slope$_A$

$v_B > v_A$

$\therefore$ Statement (E) is correct.

Also, $x_A < x_B$, A lives closer to school.

$\therefore$ Statement (A) is correct.

14. Option (1) is correct.

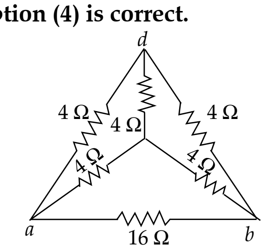
Oscillating electric field in an electromagnetic wave is given by $E = E_0 \sin(wt - kx)$

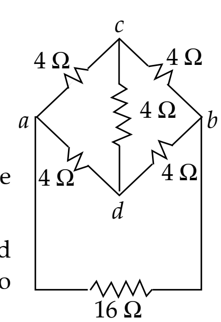
Energy contained in a small volume dV is given by

$$dU = \left(\frac{1}{2}\varepsilon_0 E^2\right) dV$$
$$= \frac{1}{2}\varepsilon_0 E_0^2 \sin^2(\omega t - kx)\, dV$$
$$= \frac{1}{2}\varepsilon_0 E_0^2 \left[\frac{1 - \cos 2(\omega t - kx)}{2}\right] dV$$

Which proves that energy oscillates with double the frequency of that of the wave.

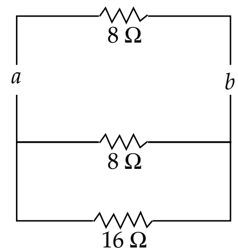
15. Option (4) is correct.





Rearranging the above circuit we get

The above circuit is a balanced wheatstone bridge there is no current in the branch cd.



$$R_{ab} = \frac{4 \times 16}{20} = \frac{16}{5} = 3.2\ \Omega$$

16. Option (4) is correct.

Given: $V_C = 15$ V and $V_m = 3$ V

$$V_{max} = V_C + V_m = 18\text{ V}$$
$$V_{min} = V_C - V_m = 12\text{ V}$$
$$\frac{V_{max}}{V_{min}} = \frac{18}{12} = \frac{3}{2}$$

17. Option (4) is correct.

Given: $x = A\sin(\omega t + \delta)$

At $t = 0,\ x = \frac{A}{2} = A\sin(\omega t + \delta) = A\sin\delta$

$$\sin\delta = \frac{1}{2} \Rightarrow \delta = \frac{\pi}{6}$$

18. Option (3) is correct.

According to Bohr's postulate, the angular momentum of an orbiting electron in a permitted orbit $\theta = \frac{\pi}{6}$

where, n = orbit number

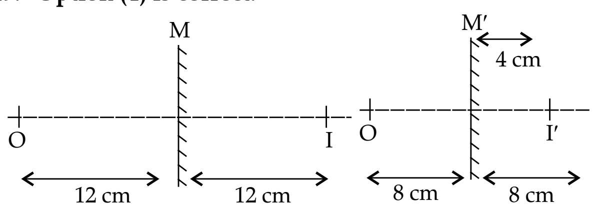
for $n = 1, L = \frac{h}{2\pi}$

for $n = 2, L' = \frac{2h}{2\pi} = 2L$

Change in angular momentum

$$\Delta L = L' - L = L$$

19. Option (4) is correct.

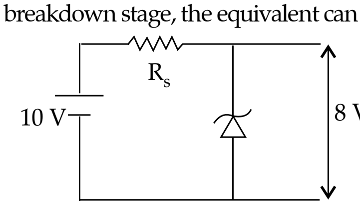


It can be seen, the position of the image shifts by 8 cm towards the mirror.

20. Option (3) is correct.

Current through the Zener diode, $I_Z = \frac{P}{V_2} = \frac{1.6}{8} = 0.2$ A

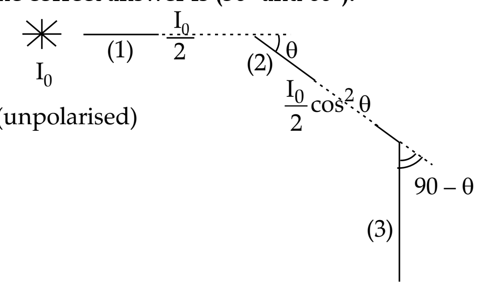
At the breakdown stage, the equivalent can be drawn as



$$R_s = \frac{10-8}{I_Z} = \frac{2}{0.2} = 10\ \Omega$$

Section B

21. The correct answer is (30° and 60°).



$$I = \frac{I_0}{2}\cos^2\theta\sin^2\theta$$
$$I = \frac{I_0}{8}\sin^2 2\theta$$

Given: $I_0 = 32$ W/m^2

$I = 3$ W/m^2

$$3 = \frac{32}{8}\sin^2 2\theta \Rightarrow \sin 2\theta = \frac{\sqrt{3}}{2}$$
$$2\theta = \frac{\pi}{3} \Rightarrow \theta = \frac{\pi}{6}$$

Also $\sin(\lambda - \theta) = \sin\theta$

$$3 = \frac{32}{8}\sin^2(\pi - 2\theta)$$
$$\sin(\pi - 2\theta) = \frac{\sqrt{3}}{2} \Rightarrow \pi - 2\theta = \frac{\pi}{3}$$
$$2\theta = \pi - \frac{\pi}{3} = \frac{2\pi}{3} \Rightarrow \theta = \frac{\pi}{3}$$

(30° and 60°)

22. The correct answer is (16).

Given: $V_2 = \frac{1}{64}V_1$ *and* $T_2 = \frac{24}{x}(h)$

$$\frac{4}{3}\pi R_2^3 = \frac{1}{64} \times \frac{4}{3}\pi R_1^3$$
$$R_2 = \frac{R_1}{4}$$

Applying COM, we get

$$I_1\omega_1 = I_2\omega_2$$

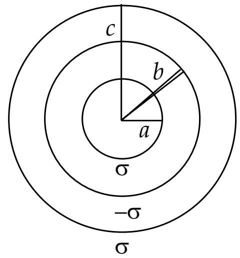
$$I\text{ (solid sphere)} = \frac{2}{5}MR^2 \text{ and } \omega = \frac{2\pi}{T}$$

$$\frac{R_1^2}{T_1} = \frac{R_2^2}{T_2}$$

$$T_2 = T_1\left(\frac{R_2}{R_1}\right)^2 = \frac{T_1}{16} = \frac{24}{16}h$$

On comparing we get, $x = 16$

23. The correct answer is (5).



Let $q_a = \sigma(4\pi a^2)$

$q_b = -\sigma(4\pi b^2)$

$q_c = \sigma(4\pi c^2)$

$$V_a = k\left(\frac{q_a}{a} + \frac{q_b}{b} + \frac{q_c}{c}\right) = \frac{\sigma}{\varepsilon_0}(a - b + c)$$

$$V_b = k\left(\frac{q_a}{b} + \frac{q_b}{b} + \frac{q_c}{c}\right) = \frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{b} - b + c\right)$$

$$V_c = k\left(\frac{q_a}{c} + \frac{q_b}{c} + \frac{q_c}{c}\right) = \frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{c} - \frac{b^2}{c} + c\right)$$

Given: $V_a = V_c$

$$\frac{\sigma}{\varepsilon_0}(a - b + c) = \frac{\sigma}{\varepsilon_0}\left(\frac{a^2 - b^2}{c} + c\right)$$

$a = 2$ cm and $b = 3$ cm

$$2 - 3 + c = \frac{4 - 9}{c} + c$$

$$-1 + c = \frac{-5}{c} + c$$

$$1 = \frac{5}{c}$$

$c = 5$ cm

24. The correct answer is (20).

$y(x, t) = 5\sin(6t + 0.003x)$

wave velocity $v = \dfrac{w}{k} = \dfrac{6}{0.003} = 2000\text{ cm s}^{-1}$

$= 20\text{ m s}^{-1}$

25. The correct answer is (100).

$R_{Max} = 10R = 100\ \Omega$ (All in series)

$R_{Min} = \dfrac{R}{10} = 1\Omega$ (All in parallel)

$$\frac{R_{Max}}{R_{Min}} = 100$$

26. The correct answer is (15).

Given decay constant, $\lambda = 1.5 \times 10^{-5}\ (\text{s}^{-1})$

In 1 mole (60 gm) there are N_A nuclei

In 1 gm, there are $\dfrac{N_A}{60}$ nuclei

In 1 u gm = 10^{-6} gm, there will be

$$N_0 = \frac{N_A \times 10^{-6}}{60} = \frac{6 \times 10^{23} \times 10^{-6}}{60} = 10^{16}$$

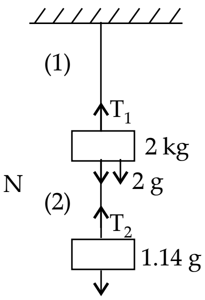
Activity, $A = A_0 e^{-\lambda t}$

$\lambda N = \lambda N_0 e^{-\lambda t}$

At $t = 0$, $A_0 = \lambda N_0 = 1.5 \times 10^{-5} \times 10^{16}$

$= 1.5 \times 10^{11} = 15 \times 10^{10}$ Bq

27. The correct answer is (20).



$r_1 = r_2 = 0.2\text{ cm} = 2 \times 10^{-3}\text{ m}$

y_1 (steel) $= 2 \times 10^{11}\text{ N m}^{-2}$

$l_1 = 1.6$ m

At equilibrium,

$T_2 = 1.14\text{ g} = 11.4$ N

$T_2 + 2g = T_1$

$\therefore\ T_1 = 11.4 + 20 = 31.4$ N

$$\Delta l_1 = \frac{T_1 l_1}{Y_1 A_1}$$

$$= \frac{31.4 \times 1.6}{2 \times 10^{11} \times \pi(2 \times 10^{-3})^2}$$

$$= \frac{16}{8} \times 10^{-5}$$

$= 2 \times 10^{-5}\text{ m} = 20 \times 10^{-6}\text{ m}$

28. The correct answer is (245).

From work energy theorem

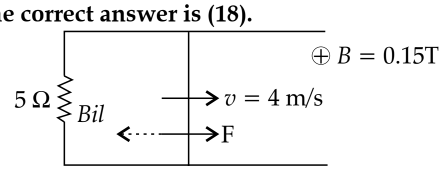
$W_{gravity} + W_{friction} = \Delta(KE) = KE_f - KE_i$

$W_{gravity} = mgh = 1 \times 10 \times 0.3 = 3\text{J}$

$W_{friction} = 0 - \dfrac{1}{2} \times (22)^2 - 3$

$= -(242 + 3) = -245$ J

29. The correct answer is (18).



To move the rod with a constant velocity $v = 4\text{ m s}^{-1}$ F_{net} on the rod should be zero.

$$F = Bil = 0.15\left(\frac{Blv}{R}\right)l$$

$$= 0.15\left(\frac{0.15 \times 1 \times 4}{5}\right) \times 1$$

$= 0.03 \times 0.15 \times 4$

$= 180 \times 10^{-4}$ N

$= 18 \times 10^{-3}$ N

30. The correct answer is (6).

$B = \mu_0 H = \mu_0 ni$

$H = ni = \dfrac{N}{l}i$

H = magnetic intensity

$= 2.4 \times 10^3\text{ A m}^{-1}$

$$i = \frac{\text{H}l}{\text{N}} = \frac{2.4 \times 10^3 \times 0.15}{60} = 6\text{ A}$$

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