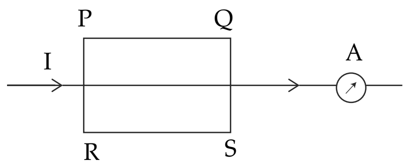
JEE (Main) PHYSICS SOLVED PAPER

2023
30th Jan Shift 2

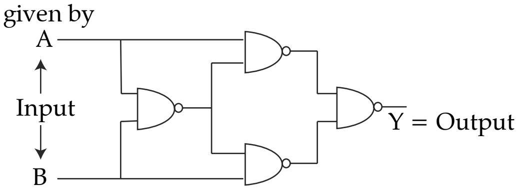
Section A

Q. 1. A current carrying rectangular loop PQRS is made of uniform wire. The length PR = QS = 5 cm and PQ = RS = 100 cm. If ammeter current reading changes from I to 2I, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively $\left(f_{PQ}^{I} : f_{PQ}^{2I}\right)$ is:



(1) 1 : 2 **(2)** 1 : 3 **(3)** 1 : 4 **(4)** 1 : 5

Q. 2. The output Y for the inputs A and B of circuit is given by



Truth table of the shown circuit is:

(1)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

(2)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

(3)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(4)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

Q. 3. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Efficiency of a reversible heat engine will be highest at −273°C temperature of cold reservoir.

Reason R: The efficiency of Carnot's engine depends not only on temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as

$$\eta = (1 - \frac{T_2}{T_1})$$

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

(1) Both A and R are true but R is NOT the correct explanation of A.

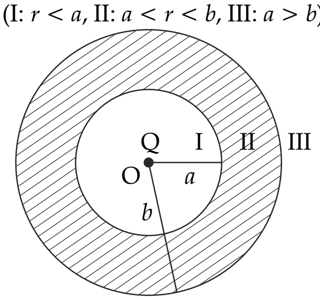
(2) Both A and R are true and R is the correct explanation of A.

(3) A is false but R is true.

(4) A is true but R is false.

Q. 4. As shown in the figure, a point charge Q is placed at the centre of conducting spherical shell of inner radius *a* and outer radius *b*. The electric field due to charge Q in three different regions I, II and III is given by:

(I: $r < a$, II: $a < r < b$, III: $a > b$)



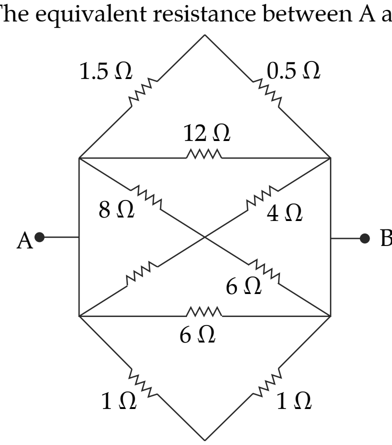
(1) $E_I = 0, E_{II} = 0, E_{III} = 0$

(2) $E_I = 0, E_{II} = 0, E_{III} \neq 0$

(3) $E_I \neq 0, E_{II} = 0, E_{III} \neq 0$

(4) $E_I \neq 0, E_{II} = 0, E_{III} = 0$

Q .5. The equivalent resistance between A and B is



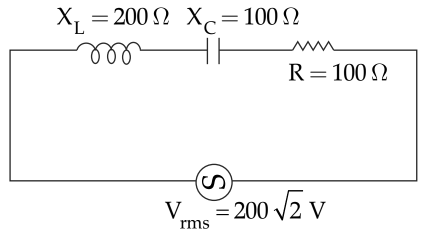
(1) $\frac{1}{3}\,\Omega$ **(2)** $\frac{1}{2}\,\Omega$ **(3)** $\frac{3}{2}\,\Omega$ **(4)** $\frac{2}{3}\,\Omega$

Q. 6. A vehicle travels 4 km with speed of 3 km/h and another 4 km with sped of 5 km/h, then its average speed is

(1) 3.50 km/h **(2)** 4.25 km/h

(3) 4.00 km/h **(4)** 3.75 km/h

Q. 7. In the given circuit, rms value of current (I_{rms}) through the resistor R is:



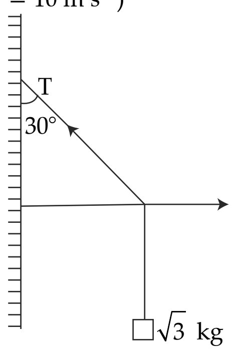
(1) $2\sqrt{2}$ A **(2)** 2 A **(3)** 20 A **(4)** $\frac{1}{2}$ A

Q. 8. A point source of 100 W emits light with 5% efficiency. At a distance of 5 m from the source, the intensity produced by the electric field component is:

(1) $\frac{1}{2\pi}\frac{W}{m^2}$ **(2)** $\frac{1}{20\pi}\frac{W}{m^2}$

(3) $\frac{1}{10\pi}\frac{W}{m^2}$ **(4)** $\frac{1}{40\pi}\frac{W}{m^2}$

Q. 9. A block of $\sqrt{3}$ kg is attached to a string whose other end is attached to the wall. An unknown force F is applied so that the string makes an angle of 30° with the wall. The tension T is: (Given $g = 10$ m s^{-2})



(1) 20 N **(2)** 10 N **(3)** 15 N **(4)** 25 N

10. Match List I with List II:

LIST I	LIST II
A. Attenuation	I. Combination of a receiver and transmitter.
B. Transducer	II. Process of retrieval of information from the carrier wave at receiver.
C. Demodulation	III. Converts one form of energy into another.
D. Repeater	IV. Loss of strength of a signal while propagating through a medium.

Choose the correct answer from the options given below:

(1) A – IV, B – III, C – I, D – II

(2) A – I, B – II, C – III, D – IV

(3) A – IV, B – III, C – II, D – I

(4) A – II, B – III, C – IV, D – I

Q. 11. An electron accelerated through a potential difference V_1 has a de-Broglie wavelength of λ. When the potential is changed to V_2, its de-Broglie wavelength increases by 50%. The value of $\left(\frac{V_1}{V_2}\right)$ is equal to:

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

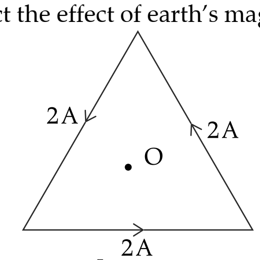
(3) 4 **(4)** $\frac{9}{4}$

Q. 12. A flask contains hydrogen and oxygen in the ratio of 2 : 1 by mass at temperature 27°C. The ratio of average kinetic energy per molecule of hydrogen and oxygen respectively is:

(1) 2 : 1 **(2)** 1 : 1

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

Q. 13. As shown in the figure, a current of 2 A flowing in an equilateral triangle of side $4\sqrt{3}$ cm. The magnetic field at the centroid O of the triangle is (Neglect the effect of earth's magnetic field)



(1) $1.4\sqrt{3} \times 10^{-5}$ T **(2)** $4\sqrt{3} \times 10^{-4}$ T

(3) $3\sqrt{3} \times 10^{-5}$ T **(4)** $\sqrt{3} \times 10^{-4}$ T

Q. 14. An object is allowed to fall from a height R above the earth, where R is the radius of earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be

(1) $\sqrt{2gR}$ **(2)** $\sqrt{\frac{gR}{2}}$

(3) $2\sqrt{gR}$ **(4)** $\sqrt{gR}$

Q. 15. **Match List I with List II:**

List I	List II
A. Torque	I. kg m^{-1} s^{-2}
B. Energy density	II. kg m s^{-1}
C. Pressure gradient	III. kg m^{-2} s^{-2}
D. Impulse	IV. kg m^2 s^{-2}

Choose the correct answer from the options given below:

(1) A – IV, B – I, C – III, D – II

(2) A – IV, B – III, C – I, D – II

(3) A – IV, B – I, C – II, D – III

(4) A – I, B – IV, C – III, D – II

Q. 16. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: The nuclear density of nuclides $^{10}_{5}B$, $^{6}_{3}Li$, $^{56}_{26}Fe$, $^{20}_{10}Ne$ and $^{209}_{83}Bi$ can be arranged as $\rho^N_{Bi} > \rho^N_{Fe} > \rho^N_{Ne} > \rho^N_{B} > \rho^N_{Li}$

Reason R: The radius R of nucleus is related to its mass number A as

$$R = R_0 A^{1/3}$$

where, R_0 is a constant.

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

(1) A is false but R is true
(2) A is true but R is false
(3) Both A and R are true but R is NOT the correct explanation of A
(4) Both A and R are true and R is the correct explanation of A

Q. 17. A force is applied to a steel wire 'A', rigidly clamped at one end. As a result elongation in the wire is 0.2 mm. If same force is applied to another steel wire 'B' of double the length and a diameter 2.4 times that of the wire 'A', the elongation in the wire ' B ' will be
(wires having uniform circular cross sections)

(1) 6.06×10^{-2} mm **(2)** 2.77×10^{-2} mm
(3) 3.0×10^{-2} mm **(4)** 6.9×10^{-2} mm

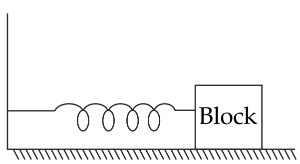
Q. 18. A thin prism, P_1 with an angle 6° and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is:

(1) 1.3° **(2)** 6° **(3)** 4.5° **(4)** 7.8°

Q. 19. A machine gun of mass 10 kg fires 20 g bullets at the rate of 180 bullets per minute with a speed of 100 m s^{-1} each. The recoil velocity of the gun is:

(1) 1.5 m s^{-1} **(2)** 0.6 m s^{-1}
(3) 2.5 m s^{-1} **(4)** 0.02 m s^{-1}

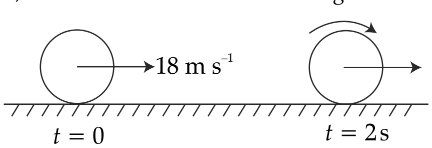
Q. 20. For a simple harmonic motion in a mass spring system shown, the surface is frictionless. When the mass of the block is 1 kg, the angular frequency is ω_1. When the mass of the block is 2 kg the angular frequency is ω_2. The ratio $\frac{\omega_2}{\omega_1}$ is:



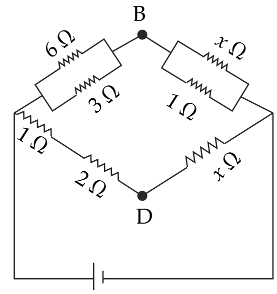
(1) $\frac{1}{\sqrt{2}}$ **(2)** $\sqrt{2}$ **(3)** 2 **(4)** $\frac{1}{2}$

Section B

Q. 21. A uniform disc of mass 0.5 kg and radius r is projected with velocity 18 m s^{-1} at $t = 0$ s on a rough horizontal surface. It starts with a purely sliding motion at $t = 0$ s. After 2 s it acquires a purely rolling motion (see figure). The total kinetic energy of the disc after 2 s will be ______ J (given, coefficient of friction is 0.3 and $g = 10$ m s^{-2}).



Q. 22. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}$ Ω. The value of n is ______.



Q. 23. A stone tied to 180 cm long string at its end is making 28 revolutions in horizontal circle in every minute. The magnitude of acceleration of stone is $\frac{1936}{x}$ m s^{-2}. The value of x is ______ .

$\left(\text{Take } \pi = \frac{22}{7}\right)$

Q. 24. A radioactive nucleus decays by two different process. The half life of the first process is 5 minutes and that of the second process is 30 s. The effective half life of the nucleus is calculated to be $\frac{\alpha}{11}$ s. The value of α is ______.

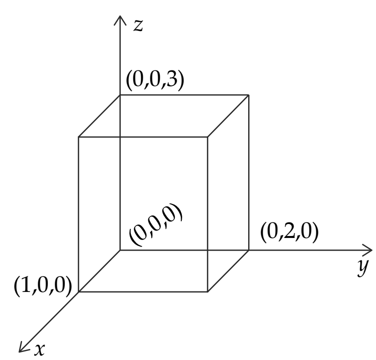
Q. 25. A faulty thermometer reads 5°C in melting ice and 95°C in steam. The correct temperature on absolute scale will be ______ K when the faulty thermometer reads 41°C.

Q. 26. In an AC generator, a rectangular coil of 100 turns each having area 14×10^{-2} m^2 is rotated at 360 rev min^{-1} about an axis perpendicular to a uniform magnetic field of magnitude 3.0 T. The maximum value of the emf produced will be ______ V.

$\left(\text{Take } \pi = \frac{22}{7}\right)$

Q. 27. A body of mass 2 kg is initially at rest. It starts moving unidirectionally under the influence of a source of constant power P. Its displacement in 4 s is $\frac{1}{3}\alpha^2\sqrt{P}$ m. The value of α will be ______.

Q. 28. As shown in figure, a cuboid lies in a region with electric field $= 2x^2\hat{i} - 4y\hat{j} + 6\hat{k}$ N C^{-1}. The magnitude of charge within the cuboid is $n\varepsilon_0$C. The value of n is ______.
(if dimension of cuboid is $1 \times 2 \times 3$ m^3).



Q. 29. In a Young's double slit experiment, the intensities at two points, for the path differences $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$ (λ being the wavelength of light used) are I_1 and I_2 respectively. If I_0 denotes the intensity produced by each one of the individual slits, then $\frac{I_1 + I_2}{I_0}$ = _______.

Q. 30. The velocity of a particle executing SHM varies with displacement (x) as $4v^2 = 50 - x^2$. The time period of oscillations is $\frac{x}{7}$ s. The value of x is _______.

$\left(\text{Take}\, \pi = \frac{22}{7}\right)$

Answer Key

Q. No.	Answer	Topic Name	Chapter Name
1	(3)	Force Between Two Current Carrying Straight Conductors	Moving Charges and Magnetism
2	(3)	Logic Gates	Semiconductor Electronics
3	(2)	Heat Engine	Electrostatic Potential and Capacitance
4	(3)	Gauss's Law	Electric Charges and Fields
5	(4)	Electric Circuit	Current Electricity
6	(4)	Avergae Speed	Motion in a Straight Line
7	(2)	LCR Circuit	Alternating Current
8	(4)	Intensity of EMW	Electromagnetic Waves
9	(1)	Tension in a String	Laws of Motion
10	(3)	Basic Terminology of Electronics Communication Systems	Communication Systems
11	(4)	de-Broglie Wavelength	Dual Nature of Radiation and Matter
12	(2)	Kinetic Energy of Ideal Gases	Kinetic Theory of Gases
13	(3)	Magnetic Field Intensity due to Current Carrying Straight Conductor	Moving Charges and Magnetism
14	(4)	Escape Velocity	Gravitation
15	(1)	Units	Units and Measurement
16	(1)	Nuclear Density	Nuclei
17	(4)	Young's Modulous of Elasticity	Mechanical Properties of Solids
18	(3)	Prism	Ray Optics
19	(2)	Conservation of Momentum	Work, Energy and Power
20	(1)	Spring Mass System	Oscillations
21	[54]	Moment of Inertia	System of Particles and Rotational Motion
22	[2]	Wheatstone Bridge	Current Electricity
23	[125]	Uniform Circular Motion	Motion in a Plane
24	[300]	Half Life	Nuclei
25	[313]	Temperature	Thermal Properties of Matter
26	[1584]	Electromagnetic Induction	Electromagnetic Induction
27	[4]	Power	Work, Energy and Power
28	[12]	Gauss's Law	Electric Charges and Fields
29	[3]	Young's Double Slit Experiment	Wave Optics
30	[88]	SHM	Oscillations

SOLUTIONS

Section A

1. Option (3) is correct.

Magnetic force per unit length $= \dfrac{\mu_0 i_1 i_2}{2\pi r}$ N m^{-1}

When ammeter reads I,

$$i_{PQ} = i_{RS} = \frac{I}{2}$$

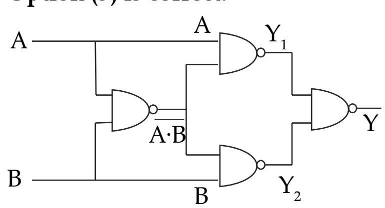
$$\frac{F_1}{l} = \frac{\mu_0\left(\frac{I}{2}\right)^2}{2\pi R}$$

where $R = 5$ cm

When ammeter reads $2I$, $i_{PQ} = i_{RS} = I$

$$\frac{F_2}{l} = \frac{\mu_0 I^2}{2\pi R} \text{ on, } \frac{\frac{F_1}{l}}{\frac{F_2}{l}} = \frac{1}{4}$$

2. Option (3) is correct.



$$Y_1 = \overline{A.\overline{A.B}} = \overline{A} + A.B$$

(using De Morgan's Theorem)

$$Y_2 = \overline{B.\overline{A.B}} = \overline{B} + A.B$$

$$Y = \overline{Y_1.Y_2} = \overline{\left(\overline{A} + A.B\right).\left(\overline{B} + A.B\right)}$$

$$= \overline{\overline{A} + A.B} + \overline{\overline{B} + A.B}$$

$$= \left(A.\left(\overline{A.B}\right)\right) + \left(B.\left(\overline{A.B}\right)\right)$$

$$= \left(A + B\right).\overline{A.B}$$

$$= (A + B).\left(\overline{A} + \overline{B}\right)$$

$$= A.\overline{A} + A.\overline{B} + B.\overline{A} + B.\overline{B}$$

$$= A.\overline{B} + B.\overline{A} \qquad \text{(XOR gate)}$$

The truth table for XOR gate is

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

3. Option (2) is correct.

Efficiency of a Carnot engine

$$\eta = 1 - \frac{T_2}{T_1} \text{ where,}$$

T_1 and T_2 are the absolute (Kelvin) temperatures of the hot and cold reservoirs respectively

If $T_2 = -273°C$

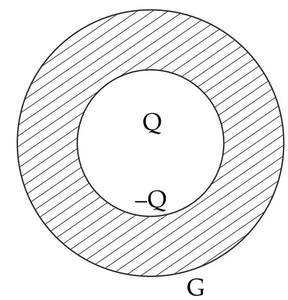
$= -273 + 273 = 0K$

$\eta = 1$ (Maximum)

4. Option (3) is correct.

Applying Gauss's law for all the regions, we get

Note that and –Q and +Q appear on the inner and the outer walls of the conductor due to induction.



For $r < a$, $E_1(4\pi r^2) = \dfrac{Q}{\varepsilon_0}$

$$E_I = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2{}_0} \neq 0$$

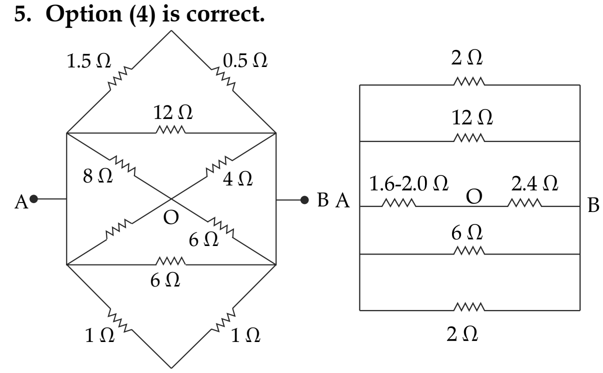
For $a < r < b E_{II}(4\pi r^2) = 0$

$$E_{II} = 0$$

For $r > b$, $E_{III}\,(4\pi\, r^2) = \dfrac{Q}{\varepsilon_0}$

$$E_{III} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2} \neq 0$$

5. Option (4) is correct.



Note $R_{A_o} = \dfrac{8 \times 2}{10} = 1.6\ \Omega$

$$R_{B_o} = \frac{4 \times 6}{10} = 2.4\ \Omega$$

$$\frac{1}{R_{AB}} = \frac{1}{2} + \frac{1}{12} + \frac{1}{4} + \frac{1}{6} + \frac{1}{2} = \frac{6+1+3+2+6}{12}$$

$$= \frac{18}{12} \Rightarrow R_{AB} = \frac{12}{18} = \frac{2}{3}\ \Omega$$

6. Option (4) is correct.

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}} = \frac{8\text{ km}}{(t_1+t_2)\text{h}}$$

$$= \frac{8}{\frac{4}{3}+\frac{4}{5}} = \frac{8\times 15}{32} = 3.75\text{ km h}^{-1}$$

7. Option (2) is correct.

$$i_{rms} = \frac{V_{rms}}{Z}$$

$$= \frac{200\sqrt{2}}{R^2+(X_L-X_C)^2} = \frac{200\sqrt{2}}{\sqrt{100^2+(200-100)^2}}$$

$$= \frac{200\sqrt{2}}{\sqrt{100^2+(200-100)^2}} = \frac{200\sqrt{2}}{100\sqrt{2}}$$

$= 2$ A

8. Option (4) is correct.

$$I = \frac{\eta P}{4\pi r^2}$$

where, η = efficiency $= \frac{5}{100}$

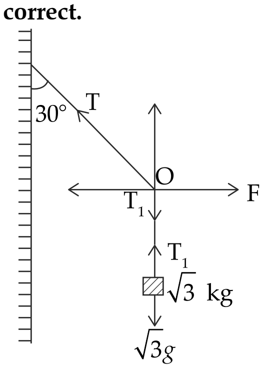
This I is equally contributed by both electric and magnetic fields.

Hence intensity due to electric field alone $= \frac{I}{2}$

$$= \frac{I}{2} = \frac{I}{2}\left(\frac{\eta P}{4\pi r^2}\right)$$

$$= \frac{1}{2}\times\frac{5}{100}\times\frac{100}{4\pi(25)} = \frac{1}{40\pi}\text{ W m}^{-2}$$

9. Option (1) is correct.



At equilibrium $T_1 = \sqrt{3}g$ of the block.

Equilibrium at point O gives

$$T\cos 30° = T_1 = \sqrt{3}g$$

$$\rightarrow \quad T = \frac{\sqrt{3}g}{\cos 30^0}$$

$$= 2g = 2\times 10 = 20\text{ N}$$

10. Option (3) is correct.

From theory of Signal communication.

11. Option (4) is correct.

De-Broglie wavelength of electron, $\lambda \propto \frac{1}{\sqrt{V}}$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}}$$

Given, $\lambda_2 = \frac{3}{2}\lambda_1$

$$\frac{\lambda_1}{\lambda_2} = \frac{2}{3} = \sqrt{\frac{V_2}{V_1}} \Rightarrow \frac{V_1}{V_2} = \frac{9}{4}$$

12. Option (2) is correct.

Average KE per diatomic molecule is given by $\frac{5}{2}K_bT$ which is independent of the mass of the gas taken. Since both the gases are at the same temperature 27°C, average KE per molecule will be same for both the gases.

13. Option (3) is correct.

Magnetic field at the centre of a regular polygon of n sides, each side measuring 'a' is given by

$$B_0 = \frac{\mu_0 ni}{\pi a}\frac{\sin^2\frac{\pi}{n}}{\cos\frac{\pi}{n}}$$

For $n = 3$ and $i = 2$ A and $a = 4\sqrt{3}$ cm

$$B_0 = \frac{4\times 10^{-7}\times 3\times 2}{4\sqrt{3}\times 10^{-2}}\times\frac{\sin^2\frac{\pi}{3}}{\cos\frac{\pi}{3}}$$

$$= 2\sqrt{3}\times 10^{-5}\times\frac{3}{4}\times 2 = 3\sqrt{3}\times 10^{-5}\text{ T}$$

14. Option (4) is correct.

By conservation of energy rule,

$$\frac{-GM_m}{R+h} = -\frac{GM_m}{R}+\frac{1}{2}mv^2$$

Here $h = R$

$$\frac{GM}{2R} = \frac{v^2}{2} \Rightarrow v = \sqrt{\frac{GM}{R}} = \sqrt{\frac{gR^2}{R}} = \sqrt{gR}$$

15. Option (1) is correct.

Torque

Unit: $\text{N m} = \text{kg m}^2\text{ s}^{-2}$

Energy density

Unit $\text{J m}^{-3} = \text{kg m}^{-1}\text{ s}^{-2}$

Pressure gradient

Unit $\text{N m}^{-3} = \text{kg m}^2\text{ s}^{-2}$

Impulse

Unit $\text{N s} = \text{kg m s}^{-1}$

16. Option (1) is correct.

Nuclear density is independent of mass number A $= 2.3\times 10^{17}$ k m^{-3} and is constant for all nuclei. The nuclear radius R is related to its mass number as

$$R = R_0(\text{A})^{1/3}$$

where, $R_0 = 1.2\times 10^{-15}$ m

17. Option (4) is correct.

Elongation, $\Delta l = \frac{Fl}{YA} = \frac{Fl}{Y(\pi d^2/4)}$

$$\Delta l \propto \frac{l}{d^2}$$

$$\frac{\Delta l_1}{\Delta l_2} = \frac{l_1}{l_2} \times \left(\frac{d_2}{d_1}\right)^2$$

Given, $l_2 = 2l_1$

$d_2 = 2.4\, d_1$

$$\frac{\Delta l_1}{\Delta l_2} = \frac{1}{2} \times 2.4 \times 2.4 = 2.88$$

$$\Delta l_2 = \frac{\Delta l_1}{2.88} = \frac{0.2}{2.88}$$

$$= \frac{1}{14.2} \cong 6.9 \times 10^{-2}\text{mm}$$

18. Option (3) is correct.

Average deviation due to both (thin) prism is

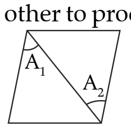
$$0 = \delta_1 + \delta_2$$

$$0 = (\mu_1 - 1)A_1 + (\mu_2 - 1)A_2$$

$$A_2 = -A_1\left(\frac{\mu_1 - 1}{\mu_2 - 1}\right) = -6\left(\frac{1.54 - 1}{1.72 - 1}\right)$$

$$= -6 \times \frac{0.54}{0.72} = -6 \times \frac{3}{4} = -4.5^{\circ}$$

Negative sign implies that both the prisms should be put opposite to each other to produce zero deviation.



19. Option (2) is correct.

By conservation by mass principle,

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

Where $\vec{p}_2$ and $\vec{p}_1$ are the momenta of the gun and bullets respectively.

$$|\vec{p}_2| = |\vec{p}_1|$$

$$Mv_2 = nmv_1$$

n = no. of bullets fired per second

$$= \frac{180}{60} = 3$$

$$10\, v_2 = 3 \times \frac{20}{1000} \times 100$$

$$v_2 = 0.6 \text{ m s}^{-1}$$

20. Option (1) is correct.

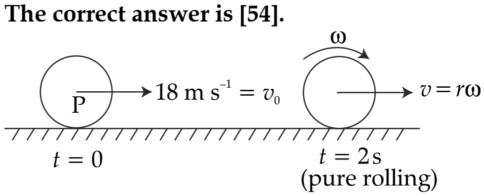
For a spring-mass system

$$\omega = \sqrt{\frac{k}{m}} \Rightarrow \omega \propto \frac{1}{\sqrt{m}}$$

$$\frac{\omega_1}{\omega_2} = \sqrt{\frac{m_2}{m_1}} \Rightarrow \frac{\omega_2}{\omega_1} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{1}{2}}$$

Section B

21. The correct answer is [54].



Since Net torque about P is zero, conservation of angular momentum about P gives

$$mv_0r = mvr + I_{CM}\,\omega$$

$$mv_0r = mvr + \frac{mr^2}{2}\left(\frac{v}{r}\right)$$

$$v_0 = v + \frac{v}{2} = \frac{3v}{2}$$

$$v = \frac{2v_0}{3} = \frac{2}{3} \times 18 = 12 \text{ m s}^{-1}$$

Total KE at t = 2 s is $\frac{1}{2}mv^2\left(\frac{K^2}{r^2} + 1\right)$

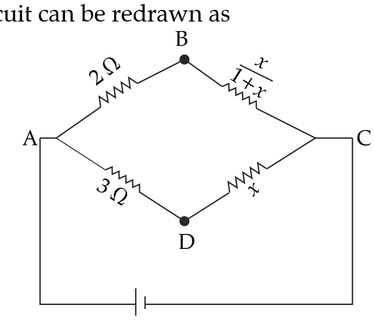
K = radius of gyration = $\frac{r}{\sqrt{2}}$ (For the disc)

$$\text{KE} = \frac{1}{2} \times 0.5 \times 144\left(\frac{1}{2} + 1\right) = 36 \times \frac{3}{2}$$

$$= 54 \text{ J}$$

22. The correct answer is [2].

Since $V_B = V_D$, it is a balanced Wheatstone bridge. The circuit can be redrawn as



$$\frac{2}{3} = \frac{\frac{x}{1+x}}{x}$$

$$2 + 2x = 3$$

$$x = \frac{1}{2} = \frac{1}{n} \text{ (given)}$$

$$n = 2$$

23. The correct answer is [125].

Given: Angular speed $= 28 \text{ rpm} = \frac{28 \times 2\pi}{60} \text{ rad s}^{-1}$

$$= \frac{14\pi}{15} \text{ rad s}^{-1}$$

Centripetal acceleration $= \omega^2 r = \frac{44}{15} \text{ rad s}^{-1}$

$$= \left(\frac{44}{15}\right)^2 \times 1.8 = \frac{1936}{125}$$

$$= \frac{1936}{x} \text{ (given)}$$

$$x = 125$$

24. The correct answer is [300].

Effective decay constant

$$\lambda = \lambda_1 + \lambda_2$$

$$\frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{t_1} + \frac{\ln 2}{t_2}$$

$$t_{1/2} = \frac{t_1 t_2}{t_1+t_2} = \frac{5\times0.5}{5+0.5} = \frac{2.5}{5.5} = \frac{5}{11} = \frac{\alpha}{11}$$

On comparing,

$\alpha = 5$ min $= 300$ s.

25. The correct answer is [313].

Applying temperature conversion rule

$$\frac{41^\circ - 5^\circ}{95^\circ - 5} = \frac{C - 0^\circ}{100^\circ - 0^\circ}$$

$$\frac{36}{90} = \frac{C}{100}$$

$$C = \frac{2}{5} \times 100 = 40^\circ = 40 + 273 = 313 \text{ K}$$

26. The correct answer is [1584].

$$\mathbf{e}_{\mathbf{max}} = NBA\omega$$

$$= 100 \times 3 \times 14 \times 10^{-2} \times \frac{360\times2\pi}{60}$$

$$= 1584 \qquad \left(\text{Take } \pi = \frac{22}{7}\right)$$

27. The correct answer is [4].

Given: $P = Fv = \text{const}$

$\rightarrow \quad P = \left(\frac{mdv}{dt}\right)v$

$$\int_0^v v dv = \frac{P}{m}\int_0^t dt$$

$$\frac{v^2}{2} = \frac{Pt}{m}$$

$$v = \sqrt{\frac{2P}{m}}\sqrt{t} = \frac{ds}{dt}$$

$$\int_0^s ds = \sqrt{\frac{2P}{m}}\int_0^t \sqrt{t}dt$$

$$s = \sqrt{\frac{2P}{m}}\left(\frac{2}{3}t^{3/2}\right)$$

At $t = 4s$, $s = \frac{2}{3}\sqrt{\frac{2P}{m}}\left(4^{3/2}\right)$

$$= \frac{16}{3}\sqrt{\frac{2P}{m}}$$

Putting $m = 2$ kg, $s = \frac{16}{3}\sqrt{Pm}$

$$t = \frac{1}{3}\alpha^2\sqrt{P} \text{ (given)}$$

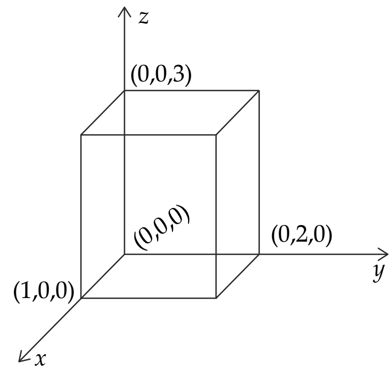
On comparing we get

$\alpha^2 = 16$

$\alpha = 4$

28. The correct answer is [12].

Given: $\vec{E} = 2x^2\hat{i} - 4y\hat{j} + 6g\hat{k}$ NC^{-1}



Flux through planes parallel to yz

$= 2 \times (1)^2 \times 2 \times 3$

$= 12$ N $m^2 C^{-1}$

Flux through planes parallel to xz

$= -4 \times 2 \times (1 \times 3)$

$= -24$ N $m^2 C^{-1}$

Flux through planes parallel to $xy = 0$

Hence, net flux (ϕ) $= 12 - 24 + 0$

$$\frac{q_{enc}}{\epsilon_0} = -12$$

or, $q_{enc} = -12\epsilon_0 C$

$|q_{enc}| = 12\epsilon_0 C = n\epsilon_0 C$

Hence, $n = 12$

29. The correct answer is [3].

$$I = 4I_0\cos^2\frac{\phi}{2}$$

Phase difference ϕ

$= \frac{2\pi}{\lambda}\Delta x$ where, Δx = path difference

For $\Delta x_1 = \frac{\lambda}{4}$, $\phi_1 = \frac{\pi}{2}$. $I = 4I_0\cos^2\frac{\pi}{4} = 2I_0$

For $\Delta x_2 = \frac{\lambda}{3}$, $\phi_2 = \frac{2\pi}{3}$, $I_2 = 4\,_0\cos^2\frac{\pi}{3} = I_0$

$$\frac{I_1+I_2}{I_0} = \frac{2I_0+I_0}{I_0} = 3$$

30. The correct answer is [88].

$4v^2 = 50 - x^2$

$v^2 = \omega^2(a^2 - x^2) = \frac{1}{4}(50 - x^2)$

Comparing we get, $\omega = \frac{1}{2} = \frac{2\pi}{T}$

$T = 4\pi = 4 \times \frac{22}{7} = \frac{88}{7} = \frac{x}{7}$ (given)

$x = 88$

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