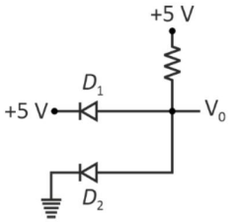
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. Find output voltage in the given circuit.



(1) +5 Volt (2) 0

(3) 10 Volt (4) –5 Volt

Answer (2)

Sol. D_2 is in forward biased.

So, $V_0 = 0$

2. A fractional errors in x, y and z are 0.1, 0.2 and 0.5 respectively. Find maximum fractional error in $x^{-2}y^{3/2}z^{-2/5}$.

(1) 0.2

(2) 0.7

(3) 0.6

(4) 0.3

Answer (2)

Sol. Max. fractional error $= 2\times0.1+\frac{3}{2}\times0.2+\frac{2}{5}\times0.5$

$= 0.2 + 0.3 + 0.2$

$= 0.7$

3. A convex lens (f = 30 cm) is in contact with concave lens (f = 20 cm). Object is placed on the left side at a distance of 20 cm. Find the image distance.

(1) 10 cm (2) 20 cm

(3) 15 cm (4) 25 cm

Answer (3)

Sol. $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{30}+\frac{1}{-20}=\frac{2-3}{60}=\frac{-1}{60}=-60$ cm

$v=\frac{Fu}{F+u}=\frac{(-60)(-20)}{-60-20}=\frac{60\times20}{-80}=-15$ cm

4. For a nucleus of mass number A and radius R, mass density is ρ. Then choose the correct option.

(1) $\rho\propto A^{\frac{1}{3}}$ (2) ρ is independent of A

(3) $\rho \propto A$ (4) $\rho \propto A^3$

Answer (2)

Sol. Conceptual

5. There are two charged sphere of radius R and $3R$. When the sphere are made to touch each other and then separate, the surface charge density becomes r_1 and r_2 respectively. Find $\frac{r_1}{r_2}$

(1) $\frac{1}{9}$ (2) $\frac{1}{3}$

(3) 3 (4) 9

Answer (3)

Sol. We know finally the potential will be same.

So, $\delta_1 r_1 = \delta_2 r_2$

$\Rightarrow \delta_1 R = \delta_2 \cdot 3R$

$\Rightarrow \frac{\delta_1}{\delta_2} = 3$

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6. Given $\lambda = \frac{2nC}{m}$ (linear charge density) is for Q wire which is passing through body diagonal of a closed cube of side length $\sqrt{3}$ cm. Find flux through the cube.

(1) $1.44\ \pi$

(2) $0.72\ \pi$

(3) $2.16\ \pi$

(4) $6.84\ \pi$

Answer (3)

Sol. Total length of the wire inside cube is 3 cm

$q_{(in)} = 2 \times 10^{-9} \times 3 \times 10^{-2}$

$\phi = 2 \times 10^{-9} \times 3 \times 10^{-2} \times 4\pi \times 9 \times 10^{9}$

$\Rightarrow \quad \phi = 2.16\pi$

7. A monoatomic gas is stored in a thermally insulated container. The gas is suddenly compressed to $\left(\frac{1}{8}\right)^{th}$ of its initial volume. Find ratio of final pressure to initial pressure.

(1) 8

(2) 16

(3) 4

(4) 32

Answer (4)

Sol. Process will be adiabatic

$$P_i V^{5/3} = P_f \left(\frac{V}{8}\right)^{5/3}$$

$$\frac{P_f}{P_i} = 32$$

8. Two balls are projected with same speed at different angles. If maximum height of 1st is 8 times maximum height of 2nd ball. Find the ratio of their time of flight

(1) $1:2\sqrt{2}$ (2) $2\sqrt{2}:1$

(3) $2:1$ (4) $4:1$

Answer (2)

Sol. $\frac{H_1}{H_2} = 8 = \frac{u^2 \sin^2\theta / 2g}{u^2 \sin^2\theta_2 / 2g} = \left(\frac{\sin\theta_1}{\sin\theta_2}\right)^2 \Rightarrow \frac{\sin\theta_1}{\sin\theta_2} = 2\sqrt{2}$

$$\frac{T_1}{T_2} = \frac{2u\sin\theta_1 / g}{2u\sin\theta_2 / g} = \frac{\sin\theta_1}{\sin\theta_2} = 2\sqrt{2}$$

9. A uniform disc of radius r is rotating about a axis passing through diameter with angular speed 800 rpm. A torque of magnitude 25π Nm is applied on the disc for 40 sec. If final angular speed of disc is 2100 rpm. Find diameter of the disc if mass is 1 kg.

(1) $\frac{40}{3}$ (2) $40\sqrt{\frac{3}{13}}$

(3) $20\sqrt{\frac{2}{13}}$ (4) $10\sqrt{\frac{3}{2}}$

Answer (2)

Sol. $\omega_f = \omega_i + \alpha t$

$$\frac{2100 \times 2\pi}{60} = \frac{800 \times 2\pi}{60} + \alpha \times 40$$

$$\alpha = \frac{13}{12}\pi$$

$$\frac{25\pi}{\frac{13\pi}{12}} = \frac{mR^2}{4}$$

$$\sqrt{\frac{1200}{13}} = 4$$

$$R = 20\sqrt{\frac{3}{13}},\ D = 40\sqrt{\frac{3}{13}}$$

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10. Water falls from 200 m height. What is increase in temperature when it touches the bottom. (Assume that all the heat goes into same amount of mass which was falling).

(1) 0.7°C

(2) $\frac{10}{21}$°C

(3) $\frac{20}{21}$°C

(4) $\frac{11}{10}$°C

Answer (2)

Sol. $mg4h = m$ and ΔT

$$\Rightarrow \quad \Delta T = \frac{g\Delta h}{s} = \frac{10\times 200}{4200}$$

$$\Delta T \approx 05°C$$

$$\Delta T = \frac{10}{21}°C$$

11. An electron is released in the field generated by a non-conductivity sheet of uniform surface charge density σ. The rate of change of de-Broglie wavelength associated with electron varies inversely as n^{th} power of distance travelled. Find the value of n

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

(3) $\frac{1}{4}$ (4) 4

Answer (1)

Sol. $E = \frac{\delta}{2\varepsilon_0}$

$$F = \frac{e\delta}{2\varepsilon_0}$$

$$\frac{1}{2}mv^2 = \frac{e\delta}{2\varepsilon_0}x$$

$$\Rightarrow \quad (mv)^1 = \frac{2me\delta}{2\varepsilon_0}x = \frac{me\delta}{\varepsilon_0}\cdot x$$

$$\Rightarrow \quad P = \sqrt{x\frac{me\delta}{\varepsilon_0}}$$

$$l = \frac{h}{p} = h\sqrt{\frac{\varepsilon_0}{me\delta\cdot x}}$$

$$\lambda \propto \cdot \frac{1}{(x)^{\frac{1}{2}}}$$

12. Bulk modulus of a liquid is 2×10^9 Pa initially and final pressure are 1 atm and 5 atm respectively. Find initial volume of the liquid if change in volume is 0.8 cm^3.

(1) 2×10^3 cm^3 (2) 4×10^3 cm^3

(3) 2×10^{-4} cm^3 (4) 4×10^{-3} cm^3

Answer (2)

Sol. $\beta = \frac{\Delta P}{\frac{\Delta V}{V}} \Rightarrow V = \frac{\Delta V\beta}{\Delta P}$

$$= \frac{0.8\times 10^{-6}\times 2\times 10^9}{4\times 10^5} = 4\times 10^{-3}\ m^3 = 4\times 10^3\ cm^3$$

13. The amplitude and phase of the wave when two travelling waves given as $y_1(x, t) = 4\sin(\omega t - kx)$ & $y_2(x, t) = 2\sin\left(\omega t - kx + \frac{2\pi}{3}\right)$ are superimposed.

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

(3) $2\sqrt{3}, \frac{\pi}{6}$ (4) $\sqrt{3}, \frac{\pi}{6}$

Answer (3)

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Sol. $A^2 = A_1^2 + A_2^2 + 2A, A\cos\phi$

$= 4^2 + 2^2 + 2\times4\times2\times-\frac{1}{2}$

$A = \sqrt{12} = 2\sqrt{3}$

$\phi = \frac{2\pi}{3}$

14. A force $6\hat{k}$ is applied for $\frac{5}{3}$ seconds on a body of mass 2 kg. If initial velocity of body was $3\hat{i}+4\hat{j}$. Then find final velocity of the body.

(1) $3\hat{i}+\hat{j}+5\hat{k}$ (2) $3\hat{i}+4\hat{j}+5\hat{k}$

(3) $3\hat{i}+2\hat{j}-3\hat{k}$ (4) $3\hat{i}+4\hat{j}-5\hat{k}$

Answer (2)

Sol. Impulse $= 6\times\frac{5}{3}\hat{k} = 10\hat{k}$

$\vec{P}_f - \vec{P}_i = 10\hat{0}$

$2v_f - 2\left(3\hat{i}+4\hat{j}\right) = 10\hat{k}$ $\quad \vec{v}_f = 3\hat{i}+4\hat{j}+5\hat{k}$

15. A rod of linear mass density 'λ' and length '*L*' is bent into the form of a ring of radius *R*. Moment of inertia of ring about any of its diameter is

(1) $\frac{\lambda L^3}{12}$ (2) $\frac{\lambda L^3}{4\pi^2}$

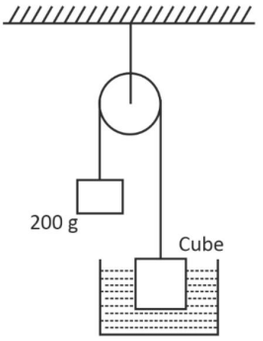
(3) $\frac{\lambda L^2}{12}$ (4) $\frac{\lambda L^3}{8\pi^2}$

Answer (4)

Sol. $I = \frac{MR^2}{2} = \frac{\lambda L}{2}R^2 \Rightarrow \frac{\lambda L L^2}{2\times4\pi^2}$ $\quad \left[\because R = \frac{L}{2\pi}\right]$

$= \frac{\lambda L^3}{8\pi^2}$

16. A cube of side 10 cm is suspended from one end of a fine string of length 27 cm, and a mass of 200 gram is connected to the other end of the string. When the cube is half immersed in water, then the system remains in balance. Find density of cube.



(1) 800 kg/m^3

(2) 500 kg/m^3

(3) 700 kg/m^3

(4) 600 kg/m^3

Answer (3)

Sol. $\left(\frac{1}{10}\right)^3\sigma g - \left(\frac{1}{10}\right)^3\frac{\rho_0 g}{2} = 0.2\ g$

$\Rightarrow \left(\frac{1}{10}\right)^3\left(\sigma - \frac{\rho_0}{2}\right)g = 0.2g$

$\Rightarrow \sigma - \frac{\rho_0}{2} = 200$

$\Rightarrow \sigma = 200 + 500$

$\Rightarrow \sigma = 700\ \text{kg/m}^3$

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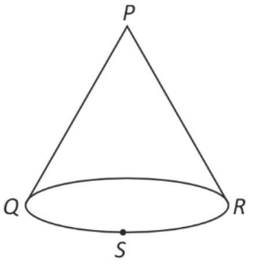
17. A cone made of conducting material is given a charge Q. $\sigma_1, \sigma_2, \sigma_3$ and σ_4 are charge densities at four points P, Q, R and S. P is at vertex of cone and Q, R and S are at periphery of the base. Choose correct option.



(1) $\sigma_1 > \sigma_2 > \sigma_3 > \sigma_4$

(2) $\sigma_1 > \sigma_2 = \sigma_3 = \sigma_4$

(3) $\sigma_1 < \sigma_2 = \sigma_2 < \sigma_4$

(4) $\sigma_1 = \sigma_2 > \sigma_3 > \sigma_4$

Answer (2)

Sol. Charge density $\propto \frac{1}{\text{Radius of curvature}}$

18. **Assertion (A) :** Work done to move a change between two points is zero inside a uniformly changed shell.

Reason (R) : Potential inside a uniformly changed shell is constant and equal to the potential at its surface.

(1) Both (A) & (R) are correct, and Reason is the correct explanation of (A).

(2) Both (A) & (R) are correct but R is not correct explanation of A.

(3) A is correct and R is incorrect

(4) A is correct and R is correct

Answer (1)

Sol. $W = 0 = 9\ \Delta V$

as $\Delta V = 0$

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Two ropes of same material of radius R and $\frac{R}{2}$. What will be the ratio of wave speed in second rope to first?

(They both are with same tension)

Answer (2)

Sol. $\mu = \frac{(\pi R^2 l \rho)}{l} = \pi R^2 \rho$

So, $v_2 = \sqrt{\frac{5\tau}{\pi \rho R^2}}$

$v_1 = \sqrt{\frac{\tau}{\pi R^2 \rho}}$

$\therefore \quad \frac{v_2}{v_1} = 2$

22.

23.

24.

25.

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