1. In the given circuit find the current through battery, given that the diode used is ideal diode.

\[ \begin{array}{c}
10 \Omega \\
\uparrow \\
10 \Omega \\
\downarrow \\
5V
\end{array} \]

Options:
1. 0.5 A
2. 1 A
3. 1.5 A
4. 2 A

Answer: (1)
2. A proton and an α-particle are accelerated same potential difference. Find ratio of their de-Broglie wavelength

\[ \lambda = \frac{h}{P} = \frac{h}{\sqrt{2mVq}} \]

\[ \frac{\lambda_\text{p}}{\lambda_\text{α}} = \sqrt{\frac{4m_\text{p}e_\text{p}}{m_αe_α}} = 2\sqrt{2} \]

3. Electric field in space is \( \frac{3}{5} E_0 \hat{i} + \frac{4}{5} E_0 \hat{j} \), where \( E_0 \) is a positive constant the flux of electric field passing through a sheet of area 0.3 m\(^2\) lying in Y-Z plane is \( \phi_1 \), another sheet of area 0.4 m\(^2\) lying in x-z plane has flux \( \phi_2 \) passing through it. Find ratio \( \phi_1 : \phi_2 \)?

\[ \text{Ans.} (1) \]

4. A box filled with gas moving with constant velocity 30 m/s. Having monoatomic gas of mass (4 u). Now block is suddenly stopped. Then find the change in temperature of gas

\[ \frac{1}{2} m v^2 = n \cdot CV \Delta T \]

\[ \Delta T = \frac{Mv^2}{3R} = \frac{4 \cdot 30 \cdot 30 \cdot 10^{-3}}{3 \cdot 8.314} = 0.144 \text{ K} \]

5. For a lens when object is placed at two positions i.e. 20 cm and 10 cm respectively, the image formed is of same size. Find focal length of lens?

\[ \text{Ans.} (1) \]

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6. **Statement – 1**: A rod true to move of length L unit placed by 31 temperature, there is no thermal stress develop in it.  
**Statement – 2**: Length of rod will increase.  
(1) Statement – 1 is false and Statement – 2 is true  
(2) Statement – 1 is True and Statement – 2 is False  
(3) Statement – 1 and Statement – 2 both are true and statement – 2 is the correct explanation of statement – 1  
(4) Statement – 1 and Statement – 2 both are true and statement – 2 is not correct explanation of statement – 1  

**Ans.** (4)

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7. A drop is charged to 2V. Now 512 drop & identical are combined to form a single drop there the voltage of bigger drop is?  
(1) 148 V  
(2) 128 V  
(3) 125 V  
(4) 127 V  

**Ans.** (2)  

**Sol.**  
\[ R \rightarrow \text{radius of bigger drop} \]  
\[ r \rightarrow \text{radius of small drop} \]  
\[ V_{\text{bigger drop}} = 512 \text{ V} \text{smaller drop} \]  
\[ \frac{4}{3} \rho R^3 = 512 \frac{4}{3} \pi r^3 \]  
\[ R = 8r \]  
\[ V = \frac{K}{r} \]  
\[ V' = \frac{K \times 512}{R} \]  
\[ V' = 64 \text{V} \]  
\[ V' = 128 \text{V} \]  

8. Relation between P and V for a process is \( P = KV^x \) for a gas. The temperature of gas is changed from 100°C to 300°C. If the work done for the process is \( x \text{nR} \). Then find the value of \( x \).  

**Ans.** 25  

**Sol.**  
\[ \int PdV = \int kV^x dV \]  
\[ kV^x = P_1, \ kV^x = P_2, \ kV^2_2 = P_2V_2, \ kV^4_4 = P_4V_4 \]  
\[ \frac{kV^2_2 - kV^4_4}{4} = nR(T_2 - T_1) \]  
\[ \frac{kV^2_2 - kV^4_4}{4} = nR(300 - 100) \]  
\[ = 50 \text{ nR} \]
9. Engine of train is crossing a signal with speed $v$ and last coach of train is crossing the signal with speed $v$ speed of. Find speed with which mid point of train crossing
\[
\begin{align*}
(1) & \quad \frac{u + v}{2} \\
(2) & \quad \sqrt{u^2 + v^2} \\
(3) & \quad \frac{u^2 + v^2}{2} \\
(4) & \quad \frac{u^2}{v}
\end{align*}
\]
Ans. (3)
Sol.
\[
\begin{align*}
V' &= u^2 + 2a \\
V' &= u^2 + 2a \left( \frac{1}{2} \right) \\
V' &= \frac{u^2 + v^2}{2}
\end{align*}
\]

10. A gas having $C_v = \frac{7R}{2}$ and $C_p = \frac{5R}{2}$. Then find the ratio of $\Delta U : \Delta W : \Delta Q$ in isobaric process
\[
\begin{align*}
(1) & \quad 5 : 2 : 7 \\
(2) & \quad 2 : 7 : 5 \\
(3) & \quad 5 : 2 : 3 \\
(4) & \quad 3 : 2 : 7
\end{align*}
\]
Ans. (1)
Sol.
\[
\begin{align*}
\Delta U &= nC_v \Delta T \\
\Delta W &= nR \Delta T \\
\Delta Q &= nC_p \Delta T
\end{align*}
\]

11. A pendulum of length 2 m having time period 2 sec on a planet. Then find acceleration due to gravity of planet:
\[
\begin{align*}
(1) & \quad \pi^2 \text{ m/s}^2 \\
(2) & \quad 2\pi^2 \text{ m/s}^2 \\
(3) & \quad 4\pi^2 \text{ m/s}^2 \\
(4) & \quad 9.8 \text{ m/s}^2
\end{align*}
\]
Ans. (2)
Sol.
\[
\begin{align*}
T &= 2\pi \sqrt{\frac{l}{g_{\text{planet}}}} \\
9_{\text{planet}} &= \frac{4\pi^2}{T^2} \\
g_{\text{planet}} &= 2\pi^2
\end{align*}
\]

12. When object is placed at a distance 10 cm & 20 cm from convex lens. Size of image obtained is same find focal length of the lens
\[
\begin{align*}
(1) & \quad 15 \text{ cm} \\
(2) & \quad 16 \text{ cm} \\
(3) & \quad 20 \text{ cm} \\
(4) & \quad 10 \text{ cm}
\end{align*}
\]
Ans. (1)
Sol. As size of image is same

\[
\begin{align*}
\begin{vmatrix}
  m_1 & m_2 \\
  f & f \\
  f + u_1 & f + u_2 \\
\end{vmatrix}
\end{align*}
\]

\[
\begin{align*}
\frac{f}{f + u_1} = \frac{1}{1 + \frac{u_2}{u_1}}
\end{align*}
\]

\[
\Rightarrow \quad \text{as one image in real & other is virtual}
\]

\[
\begin{align*}
f + u_2 &= f - u_1 \\
2f &= u_2 - u_1 \\
2f &= (-10) - (-20) \\
2f &= 10 + 20 \\
f &= 15 \text{ cm}
\end{align*}
\]

13. The Ratio of magnetic field by Ring at a distance of 0.05 m & 0.2 m from centre on axis of ring is 8 : 1.

Find radius of ring?

(1) 0.25 m  (2) 0.1 m  (3) 0.3 m  (4) 0.5 m

Ans. (2)

Sol.

\[
B_1 = \frac{\mu_0 NI R^2}{2(X_1^2 + R^4)^{3/2}}
\]

\[
B_2 = 8
\]

\[
\frac{\mu_0 NI R^2}{2(X_2^2 + R^4)^{3/2}} = 8
\]

\[
\frac{2(X_2^2 + R^4)^{3/2} - 2(X_1^2 + R^4)^{3/2}}{\mu_0 NI R^2} = 4
\]

\[
\frac{(X_2^2 + R^4)^{3/2} - (X_1^2 + R^4)^{3/2}}{X_2^2 + R^4} = 4
\]

\[
\frac{4}{100} + R^2 = 4 \left( \frac{25}{100} + R^2 \right)
\]

\[
\frac{4}{100} = R^2 - \frac{4}{100} + 4R^2
\]

\[
\frac{3}{100} = 3R^2
\]

\[
R = \frac{1}{10} = 0.1 \text{ m}
\]

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14. Resonance tube of diameter d = 6 cm. Sounded with tuning fork of frequency f = 504 Hz. If speed of sound is equal to 336 m/s. than find the height of air column.

(1) 14.87 cm  (2) 10.32 cm  (3) 24.52 cm  (4) 23.32 cm

Ans. (1)

Sol.

\[
V = \lambda
\]

\[
\lambda = \frac{V}{f}
\]

\[
\lambda = \frac{336}{504} = \frac{1}{2}
\]

\[
f + \theta = \frac{\lambda}{4}
\]
15. A particle is moving in a vertical circle with radius 1 m. If the ratio of \( \frac{T_{\text{max}}}{T_{\text{min}}} = 5 \) find the velocity at highest point.

**Ans.** (1) 5 m/s

**Sol.**

We know that \( T_{\text{max}} = T_{\text{min}} = 6mg \) and given that \( \frac{T_{\text{max}}}{T_{\text{min}}} = 5 \) Solving these \( T_{\text{max}} = \frac{15}{2} mg \) and \( T_{\text{min}} = \frac{3}{2} mg \)

\[ T_{\text{max}} = \frac{mv^2}{r} - mg \]

\[ 5mg = \frac{mv^2}{r} \]

\[ v = 5 \text{ m/s} \]

16. Potential energy is region is given by \( U = \frac{\alpha}{r^\beta} - \frac{\beta}{r^\alpha} \) at equilibrium. Inter molecular distance between particle is given as \( r = \left( \frac{2\alpha}{\beta} \right)^{\frac{\beta}{\beta-1}} \). Then \( a \) will be:

**Ans.** 1

**Sol.**

\[ F = \frac{\text{d}U}{\text{d}r} = \alpha \left( \frac{-10}{r^{10}} \right) - \beta \left( \frac{10}{r^9} \right) \]

At Eq. \( F = 0 \)

\[ \frac{\alpha(10)}{r^{10}} = \frac{\beta}{r^6} \]

\[ r^4 = \frac{10\alpha}{5\beta} \]

\[ r = \left( \frac{2\alpha}{\beta} \right)^{\frac{2}{2}} \]

\[ a = 1 \]

\[ \frac{b}{5} \]

\[ a = 1 \quad b = 5 \]

17. Two Sources of light whose Ratio of intensities are \( \frac{I_2}{I_1} = 2x \). Find the value of \( \frac{I_{\text{max}} - I_{\text{min}}}{I_{\text{max}} + I_{\text{min}}} \).
18. Three particles proton, \( \alpha \)-particles & deuteron enters in a uniform magnetic field with same linear momentum. The correct ratio of magnetic forces and velocities on the particles are respectively

(1) 2 : 1 : 4 & 3 : 4 : 6 
(2) 1 : 2 : 4 & 3 : 2 : 3 
(3) 2 : 1 : 3 & 4 : 3 : 2 
(4) 2 : 1 : 1 & 4 : 1 : 2

Ans. (4)

Sol. 

\[ F = qV \frac{B}{m} \]

\[ F \propto \frac{q}{m} \]

\[ F_1 : F_2 : F_3 = \frac{1}{1} : \frac{1}{4} : \frac{1}{2} \]

\[ = 4 : 1 : 2 \]

\[ = 2 : 1 : 1 \]

\[ P = mV \Rightarrow V \propto \frac{1}{m} \]

\[ v_1 : v_2 : v_3 = \frac{1}{1} : \frac{1}{4} : \frac{1}{2} \]

\[ = 4 : 1 : 2 \]

19. The pitch of a micrometer screw gauge is 1 mm and the circular scale has 100 divisions. When there is nothing between the jaws, the zero of the circular scale's 8 division below the main scale. When a wire is put between the jaws, the 1st division of main scale is visible and 72th division of circular scale coincides with the main scale. The radius of wire is:

(1) 1.8 mm 
(2) 0.9 mm 
(3) 1.04 mm 
(4) 0.82 mm

Ans. (4)

Sol. 

\[ \text{pitch} = \frac{1}{100} \]

error = \( 6 \times \frac{1}{100} \)

Reading \( 2R = 1 + 72 \times \frac{1}{100} - 8 \times \frac{1}{100} \)

\[ 2R = 1.64; \quad R = 0.82 \text{ mm} \]

20. Match the column

(a) Planck's constant (i) [M^L^2^E^A^-^1 ^T^-^1]
(b) Kinetic Energy (ii) [M^L^2^T^-^2]
(c) Potential electric (iii) [M^L^2^E^A^-^1]
(d) Momentum (iv) [M^L^2^T^-^1]

Ans. (a) – (ii), (b) – (iv), (c) – (i), (d) – (iii)