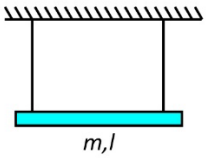
PHYSICS

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. A rod of mass m and length l is attached to two ideal strings. Find tension in left string just after right string is cut.



(1) $\frac{mg}{2}$ (2) $\frac{mg}{4}$

(3) $\frac{2}{3}mg$ (4) $\frac{mg}{5}$

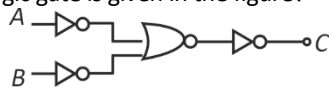
Answer (2)

Sol. $\alpha = \frac{mg\frac{l}{2}}{\frac{ml^2}{3}} = \frac{3g}{2l}$

$a_{com} = \frac{3g}{4}$

$T = \frac{mg}{4}$

2. Which logic gate is given in the figure?



(1) XOR (2) NOR

(3) NAND (4) OR

Answer (3)

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

3. Find dimensions of $\frac{A}{B}$ if $\left(P+\frac{At^2}{B}\right)+\frac{1}{2}\rho V^2$ = constant where $P \rightarrow$ pressure, $\rho \rightarrow$ density, $V \rightarrow$ speed.

(1) ML^1T^{-4} (2) $ML^{-1}T^{-4}$

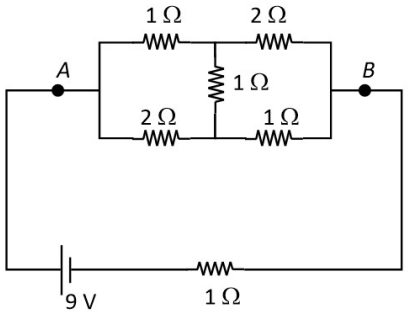
(3) ML^2T^{-4} (4) $ML^{-1}T^{-2}$

Answer (2)

Sol. $\left[\frac{At^2}{B}\right] = [P] = ML^{-1}T^{-2}$

$\left[\frac{A}{B}\right] = ML^{-1}T^{-4}$

4. Find the heat produced in external circuit (AB) in one minute.

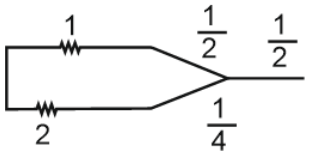


(1) 1181.25 J (2) 1311.25 J

(3) 1207.50 J (4) 1410.50 J

Answer (1)

Sol. You can use Kirchoff's law or star-delta



$R_{AB} = \frac{\frac{3}{2}\times\frac{9}{4}}{\frac{3}{2}+\frac{9}{4}} + \frac{1}{2} = 1.4\ \Omega\ ;\ P = i^2R$

5. An α-particle having kinetic energy 7.7 MeV is approaching fixed gold nucleus (atomic number is 79). Find distance of closest approach.

(1) 1.72 nm (2) 6.2 nm

(3) 16.8 nm (4) 0.2 nm

Answer (1)

Sol. ${}_2^4\text{He} \xrightarrow{v} \ldots\ldots v + 79e$

$$\frac{1}{2}mv^2 = \frac{K(2e)(79e)}{r^2}$$

$$7.7\times10^6\times1.6\times10^{-19}\,J = \frac{9\times10^9\times158\times(1.6\times10^{-19})^2}{r^2}$$

$$r^2 = \frac{2275.2\times10^{-10}}{7.7\times10^6}$$

$r = 17.2\times10^{-8}$

$r = 17$ nm

296×10^{-16}

6. An air filled capacitor of capacitance C is filled with dielectric ($k = 3$) of width $d/3$, where d is separation between plates. The new capacitance is

(1) $\frac{9}{5}C$ (2) $\frac{5}{4}C$

(3) $\frac{4}{3}C$ (4) $\frac{9}{7}C$

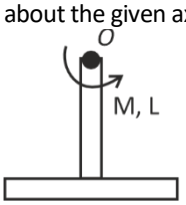
Answer (4)

Sol. $C = \dfrac{\epsilon_0 A}{\frac{d_1}{k_1}+\frac{d_2}{k_2}}$

$$\frac{\epsilon_0 A}{\frac{d}{3\times3}+\frac{2d}{3}}$$

$$= \frac{9\epsilon_0 A}{d+6d} = \frac{9\epsilon_0 A}{7d}$$

7. Find the moment of inertia of system formed using two identical rods about the given axis of rotation as shown



(1) $\frac{17}{12}ML^2$ (2) $\frac{13}{12}ML^2$

(3) $\frac{2ML^2}{3}$ (4) $\frac{3ML^2}{4}$

Answer (1)

Sol. For vertical rod about O $I_{10} = \dfrac{ML^2}{3}$

For horizontal rod about O $I_{20} = \dfrac{ML^2}{12} + ML^2 = \dfrac{13}{12}ML^2$

$$I_{O_{sys}} = I_{10} + I_{20} = \frac{17}{12}ML^2$$

8. If electric field of EM wave is given by $60[\sin(3\times10^{14}t) + \sin(12\times10^{14}t))]$ at $x = 0$ falls on a photo sensitive material having work function 2.8 eV. Find the maximum kinetic energy (M eV) of ejected electrons.

(1) 2.52 eV (2) 2.16 eV

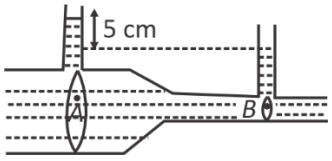
(3) 2.00 eV (4) 2.34 eV

Answer (2)

Sol. $\dfrac{h\nu}{c} = 4.963$ eV

$KE_{max} = 4.963 - 2.8 = 2.163$ eV

9. Find volume flow rate in the venturi meter given below in which water is flowing.



[cross section area at A & B is A & a, $\frac{A}{a} = 2.4A = \sqrt{3}$ m^2. P = 1000 kg/m^3.]

(1) 1 (2) $\sqrt{3}$

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

Answer (1)

Sol. $P_A+\frac{1}{2}PV_A^2 = P_B+\frac{1}{2}PV_B^2$

$P_A - P_B = \frac{1}{2}P\left(V_B^2 - V_A^2\right)$

$\Rightarrow \quad V_B^2 - V_A^2 = 1$

and $AV_A = aV_B$

$\Rightarrow \quad 3V_A^2 = 1 \quad \Rightarrow \quad V_A = \frac{1}{\sqrt{3}}$

10. An ideal solenoid is kept with its axis vertical. Current I_0 is flowing in the solenoid. A charge Q is thrown downward inside the solenoid it acceleration of the charge particle is a then

(1) $a > g$ (2) $a = g$

(3) $a < g$ (4) $a = 0$

Answer (2)

Sol. $\vec{V} \| \vec{B} \Rightarrow F_m = 0$

$a = g$

11. Wave propagates whose electric field is given by $\vec{E} = 69\sin(\omega t - kx)\hat{j}$ find the direction of magnetic field

(1) $\hat{k}$ (2) $-\hat{k}$

(3) $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (4) $\frac{\hat{i}-\hat{j}}{\sqrt{2}}$

Answer (1)

Sol. $\hat{E} \Rightarrow \hat{j}, \hat{C} \Rightarrow \hat{i}$

$\vec{E} \times \vec{B} = \vec{C}$

$B = \hat{k}$

12. Two rods of equal length of 60 cm each are joined together end to end. Coefficient of linear expansions of the rods are $24 \times 10^{-6}\ C^{-1}$ and $1.2 \times 10^{-5}\ C^{-1}$. Their temperatures are same and equal to 30°C which is increased to 100°C. Find final length of the combination (in cm).

(1) 120.1321 (2) 120.1123

(3) 120.1512 (4) 120.1084

Answer (3)

Sol. $\Delta\ell_1 + \Delta\ell_2 = 60\ (3.6 \times 10^{-5} \times 70)$

$\Rightarrow \quad 15.12 \times 10^{-2}$ cm = 0.1512 cm

$\ell_f = 120 + 0.1512 = 120.1512$ cm

13. Find change in internal energy of gas if its temperature changes by 10K. Number of moles of gas is 10, C_P (specific heat at constant pressure of the gas is 7 cal/K-mol) and R (gas constant) = 2 cal/K.

(1) 500 cal (2) 1000 cal

(3) 250 cal (4) 100 cal

Answer (1)

Sol. CP – CV = R = 2

$C_V = 5$

$\Delta V = nC_V\Delta T = 10 \times 5 \times 10 = 500$ cal

14. Two mechanical wave on strings of equal length (L) tension (T) having linear mass density $\frac{\mu_1}{\mu_2} = \frac{1}{2}$. Find the ratio of time taken for a wave pulse to travel from one end to the other in both strings. (ignore gravity)

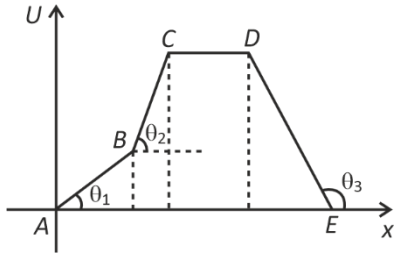
(1) $\frac{1}{2}$ (2) $\frac{1}{\sqrt{2}}$

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

Answer (2)

Sol. $C = \sqrt{\frac{T}{\mu}}$ and $t = \frac{L}{C}$ $t \propto \sqrt{\mu} \Rightarrow \frac{t_1}{t_2} = \sqrt{\frac{1}{2}}$

15. A curve is given between potential energy of a particle and its position on *x*-axis.



Given: $\tan\theta_1 = 1$, $\tan\theta_2 = 3$, $\tan\theta_2 = \frac{-1}{2}$

If F_{AB} be force acting on the particle during *A* to *B* similarly F_{BC}, F_{CD} and F_{DE} are the forces during *B* to *C*, *C* to *D* and *D* to *E* respectively. Arrange magnitudes of these forces in decreasing order

(1) $F_{BC} > F_{AB} > F_{CD} > F_{DE}$ (2) $F_{BC} > F_{AB} > F_{DE} > F_{CD}$

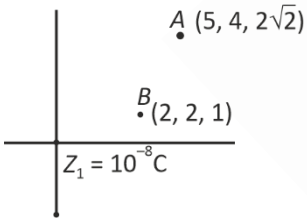
(3) $F_{AB} > F_{BC} > F_{DE} > F_{CD}$ (4) $F_{BC} > F_{DE} > F_{AB} > F_{CD}$

Answer (2)

Sol. $F = -\frac{dU}{dx}$

$\therefore$ Higher the slope greater the force.

16. Find out work done in moving a 2μC. Choose from *A* to *B*.



(1) 6 μJ (2) 120 mJ

(3) 34.3 μJ (4) 24.2 μJ

Answer (3)

Sol. $w = U_2 - U_1 = 9\times10^9 \times10^{-8} \times2\times10^{-6}\left(\frac{1}{3}-\frac{1}{7}\right)$

= 34.3 μJ

17.

18.

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. 21. A satellite is revolving around a planet in orbit radius of 1.5 R. Additional minimum energy required to transfer the satellite to new orbit radius of 3R is (m and M are mass of satellite & planet) $\frac{GMm}{\lambda R}$ then *X* is _____.

Answer (6)

Sol. $M.E = \frac{-GMm}{2a}$

$W = \Delta M = M_f - M_i$

$= \frac{-GMm}{2(3R)} - \left(-\frac{GMm}{2(1.5R)}\right)$

$= +\frac{GMm}{R}\left\{-\frac{1}{6}+\frac{1}{3}\right\}$

$= \frac{GMm}{6R}$

22. There are two springs of spring constants $k_1 = (20 \pm 0.2)$ N/m and $k_2 = (30 \pm 0.3)$ N/m. If they are connected in parallel then percentage error in equivalent spring constant of combination is _____%.

Answer (1)

Sol. $\Delta k = \Delta k_1 + \Delta k_2 = 0.5$

Keq = 50 N/m

% error = $\frac{0.5}{50}\times100 = 1$

23. In a *YDSE* set up, a slab of width *t* is inserted in front of one of slit. The interference pattern shifts by 0.2 cm on the screen. If the refractive index of slab is 1.5 than *t* is *N* μm (screen distance 50 cm and slits separation 1 mm) then *N* is _____

Answer (8)

Sol. Path difference by shift is neutralised from path difference by slab $\frac{dy}{D}=(\mu-1)t$.

$$\frac{10^{-3}}{0.5}\times 0.2\times 10^{-2}=\frac{1}{2}\times t$$

$$10^{-3}\times\frac{2}{5}\times 2\times 10^{-2}=t$$

$$10^{-5}\times\frac{4}{5}=t$$

$0.8 \times 10^{-5} = 8\ \mu m = t$

24. A particle of mass 1 kg, initially resting at origin, starts moving under the influence of a force $\vec{F}=4t^3\hat{i}-3t^2\hat{j}$. If the speed of the particle at *t* = 1 is $\sqrt{\alpha}$, then value of α is

Answer (2)

Sol. $v_x=4t^3=\frac{dv_x}{dt}$

$v_x = 1$ m/s

$v_y = -3t^2$

$v_y = 1$ m/s

$v=\sqrt{2}$ m/s

25. Focal length of objective lens and eyepiece lens are 1.25 cm and 5 cm and tube length is 26 cm. Find magnification of compound microscope in normal adjustment.

Answer (104)

Sol. $M=\frac{L}{f_0}\cdot\frac{D}{f_e}$

$$=\frac{26}{1.25}\times\frac{25}{5}$$

$M = 104$