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 the dimensions of the expression $\frac{\varepsilon_0 E}{T}$, where ε_0, E and T are permittivity, electric field and time.

(1) AL (2) AL^{-2}

(3) $MA^{-1}L$ (4) MLA^2

Answer (2)

Sol. $EA = \frac{q}{\varepsilon_0}; \varepsilon_0 = \frac{q}{EA}$

$\Rightarrow \quad \varepsilon_0 E = \frac{q}{A}$

$\frac{q}{AT} = \frac{AT}{L^2 T}$

2. In an open organ pipe 3rd and 6th harmonic frequency differ by 3200 Hz. Find the length of organ pipe (speed of sound = 320 m/s)

(1) 5 cm (2) 10 cm

(3) 15 cm (4) 20 cm

Answer (3)

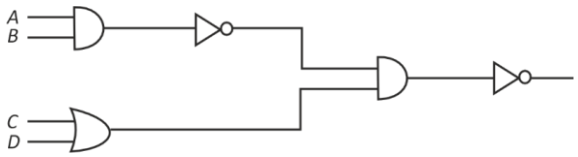
Sol. $\frac{6C}{2l} - \frac{3C}{2l} = 2200$

$\Rightarrow \quad \frac{3C}{2l} = 3200$

$\Rightarrow \quad \frac{3 \times 320}{2l} = 3200 = 10$

$\frac{3}{20}$ = 0.15 m or 15 cm

3. For the given logic gate find output functions.



(1) $\overline{A} \cdot \overline{B} + C + D$

(2) $\overline{A} + \overline{B} + \overline{C} \cdot \overline{D}$

(3) $AB + CD$

(4) $AB + \overline{C} \cdot \overline{D}$

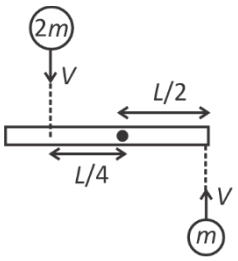
Answer (4)

Sol. $\overline{\overline{AB} \cdot (C + D)}$

$= \overline{\overline{AB}} + \overline{C + D}$

$= AB + \overline{C} \cdot \overline{D}$

4. Two balls of mass $2m$ and m collides with rod of mass m and length L as shown, balls stick to the rod after collision. Find $\frac{V}{\omega}$ if rod is hinged at centre. ($L = 8m$)



(1) $\frac{11}{2}$ (2) $\frac{11}{3}$

(3) $\frac{11}{4}$ (4) $\frac{9}{4}$

Answer (2)

Sol. $2mV\frac{L}{4}+\frac{mVL}{2}=\left(\frac{ml^2}{12}+\frac{mL^2}{4}+\frac{2mL^2}{16}\right)\omega$

$mVL=\frac{11}{24}mL^2\omega$

$\frac{V}{\omega}=\frac{11}{24}L$

$=\frac{11}{3}$

5. A gas undergoes a process in which state variable changes from (1 atm, 60ml, 27°C) to (*P* atm, 30 ml, 77°C) then *P* is

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

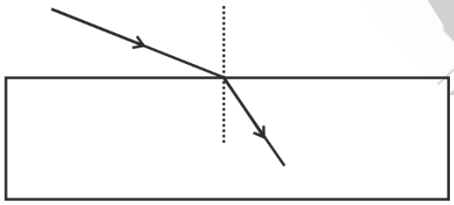
(3) $\frac{7}{3}$ atm (4) $\frac{4}{3}$ atm

Answer (3)

Sol. $\frac{1\times60}{300}-\frac{P\times30}{350}$

$\Rightarrow P=2\times\frac{7}{6}=\frac{7}{3}$ atm

6. A light ray incident on a slab of refractive index $\frac{3}{2}$. If wavelength of refracted ray is 520 nm. Find wavelength of incident ray.



(1) 460 nm (2) 780 nm

(3) 360 nm (4) 560 nm

Answer (2)

Sol. $V=f\lambda$

$\lambda_{slab}=\frac{\lambda}{\mu}$

$\lambda=520\times\frac{3}{2}$ = 780 nm

7. Which of the following is/are true for YDSE experiment?

i. Fringe width increases if slit distance is constant & wavelength increased

ii. Fringe width increases if slit distance is constant & wavelength decreased

iii. Fringe width increases if slit distance is increased & wavelength constant

iv. Fringe width increases if slit distance is decreased & wavelength constant.

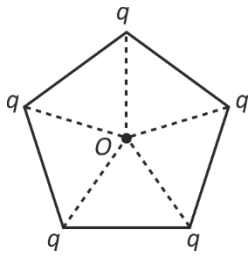
(1) i, iii (2) i, iv

(3) ii, iii (4) ii, iv

Answer (2)

Sol. $\beta=\frac{\lambda D}{d}$

8. For the given arrangement of charges find the strength of electric field *E* and potential V at geometrical center *O*.



(1) *E* = 0; *V* = 0

(2) *E* = 0; *V* = Non-zero

(3) *E* = Non-zero; *V* = Non-zero

(4) *E* = Non-zero; *V* = 0

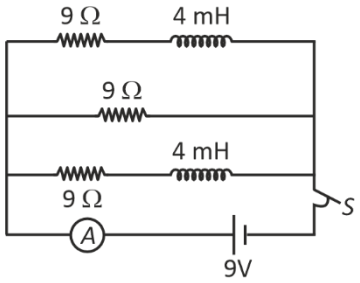
Answer (2)

Sol. $E = 0$

$$V = 5 \cdot \frac{kq}{r}$$

So $E = 0$; $V \neq 0$

9. For the given circuit, find reading of ammeter just after key(s) is closed.



(1) 1 A (2) 3 A

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

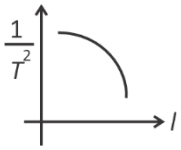
Answer (1)

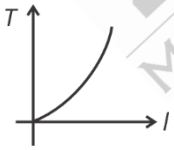
Sol. At $t = 0$, inductor will behave like open circuit.

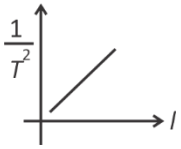
So,

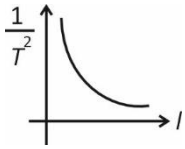
$$I = \frac{9}{9} = 1\text{ A}$$

10. Choose the correct graph between time period T and length of pendulum l.

(1) 

(2) 

(3) 

(4) 

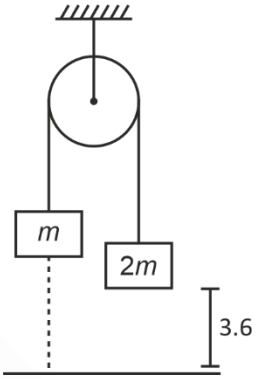
Answer (4)

Sol. $T = 2\pi\sqrt{\frac{l}{g}}$

$$l \cdot \frac{1}{T^2} = k$$

$$T^2 = kl$$

11. If the string connecting m and ground is cut find the speed with which $2m$ block hits the ground as shown. (g = 10 m/s^2)



(1) 3 m/s (2) 4 m/s

(3) $2\sqrt{6}$ m/s (4) $6\sqrt{2}$ m/s

Answer (3)

Sol. $a = \frac{2m - m}{2m + m} g = \frac{g}{3}\text{ m/s}^2$

$$v = \sqrt{2as} = \sqrt{7.2 \times \frac{g}{3}} = \sqrt{24}\text{ m/s}$$

12. In hydrogen type atom, shortest wavelength in Lyman series is given as 91 nm. Then longest wavelength in Paschen series of this atom shall be

(1) 31.82 nm (2) 113.3 nm

(3) 1.87 μm (4) 2.31 μm

Answer (3)

Sol. Lowest Lyman $\frac{1}{\lambda_1} = RZ^2\{1\}$

Highest Paschen $\frac{1}{\lambda_2} = RZ^2\left(\frac{1}{9} - \frac{1}{16}\right)$

$\frac{\lambda_2}{\lambda_1} = \frac{144}{7}$

$\lambda_2 = \frac{144}{7} \times 9 = 1872$

13. **Statement-1:** Kinetic energy of system = $\frac{1}{2}m_1v_1^2$ + $\frac{1}{2}m_2v_2^2$ ... $\frac{1}{2}m_nv_n^2$

Statement-2: Kinetic energy of system = Kinetic energy of center of mass + kinetic energy with respect to center of mass

(1) Statement I is true
Statement II is true

(2) Statement I is true
Statement II is false

(3) Statement I is false
Statement II is true

(4) Statement I is false
Statement II is false

Answer (1)

Sol. KE = KE_0 + *KE*

14. Find the percentage change in height risen by liquid if density of fluid, radius of capillary and surface tension of liquid are decreased by 1%. Assume contact angle doesn't change and capillary is of sufficient length.

(1) +1% (2) –1%

(3) +3% (4) –3%

Answer (1)

Sol. $\frac{2S\cos\theta}{r} = h\rho g$

$h = \frac{2S\cos\theta}{\rho g r}$

$\frac{\Delta h}{h} = \frac{\Delta S}{S} = \frac{\Delta\rho}{\rho} - \frac{\Delta r}{r}$

= –1% + 1% + 1%

= 1%

15. A capacitor of capacitance 10 μF is connected with a battery of emf 6V. Now battery is disconnected and another uncharged capacitor of capacitance 20 μF is connected to the capacitor. Find charge on 20 μF capacitor.

(1) $\frac{30}{4}$ μC (2) 10 μC

(3) $\frac{20}{3}$ μC (4) 40 μC

Answer (4)

Sol. $V = \frac{c_1 v}{c_1 + c_2} = \frac{60}{30} = 2$ Volt

$q_2 = 20 \times 2 = 40$ μC

16. **Statement-1:** Time period of simple pendulum is increased if density of material of pendulum is increased.

Statement-2: Time a period of simple pendulum is $T = 2\pi\sqrt{\frac{l}{g}}$.

(1) Statement I is true
Statement II is true

(2) Statement I is true
Statement II is false

(3) Statement I is false
Statement II is true

(4) Statement I is false
Statement II is false

Answer (3)

Sol. Conceptual

17. For the given statements below mark the correct option.

Statement-I: Work done by a conservative force *f*, from $\vec{r}_1$ to $\vec{r}_2$ is given by $W = -\int_{r_1}^{r_2} f \cdot dr$.

Statement-II: Work done by conservative force is path dependent.

(1) Statement-I and statement-II is true

(2) Statement-I is true and statement-II is false

(3) Statement-I is false and statement-II is true

(4) Statement-I and statement-II is false

Answer (4)

Sol. $W = \int_{r_1}^{r_2} f \cdot dr$, is path independent.

18. Electromagnetic wave with intensity $I = 4 \times 10^{14}$ watt/m^2 is propagating in free space. Find the amplitude of magnetic field B_0.

(Use $c = 3 \times 10^8$ m/s, $\varepsilon_0 = 8.85 \times 10^{-12}$ c^2/N.m^2)

(1) 1.83 Tesla (2) 0.5 Tesla

(3) 4.5 Tesla (4) 1 Tesla

Answer (1)

Sol. $E_0 = CB_0$

And $I = \frac{1}{2}\varepsilon_0 E_0^2 \times c$

$\Rightarrow I = \frac{1}{2}\varepsilon_0 c^3 \cdot B_0^2$

$\Rightarrow \frac{2I}{\varepsilon_0 c^3} = B_0^2 = 3.35$

$\Rightarrow B_0 = 1.83$ Tesla

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.

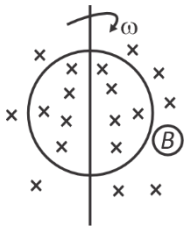
21. Three identical liquid drops each carrying same charges coalesce to form single drop. Ratio of potential of large drop and single smaller drop is $3^{N/3}$ then *N* is

Answer (2)

Sol. $\frac{4}{3}\pi r^3\, 3 = \frac{4}{3}\pi R^3 \Rightarrow R = 3^{1/3} r$

$v = \frac{q}{4\pi\varepsilon_0 r} \quad V = \frac{3q}{4\pi\varepsilon_0 R} \quad V = \frac{3}{3^{1/3}} = 3^{2/3}$

22. A circular coil is rotating in magnetic field of magnitude 0.25*T* with angular speed 6 rpm about its diameter. At *t* = 0 coil's configuration is given as shown. If induced emf after coil rotated by angle 30° is 1.6 mV. Find radius of the coil (in cm). ($\pi^2 = 10$)



Answer (8)

Sol. $\sum = BA\omega\sin(\cos t)$

$B\pi R^2 \cdot \frac{6\times 2\pi}{60}\frac{1}{2} = 16\times 10^{-4}$

$R^2 = \frac{16\times 10^{-4}}{0.25}$

$R = 8$ cm

23. A metallic conductor of length 2*m* and cross-sectional area 0.2 mm^2 carries steady current of 1.2A when a potential difference of 2V is applied across it. ($e = 1.6 \times 10^{-19}$, charge density = 7.5×10^{28} m^{-3})

Then the mobility of charge carrier is $x \times 10^{-4}$ SI units. Find *x*

Answer (5)

Sol. $\mu = \frac{v_d}{E} = \frac{Il}{neA(El)} = \frac{Il}{neAV}$

$= 5 \times 10^{-4}$ m^{2}V^{-1}S^{-1}

24.

25.