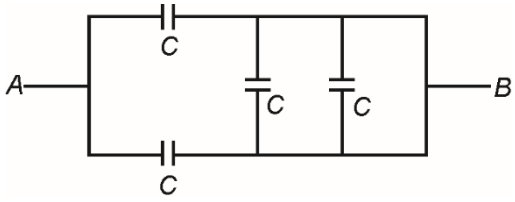
PHYSICS

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 equivalent capacitance across points *A* and *B* in the given electrical circuit

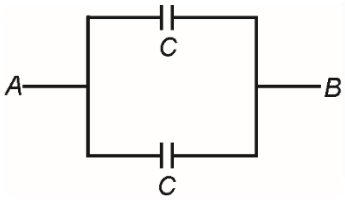


(1) $\frac{C}{2}$ (2) $2C$

(3) $\frac{5C}{3}$ (4) $\frac{3C}{4}$

Answer (2)

Sol. Two capacitors will get short-circuited also,



$C_{AB} = 2C$

2. A particle of mass *m* moving with velocity *v* collides with a particle of mass 2*m* at rest and sticks to it. Velocity of combined mass is equal to

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

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

Answer (3)

Sol. $mv = (m + 2m)v'$

$\Rightarrow \quad v' = \frac{v}{3}$

3. An object weighs 200 N at the surface of earth. Find the weight at a depth of $\frac{R}{2}$, where *R* is radius of earth.

(1) 100 N (2) 300 N

(3) 50 N (4) 150 N

Answer (1)

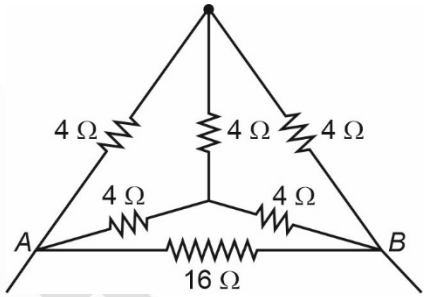
Sol. $g' = g\left[1 - \frac{d}{R}\right]$

$= g\left[1 - \frac{R/2}{R}\right]$

$= \frac{g}{2}$

$\Rightarrow W' = \frac{W}{2} = 100 \text{ N}.$

4. Find the equivalent resistance across *A* and *B* for given circuit.



(1) 6.4 Ω (2) 4 Ω

(3) 3.2 Ω (4) 8 Ω

Answer (3)

Sol. $R_{eq} = \frac{16 \times 4}{20} = \frac{64}{20} = \frac{32}{10} = 3.2\ \Omega$

5. For an object radiating heat at 300 K, the wavelength corresponding to maximum intensity is λ. If the temperature of body is increased by 300 K, the new wavelength corresponding to maximum intensity will be

(1) $\frac{\lambda}{2}$ (2) 2λ

(3) λ (4) $\frac{5\lambda}{2}$

Answer (1)

Sol. λT = constant

$\therefore \quad \frac{\lambda_1}{\lambda_2} = \frac{T_2}{T_1}$

$\lambda_2 = \lambda\left(\frac{300}{600}\right) = \frac{\lambda}{2}$

6. A monoatomic gas initially at pressure *P* and volume *V* is compressed to $\frac{1}{8}$th of its volume adiabatically. Final pressure of the gas is equal to

(1) $4P$ (2) $8P$

(3) $16P$ (4) $32P$

Answer (4)

Sol. $PV^{\gamma} = \text{Constant}$

$$\Rightarrow \quad PV^{\frac{5}{3}} = P_f\left(\frac{V}{8}\right)^{\frac{5}{3}}$$

$$\Rightarrow \quad P_f = P(8)^{\frac{5}{3}}$$

$= 32P$

7. A projectile, when projected at 15° with horizontal, has a range of 50 m. Find the range when projected at 45° with horizontal.

(1) 50 m (2) 100 m

(3) 80 m (4) 120 m

Answer (2)

Sol. $R = \dfrac{U^2 \sin 2\theta}{g}$

$$\Rightarrow \quad 50 = \frac{U^2 \sin 30°}{g}$$

and $R' = \dfrac{U^2 \sin 90°}{g}$

$\Rightarrow R' = 100$ m

8. **Statement (1):** An *LCR* circuit connected to an AC source has maximum average power at resonance.

Statement (2): A resistor only circuit with zero phase difference has maximum average power.

(1) (1) and (2) both are correct

(2) (1) is correct but (2) is incorrect

(3) (1) is incorrect but (2) is correct

(4) Both (1) and (2) are incorrect

Answer (1)

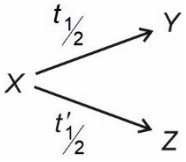
Sol. $P_{avg} = \dfrac{I_{rms}V_{rms}}{2}\cos\phi$

For maximum $P_{avg}\cos\phi = 1$

$\Rightarrow \phi = 0$

or circuit is a resistive circuit or an *LCR* is at resonance.

9. A radioactive nuclei *X* decays simultaneously to two nuclei *Y* and *Z* as:



$t_{1/2}$ is 12 minutes while $t'_{1/2}$ is 3 minutes. Find the time in which nuclei *X* decays 50%.

(1) 4.8 minutes (2) 15 minutes

(3) 2.4 minutes (4) 9 minutes

Answer (3)

Sol. $\left(t_{1/2}\right)_{Eff} = \dfrac{t_{1/2} \cdot t'_{1/2}}{t_{1/2} + t'_{1/2}}$

$= 2.4$ minutes.

10. What is the maximum percentage error in the measurement of quantity *I*, if it is given by $I = \dfrac{a^2b^3}{c\sqrt{d}}$.

Given the percentage error in the calculation of *a*, *b*, *c* and *d* are 1%, 2%, 3% and 4% respectively.

(1) 11% (2) 12%

(3) 9% (4) 13%

Answer (4)

Sol. $\dfrac{\Delta I}{I} \times 100 = \pm\left(\dfrac{2\Delta a}{a} + \dfrac{3\Delta b}{b} + \dfrac{\Delta c}{c} + \dfrac{1}{2}\dfrac{\Delta d}{d}\right) \times 100$

$$= \left[2(1) + 3(2) + (3) + \frac{1}{2}(4)\right]$$

$= 13$ %

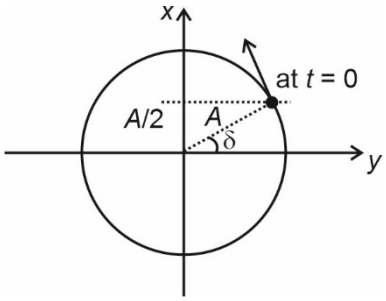
11. For a particle performing linear SHM, its position (*x*) as a function of time (*t*) is given by $x = A\sin(\omega t + \delta)$. Given that, at $t = 0$, particle is at $+\dfrac{A}{2}$ and is moving towards $x = +A$. Find δ

(1) $\dfrac{\pi}{3}$ rad (2) $\dfrac{\pi}{6}$ rad

(3) $\dfrac{\pi}{4}$ rad (4) $\dfrac{5\pi}{6}$ rad

Answer (2)

Sol.



In the phasor diagram

$$\sin\delta = \frac{\frac{A}{2}}{A} = \frac{1}{2}$$

$$\delta = \frac{\pi}{6} \text{ radian}$$

12. A solenoid having 60 turns and length 15 cm produces magnetic field of 2.4×10^{-3} T, Find the current in the solenoid.

(1) $\frac{90}{2\pi}$ A (2) $\frac{30}{2\pi}$ A

(3) $\frac{10}{\pi}$ A (4) $\frac{20}{\pi}$ A

Answer (2)

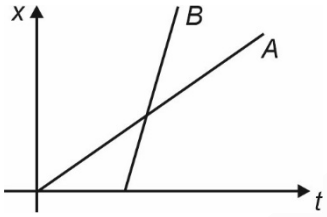
Sol. $B = \mu_0 ni$

$\Rightarrow 2.4\times10^{-3} = 4\pi\times10^{-7}\times\frac{60}{0.15}\times i$

$\Rightarrow 2.4\times10^{-3} = 16\pi\times10^{-5}\times i$

$i = \left(\frac{240}{16\pi}\right) = \frac{60}{4\pi} = \left(\frac{30}{2\pi}\right)$ A

13. The given graph shows the position (x)–time (t) relation for two students, A and B from school to their home. Consider the following statements



a. A is faster than B

b. B is faster than A

c. B lives further away than A

d. A live further away than B

Correct statements are

(1) a, d (2) b, c

(3) b, d (4) a, c

Answer (2)

Sol. (Slope of x-$t)_B$ – (Slope of x-$t)_A$

$V_B > v_A$

Also, (x of home)$_B$ > (x of home)$_A$

14. Angular momentum of an e^- in first Bohr's orbit is L. The change in angular momentum if this electron jumps to the second orbit will be

(1) L (2) $2L$

(3) $3L$ (4) $1.5L$

Answer (1)

Sol. $L_i = L = \frac{L}{2\pi}$

$L_f = \frac{2h}{2\pi} = 2L$

$\therefore \Delta L = L$

15. The mass and radius of orbit for two satellites are (m, r) and ($3m$, $3r$) respectively. Find the ratio of their orbital velocity about earth.

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

(3) $\sqrt{2}:1$ (4) 1 : 2

Answer (1)

Sol. $v_1 = \sqrt{\frac{Gm}{r}}, \quad v_2 = \sqrt{\frac{Gm}{3r}}$

$\therefore \frac{v_1}{v_2} = \frac{\sqrt{3}}{1}$

16. Decay constant for a radioactive nuclide is given to be 2×10^3. If molar mass of sample is 60 gm then activity of 0.3 μgm sample is equal to (in disintegration/seconds)

(1) 6.023×10^{15} (2) 6.023×10^{18}

(3) 6.023×10^{12} (4) 3.012×10^{12}

Answer (2)

Sol. λN

$= 2\times10^3 \times \frac{3\times10^{-7}}{60}\times6.023\times10^{23}$

$= 6.023 \times 10^{18}$

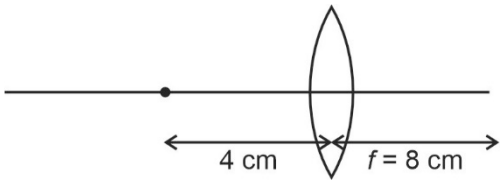
17. An point sized object is placed 4 cm from the double convex lens of focal length 8 cm. The change in the position of image, when the object is moved 2 cm towards the lens, is

(1) 8 cm (2) $\frac{8}{3}$ cm

(3) $\frac{16}{3}$ cm (4) $\frac{32}{3}$ cm

Answer (3)

Sol.



For $u = -4$ cm $\Rightarrow \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\Rightarrow \frac{1}{v} + \frac{1}{4} = \frac{1}{8} \Rightarrow \frac{1}{v} = \frac{1}{8} - \frac{1}{4}$

$v = -8$ cm

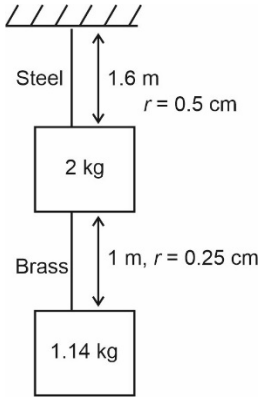
For $u = -2$ cm

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} + \frac{1}{2} = \frac{1}{8}$

$v = \frac{-8}{3} \Rightarrow \Delta v = \left|\frac{16}{3}\right|$ cm

18. Two blocks of mass 2 kg and 1.14 kg are hanged by steel and brass wire respectively as shown in figure. The change in length for steel wire will be (Y_{steel} = 2 × 10^{11} N/m^2, Y_{brass} = 1 × 10^{10} N/m^2)



(1) 3.2 μm

(2) 1.6 μm

(3) 0.8 μm

(4) 4.8 μm

Answer (1)

Sol. $\Delta l = l\left(\frac{\text{Stress}}{Y_{steel}}\right)$

$= 1.6 \times \frac{3.14 \times 10}{3.14\left(0.5 \times 10^{-2}\right)^2 \times 2 \times 10^{11}}$

= 3.2 × 10^{-6} m

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. The equation of progressive wave is given as $y = 5 \sin(6t + 0.03x)$. Find the speed of wave. (Assume all units in SI unit)

Answer (200)

Sol. $\frac{dx}{dt} = v = \frac{6}{0.03} = \frac{600}{3} = 200$ m/s

22. Earth shrinks to $\frac{1}{64}$ times of its initial volume. Time period of earth rotation is found to be $\frac{24}{x}$ hrs.

Answer (16)

Sol. $V = \left(\frac{V_0}{64}\right)$

$\frac{4}{3}\pi R^3 = \frac{1}{64} \times \frac{4}{3}\pi R_0^3$

$R = \left(\frac{R_0}{4}\right)$

M Remains same,

$I\omega$ = constant

$\Rightarrow \frac{2}{5}M(R_0^2)\frac{2\pi}{(24\text{ hr})} = \frac{2}{5} \times M \times \frac{R_0^2}{16} \times \frac{2\pi}{T}$

$T = \left(\frac{24}{16}\text{ hr}\right)$ so, $\boxed{x = 16}$

23. 10 resistors each of 10 Ω resistance when connected together give minimum equivalent resistance R_1 and maximum equivalent resistance R_2 among various possible combinations.

So $\frac{R_2}{R_1}$ is equal to

Answer (100)

Sol. $R_{min} = \frac{R}{10} = 1\,\Omega$ (when all resistors are placed in parallel)

R_{max} = 10 R = 100 Ω (when all resistors are placed in series)

$\Rightarrow \frac{R_{max}}{R_{min}} = 100$

24. A conducting rod of length 1 m is moved across a magnetic field of 0.15 T, with constant speed of 4 m/s. Find force (in N) on rod.

Answer (0)

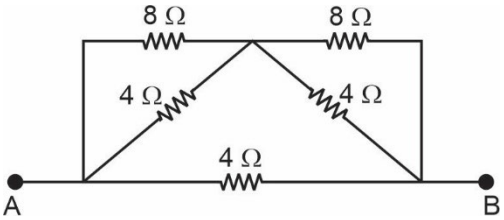
Sol. Since system is open

$\Rightarrow$ Current i = 0

$\Rightarrow$ Force = $i\ell B$

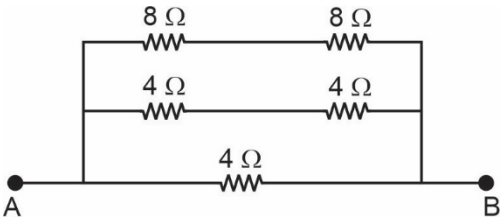
= 0

25. Equivalent resistance of the following circuit (in ohms) is equal to $x/7$. Value of x is equal to _____.



Answer (16)

Sol. Equivalent circuit



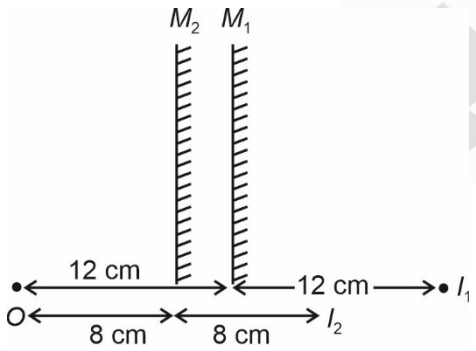
$$R_{eq} = \left(\frac{1}{4}+\frac{1}{8}+\frac{1}{16}\right)^{-1}\ \Omega$$

$$= \frac{16}{7}\ \Omega$$

26. An object is placed Infront of a plane mirror 12 cm away from it. The object is kept fixed while the plane mirror is shifted towards the object by a distance of 4 cm. The length of shift in the position of image is equal to _____ cm.

Answer (8)

Sol.



$\Rightarrow I_1I_2 = 24\text{ cm} - 16\text{ cm}$

$= 8\text{ cm}$

27. In an AM wave, amplitude of modulating wave = 3 units and amplitude of carrier wave = 15 units. Find the ratio of maximum to minimum intensity $\frac{I_{max}}{I_{min}}$.

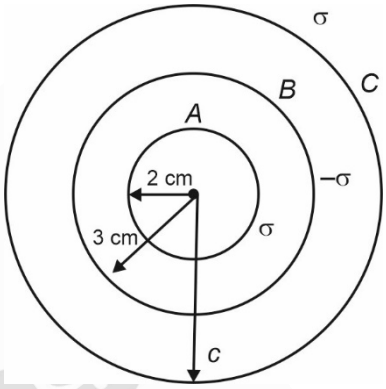
Answer (02.25)

Sol. $A_{max} = 15 + 3 = 18$

$A_{min} = 15 - 3 = 12$

$$\Rightarrow \frac{I_{max}}{I_{min}} = \left(\frac{18}{12}\right)^2 = 2.25$$

28. Three concentric shells A, B and C having surface charge density σ, $-\sigma$ and σ respectively. The radii of A and B are 2 cm and 3 cm respectively. Electric potential at surface A is V_A and at C is V_C. If $V_A = V_C$ then find the radius of C in cm



Answer (5)

Sol. $$V_A = \frac{K(\sigma\times 4\pi a^2)}{a} - \frac{K(4\pi b^2)\sigma}{b} + \frac{K}{c}(4\pi c^2)\sigma$$

$$V_C = \frac{K}{c}(4\pi a^2\sigma - 4\pi b^2\sigma) + \frac{K}{c}(4\pi c^2)\sigma$$

$V_A = V_C$

$$\Rightarrow a - b = \left(\frac{a^2-b^2}{c}\right)$$

$$\Rightarrow a - b = \frac{(a-b)(a+b)}{c}$$

$\Rightarrow c = a + b$

$\Rightarrow c = 5$ cm

29.

30.