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. The correct expression for Bernoulli's theorem is (symbols have their usual meaning)

(1) $P+\rho gh+\frac{1}{2}\rho v^2=\text{constant}$

(2) $P+\frac{1}{2}\rho gh+\frac{1}{2}\rho v^2=\text{constant}$

(3) $P+\rho gh+\rho v^2=\text{constant}$

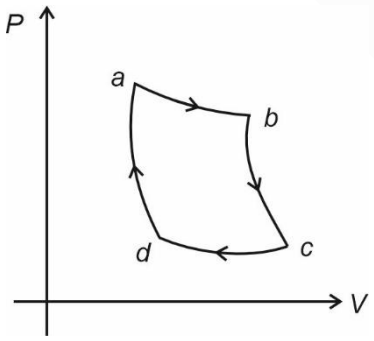
(4) $P+2\rho gh+\rho v^2=\text{constant}$

Answer (1)

Sol. According to Bernoulli's theorem

$$P+\rho gh+\frac{1}{2}\rho v^2=\text{constant}$$

2. The PV curve shown in diagram consists of two isothermal & two adiabatic curves. Then



(1) $\frac{V_a}{V_d}=\frac{V_b}{V_c}$ (2) $\frac{V_a}{V_d}=\left(\frac{V_b}{V_c}\right)^{-1}$

(3) $\frac{V_a}{V_d}=\left(\frac{V_c}{V_b}\right)^2$ (4) $\frac{V_a}{V_d}=\frac{V_c}{V_b}$

Answer (1)

Sol. $T_a = T_b$, $T_c = T_b$

$T_bV_b^{\gamma-1} = T_cV_c^{\gamma-1}$

$T_aV_a^{\gamma-1} = T_dV_d^{\gamma-1}$

$\frac{V_b}{V_a}=\frac{V_c}{V_d}$

$\therefore \quad \frac{V_a}{V_d}=\frac{V_b}{V_c}$

3. In a series LCR circuit, the value of resistance as well as $(X_L - X_C)$ is halved, then the new current amplitude (I_2) will satisfy (I_1 is old current amplitude)

(1) $I_2 = 2I_1$

(2) $I_2 = 0$

(3) $I_2=\frac{I_1}{2}$

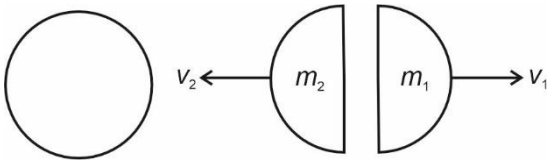
(4) $I_2 = I_1$

Answer (1)

Sol. $I_1=\frac{V_0}{\sqrt{R^2+(X_L-X_C)^2}}$,

$$I_2=\frac{V_0}{\sqrt{\left(\frac{R}{2}\right)^2+\left(\frac{X_L-X_C}{2}\right)^2}}=2I_1$$

4. A ball initially at rest breaks in two masses m_1 and m_2 that move with speed v_1 and v_2 respectively as shown in figure.



The ratio of kinetic energy of right mass to the left mass is

(1) $\frac{m_1}{m_2}$ (2) $\frac{m_2}{m_1}$

(3) $\frac{m_1^2}{m_2^2}$ (4) $\frac{m_2^2}{m_1^2}$

Answer (2)

Sol. From momentum conservation :

$|m_1v_1| = |m_2v_2| = p$

$K_1 = \frac{p^2}{2m_1}$

$K_2 = \frac{p^2}{2m_2}$

$\frac{K_1}{K_2} = \frac{m_2}{m_1}$

5. Critical angle for a pair of medium is given to be 45°. Find the ratio of the refractive index of rarer medium to denser.

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

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

(3) 1 : 2

(4) 2 : 1

Answer (2)

Sol. $\sin C = \frac{\mu_{Rarer}}{\mu_{Denser}}$

$\Rightarrow \sin 45° = \frac{\mu_{Rarer}}{\mu_{Denser}}$

$\Rightarrow \mu_R : \mu_D = 1:\sqrt{2}$

6. A ball of mass 150 g moving with speed 20 m/s is catched in 0.1 sec. Find the average force exerted by the hands.

(1) 40 N (2) 60 N

(3) 20 N (4) 30 N

Answer (4)

Sol. $F_{avg} = \frac{mv}{t} = \frac{0.15 \times 20}{0.1} = 30\ N$

7. For a number given as ($a \times 10^b$) the order of number is

(1) b if $a \geq 5$

(2) b if $a \leq 5$

(3) b if $5 < a < 10$

(4) a when $b \geq 5$

Answer (2)

Sol. Rules for scientific notation

8. An electron and a proton are having same kinetic energy. Find ratio of their linear momentum. (mass of electron = 9.1×10^{-31} kg, mass of proton = 1.67×10^{-27} kg)

(1) 1.67×10^{-3} kg.m/s

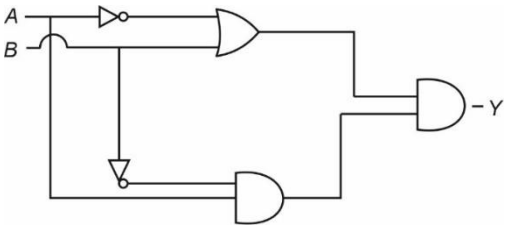
(2) 1.33×10^{-2} kg.m/s

(3) 1.23×10^{-2} kg.m/s

(4) 2.33×10^{-2} kg.m/s

Answer (4)

Sol. $\frac{P_e^2}{2m_e} = \frac{P_p^2}{2m_p} \Rightarrow \frac{P_e}{P_p} = \sqrt{\frac{m_e}{m_p}} = 2.33 \times 10^{-2}$

9. 

For given logic circuit, correct relation between input (x, y) and output (Y) is

(1) $y = 0$ (2) $y = A \cdot \overline{B}$

(3) $y = A + \overline{B}$ (4) $y = \overline{A} \cdot B$

Answer (1)

Sol. $\left(\overline{A}+B\right)\cdot\left(A\cdot\overline{B}\right)$

$\overline{A}\cdot\left(A\overline{B}\right)+B\cdot\left(A\cdot\overline{B}\right)$

= zero

10. Two organ pipes having same length, one is open while other is closed. Find ratio of 7th overtone of these organ pipes.

(1) $\frac{15}{16}$ (2) $\frac{16}{15}$

(3) $\frac{14}{15}$ (4) $\frac{13}{14}$

Answer (2)

Sol. $n_o = (n+1)\frac{V}{2l}$, $n_c = (2n+1)\frac{V}{4l} = \frac{15V}{4l}$

$= \frac{4V}{l}$

11. Two planets of mass m_1 and m_2 are revolving around their sun in radius of their orbits r_1 and r_2 respectively. Angular momentum of planets are in ratio of 3 then $\frac{T_1}{T_2}$ is (T_1 and T_2 are periods of revolutions)

(1) $27\left(\frac{m_2}{m_1}\right)^3$ (2) $\frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$

(3) $\left(\frac{r_1}{r_2}\right)^3$ (4) $\left(\frac{r_2}{r_1}\right)^{3/2}$

Answer (2)

Sol. $m_1 v_1 r_1 = L \quad \Rightarrow \quad v_1 = \frac{L}{m_1 r_1}$

$m_1 v_2 r_2 = 3L \quad \Rightarrow \quad v_2 = \frac{3L}{m_2 r_2}$

$$\frac{T_1}{T_2} = \frac{\frac{2\pi r_1}{v_1}}{\frac{2\pi r_2}{v_2}} = \frac{r_1 v_2}{r_2 v_1} = \frac{r_1}{r_2}\frac{m_1 r_1}{L}\frac{3L}{m_2 r_2}$$

$$= \frac{3m_1}{m_2}\cdot\frac{r_1^2}{r_2^2}$$

Also, $\frac{T_1}{T_2} = \frac{r_1^{3/2}}{r_2^{3/2}}$

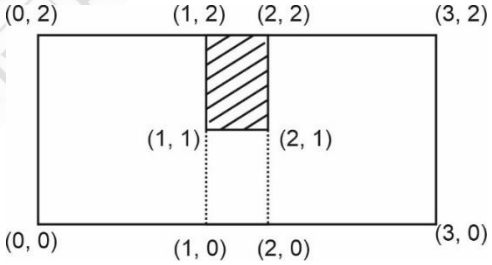
$$\frac{T_1^{4/3}}{T_2^{4/3}} = \frac{r_1^2}{r_2^2}$$

$$\frac{T_1}{T_2} = \frac{3m_1}{m_2}\cdot\frac{(T_1)^{4/3}}{(T_2)^{4/3}}$$

$$\frac{m_2}{3m_1} = \left(\frac{T_1}{T_2}\right)^{1/3}$$

$$\frac{T_1}{T_2} = \frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$$

12. From a rectangular sheet, the shaded portion is removed. Find the co-ordinates of centre of mass after the portion has been removed.



(1) (1.5, 0.9) (2) (2.5, 1.5)

(3) (1, 1) (4) (2, 2)

Answer (1)

Sol. $x_{com} = \frac{6\sigma\times1.5+(-\sigma\times1.5)}{5\sigma} = 1.5$

$y_{com} = \frac{6\sigma\times1+(-\sigma\times1.5)}{5\sigma} = 0.9$

13. An $\bar{e}$ passing through cross magnetic and electric field undergoes zero deviation. If the kinetic energy of electron is 5 μeV and magnetic field is B_0, electric field will be

(1) 800 B_0 (2) 2320 B_0

(3) 1320 B_0 (4) 2000 B_0

Answer (3)

Sol. $E = Bv$

$$\frac{1}{2}mv^2 = 5\times10^{-6}\times1.6\times10^{-19}$$

$$\therefore\ v = 1.32\times10^3 \text{ m/s}$$

E = 1320 B_0.

14. Which of the following is incorrect for paramagnetic materials?

(1) They are strongly attracted by magnetic field

(2) Magnetic susceptibility is slightly more than zero

(3) They align in direction of magnetic field

(4) None of the above

Answer (1)

Sol. Theory based.

15. If radius of earth reduced by one fourth of it's present value, then duration of days will be

(1) 13 hours and 30 min (2) 13 hours and 20 min

(3) 18 hours and 20 min (4) 16 hours and 10 min

Answer (1)

Sol. From conservation of angular momentum

$$\frac{2}{5}mR^2\omega_0 = \frac{2}{5}m\times\frac{9R^2}{16}\omega$$

$$\frac{\omega_0}{\omega} = \frac{9}{16}$$

$$T = T_0\left(\frac{9}{16}\right)$$

= 13 hours, 30 min

16. An electromagnetic radiation of intensity 360 W/cm^2 is incident normally on a non-reflecting surface having area A. Average force on the surface is found to be 2.4 × 10^{-4} N. Find the value of A.

(1) 0.02 m^2 (2) 0.2 m^2

(3) 2 m^2 (4) 20 m^2

Answer (1)

Sol. $F = \frac{IA}{C} \Rightarrow A$= 0.02 m^2

17. A solenoid of 10 turns, cross section 36 cm^2 and of resistance 10 Ω is placed in magnetic field which is varying at constant rate of 0.5 T / sec. Find power of heat dissipation.

(1) 1.8 W (2) 3.8 W

(3) 2.34 W (4) 7.6 W

Answer (3)

Sol. $V = \varepsilon = \frac{d\phi}{dt} = \frac{dB}{dt}$ NA

$$= 0.5\times10\times36\times10^{-4}$$

$$P = \frac{V^2}{R} = \frac{(0.5)^2\times10^2\times(36)^2\times10^{-8}}{10\times10\times10^{-6}}$$

$$= \frac{1}{4}\times36\times36\times10^{-2}$$

= 2.34 W

18. The diameter of a sphere having mass 8.635 gm is measured by a vernier scale. 10 divisions of vernier scale coincides with 9 divisions of main scale and one main scale division is 1 mm. The reading of main scale is 2 cm and 2 divisions of vernier coincide with a main scale division, the density of the sphere is

(1) 2.2 g/cm^3 (2) 2 g/cm^3

(3) 2.5 g/cc (4) 1.75 g/cm^3

Answer (2)

Sol. LC = 0.1 mm

d = 2 cm + 2 × 0.1 mm

= 20.2 mm

= 2.02 cm

$$\rho = \frac{m}{\frac{4}{3}\pi\left(\frac{d}{2}\right)^3} = \frac{8.635}{\frac{4}{3}\pi(1.01)^3} = 2 \text{ g/cm}^3$$

19. Three particles having different masses have same momentum.

Find the ratio of their kinetic energy.

(m_1 = 400 gm, m_2 = 1.2 kg, m_3 = 1.6 kg)

(1) 1 : 2 : 3

(2) 3 : 2 : 1

(3) 2.5 : 0.8 : 0.6

(4) 2.8 : 0.6 : 0.8

Answer (3)

Sol. $KE = \frac{P^2}{2m}$

$$KE_1 : KE_2 : KE_3 = \frac{1}{0.4} : \frac{1}{1.2} : \frac{1}{1.6}$$

$$= 2.50 : 0.83 : 0.63$$

20.

SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. In a clock, second hand and minute hand are of 75 cm and 60 cm respectively. After 30 minutes, ratio of distance travelled by tip of second hand to that of minute hand is x. Find x.

Answer (75)

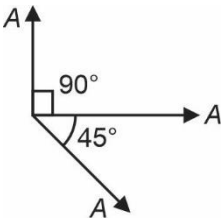
Sol. 30 minutes $\Rightarrow$ 30 revol. by second hand

$\frac{1}{2}$ revol. by minute hand

$$\text{Ratio} = \frac{2\pi r_s \times 30}{2\pi r_m \times \frac{1}{2}}$$

$$= \frac{75}{60} \times 60 = 75$$

22. If the resultant of the vectors shown is $A\sqrt{x}$, find x.



Answer (3)

Sol. $R = \sqrt{(A\sqrt{2})^2 + (A)^2} = A\sqrt{3}$

23. In a diffraction pattern of a monochromatic light of wavelength 6000 pm, slit width is 3 mm. If the angular position of 2nd minima is $N \times 10^{-6}$ radians, find N.

Answer (4)

Sol. $\theta = \frac{2\lambda}{a} = \frac{2 \times 6000 \times 10^{-12}}{3 \times 10^{-3}} = 4 \times 10^{-6}$ rad

24. The ratio of specific heat at constant volume of one mole monoatomic gas to the one mole diatomic gas is given as $\frac{a}{b}$ where a and b are co-prime number, then find $(a + b)$.

Answer (8)

Sol. $(C_v)_1 = \frac{3}{2}R$

$(C_v)_2 = \frac{5}{2}R$

$$\frac{(C_v)_1}{(C_v)_2} = \frac{3}{2} \times \frac{2}{5} = \frac{3}{5}$$

25.

26.

27.

28.

29.

30.