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. An ideal gas with an adiabatic exponent 1.5, initially at 27°C is compressed adiabatically from 800 cc to 200 cc. The final temperature of the gas is

   (1) 600 K

   (2) 300 K

   (3) 450 K

   (4) 273 K

Answer (1)

Sol. $T_i = 27°C$ or 300 K

$T_f V_f^{\gamma-1} = T_i V_i^{\gamma-1}$

$T_f = T_i\left(\frac{V_i}{V_f}\right)^{\gamma-1}$

$T_f = (300\text{ K})\left(\frac{800\text{ cc}}{200\text{ cc}}\right)^{1.5-1}$

$= 300\text{ K}\,(4)^{0.5}$

$= 600$ K

2. In YDSE, light of intensity of $4I$ and $9I$ passes through two slits respectively. Difference of maximum and minimum intensity of interference pattern is

   (1) $5I$ (2) $10I$

   (3) $24I$ (4) $26I$

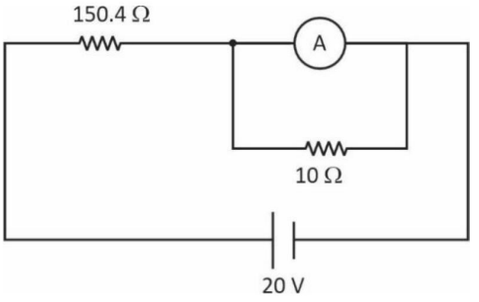
Answer (3)

Sol. $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = 25I$

$I_{min} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = I$

$\Delta I = 24I$

3. An ammeter having resistance 240 Ω is connected in the given circuit as shown. Find current through the ammeter.



   (1) 1 mA

   (2) 5 mA

   (3) 100 mA

   (4) 2.5 mA

Answer (2)

Sol. $R_{eq} = 150.4 + \frac{10\times240}{250}$

$= 160\ \Omega$

$I = \frac{20}{160} = \frac{1}{8}$

$I_A = \frac{10}{250} I = \frac{1}{25\times8} = \frac{1}{200}$

$I_A = 5$ mA

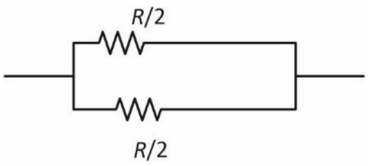
4. A thin uniform wire of length 25 m and area of cross-section $5mm^2$ has resistivity $2 \times 10^{-6}\ \Omega - m$. If the wire is bent to form a circle, the resistance across diametrically opposite points is

   (1) 5 Ω (2) 2.5 Ω

   (3) 10 Ω (4) 12.5 Ω

Answer (2)

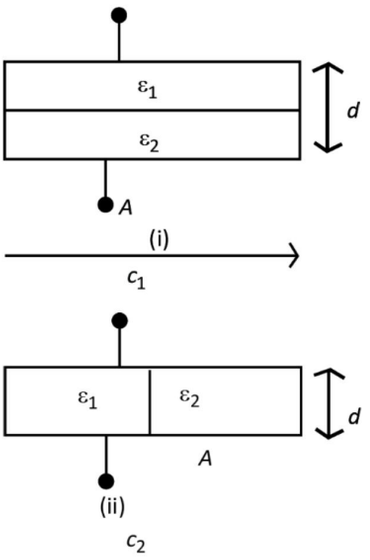
Sol. $R=\rho\frac{l}{A}=\frac{\left(2\times10^{-6}\,\Omega\,\text{m}\right)(25\,\text{m})}{5\times10^{-6}\,\text{m}^2}$



$R = 10\ \Omega$

Resistance across diametrically point is $\frac{R}{4}=2.5\ \Omega$

5. Capacitors with dielectric are shown in figure (symmetric situation).



Find $\frac{c_1}{c_2}$

(1) $\frac{4\varepsilon_1\varepsilon_2}{(\varepsilon_1+\varepsilon_2)^2}$ (2) $\frac{4\varepsilon_1\varepsilon_2}{\varepsilon_1+\varepsilon_2}$

(3) $\frac{2\varepsilon_1\varepsilon_2}{(\varepsilon_1+\varepsilon_2)^2}$ (4) $\frac{(\varepsilon_1\varepsilon_2)^2}{(\varepsilon_1+\varepsilon_2)^2}$

Answer (1)

Sol. $\frac{1}{c_1}=\frac{d}{2A\varepsilon_1}+\frac{d}{2A\varepsilon_2}$

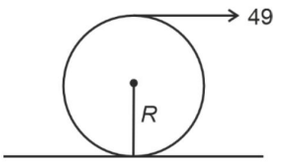
$\Rightarrow\quad c_1=\frac{2A}{d}\frac{\varepsilon_1\varepsilon_2}{(\varepsilon_1+\varepsilon_2)^2}$

$c_2=\frac{A\varepsilon_1}{2d}+\frac{A\varepsilon_2}{2d}$

$c_2=\frac{A}{2d}(\varepsilon_1+\varepsilon_2)$

$\frac{c_1}{c_2}=\frac{4\varepsilon_1\varepsilon_2}{(\varepsilon_1+\varepsilon_2)^2}$

6. A sphere of mass 20 kg is pulled with force of 49 N as shown in diagram. Acceleration of sphere assuming no slipping.



(1) 2.5 m/s² (2) 2.8 m/s²

(3) 1.4 m/s² (4) 3.5 m/s²

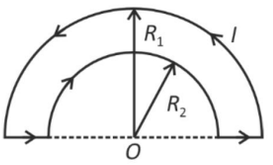
Answer (4)

Sol. $\tau=F2R=\frac{7}{5}MR^2\alpha=\frac{7}{5}MRa$

$2F=\frac{7}{5}Ma$

$a=\frac{10F}{7M}=\frac{10\times49}{7\times20}=3.5\ \text{m/s}^2$

7. A current carrying wire is bent as shown in the figure. Find magnetic field at centre '*O*' of the semi-circles. (take $R_1 = 4\pi$ and $R_2 = 6\pi$)



(1) $8.3I\times10^{-6}$ T (2) $8.3I\times10^{-9}$ T

(3) $4\pi I\times10^{-7}$ T (4) $6I\times10^{-8}$ T

Answer (2)

Sol. $B = \frac{\mu_0 I}{4R_1} - \frac{\mu_0 I}{4R_2}$

$= \frac{4\pi \times 10^{-7} I}{4}\left(\frac{1}{4\pi} - \frac{1}{6\pi}\right)$

$= \frac{1}{12} \times 10^{-7} I$

$= 8.3I \times 10^{-9}$ T

8. A biconvex lens is having the radius of curvature of 10 cm and 15 cm. If focal length of the lens is 12 cm find refractive index of material of the lens.

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

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

Answer (1)

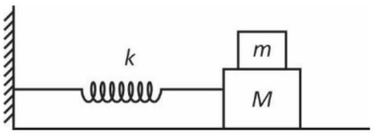
Sol. $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{12} = (\mu - 1)\left(\frac{1}{10} + \frac{1}{15}\right)$

$\mu - 1 = \frac{1}{2}$

$\mu = \frac{3}{2}$

9. The figure below shows an oscillating system of two blocks and a spring. The horizontal surface is smooth and the contact between the blocks is rough with coefficient of static friction μ.



Considering that the blocks of mass m is always stationary relative to M, choose the correct option regarding the statements below:

(A) Maximum frictional force between blocks is μmg.

(B) Time period of oscillation is $2\pi\sqrt{\frac{m+M}{k}}$

(C) Friction between the blocks at any instant is $\mu(m + M)g$

(1) Only A is correct

(2) Only B is correct

(3) A, B and C all three are correct

(4) Only C is correct

Answer (2)

Sol. $f \le \mu N$

$\Rightarrow \quad f \le \mu mg$

$T = 2\pi\sqrt{\frac{m+M}{k}}$ for no shipping between the blocks.

10. A point source of power 450 W is emitting light in all direction. Radiation pressure at distance of 2m from the source is nearly

(1) 3×10^{-8} Pa (2) 2×10^{-8} Pa

(3) 2×10^{-9} Pa (4) 4×10^{-7} Pa

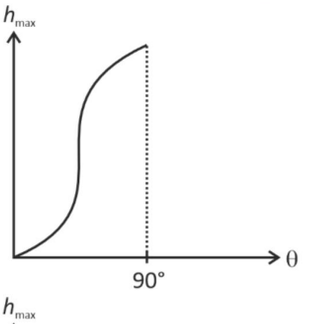
Answer (1)

Sol. $p = \frac{I}{C} = \frac{P}{AC} = \frac{450}{4 \times 3.14 \times 2^2 \times 3 \times 10^8} = \frac{450}{48 \times 3.14} \times 10^{-8}$

$\approx 3 \times 10^{-8}$ Pa

11. From a horizontal surface a particle is projected with a speed u. Which of the following graph correctly represent the variation of maximum height above the surface attained by the particle as the angle of projection is varied?

(1)



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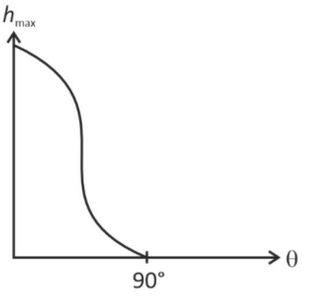

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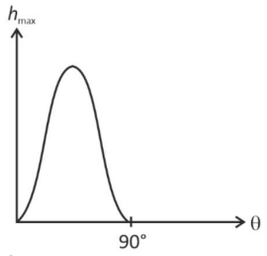
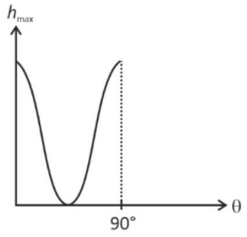


(4)



Answer (1)

Sol. $h_{max} = \frac{u^2}{2g}\sin^2\theta$

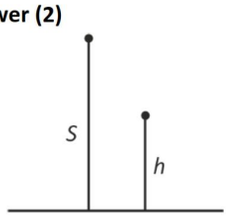
12. An object is dropped from height *S*. At a point its kinetic energy is three times its potential energy. Find its height from ground and speed at that point.

(1) $\frac{3S}{4}, \sqrt{\frac{3gS}{2}}$ (2) $\frac{S}{4}, \sqrt{\frac{3gS}{2}}$

(3) $\frac{S}{2}, \sqrt{gS}$ (4) $\frac{S}{4}, \sqrt{\frac{3gS}{4}}$

Answer (2)

Sol.



KE + PE = mgS

3PE + PE = mgS

$4mgh = mgS$

$h = \frac{S}{4}$

$v = \sqrt{2g \cdot \left(\frac{3S}{4}\right)}$

$v = \sqrt{\frac{3gS}{2}}$

13. The electric potential at the surface of a shell of radius 10 cm is 120 V. Find the potential at its centre, at r = 5 cm from centre and at r = 15 cm from centre.

(1) 0 V, 0 V, 80 V (2) 120 V, 120 V, 80 V

(3) 120 V, 0 V, 80 V (4) 80 V, 0 V, 120 V

Answer (2)

Sol. $V_{inside} = V_{surface}$

$\Rightarrow V_{centre} = V(r = 5\text{ cm}) = 120\text{ V}$

$V_{outside} = \frac{(V_{surface})(R)}{r}$

$\Rightarrow V(r = 15\text{ cm}) = \frac{(120\text{ V})(10\text{ cm})}{(15\text{ cm})}$

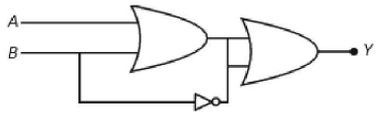
$= 80\text{ V}$

14. Truth table of logical circuit is given

A	B	Y
0	0	0
1	1	1
0	1	0
1	0	0

Then identify the correct circuit.

(1)



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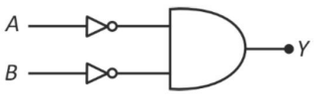

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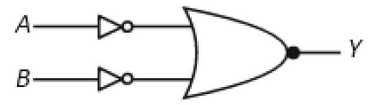

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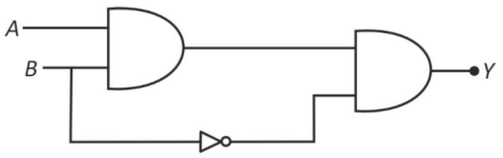


Answer (3)

Sol. Truth table is of AND gate

$A \cdot B = \overline{\overline{A} + \overline{B}}$

15. Find the colour corresponding to photons of energy 3 eV.

(1) Violet

(2) Yellow

(3) Green

(4) Blue

Answer (4)

Sol. $\lambda = \frac{12400}{E(eV)}\text{ Å} = \frac{12400}{3} = 4133\text{ Å}$

V I B G Y O R

3800Å 5500Å 7600Å

16. Choose the correct option.

a. Gravitational potential (i) $M^{-1}L^3T^{-2}$

b. Gravitational constant (ii) ML^2T^{-2}

c. Acceleration due to gravity (iii) $M^0L^2T^{-2}$

d. Potential energy (iv) M^0LT^{-2}

(1) a(iii), b(ii), c(iv), d(i)

(2) a(iii), b(i), c(iv), d(ii)

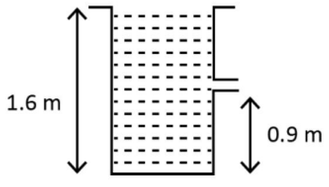
(3) a(ii), b(i), c(iv), d(iii)

(4) a(ii), b(iv), c(i), d(iii)

Answer (2)

Sol. Conceptual

17. A container of height 1.6 m is having a small hole at height of 0.9 m from ground then find speed of efflux from the hole [use $g = 9.8\text{ m/s}^2$]



(1) 3.71 m/s

(2) 2.97 m/s

(3) 4.12 m/s

(4) 5.79 m/s

Answer (1)

Sol. $u = \sqrt{2gh} = \sqrt{2\times9.8\times0.7} = \sqrt{2\times14\times0.7\times0.7} = 0.7\sqrt{28}$

$= 0.7 \times 5.3$

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. Find force (in millinewton) on current carrying wire of length $l = 4$ m, and current of 8 A placed perpendicular to the magnetic field of $\beta = 0.15$ T.

Answer (4800)

Sol. $F = Id\vec{\ell}\times\vec{B}$

$\Rightarrow \left|\vec{F}\right| = 8\times4\times0.15 = 4.8\text{ N}$

$\Rightarrow \left|\vec{F}\right| = 4800\text{(milli Newton)}$

22.

23.

24.

25.