1. A mass of 15 kg is kept at the center of a spherical shell of mass 50 kg and radius 50 m. Find the value of gravitational potential at a distance 25 m from the center.

(A) $-\frac{3G}{8}$

(B) $-\frac{8G}{5}$

(C) $-\frac{6G}{4}$

(D) $-\frac{7G}{5}$

Ans. (B)

Sol.

Since potential is a scalar quantity, so,

$$V_p = V_{50\ kg} + V_{15\ kg}$$

$$V_p = -\frac{G(50)}{50} - \frac{G(15)}{25}$$

$$V_p = -\frac{80G}{50} = -\frac{8G}{5}$$

2. Drops are falling from 9.8 m height. When the first drop touches the ground, the third drop leaves. Find the height of the second drop when the first drop is about to touch the ground: ($g = 9.8\ m/s^2$)

(A) 7.35 m

(B) 8.35 m
(C) 6.35 m

(D) 9.35 m

Ans. (A)

Sol.

For first drop.

\[ h = \frac{1}{2} g (2n)^2 \]

For 2nd drop

\[ h' = \frac{1}{2} g (n)^2 \]

\[ \frac{h}{h'} = \frac{4}{1} \]

\[ h' = \frac{h}{4} = \frac{9.8}{4} \]

so height of 2nd drop

\[ H = h - h' = 9.8 - \frac{9.8}{4} = \frac{3}{4} \times 9.8 = 7.35 \text{ m} \]

3. A player hits a ball at an angle 45° from horizontal with velocity 25 m/s. Find time taken to reach maximum height and maximum height (g = 10 m/s²)

(A) \( \frac{7}{2\sqrt{2}}s, \frac{125}{8} \text{ m} \)

(B) \( \frac{5}{2}s, \frac{135}{3} \text{ m} \)

(C) \( \frac{5}{\sqrt{2}}s, \frac{125}{4} \text{ m} \)

(D) \( \frac{5}{2\sqrt{2}}s, \frac{125}{8} \text{ m} \)

Ans. (D)

Sol. \( \theta = 45° \)
\[ H = \frac{u^2 \sin^2 \theta}{2g} = \frac{(25)^2 \times \frac{1}{2}}{2 \times 10} = \frac{125}{8} \text{ m} \]

and time \( t = \frac{T}{2} \)

\[ = \frac{u \sin \theta}{g} = \frac{25 \left(\frac{1}{\sqrt{2}}\right)}{10} = \frac{25}{10\sqrt{2}} = \frac{5}{2\sqrt{2}} \text{ s} \]

4. In the given arrangement, find EMF induced in 1 second if magnetic field is \( B = 1 \text{T} \) and radius of circular loop is 1 m.

\[ \mathcal{E} = \frac{\pi R^2}{2} \]

5. In YDSE experiment, there are two light waves of intensity \( I_1 \) and \( I_2 \) forms interference pattern on screen. If minimum intensity of fringes is zero, what will be the maximum intensity?

(A) \( 3I_1 \)

(B) \( 4I_1 \)

(C) \( 2I_1 \)

(D) \( \sqrt{8}I_1 \)
Ans. (B)

Sol. Given,

\[ I_{\text{minimum}} = 0 \]

\[ (\sqrt{I_1} - \sqrt{I_2})^2 = 0 \]

It means,

\[ \Rightarrow I_1 = I_2 \]

Now as we know that-

\[ I_{\text{max}} = (\sqrt{I_1} + \sqrt{I_2})^2 \]

So,

\[ I_{\text{max}} = 4I_1 \]

6. Find total number of spectral lines in emission spectrum of a sample of H like atoms highest quantum state is \( n = 6 \).

(A) 6
(B) 5
(C) 15
(D) 20

Ans. (C)

Sol. Total number of spectral lines in emission spectrum

\[ 6C_2 = 15 \]

7. A bullet of mass 10g travelling with velocity 'v' collides with pendulum-mass system of mass 1kg and length 1m and embedded in it as shown in figure. Find minimum value of \( V \), so that pendulum mass undergoes complete circular motion. \( (g = 9.8\text{m/s}^2) \)
Sol. As we know that to complete the just vertical circular motion velocity at bottom should be $\sqrt{5gl}$
So,
Final velocity of system (bullet + mass) = $\sqrt{5gl}$
Now according to momentum conservation,
$$(m + M)\sqrt{5gl} = m \times v$$
Thus,
$$v = \frac{(1+0.01) \times \sqrt{5 \times 9.8 \times 1}}{0.01}$$
$$v = 707 \text{ m/s}$$

8. If water fall from height 63 meter. Then find the temperature difference of water between top and bottom position. ($g = 9.8 m/s^2$)

(A) 30°C  
(B) 40°C  
(C) 50°C  
(D) 0.147°C  

Ans. (D)

Sol. $mgh = ms\Delta\theta$
$$g \times 63 = \Delta\theta \times 4.2 \times 10^3$$
$$\Delta\theta = 0.147^\circ\text{C}$$

9. In the given circuit, if $C_1 = 2F$, $C_2 = 6F$ & $C_3 = 12F$. Find the ratio of charge on capacitor $C_1$ and $C_2$ at steady state?
Sol. \( C_2 \) & \( C_3 \) are in series with each other and their series combination is in parallel with \( C_1 \)

So,

\[
C_{eq} = C_1 + \frac{C_2C_3}{C_2+C_3}
\]

\[
C_{eq} = 2 + \frac{6 \times 12}{6+12} = 6F
\]

Then,

\[
\frac{Q_{C_1}}{Q_{C_2}} = \frac{C_1V}{\frac{C_2C_3}{C_2+C_3}V} = \frac{2 \times (6+12)}{6 \times 12} = \frac{1}{2}
\]

10. For given arrangement as shown in figure, what will be the ratio of radius of curvature to equivalent focal length for given arrangement as shown in figure.

(A) \( \mu_1 - \mu_2 \)
(B) \( \mu_2 - \mu_1 \)
(C) \( \frac{\mu_1 - \mu_2}{4} \)
(D) \( 2(\mu_1) \)

Ans. (A)

Sol. \( \frac{1}{f_1} = (\mu_1 - 1) \left[ \frac{1}{R} \right] \)

\( \frac{1}{f_2} = (\mu_2 - 1) \left[ \frac{1}{R} \right] \)

\( \frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{(\mu_1-1)}{R} - \frac{(\mu_2-1)}{R} \)

\( \frac{1}{f_{eq}} = \frac{(\mu_1 - \mu_2)}{R} \)

\( \frac{R}{f_{eq}} = \mu_1 - \mu_2 \)

So the (A) option is the correct option.

11. Initially in an AC circuit \( X_L = 3R \) and resistance is \( R \). Now if a capacitor of reactance \( 2R \) is connected in series then find ratio of new power factor to old power factor.

(A) \( \sqrt{8} \)
(B) \( \sqrt{7} \)
(C) \( \sqrt{6} \)
(D) \( \sqrt{5} \)

Ans. (D)

Sol. initial power factor \( = \frac{R}{\sqrt{9R^2 + R^2}} = \frac{1}{\sqrt{10}} \)

final power factor \( = \frac{R}{\sqrt{(3-2)^2R^2 + R^2}} = \frac{1}{\sqrt{2}} \)

\( \frac{PF_{final}}{PF_{initial}} = \sqrt{5} \)

So the (D) option is the correct option.

12. If fundamental frequency of close organ pipe is in resonance with the turning fork of frequency 250 Hz. What should be the length of pipe?

(A) 23 cm
(B) 43 cm
(C) 33 cm  
(D) 30 cm  

Ans. (C)  

Sol. For closed organ pipe  

\[ f = (2n + 1) \frac{v}{4\ell} \]  

for fundamental frequency, \( n = 0 \)  

\[ f_0 = \frac{v}{4\ell} \]  

⇒ \( \ell = \frac{v}{4f_0} \)  

\[ = \frac{330}{4 \times 250} = 33 \text{ cm} \]  

13. A galvanometer of 50 division having sensitivity is 2 div/mA. Potential difference across galvanometer is 50 mV. Find resistance of galvanometer is:  

(A) 8  
(B) 6  
(C) 4  
(D) 2  

Sol. C.S. = \( \frac{\theta}{I_g} \)  

\[ I_g = \frac{\theta}{\text{C.S.}} = \frac{50\text{div}}{2\text{div/mA}} = 25\text{mA} \]  

Potential difference = 50 mV  

Resistance = \( \frac{V}{I} = \frac{50\text{mV}}{25\text{mA}} = 2\Omega \)  

14. If we consider force (F), length (L) and time (T) as a fundamental quantities then Find dimensional formula for density.  

(A) \([FL^{-1}T^2]\)  
(B) \([F^3L^{-4}T]\)  
(C) \([F^2L^{-4}T]\)  
(D) \([FL^{-3}T^{-2}]\)  

Ans. (C)  

Sol. \( d \propto F^aL^bT^c \)
\[ [ML^{-3}] = [MLT^{-2}]^a[L^b][T^c] \]
\[ = [M^aL^{a+b}T^{-2a+c}] \]

comparing:

\( a = 1 \quad \ldots (i) \)

\( a + b = -3 \quad \ldots (ii) \)

\( -2a + c = 0 \quad \ldots (iii) \)

\( c = 2; \quad b = -4; \quad \therefore [d] = [FL^{-4}T^2] \)

15. Find the value of \( x \). If the ratio of equivalent resistance across A and B when the switch is close and switch is open is \([8: x]\)

(A) 2

(B) 8

(C) 9

(D) 1

Ans. (C)

Sol. When switch is closed

\[ R_1 = \frac{2R}{3} + \frac{2R}{3} = \frac{4R}{3} \]

When open \( R_2 = \frac{3R - 3R}{3R + 3R} = \frac{3R}{2} \)

\[ \frac{R_1}{R_2} = \frac{4R}{3} \times \frac{2}{3R} = \frac{8}{9} \]

Now according to question

\[ \frac{R_1}{R_2} = \frac{8}{x} \]
\[
\frac{8}{9} = \frac{8}{x}
\]

\[x = 9\]

16. Using the colour code scheme of resistors calculate the value of given colour coded resistor.

![Colour code chart]

(A) \(47 \times 10^4 \pm 5\%\)

(B) \(57 \times 10^{-4} \pm 10\%\)

(C) \(64 \times 10^{-4} \pm 5\%\)

(D) \(57 \times 10^4 \pm 10\%\)

Ans. (D)

Sol. A colour code is used to indicate the resistance value of a carbon resistor and its percentage accuracy.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Letter as an aide to memory</th>
<th>Number</th>
<th>Multiplier</th>
<th>Colour</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>B</td>
<td>0</td>
<td>(10^0)</td>
<td>Gold, Silver, No fourth band</td>
<td>5%</td>
</tr>
<tr>
<td>Brown</td>
<td>B</td>
<td>1</td>
<td>(10^1)</td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Red</td>
<td>R</td>
<td>2</td>
<td>(10^2)</td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Orange</td>
<td>O</td>
<td>3</td>
<td>(10^3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>Y</td>
<td>4</td>
<td>(10^4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>G</td>
<td>5</td>
<td>(10^5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>B</td>
<td>6</td>
<td>(10^6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Violet</td>
<td>V</td>
<td>7</td>
<td>(10^7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grey</td>
<td>G</td>
<td>8</td>
<td>(10^8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>While</td>
<td>W</td>
<td>9</td>
<td>(10^9)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A set of coloured co-axial rings or bands is printed on the resistor which reveals the following facts:

1. The first band indicates the first significant figure.

2. The second band indicates the second significant figure.

3. The third band indicates the power of ten with which the above two significant figures must be multiplied to get the resistance value in ohms.
4. The fourth band indicates the tolerance or possible variation in percent of the indicated value. If the fourth band is absent, it implies a tolerance of 20%.

\[ R = 57 \times 10^4 \pm 5\% \]

17. For the given value of temperature find the ratio of RMS velocity of \( \text{O}_2 \) molecule to \( \text{H}_2 \) molecule.

(A) \( \frac{1}{6} \)

(B) \( \frac{1}{4} \)

(C) 6

(D) 4

Ans. (B)

Sol. \( V_{\text{rms}} = \sqrt{\frac{3RT}{M}} \)

\[ V_{\text{rms}} \propto \frac{1}{\sqrt{M}} \]

\[ \frac{(V_{\text{rms}})_{\text{O}_2}}{(V_{\text{rms}})_{\text{H}_2}} = \frac{M_{\text{H}_2}}{M_{\text{O}_2}} = \frac{2}{32} = \frac{1}{16} \]

18. A coaxial cable having a inner core of radius \( a \) and carrying current \( i \) covered by a shell whose inner radius is \( a \) and outer radius \( b \) also carrying a current \( i \) but in opposite direction then find the ratio of magnetic field at a distance \( a/2 \) inside and outside from surface of inner core. \((b > 2a)\)
19. In a photoelectric experiment, when wavelength of light is 642.4 nm falls on metal surface, stopping potential of photo electrons is 0.48 eV. What will be the stopping potential when wavelength of light used is 474 nm?

(A) 1.10 eV
(B) 1.16 eV
(C) 1.25 eV
(D) 1.30 eV
Ans. (B)

Sol. According to Einstein’s equation,

\[ eV = \frac{hc}{\lambda} - \phi \]

Write the two equations for 2 different cases and take difference of both case

\[ e(V' - V) = hc \left( \frac{1}{\lambda'} - \frac{1}{\lambda} \right) \]

\[ V' = \frac{hc}{e} \left( \frac{1}{\lambda'} - \frac{1}{\lambda} \right) + V \]

\[ = 1240 \left( \frac{1}{642.4} - \frac{1}{642.4} \right) + 0.48 \]

\[ = 1.16 \text{ eV} \]

20. What is the relation between current gain \( \alpha \) and \( \beta \) in transistor ?

(A) \( \beta = \frac{\alpha}{1+\alpha} \)

(B) \( \beta = \frac{\alpha}{1-\alpha} \)

(C) \( \beta = \frac{1+\alpha}{\alpha} \)

(D) \( \beta = \alpha \)

Ans. (B)

As we know

\[ i_E = i_B + i_C \]

Divide by \( i_C \) in both side

\[ \frac{i_E}{i_C} = \frac{i_B}{i_C} + 1 \]

\[ \frac{1}{\alpha} = \frac{1}{\beta} + 1 \]

\[ \Rightarrow \beta = \frac{\alpha}{1-\alpha} \]

21. As shown in fig. Find the electric field at center of uniformly charged an arc having total charge \((-Q)\).
22. Two SHM equations are represented by $y_1 = 10 \sin \left(3\pi t + \frac{\pi}{3}\right)$ and $y_2 = 5 \left[\sin 3\pi t + \sqrt{3} \cos \pi t\right]$. Then what will be the ratio of amplitude $\frac{A_1}{A_2}$?

(A) 1
(B) 2
(C) 3
(D) 4

Ans. (A)

Sol. $y_1 = 10 \sin \left(3\pi t + \frac{\pi}{3}\right) \ldots \ldots (1)$

$y_2 = 5 \left[\sin 3\pi t + \sqrt{3} \cos \pi t\right]$
After rearranging the second wave equation of SHM

\[ y_2 = 10 \sin \left( 3\pi t + \frac{\pi}{3} \right) \]  

\[ \ldots \ldots \ldots \ldots \ldots (2) \]

Now,

\[ \frac{A_1}{A_2} = \frac{10}{10} = 1 \]

23. In the given arrangement, if initially system is at rest then what will be the time taken by 8 kg block to reach ground?

(A) 2s  
(B) 10s  
(C) 8s  
(D) 4s  

Ans. (D)
According to constraint relation if acceleration of block 2 kg is $a$ then acceleration of 8 kg block will be $2a$

$$8g - 2T = 8a \quad \ldots \ldots (1)$$

$$T - 2g = 4a \quad \ldots \ldots (2)$$

Multiply equation (2) by 2 and add with equation (1)

$$4g = 16a \Rightarrow a = \frac{5}{2} \text{ m/s}^2$$

Thus

$$s = ut + \frac{1}{2}at^2$$

$$20 = 0 + \frac{1}{2} \times \frac{5}{2} \times t^2$$

$$t = 4s$$

24. In the given circuit, A diode and a load resistance are connected with source voltage of 14V. What will be load resistance $R_L$ if power loses in diode is $2 \times 10^{-3}$ W and potential drop across diode is 10V.
(A) 50 mΩ
(B) 30 mΩ
(C) 10 mΩ
(D) 20 mΩ
Ans. (D)

Sol. For diode

\[ P = VI \]
\[ I = \frac{P}{V} = \frac{2}{10} = 0.2 \text{ mA} \]

Now for, \( V_S = 14 \text{ V} \)

Voltage drop across \( R_L = 14 - 10 = 4 \text{ V} \)

Thus, \( V = IR_L \)

\[ R_L = \frac{4}{0.2 \times 10^{-3}} = 20 \text{ mΩ} \]

25. If electric field of 6V/m is present in a region, then magnetic field will be?

(A) \( 4 \times 10^{-8} \text{T} \)

(B) \( 6 \times 10^{-8} \text{T} \)

(C) \( 2 \times 10^{-8} \text{T} \)

(D) \( 8 \times 10^{-8} \text{T} \)

Ans. (C)

Sol. As we know that; \( B = \frac{E}{c} \)

\[ B = \frac{E}{c} = \frac{6}{3 \times 10^8} = 2 \times 10^{-9} \text{ T} \]

26. Metallic rod is connected between hot liquid (Temperature \( T_1 \)) and cold liquid (Temperature 400K) rate of heat supplied from hot to cold liquid from rod is 60J/sec. Then find temperature \( T_1 \) (given \( K = 0.1 \text{ W/m – °C}, L = 10\text{cm} \) and \( A = 1\text{m}^2 \))

(A) 450k

(B) 460k

(C) 480k

(D) 500k

Ans. (B)
Sol. $Q = \frac{kA}{L}(T_1 - T_2)$

$\Rightarrow 60 = 1(T_1 - 400)$

$\Rightarrow T_1 = 460$ k

27. In the given arrangement of two blocks of masses 2kg and 4kg are attached with a spring of spring constant 100 N/m. If time period of their SHM is $2\pi \sqrt{\frac{1}{n}}$ then find:

| 2 kg | $k = 100$ N/m | 4 kg |

Sol. $\mu = \frac{m_1m_2}{m_1 + m_2} = \frac{2 \times 4}{6} = \frac{4}{3}$

$T = 2\pi \sqrt{\frac{\mu}{k}} = 2\pi \sqrt{\frac{4}{100}} = 2\pi \sqrt{\frac{1}{75}}$

Thus $n = 75$