## JEE MAIN ANSWER KEY & SOLUTIONS

**SUBJECT :- PHYSICS**
**CLASS :- 11th** **PAPER CODE :- CWT-7**
**CHAPTER :- CENTRE OF MASS**

## ANSWER KEY

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | (B) | **2.** | (C) | **3.** | (A) | **4.** | (B) | **5.** | (D) | **6.** | (D) | **7.** | (C) |
| **8.** | (A) | **9.** | (B) | **10.** | (B) | **11.** | (C) | **12.** | (B) | **13.** | (B) | **14.** | (C) |
| **15.** | (C) | **16.** | (B) | **17.** | (D) | **18.** | (C) | **19.** | (C) | **20.** | (A) | **21.** | 100 |
| **22.** | 8 | **23.** | 10 | **24.** | 2 | **25.** | 1 | **26.** | 10 | **27.** | 2 | **28.** | 44 |
| **29.** | 7 | **30.** | 288 | | | | | | | | | | |

## SOLUTIONS

**1.** (B)

**Sol.** When sand start falls from A CM falls down from each centre of hollow sphere then it again rises & finally when sand is fully filled centre of mass is again at centre of sphere. Now when B is opened CM again starts falling down.

**2.** (C)

**Sol.** Speed becoming 80% means kinetic energy becomes 64% just before collisions that means

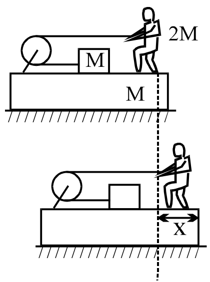
$mgh' = \frac{64}{100} mgh \Rightarrow h' = 0.64\ h$

**3.** (A)

**Sol.** Since thre is no external horizontal force on whole system C.M. of wholen system need move

$\Delta r_{CM} = \frac{m_1 \Delta r_1 + m_2 \Delta r_2}{m_1 + m_2}$

$O = \frac{M(x-2) + 3Mx}{4M}$




$Mx - 2M + 3Mx = 0$

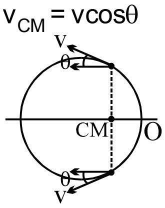
$4x = 2$

$x = 0.5\ m$

**4.** (B)

**Sol.** At any instant

$v_{CM} = v\cos\theta$




< v

**5.** (D)

**Sol.** $(K_{system})_{total} = K_{CM} + (K_{system})_{about\ CM} = \frac{1}{2}(m_1 + m_2) v_c^2 + \frac{1}{2} \mu v_{rel}^2$

$= \frac{1}{2}(4)(0.5)^2 + \frac{1}{2} \times \frac{3}{4}(2)^2 = 2J$

$(K_{system})_{total} = 2 = \frac{1}{2} \times 4 \times v_c^2 + \frac{1}{2}\left(\frac{3}{4}\right) \times (3)^2$

$v_c^2 = \frac{-11}{16}$

**6.** (D)

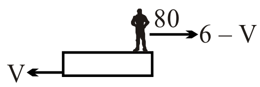
**Sol.** No symmetry about live y = –x

**7.** (C)

**Sol.** Using $\frac{1}{2} m_1 v_1^2 = \frac{1}{2} m_2 v_2^2$, Prove $\frac{m_1 v_1}{m_2 v_2} = \frac{1}{2}$

**8.** (A)

**Sol.**




$80(6 - V) - 40\ V = 0$

$V = 4 \Rightarrow 6 - V = 2$

**9.** (B)

**Sol.** $\frac{p^2}{2m_1} = 216$

$\frac{p^2}{2} = 216 \times 3$

$\frac{p^2}{2m_2} = \frac{216 \times 3}{6} = 108\ J$

**10.** (B)

**Sol.** Since the breakup occurs at the highest point, the vertical velocity just before the breakup is zero. The vertical momentum is therefore also zero. After the breakup piece A is at rest, and hence has zero vertical momentum, so by conservation of momentum piece B must also have zero vertical momentum, and therefore zero vertical velocity. Since pieces A and B are falling from the same height with the same initial vertical velocity, they will hit the ground at the same time. The pieces differ only in their masses and in their horizontal velocities, but neither of these quantities affect the time of fall.

**11.** (C)

**Sol.**


$m_1u_1 + m_2(-u_2) = 0$

$(m_1 + m_2)v = m_1u_1 + m_2(-u_2) = 0$

**12.** (B)

**Sol.** COM gives $mv \sin 30° = (2m)\, v_T \Rightarrow v_\perp = \frac{v}{4}$

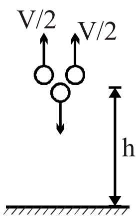
**13.** (B)

**Sol.** $2 \times 4 - 3 \times 4$

$= 2 \times v$

**14.** (C)

**Sol.** $h = V(10) + \frac{1}{2} g(10)^2$




$h = -\frac{V}{2}(20) + \frac{1}{2} g(20)2$

adding we get h = 1250 m

**15.** (C)

**Sol.** Area under curve $= \frac{10 \times 20}{2} + 5 \times 20 = 200$

= impulse

= change in momentum

= mv – 0

m = 8 kg, v = 25 m/s

**16.** (B)

**Sol.** $\frac{1}{2} mV_2^2 = mgh \Rightarrow V_2 = \sqrt{2gh} = \sqrt{2 \times 10 \times 3.2} = 8$ m/s

$m \times 10 + m \times 0 = m \times V_1 + mV_2$

$V_1 = 2$ m/s

$e = \frac{V_2 - V_1}{10 - 0} = 0.6$

**17.** (D)

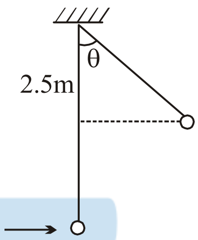
**Sol.** Momentum conservation

**18.** (C)

**Sol.** $0.1 \times 150 = 3v$

v = 5m/s

$-mg(\ell - \ell \cos\theta) = 0 - \frac{1}{2} mv^2$




$\Rightarrow 1 - \cos\theta = \frac{v^2}{2g\ell} = \frac{25}{2 \times 2.5 \times 10} = \frac{5}{10} = 0.5$

$\cos\theta = \frac{1}{2}$, $\theta = 60°$

**19.** (C)

**Sol.** $Mg = nm(v + eV)$

$M = \frac{nmv}{g}(1 + e)$

**20.** (A)

**Sol.** $\tan 30° = \frac{eV \sin 60°}{\tan 60°}$

$e = \frac{\tan 30°}{\tan 60°} = \tan^2 30°$.

**21.** 100

**Sol.** Velocity of particle after 5 s

$v = u - gt$

$v = 100 - 10 \times 5$

$= 100 - 50 = 50$ m/s (upwards)

Conservation of linear momentum gives

$Mv = m_1v_1 + m_2v_2$ ......(i)

Taking upward direction positive, the velocity $v_1$ will be negative.

$\therefore v_1 = -25$ m/s, v = 50 m/s

Also M = 1 kg, $m_1$ = 400 g = 0.4 kg

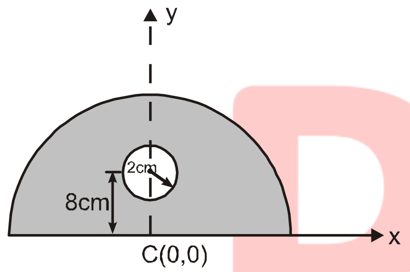
and $m_2 = (M - m_1) = 1 - 0.4 = 0.6$ kg

Thus, Eq. (i) becomes,
$1 - 50 = 0.4 \times (-25) + 0.6\, v_2$
or $50 = -10 + 0.65\, v_2$
or $0.6\, v_2 = 60$
or $v_2 = \frac{60}{0.6} = 100$ m/s
As $v_2$ is positive, therefore the other part will move upwards with a velocity 100 m/s.

**22.** 8
**Sol.** Taking C as origin and x & y–axes as shown in figure.
Due to symmetry about y–axis
$x_{cm} = 0$

$$y_{cm} = \left(\frac{m_1y_1 - m_2y_2}{m_1 - m_2}\right)$$

$$= \frac{\left(\frac{\pi(6\pi)^2}{2}\right)\left(\frac{4(6\pi)}{3\pi}\right) - [\pi(2)^2(8)]}{\frac{\pi(6\pi)^2}{2} - \pi(2)^2} \quad (m \propto \text{Area})$$




$$= \frac{8(18\pi^2 - 4)}{(18\pi^2 - 4)} = 8 \text{ cm.}$$

**23.** 10
**Sol.** Centre of mass are $r_{cm} = \frac{h}{4} = \frac{40}{4} = 10$ cm

**24.** 2
**Sol.** by energy conservation $\frac{1}{2}mv^2 = \frac{1}{2}(2m)\left(\frac{v}{2}\right)^2 + \frac{1}{2}kx^2$
$\Rightarrow \quad x = \sqrt{2mK}$

**25.** 1
**Sol.** $v_1 = \sqrt{2gh} = \sqrt{2 \times 10 \times 10} = 10\sqrt{2}$
$k_2 = \frac{1}{4}k_1 \Rightarrow v_2^{\,2} = \frac{1}{4}v_1^{\,2}$
$\therefore v_2 = \frac{v_1}{2} = 5\sqrt{2}$
$|\Delta P| = |-mv_2 - (mv_1)| = m|-v_2 - v_1|$
$|\Delta P| = 50 \times 10^{-3} \times \frac{3}{2} \times 10\sqrt{2} = \frac{15 \times 10^{-2}}{\sqrt{2}}$
$J = \Delta P = 1.05$N-s.

**26.** 10
**Sol.** $\Delta U = \frac{1}{2}\frac{m_1m_2}{(m_1 + m_2)}(V_1 - V_2)^2 = \frac{100}{3}$

$(V_1 - V_2)^2 \times \frac{2m.m}{2(m + 2m)} = \frac{100}{3}$

putting m = 1 kg
$(V_1 - V_2) = 10$ m/sec.

**27.** 2
**Sol.** $a_{cm} = \frac{30}{(10 + 20)} = 1$ ms$^2$

$S = 0\,(2) + \frac{1}{2}(1)(2)^2$
$= 2$ m

**28.** 44
**Sol.** we have $\frac{p_2 - p_1}{p_1} = 0.2$

$\Rightarrow \frac{p_2}{p_1} = 1.2$

so $\left(\frac{k_2 - k_1}{k_1}\right) \times 100 = \left(\frac{k_2}{k_1} - 1\right) \times 100$

$= \left(\frac{p_2^2}{p_1^2} - 1\right) \times 100$ (since $k = \frac{p^2}{2m}$)

$= ((1.2)^2 - 1) \times 100 = 44$ %

**29.** 7
**Sol.** Let Initial thrust of the blast be F then
$F - mg = ma$
$F = m(g + a) = 3.5 \times 10^4 \times (10 + 10)$
$= 7 \times 10^5$ N

**30.** 288
**Sol.** By conservation of linear momentum
$P_i = P_f \Rightarrow \quad 0 = 12 \times 4 + 4 \times v$
$\Rightarrow \quad v = 12$ m/s

So, kinetic energy of other mass is $\frac{1}{2}mv^2 = \frac{1}{2} \times 4(12)^2 = 288$ J,