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A right Choice for the Real Aspirant

ICON CENTRAL OFFICE, MADHAPUR-HYD

Sec: Sr.IPLCO	JEE–ADVANCE	Date: 27-09-15
Time: 3 Hours	2014-P2-Model	Max Marks: 180

PAPER-II
KEY & SOLUTIONS

PHYSICS

1	**B**	2	**B**	3	**C**	4	**C**	5	**B**	6	**A**
7	**C**	8	**C**	9	**B**	10	**D**	11	**B**	12	**A**
13	**C**	14	**C**	15	**A**	16	**B**	17	**A**	18	**A**
19	**C**	20	**A**								

CHEMISTRY

21	**D**	22	**D**	23	**D**	24	**C**	25	**D**	26	**C**
27	**C**	28	**B**	29	**C**	30	**D**	31	**C**	32	**A**
33	**A**	34	**B**	35	**A**	36	**B**	37	**A**	38	**C**
39	**D**	40	**B**								

MATHS

41	**D**	42	**B**	43	**C**	44	**B**	45	**B**	46	**C**
47	**C**	48	**D**	49	**C**	50	**D**	51	**B**	52	**C**
53	**B**	54	**D**	55	**B**	56	**B**	57	**D**	58	**B**
59	**D**	60	**C**								

PHYSICS

1. The energy stored in the spring when it is compressed to $\frac{L_0}{2}$ is converted into kinetic energy of the block

$$\frac{1}{2}mv^2 = \frac{1}{2}k\left(\frac{L_0}{2}\right)^2$$

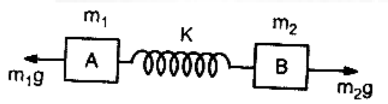
2. $$\vec{a} = \frac{\vec{F}}{m}\frac{F_0^2}{m}\left[\cos(t)\hat{i} + \sin(t)\hat{j}\right]$$

$$\vec{v} = \int_0^1 \vec{a}\ dt = \frac{F_0^2}{M}\left[\sin(t)\hat{i} + (1-\cos t)\hat{j}\right]$$

$$K.E = \frac{1}{2}m(\vec{v}.\vec{v}) = \frac{1}{2}m\left[\frac{F_0^2}{m}(2-2\cos t)\right]$$

$$= \frac{F_0^2}{m}(1-\cos t)$$

3. The system is equivalent to the following solution



4. $$U = \int_0^T \left(-2x - x^3\right)dx = x^2 + \frac{x^4}{4}$$

Since there is no loss of energy, so

$$\frac{x^4}{4} + x^2 = E_i = \frac{1}{2}mv^2 = 3$$

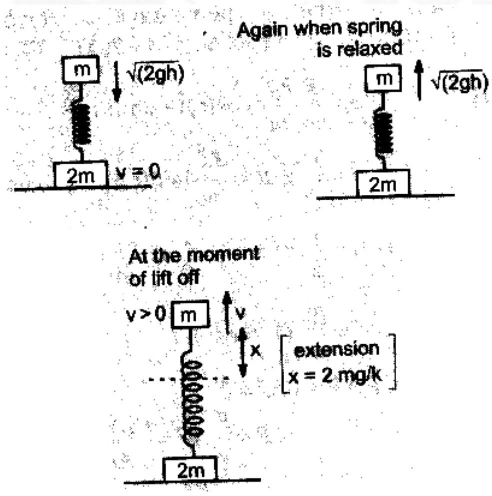
$$x^4 + 4x^2 - 12 = 0$$

$$\Rightarrow x^2 = \frac{-4x\sqrt{16+48}}{2}$$

$$= \frac{-4\pm 8}{2} = -6, +2$$

$$\Rightarrow x = \sqrt{2}$$

5. Just after collision with grund



Applying COE

$$\frac{1}{2}mv^2 + mgx + \frac{1}{2}kx^2 = \frac{1}{2}m(2gh) + 0 + 0$$

$$\Rightarrow \frac{1}{2}mv^2 > 0$$

$$\Rightarrow h > 4mg/k$$

6. Let $x_1 = a\sin\omega t$ and $x_2 = a\sin(\omega t + \delta)$ be two S.H.M

$$\frac{a}{3} = a\sin\omega t \;\; and \;\; \frac{-a}{3} = a\sin(\omega t + \delta)$$

$$\sin\omega t = \frac{1}{3} \;\; and \sin(\omega t + \delta) = \frac{-1}{3}$$

Eliminating $t, \frac{1}{3}\cos\delta + \sqrt{1 - \frac{1}{9}}\sin\delta = \frac{-1}{3}$

$$9\cos^2\delta + 2\cos\delta - 7 = 0$$

$$\cos\delta = -1 \;\; or \;\; 7/8 \;\; i.e \;\; \delta = 180^o \;\; or \;\; \cos^{-1}(7/9)$$

Now $v_1 = a\omega \cos\omega t$ and $v_2 = a\omega\cos(\omega t + \delta)$

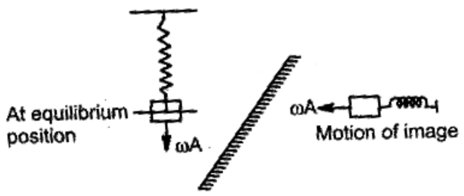
If we put $\delta = 180^o$

We find that v_1 and v_2 are of opposite signs.

Hence $\delta = 180^o$ is not applicable

$$\delta = \cos^{-1}(7/9)$$

7. Thus $v_{max} = v\sqrt{2} = \sqrt{2}\omega A$



8. The sphere, as it falls from a large height, has a large velocity when it enters the viscous liquid. So it experiences a large viscous force upwards. The velocity from then keeps on decreasing. Thus the viscous force and the magnitude of (negative) acceleration go on decreasing non-linearly. At a particular point of time, acceleration becomes zero and velocity remains constant. So, the best curve is C.

9. Thickness of annular space

$$= \frac{20.0628 - 20}{2}$$

= 0.0314 cm = 0.000314 m

In steady state

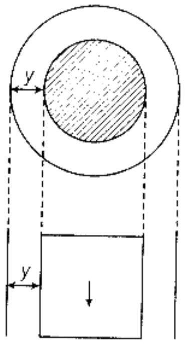
Gravitational force = viscous force

Or $mg = \eta A \frac{\Delta v}{\Delta y}$ …..(1)

But $A = 2\pi r\ell$

$$= 2 \times 3.14 \times (10 \times 10^{-2})(20 \times 10^{-2}) = 0.1256\, m^2$$

From eq (1)



$\therefore 1\times 10 = \left(10\times 10^{-1}\right)\left(0.1256\right)\left(\dfrac{v-0}{0.000314}\right)$

$\Rightarrow v = 0.025\,ms^{-1} = 2.5\,cms^{-1}$

10. Buoyant force + viscous force = mg

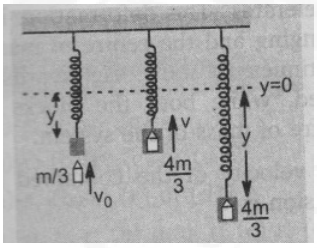
$yg + 6\pi\eta r V_T = xg$

$\Rightarrow V_T = \dfrac{(x-y)g}{r(6\pi\eta)}$

$\therefore V_T \propto \dfrac{x-y}{r}$

11 & 12:Initially in equilibrium let the elongation in spring be y_0, then mg = ky_0

$\Rightarrow y_0 = \dfrac{mg}{k}$



As the bullet strikes the block with velocity v_0 and gets embedded into it, the velocity of the combined mass can be computed by using the principle of momentum conservation.

$\dfrac{m}{3}v_0 = \dfrac{4m}{3}v$

$\Rightarrow v = \dfrac{v_0}{4}$

Let new mean position is at distance y from origin, then

$ky = \dfrac{4m}{3}g$

$\Rightarrow y = \dfrac{4mg}{3k}$

Now, the block executes S.H.M about mean position defined by $y = \dfrac{4mg}{3k}$ with time, period $T = 2\pi\sqrt{\dfrac{4m}{3k}}$. At t =0, the combined mass is at a displacement of y – y_0

from mean position and is moving with velocity v, then by using $v=\omega\sqrt{A^2-x^2}$, we can find the amplitude of motion.

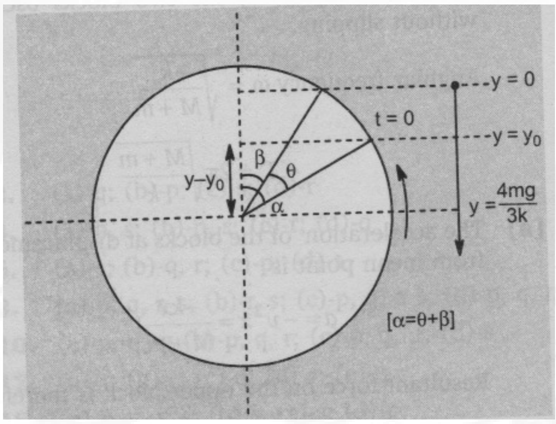
$$\left(\frac{v_0}{4}\right)^2=\frac{3k}{4m}\left[A^2-(y-y_0)^2\right]$$

$$=\frac{3k}{4m}\left[A^2-\left(\frac{mg}{3k}\right)^2\right]$$

$$\Rightarrow\frac{mv_0^2}{12k}=A^2-\left(\frac{mg}{3k}\right)^2$$

$$\Rightarrow A=\sqrt{\frac{mv_0^2}{12k}+\left(\frac{mg}{3k}\right)^2}$$

To compute the time taken by the combined mass from $y=\frac{mg}{k}$ to y = 0, we can either go for equation method or circular motion projection method.



Required time, $t=\frac{\theta}{\omega}=\frac{\alpha-\beta}{\omega}$

$$t=\frac{\theta}{\omega}=\frac{\alpha-\beta}{\omega}$$

$$\cos\alpha=\frac{y-y_0}{A}=\frac{mg}{3kA}$$

$$\cos\beta=\frac{y}{A}=\frac{4mg}{3kA}$$

$$\text{so}, t=\frac{\cos^{-1}\left(\frac{mg}{3kA}\right)-\cos^{-1}\left(\frac{4mg}{3kA}\right)}{\omega}$$

$$=\sqrt{\frac{4m}{3k}}\left[\cos^{-1}\left(\frac{mg}{3kA}\right)-\cos^{-1}\left(\frac{4mg}{3kA}\right)\right]$$

13.

14. To compute the time taken by the block to cross mean position for the first time we can make use of circular motion representation:

$$t=\frac{\pi-\delta}{\omega}=\frac{\pi-\sin^{-1}\left(\frac{h}{A}\right)}{\sqrt{\frac{k}{m}}}$$

17. **Step I:** $v_{CM} = \frac{(3mv) - 3mv}{5m} = \frac{v}{5}$

Step II: In COM frame

Initial velocity of $A = \left(-v - \frac{v}{5}\right)$

$= -\frac{6v}{5}$ to left

Initial velocity of $B = v - \frac{v}{5} = \frac{4}{5}v$

$= \frac{4}{5}v$ to right

Blocks are executing S.H.M in CM frame with initial position as equilibrium position

Step – III: Velocity variation of B in ground frame, considering right as +ve

From $\left(\frac{4v}{5} + \frac{v}{5}\right) = v \ to \ \frac{4v}{5} + \frac{v}{5} = -\frac{3v}{5}$

So $\left|v_{B_{\max}}\right| = v \& \left|v_{B_{\min}}\right| = 0$

Velocity variation A in ground frame

From $\left(\frac{6v}{5} + \frac{v}{5}\right) = \frac{7v}{5} \ to \ \frac{-6v}{5} + \frac{v}{5} = -v$

Thus minimum velocity of A is $\frac{-v}{5}$ when spring is at maximum extension.

20. (a) i) Stoke's law, $F = 6\pi\eta r v$

(ii) Terminal velocity $V_T = \frac{2}{9} \cdot \frac{r^2 g(\rho_s - \rho_L)}{\eta}$

(iii) Excess pressure inside a mercury drop is $\Delta p = \frac{2T}{r}$

(iv) Viscous force is $F_V = -\eta A \frac{dv}{dy}$

Hence $(i) \to pr, (ii) \to pqr, (iii) \to ps, (iv) \to rt$