JEE EXPERT

ANSWER KEY

RANK ELEVATOR TEST SERIES

(REFT/FT-01)

12^{TH} (Zenith X01 & X02)

Date 15.09.2019

PHYSICS

1	(C)	2	(D)	3	(A)	4	(B)	5	(D)
6	(D)	7	(A)	8	(C)	9	(A)	10	(C)
11	(A)	12	(B)	13	(B)	14	(C)	15	(A)
16	(B)	17	(B)	18	(B)	19	(B)	20	(D)
21	(0006)	22	(0008)	23	(0004)	24	(0005)	25	(0001)

CHEMISTRY

26	(B)	27	(A)	28	(B)	29	(C)	30	(A)
31	(C)	32	(C)	33	(A)	34	(A)	35	(B)
36	(B)	37	(B)	38	(C)	39	(B)	40	(D)
41	(B)	42	(A)	43	(D)	44	(C)	45	(A)
46	(8500)	47	(0045)	48	(0040)	49	(0006)	50	(0002)

MATHEMATICS

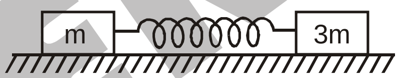
51	(C)	52	(C)	53	(C)	54	(B)	55	(B)
56	(B)	57	(C)	58	(D)	59	(B)	60	(C)
61	(D)	62	(A)	63	(A)	64	(B)	65	(C)
66	(C)	67	(C)	68	(A)	69	(D)	70	(D)
71	(1240)	72	(0002)	73	(0101)	74	(0059)	75	(0008)

JEE EXPERT

SOLUTIONS
RANK ELEVATOR TEST SERIES
(REFT/FT-01)
12^{TH} (Zenith X01 & X02)
Date 15.09.2019

PART - I [PHYSICS]

1. **Sol. (C)** Initially system is at rest net momentum = 0 when it is released, m & 3m gains speed. spring force is internal force



we have $\vec{F}_{ext} = \frac{d}{dt}(\vec{P}_f - \vec{P}_i)_{system}$

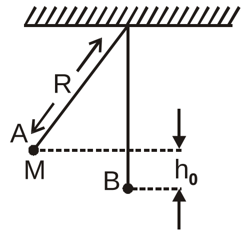
$\because \quad \vec{F}_{ext} = 0 \quad \Rightarrow \quad \vec{P}_{f_{system}} = \vec{P}_{i_{system}} = 0$

So momentum of m & 3 m are opposite but equal in magnitude.

2. **Sol. (D)** Particle will reach upto D due to conservation of energy.
(there is no dissipative forces, only conservative forces are there.)

3. **Sol. (A)**

Speed of A just before colliding to B = $\sqrt{2gh_0}$ and it is horizontal.

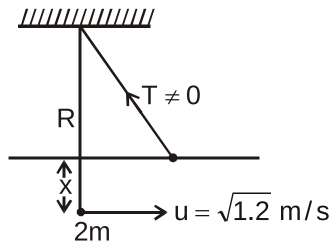


When A & B stick together, their combined horizontal

speed = $\frac{\sqrt{2gh_0}}{2} = \sqrt{\frac{gh_0}{2}} = \sqrt{\frac{10}{2} \times \frac{24}{100}} = \sqrt{1.2}$ m/s

Horizontal speed $\sqrt{1.2} < \sqrt{2gR} = \sqrt{10}$

So in this case mass will oscillate
maximum height reached = x



Applying conservation of energy, $\frac{1}{2}(2m)u^2 = (2m)gx$

$\Rightarrow$ x = $\frac{u^2}{2g} = \frac{1.2}{2 \times 10} = \frac{6}{100}$ meter = 6 cm

4. **Sol. (B)**
F is sinusoidal function of time, so it is periodical
μ mg > F. So, a = 0

5. **Sol. (D)**
Force of engine = F = (20 M)K 1M = 1000 kg
K = constant,

Retardation of last box = $\frac{(4M)K}{4M} = K$

Acceleration of train for 3200 meter = $\frac{20MK}{16M} = \frac{20K}{16}$

Speed of rest train for this distance = 3200 meter

$$v_1^2 = v^2 + \left(\frac{5}{4}K\right)3200$$

Retardation there after = $\frac{(16M)K}{16M} = K$

$v^2 = u^2 + 2as$

$$0 = v^2 + \left(\frac{5K}{4}\right)3200 - 2K(s); S = \frac{v^2}{2K} + \frac{5}{8}(3200)$$

Distance travelled by last box till it stops

$$S_1 = \frac{v^2}{2K}$$

Total distance = $3200 - \frac{v^2}{2K} + 5$

6. Sol. (D)

N – mg cos 60º = m(3)

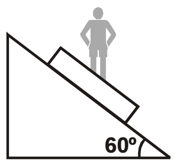
N = 8M

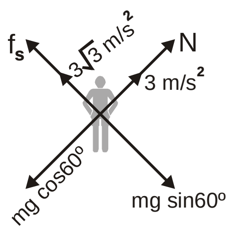
N = 400 Newton

in kg 40 kg

40 = 10x

x = 4





7. Sol. (A)

$mg = Kx_0$ ...... (i)

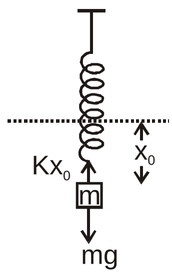
All force are conservative force & mass m is pulled down slowly.

Here applying principle of conservation of work, we have

$W_{man} + W_{mg} + W_{spring\ force}$ = change in K.E. = 0

$\Rightarrow \quad W_{man} = W_{mg} - W_{spring\ force}$

$$= -mg\,y + \left\{\frac{1}{2}K(x_0 + y)^2 - \frac{1}{2}Kx_0^2\right\} \quad ..... (ii)$$

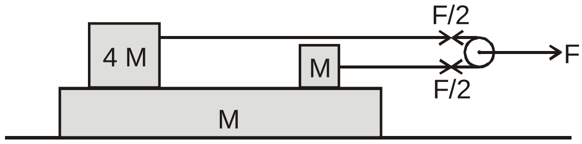


from (i) & (ii)

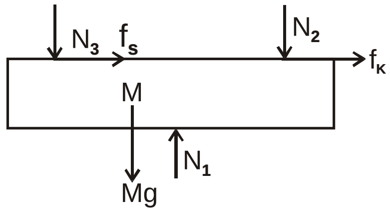
$$W_{max} = \frac{1}{2}\frac{mg}{x_0}y$$

8. **Sol. (C)**

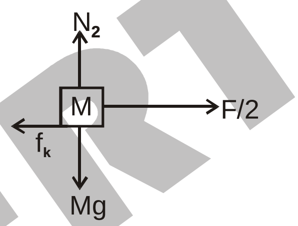
F.B.D. of platform



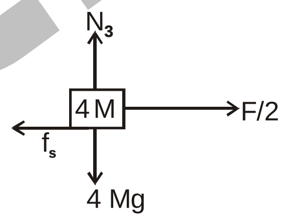
F.B.D. of platform



F.B.D. of mass M



Equation of motion for platform $f_k + f_s = M \times 0.2\,g$ F.B.D. of mass M



or $\mu_k Mg + f_s = 0.2\ Mg$

or $0.1\ Mg + f_s = 0.2\ Mg \quad \Rightarrow \quad f_s = 0.1\ Mg \quad ......\ (1)$

Equation of motion for 4 M, $\frac{F}{2} - f_s = 4M \times 0.2Mg$

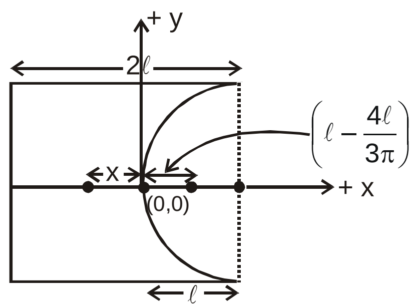
Here 4 M has same acceleration as platform.

$\frac{F}{2} = 0.8Mg + f_s = 0.9\ Mg$ (From (i) $\Rightarrow$ F = 1.8 Mg

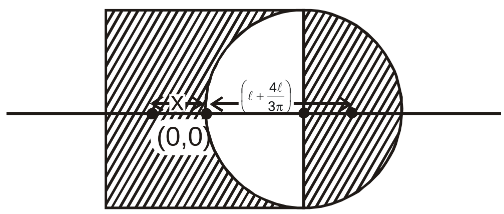
9. **Sol. (A)**

Let CM of only square without semicircular portion is at distance x right side from origin then

$$\left(M - \frac{M}{4\ell^2} \times \frac{\pi\ell^2}{2}\right) x = \frac{M}{4\ell^2} \times \frac{\pi\ell^2}{2}\left(\ell - \frac{4\ell}{3\pi}\right)$$



$$x = \frac{\frac{\pi}{8}\left(1 - \frac{4}{3\pi}\right)\ell}{\left(1 - \frac{\pi}{8}\right)} = \frac{(3\pi - 4)\ell}{3(\pi - 8)}$$



Now, $X_{CM} = M\dfrac{M\left(1-\frac{\pi}{8}\right)(-)\frac{(3\pi-4)\ell}{3(\pi-8)}+\frac{\pi M}{8}\cdot\left(\ell+\frac{4\ell}{3\pi}\right)}{M} = \dfrac{\ell}{3} = 4$ cm

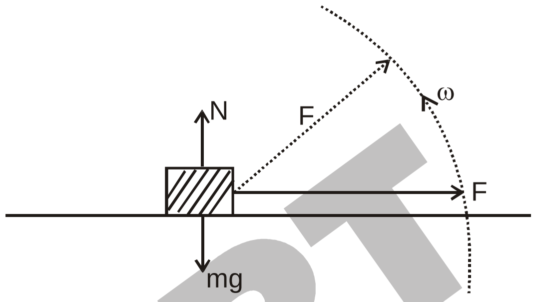
10. Sol. (C)

We can write $\vec{F} = 40\{(\cos\omega t)\hat{i} + (\sin\omega t)\hat{j}\}$

where $\omega = 2$ rad/sec.

$\Rightarrow$ $F_x = 40 \cos 2t$ & $F_y = 40 \sin 2t$

Here F_y, N & mg balances each other



So $F_x = m\dfrac{dV}{dt} = 40 \cos 2t$

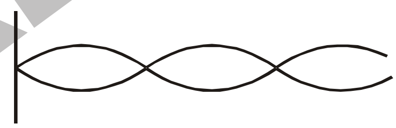
integrating $mV = 40\left.\dfrac{\sin 2t}{2}\right|_0^{t=\frac{\pi}{4\omega}}$

$5 \times V = 40 \times \dfrac{1}{2\sqrt{2}}$ $\Rightarrow$ $V = 2\sqrt{2}$

$\therefore$ $\dfrac{V^2}{8} = 1$ Ans.

11. Sol. (A)

$y_1 = a \sin kx \cos \omega t$



$k = \dfrac{2\pi}{\lambda}; \lambda = \left(\dfrac{2\pi}{k}\right)$

$\dfrac{\lambda}{2} \Rightarrow \left(\dfrac{\pi}{k}\right)$

Particles at x_1 and x_2 are in opposite phase as $x_2 > \dfrac{\lambda}{2}$ and $x_1 < \dfrac{\lambda}{2}$ and x = 0 is a node.

So $\phi_1 = \pi$.

Travelling wave $y_2 = a\sin(\omega t - kx)$

$$\Delta x = \frac{3\pi}{2k} - \frac{\pi}{3k} = \frac{7\pi}{6k}$$

$$\lambda = \frac{2\pi}{k}$$

$$\Delta\phi = 2\pi \times \frac{\Delta x}{\lambda} = 2\pi \times \frac{\frac{7\pi}{6k}}{2\pi/k}$$

$$\phi_2 \Rightarrow \frac{7\pi}{6}$$

$$\frac{\phi_1}{\phi_2} = \frac{\pi}{\frac{7\pi}{6}} = \frac{6}{7}$$

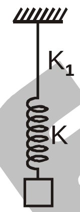
12. **Sol. (B)**

By COM

$$\frac{p^2}{2(m+m)} + \frac{1}{2}k\left(\frac{A\sqrt{3}}{2}\right)^2 = \frac{1}{2}kx^2$$ where x is new amplitude

$$\frac{\left[m\omega\sqrt{A^2-\left(\frac{A\sqrt{3}}{2}\right)^2}\right]}{2\times 2m} + \frac{1}{2}k\frac{A^2 3}{4} = \frac{1}{2}kx^2$$ Solving we get $x = A\sqrt{\frac{7}{8}}$]

13. **Sol. (B)**



Spring const. of wire = $K_1 = \frac{AY}{\ell}$

As $F = \left(\frac{AY}{\ell}\right)\Delta\ell$

Net spring const. = $\frac{K_1 K}{K+K_1}$

14. **Sol. (C)**

When frequency (apparent) of A decreases, number of beats increases.

First case $$\left|n_A\left(\frac{V-V_0}{V-V_s}\right)-n_B\right| = 6$$

$$\left|500\left(\frac{340}{340-4}\right)-n_B\right| = 6$$

$$\left|500\left(\frac{340}{340+4}\right)-n_B\right| = 18$$

$$500\left(\frac{340}{340-4}\right)-500\left(\frac{340}{340+4}\right) = 505.95 - 494.186 \approx 12$$

So frequency of B is 512.

15. **Sol. (A)**

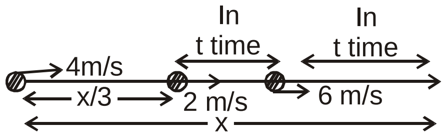
Adhesive force of water-wax is less then that of water glass.

16. **Sol. (B)**

17. **Sol. (B)**

18. **Sol. (B)**

19. **Sol. (B)**

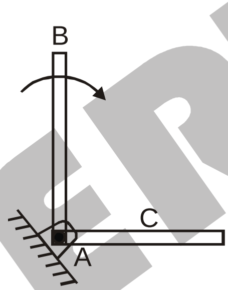


Here $2t + 6t = \frac{2x}{3} \Rightarrow t = \frac{x}{12}$

$$\text{average velocity} = \frac{x}{\frac{x}{3\times 4} + t + t} = \frac{x}{\frac{x}{12} + \frac{2x}{12}} = 4\,\text{m/s}$$

20. **Sol. (D)**

21. **Sol. (0006)** $\frac{1}{2}I\omega^2 = mg\frac{L}{2}$



(Energy conservation)

$$\omega^2 = \frac{mgL}{I} = \frac{mgL}{\frac{mL^2}{3}} = \frac{3g}{L}$$

$$\alpha = \frac{\tau}{I} = \frac{mg\frac{L}{2}}{\frac{ML^2}{3}} = \frac{3g}{2L}$$

$C \to$ COM,

Horizontal anc. of COM is $\omega^2\frac{L}{2}$ = centripetal acn.

$m\omega^2\frac{L}{2}$ = Horizontal comp. of reaction = $\frac{m3g}{L}\frac{L}{2} = \frac{3mg}{2}$

Vertical acn. of COM = $\alpha\frac{L}{2} = \frac{3g}{4}$

Net vertical force = mg – (Vertical comp. of reaction) = $m\left(\frac{3g}{4}\right)$

Vertical comp. = $\frac{mg}{4}$, tan α = vertical comp./Hori. comp. = $\frac{mg}{4}\Big/\frac{3mg}{2} = \frac{2}{12} = \frac{1}{6}$

22. **Sol. (0008)** $\vec{L} = \vec{L}_{COM} + M_{total}\left(\vec{r}_{COM} \times \vec{V}_{COM}\right) = +\left(\frac{1}{2}mR^2\right)\omega - M(6\omega R^2) = -\frac{11}{2}mR^2\omega$

or $\vec{L} = \left(-\frac{11}{2}mR^2\omega\right)\hat{k}$ (Note the direction of ω)

23. Sol. (0004)

$$\sqrt{2}\,\lambda_0 T_1 = \lambda_0 T_2$$

$$\frac{T_2}{T_1} = \sqrt{2}$$

$$\frac{A_2}{A_1} = \left(\frac{T_2}{T_1}\right)^4 = 4$$

24. Sol. (0005) $F = 2\rho s v^2 = 2 \times 1000 \times 10^{-4} \times 5 \times 5 = 5\text{ N}$

25. Sol. (0001)

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

$$\frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta \ell}{\ell} - \frac{1}{2}\frac{\Delta g}{g}$$

$$\Delta T = 0$$

$$\Rightarrow \quad \frac{\Delta \ell}{\ell} = \frac{\Delta g}{g}$$

$$\frac{\Delta g}{g} = \frac{2h}{R} \quad \text{if } h << R$$

$$\alpha(10) = \frac{2h}{R}$$

$$\frac{5\alpha R}{h} = 1$$