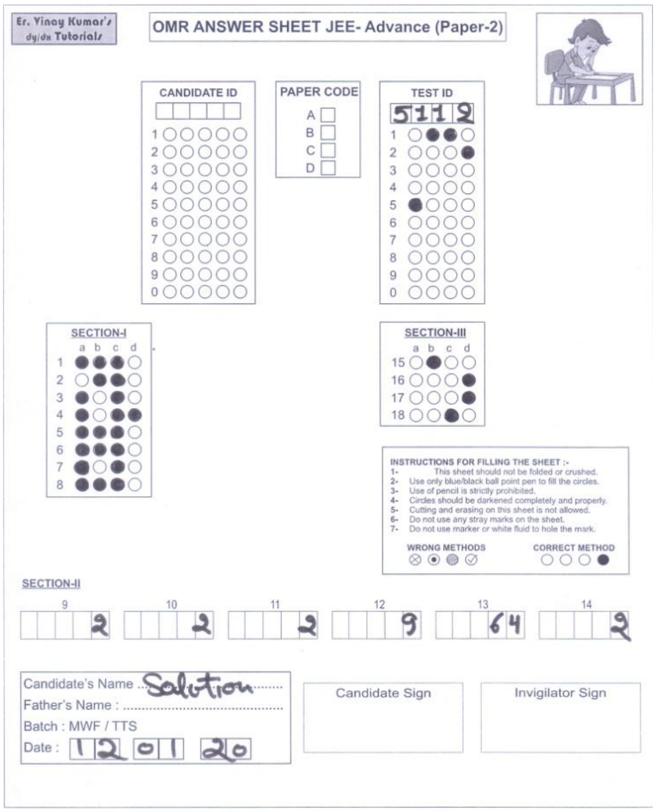

Er. Vinay Kumar's dy/dx Tutorials

OMR ANSWER SHEET JEE- Advance (Paper-2)

CANDIDATE ID | PAPER CODE | TEST ID: 5112

SECTION-I | SECTION-III | SECTION-II

9: 2 | 10: 2 | 11: 2 | 12: 3 | 13: 64 | 14: 2

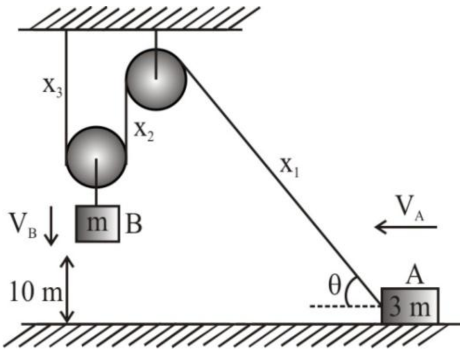
INSTRUCTIONS FOR FILLING THE SHEET :-
1- This sheet should not be folded or crushed.
2- Use only blue/black ball point pen to fill the circles.
3- Use of pencil is strictly prohibited.
4- Circles should be darkened completely and properly.
5- Cutting and erasing on this sheet is not allowed.
6- Do not use any stray marks on the sheet.
7- Do not use marker or white fluid to hole the mark.

WRONG METHODS | CORRECT METHOD

Candidate's Name: Solution
Father's Name :
Batch : MWF / TTS
Date : 12 01 20

Candidate Sign | Invigilator Sign

Q1.



$x_1+x_2+x_3=l$

$-V_A\cos\theta^0+V_B+V_B=0 \Rightarrow\ 2V_B=V_A\cos\theta$

when the body strikes the floor : $\theta=60^o$

$2V_B=V_A\cos 60^o\ \Rightarrow\ V_A=4V_B$

$\Rightarrow$ If $V_B = V$ then $V_A = 4V$

$W=\Delta KE$

$\Rightarrow\ mg\times 10=\left(\frac{1}{2}mV_B^2+\frac{1}{2}(3m)\ V_A^2\right)-0$

$\Rightarrow\ m\times 0.8\times 10=\frac{1}{2}mv^2+\frac{1}{2}(3m)\ (4v)^2$

$\Rightarrow\ 100\ m=\frac{1}{2}mv^2+\frac{48}{2}mv^2$

$\Rightarrow\ 98m=\frac{49}{2}v^2\ \Rightarrow\ v^2=4\ \Rightarrow\ v=2m/s$

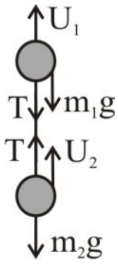
(a) $V_B = V = 2$ m/s

(b) $V_A=4V=4\times 2=8m/s$

(c) $W_{mg}=mg\times 10=m\times 9.8\times 10=98m$

(d) work done by T force on the whole system is zero, not on the individual body.

Q2. $U_1 = T + m_1g$



$250\times 10^{-6}\times\rho_l\times 10$

$=T+250\times 10^{-6}\times 0.8\times 10^3\times 10$ ……. (1)

$U_2+T=m_2g\ \Rightarrow\ U_2=m_2g-T$

$\Rightarrow\ 250\times 10^{-6}\times\rho_l\times 10$

$=250\times 10^{-6}\times 1.2\times 10^3\times 10-T$ …… (2)

Equating (1) & (2) :

$T+250\times 10^{-6}\times 0.8\times 10^3\times 10$

$=250\times 10^{-6}\times 1.2\times 10^3\times 10-T$

$\Rightarrow\ 2T=250\times 10^{-6}(1.2-0.8)\times 10^3\times 10$

$\Rightarrow\ T=0.5\ N$ ….(3)

From eq, (1) and (3):

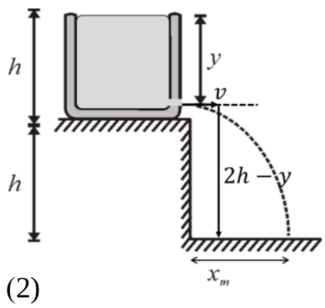
$250\times 10^{-6}\times\rho_l\times 10=T+250\times 10^{-6}\times 0.8\times 10^3\times 10$

$\Rightarrow 250\times 10^{-5}\times\rho_l=0.5+2$

$\Rightarrow 2.5\times 10^{-3}\times\rho_l=2.5\Rightarrow\rho_l=10^3$

Q3. Efflux velocity $v=\sqrt{2gy}$ ……. (1)

For range to be found : $\left[h=\frac{1}{2}g\ \frac{x^2}{u^2}\right]$



$\Rightarrow\ (2h-y)=\frac{1}{2}\,g\,\frac{x^2}{v^2}$

$\Rightarrow\ 2h-y=\frac{1}{2}g\frac{x^2}{(2gy)}$

$\Rightarrow\ x^2=4y\,(2h-y)$

$\Rightarrow\ x^2=8yh-4y^2$ ……. (2)

For x to be maximum $\Rightarrow\ \frac{dx}{dy}=0$

Differentiating eq. (2) $\Rightarrow$ $2x\dfrac{dx}{dy} = 8h - 8y$

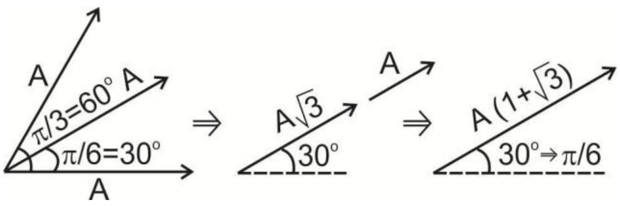
$\Rightarrow\ 0 = 8h - 8y \ \Rightarrow\ 8h = 8y \ \Rightarrow\ y = h$

From eq. (2) $\Rightarrow$ $x^2 = 8yh - 4y^2$

$\Rightarrow\ x_{\max}^2 = 8\,h.h. - 4h^2 = 4h^2$

$\Rightarrow\ x_{\max} = 2\,h$

Q4.



Amplitude $= A\,(1+\sqrt{3})$

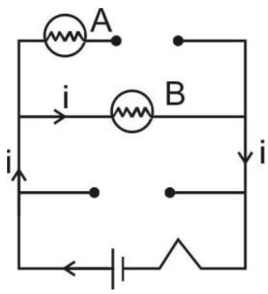
Epoch $= \pi/6$

$v_{\max} = \omega A$

$= \omega \times A\,(1+\sqrt{3}) = \omega A\,(1+\sqrt{3})$

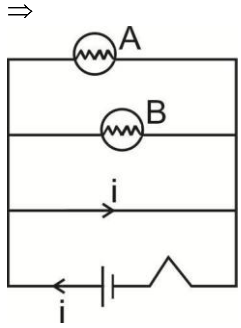
KE vibrates with double frequency $\Rightarrow\ 2\omega$

Q5. Just at the moment the switch is connected inductance coils create insulation then the effective circuit at this moment is⇨



All the current passes through B and B immediately glows.

In steady state the coils act like zero resistance $\Rightarrow$



The whole circuit is short circuited and both the bulbs die out.

Q7. (a) due to symmetry the sides BC & AD experience force of same value but of opposite direction

(b) Force on BC is upward and on AD is downward giving clock wise rotation as seen from 0 during charging

Q9. $T_1 = T_2 e^{\mu\theta} \quad \Rightarrow \quad T_1 = T_2 e^{\frac{1}{\pi}\cdot\pi}$

$\Rightarrow\quad T_1 = T_2 e$ ……… (1)

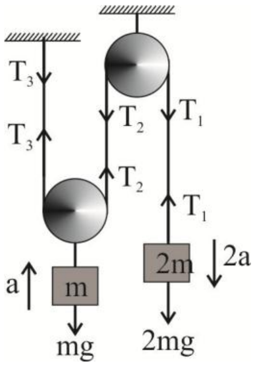
$\Rightarrow\quad T_2 = T_3 e^{\frac{1}{\pi}\cdot\pi} \quad \Rightarrow \quad T_2 = T_3 e$ ……… (2)

from (1) & (2) : $T_1 = (T_3 e)e$

$\Rightarrow\quad T_1 = T_3 e^2$ ……… (3)

for body A : $2m \cdot 2a = 2mg - T_1$

$\Rightarrow\quad 4ma = 2mg - T_1$ .. (1)



for body B :

$ma = (T_2 + T_3) - mg$

$\Rightarrow\ ma = \left(\dfrac{T_1}{e} + \dfrac{T_1}{e^2}\right) - mg$

$\Rightarrow\quad ma = T_1\left(\dfrac{e+1}{e^2}\right) - mg$.........(2)

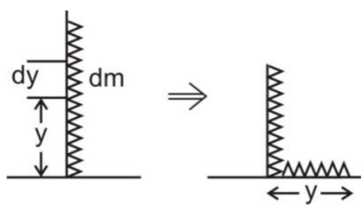
$(1) \times \left(\dfrac{e+1}{e^2}\right) + (2)$ **:**

$ma\left[\dfrac{4(e+1)}{e^2} + 1\right] = mg\left[\dfrac{2(e+1)}{e^2} - 1\right]$

$\Rightarrow\quad a\left[\dfrac{4e+4+e^2}{e^2}\right] = \left[\dfrac{2e+2-e^2}{e^2}\right]g$

$\Rightarrow\quad a = \left[\dfrac{2e+2-e^2}{4e+4+e^2}\right]g$ ⇨ *x=2*

Q10. Retarding force created on the trolly due to loading of chain



$F = v_r\,\dfrac{dm}{dt}$ …… (1)

The elemental length dy is loaded after falling by a height y.

Rate of loding $\frac{dm}{dt} = \frac{\lambda dy}{dt} \Rightarrow \quad \frac{dm}{dt} = \lambda v$ ………. (2)

$v \quad \Rightarrow$ velocity with which the element strikes the trolly after falling under gravity

$\Rightarrow \quad v^2 = 2gy \quad \Rightarrow \quad v = \sqrt{2gy}$ ……. (3)

From (2) & (3) : $\frac{dm}{dt} = \lambda\sqrt{2gy}$ ……….. (4)

The relative velocity of loading with respect to trolly $\Rightarrow \ v$ therefore $F = v\,\lambda\sqrt{2gy}$

Retardation $= \frac{F}{m_o + m} = \frac{\lambda\sqrt{2gy}\cdot v}{m_o + \lambda y} \Rightarrow$ *x=2*

Q11. Velocity of centre of mass :

$$2mv_0 = mv + m2v \quad \Rightarrow \quad v_0 = \frac{3}{2}v$$

in the frame of centre of mass : $\frac{3v}{2}$

at maximum extension the bodies stop moving i.e. all the kinetic energy is converted into potential energy of extended spring

$$\frac{1}{2}kx^2 = \frac{1}{2}m\left(\frac{v}{2}\right)^2 \Rightarrow kx^2 = \frac{mv^2}{2} \Rightarrow x = v\sqrt{\frac{m}{2k}}$$

$\Rightarrow$ *α =2*

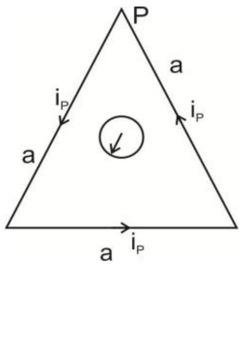
Q12. $\phi_S = B_P A_S$

$$= \frac{\mu_0}{4\pi}\frac{i_p}{a}\left[4\times 3\sin\frac{180^o}{3}\cdot\tan\frac{180^o}{3}\right]\pi r^2$$

$$= \frac{\mu_0}{4\pi}\frac{i_p}{a}\left[12\times\sin 60^o \tan 60^o\right]\pi r^2$$

$$= \frac{\mu_0}{4}\frac{r^2}{a}\left[12\times\frac{\sqrt{3}}{2}\times\sqrt{3}\right]i_p$$

$$= \frac{\mu_0}{4}\frac{r^2}{a}[18]\,i_p = \left(\frac{9}{2}\mu_0\frac{r^2}{a}\right)i_p$$



$$\left.\begin{array}{l}\phi_S = \left(\frac{9}{2}\mu_0\frac{r^2}{a}\right)i_p \\ \text{also } \phi_S = Mi_p\end{array}\right\} \Rightarrow M = \frac{9}{2}\mu_0\frac{r^2}{a} \Rightarrow n=9$$

Q13.

$A = A_0e^{-bt} \Rightarrow \frac{A}{A_0} = e^{-bt} \Rightarrow \frac{80}{100} = e^{-5b}$

$\Rightarrow 0.8 = e^{-5b}$ ….(1)

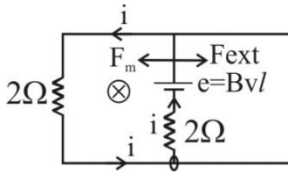
$\frac{A}{A_0} = e^{-bt} \Rightarrow \frac{\alpha}{100} = e^{-b(5+5)} \Rightarrow \alpha = 100e^{-10b}$

$\Rightarrow \alpha = 100\left(e^{-5b}\right)^2$ ….(2)

From eq (1) and (2): $\Rightarrow \alpha = 100(0.8)^2 \Rightarrow \boldsymbol{\alpha = 64}$

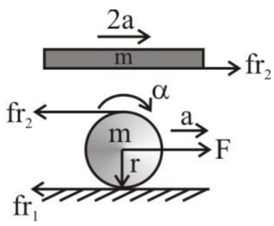
Q14. $i = \frac{Bvl}{2+2} = \frac{2\times 2\times 1}{4}$

= 1A



$$Fext = Fm = ilB = 1\times 1\times 2 = 2N$$

Q15.



For plank :

m.2a = fr_2 ………. (1)

For cylinder:

$ma = F - fr_1 - fr_2$ ……… (2)

$I\alpha = fr_1 r - fr_2 r$ ………….. (3)

$a = \alpha r$ ……….. (4)

From (3) & (4) :

$\frac{mr^2}{2}\times\frac{a}{r} = (fr_1 - fr_2)\,r \Rightarrow \frac{ma}{2} = fr_1 - fr_2$ …… (5)

$(1)\times 2 + (2) + (3)$:

$$4ma + ma + \frac{ma}{2} = 2fr_2 + F - fr_1 - fr_2 + fr_1 - fr_2$$

$$\Rightarrow \frac{11\,ma}{2} = F \Rightarrow \boldsymbol{a = \frac{2F}{11\,m}} \Rightarrow \boldsymbol{a = \frac{2F}{11\times 2}}$$

$$\Rightarrow \boldsymbol{a = \frac{F}{11}}$$

Acc. of plank $\Rightarrow \boldsymbol{2a = 2}\times\boldsymbol{\frac{F}{11}} = \frac{2F}{11}$

$(1)+(5)$: $2ma + \frac{ma}{2} = fr_1 \Rightarrow fr_1 = \frac{5ma}{2}$

$\Rightarrow\ fr_1 = \frac{5}{2}m\times\frac{2F}{11\,m} \Rightarrow\ \boldsymbol{fr_1 = \frac{5F}{11}}$

From eq. (1):

$m.2a = fr_2$

$\Rightarrow m\,\frac{4F}{11\,m} = fr_2 \Rightarrow \boldsymbol{fr_2 = \frac{4F}{11}}$

Q16. $p_i = p_f \ \Rightarrow\ mu = mv + m[-(v_r - v)]$

$\Rightarrow\ u = v - v_r + v \ \Rightarrow\ u = 2v - v_r$ ……… (1)

Since the body just reaches the highest point this the case of critical circular motion, hence velocity at top : $v_r = \sqrt{gR}$ ………… (2)

$W = \Delta KE$

$$\Rightarrow\ -mg2R = \frac{1}{2}mv^2 + \frac{1}{2}m(v_r - v)^2 - \frac{1}{2}mu^2$$

$$\Rightarrow\ -2mgR = \frac{1}{2}m[v^2 + (v_r - v)^2 - u^2]$$

$$\Rightarrow\ v^2 + v_r^2 - 2vv_r + v^2 - u^2 = -4gR$$

$$\Rightarrow\ v^2 + v_r^2 - 2vv_r + v^2 - (2v - v_r)^2 = -4gR$$

$$2v^2 + v_r^2 - 2vv_r - (4v^2 - 4vv_r + v_r^2) = -4gR$$

$$\Rightarrow\ 2v^2 + v_r^2 - 2vv_r - 4v^2 + 4vv_r - v_r^2 = -4gR$$

$$\Rightarrow\ -2v^2 + 2vv_r = -4gR \ \Rightarrow\ v^2 - vv_r = 2gR$$

$v^2 - vv_r = 2v_r^2$ (from eq. 2)

$$\Rightarrow\ v^2 - vv_r - 2v_r^2 = 0$$

$$\Rightarrow\ v^2 - 2vvr + vvr - 2v^2 = 0$$

$$\Rightarrow\ v(v - 2v_r) + v_r(v - 2v_r) = 0$$

$$\Rightarrow\ (v + v_r)(v - 2v_r) = 0$$

$\Rightarrow\ v = -v_r$ or $v = 2v_r$ v $\Rightarrow$ (–) is not possible

hence $v = 2v_r = 2\sqrt{gR}$ ……….. (3)

From (1), (2) & (3)

$$u = 2v - vr = 2\left(2\sqrt{gR}\right) - \sqrt{gR} = 3\sqrt{gR}$$

Actual velocity at P :

$$-(v_r - v) = -\left(\sqrt{gR}\right) - 2\sqrt{gR} = \sqrt{gR}$$