3rd year secondary

Dynamics

booklets 2017

إعداد فريق العمل

أ/جمال الشاهد	موجه اول المدارس الرسميه للغات بمحافظه الجيزه
أ/محمد يس جمعه	موجه رياضيات
أ/محمد على السعيد	موجه رياضيات
أ/سيد محمد عبد العزيز	موجه رياضيات
أ/بسيونى ابراهيم	كبير معلمين (مدرسه الاورمان)
أ/محمد على قاسم	معلم اول أ. (مدرسه هضبه الاهرام)

مع خاص التمنيات للطلبه بالنجاح و التوفيف

Guide Answers

Q(1) A stone is projected vertically upwards and its height (X) after (t) second from the projection is given by the relation $X = 49\,t - 4.9\,t^2$ where X is in meters. Then the maximum height the projected body can reach.

① 122.5m ② 49m ③ 490m ④ 245m

$V = \frac{dX}{dt} = 49 - 9.8t$ maximum velocity when V=0 $\therefore t = 5\,\text{sec}$

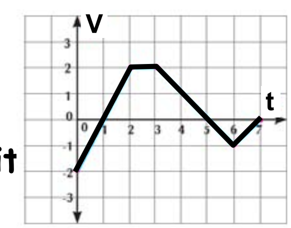
Maximum height $= 49 \times 5 - 4.9 \times 5^2 = 122.5m$

Q(2) particle moves in a straight line velocity V is given in a relation with the algebraic measure of the position x in the form $V^2 = 16 - 9\cos X$. then The acceleration at the maximum velocity equals …………………….

①$9\sin X$ ②$-9\sin X$ ③$\frac{9}{2}\sin X$ ④$25\sin X$

$2V\frac{dV}{dX} = 9\sin X \quad \therefore V\frac{dV}{dX} = a = \frac{9}{2}\sin X$

Q(3) From the velocity-time graph in the opposite figure,
The magnitude of displacement is equal to …………



①3 unit ②5 unit ③5unit ④2unit

$-\frac{1}{2} \times 1 \times 2 + \frac{1}{2}(1+4) \times 2 - \frac{1}{2} \times 2 \times 2 = 2\text{units}$

Q(4) car of mass 2 tons moves in a straight line such that $\overrightarrow{X} = \left(3t^2 - 4t + 1\right)\hat{C}$ then the magnitude of the momentum of the car after 3 seconds of its motion. Equals…………… Kg.m/sec

①29000 ②28000 ③ 27000 ④26000

$V = \frac{dX}{dt} = 6t - 4$ when t=3sec $V = 14$ $\therefore H = mV = 14 \times 2000 = 28000$

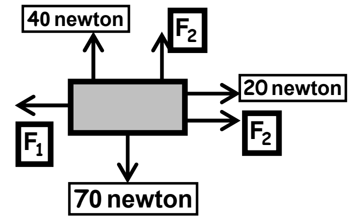
Q(5) A particle moves in a straight line under the action of the force $\overrightarrow{F} = 6\,\hat{i} + 8\,\hat{j}$ from point A (3 , -4) to point B (7 , 2), then the work done by this force equals …………………….unit of work

①10 ②72 ③ 24 ④12

$\overrightarrow{AB} = \overrightarrow{B} - \overrightarrow{A} = (4,6) \quad \therefore W = \overrightarrow{F} \bullet \overrightarrow{S} = (6,8) \bullet (4,6) = 6 \times 4 + 8 \times 6 = 72$

Q(6) The opposite Figure shows a body at rest and a system of forces acting on it then $F_1 + F_2 = \ldots\ldots$Newton

① 50 ② 30 ③ 80 ④ 100



$F_2 + 40 = 70 \quad \therefore F_2 = 30 \quad , F_2 + 20 = F_1 \quad \therefore F_1 = 50$
$F_1 + F_2 = 50 + 30 = 80$

Q(7) A lift moves vertically with a uniform acceleration of $70\,cm/sec^2$ if a spring balance is hanged to its ceiling and carrying a body of mass 14Kg then the balance reading in Kg.wt if the lift is moving upwards equals ....

①15Kg.Wt ②13Kg.Wt ③1117.2Kg.Wt ④12740Kg.Wt

$$N = m(g + a) \quad \therefore N = \frac{14(9.8 + 0.7)}{9.8} = 15\ Kg.wt$$

Q(8) A body of mass 12 kg is placed on a smooth plane inclines at 30^o, to the horizontal. A force of magnitude 88.8 Newton acts in the direction of the line of the greatest slope upwards the plane. then the velocity of this body after 14 seconds from the beginning of the motion.

① 35m/sec ② 36m/sec ③ 37m/sec ④ 40m/sec

$F - mg\sin\theta = ma \quad \therefore a = 2.5 m/sec^2 \quad \because V = V_o + at \quad \therefore V = 0 + 2.5 \times 14 = 35 m/sec$

Q(9) A body of weight 1Kg.wt fall from a height 4.9m above the ground then its momentum when its reach ground =................Kg/sec

① 48.02 joules ② 4.1Kgm/sec ③ 4.8Kgm/sec ④ 4.9 joules

$V^2 = V_o^2 + 2gS \quad \therefore V^2 = 0 + 2 \times 9.8 \times 4.9 \quad \therefore V = 9.8 m/sec$
$H = mV == 1 \times 9.8 = 9.8\ Kg.m/sec$

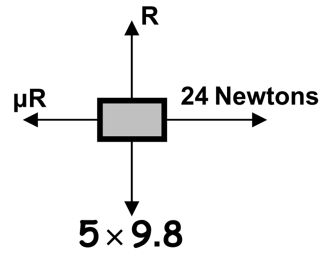
Q(9) If the power of a machine in watt is given by the relation (8t-5) and the work done at t=3sec equals 24 joule ,then the work done at t = 1 sec equals .... joule

① 1 ② 2 ③ 3 ④ 4

$$W = \int P dt = \int (8t - 5) dt = 4t^2 - 5t + C \quad \therefore 24 = 4(3)^2 - 5 \times 3 + C$$
$$\therefore C = 3 \quad \therefore W = 4t^2 - 5t + 3 \quad \text{when } t = 1 \ \therefore W = 4 - 5 + 3 = 2$$

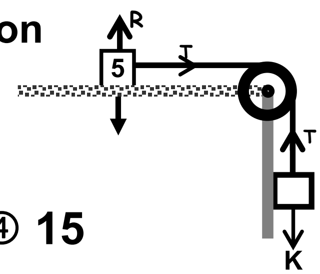
Q(10) If the show body move with an acceleration 2m/sec^2 On a rough horizontal plane Then the value of $\mu =$ ....

① $\frac{2}{7}$ ② $\frac{7}{2}$ ③ 14 ④ 10



$24 - \mu R = ma \quad \therefore 24 - \mu \times 5 \times 9.8 = 5 \times 2 \quad \therefore \mu = \frac{2}{7}$

Q(11) The plane is smooth and the pulley is smooth And the pressure on the pulley $= 14\sqrt{2}$ Newton Then the magnitude of the acceleration equals .....m/sec^2



① 14 ② 2.8 ③ 5 ④ 15

$P = \sqrt{2}T = 14\sqrt{2} \quad \therefore T = 14$ Newton

$T = 5a \quad \therefore 14 = 5a \quad \therefore a = \frac{14}{5} = 2.8 m/sec^2$

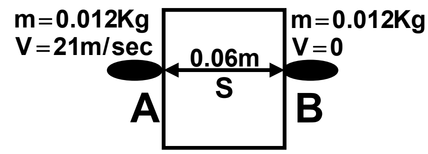
Q(12) A body of mass 35 kg, is placed on a pressure scale fixed in the celing of a lift moving upward with velocity of magnitude 4 m/sec and the scale reading is 343 newton, then the distance traveled by the lift in 7 seconds is.................... meters.

① 25 ② 26 ③ 27 ④ 28

$N = m(g + a) \quad \therefore 343 = 35(9.8 + a) \quad \therefore a = 0$ The body move with uniform velocity

$\therefore S = tV = 7 \times 4 = 28m$

Q(13) A bullet of mass 0.012Kg is fired with velocity of magnitude 21m/sec . the bullet penetrated through it a distance 6cm before coming to rest . find the magnitude of the wall resistance in Kg.wt assuming it is constant



$$V^2 = V_o^{\,2} + 2aS$$
$$0^2 = 21^2 + 2a \times 0.06 \quad \therefore\ a = -3675\text{m/sec}^2$$
$$-r = ma \quad \therefore\ -r = 0.012 \times -3675 = -44.1$$
$$r = 44.1\text{N} \div 9.8 = 4.5\text{Kg.wt}$$

Q(14) A pressure balance is fixed to the ceiling of a lift moving vertically .A man stands on the balance If the balance records 75 Kg.wt when the lift is ascending with a uniform acceleration of magnitude ''a'' m/sec^2 and records 60Kg.wt when the lift is descending with uniform acceleration of magnitude ''2a'' m/sec^2 find ''a'' and the mass of the man

$$75 \times 9.8 = m(9.8 + a) \quad \to (1)$$
$$60 \times 9.8 = m(9.8 - 2a) \to (2)$$
$$\text{By dividing the 1,2} \quad \therefore \frac{9.8 + a}{9.8 - 2a} = \frac{5}{4} \quad \therefore 5(9.8 - 2a) = 4(9.8 + a)$$
$$49 - 10a = 39.2 + 4a \quad \therefore 10a + 4a = 49 - 39.2 \quad \therefore 14a = 9.8$$
$$\therefore a = 0.7\text{m/sec}^2 \qquad \therefore\ m = 70\text{Kg}$$

Q(15) A cyclist and the bike of mass 98 kg move on a rough horizontal ground from rest to reach the maximum velocity of magnitude 7.5 m/sec after time of magnitude 1 minute when the cyclist stop peddling. The bike gets rested after it traveled a distance of magnitude 15 m. Calculate the maximum power in horse for the cyclist during this trip.

after one minute :(when the cyclist stop peddiling)

$$V^2 = V_o^{\,2} + 2aS \ \therefore 0 = (7.5)^2 + 2 \times a \times 15 \quad \therefore a = -\frac{15}{8}m/sec^2$$
$$-r = ma \quad \therefore -r = 98 \times -\frac{15}{8} = 183.75 \text{ Newton}$$

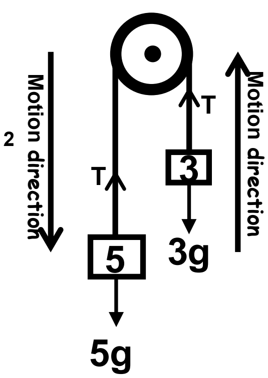
when moving with maximum velocity

$$V = V_o + at \quad \therefore 7.5 = 0 + a' \times 60 \quad \therefore a' = \frac{1}{8} m/sec^2$$
$$F - r = ma \ \therefore F = r + ma = 183.75 + 98 \times \frac{1}{8} = 196\text{N}$$
$$\text{power } = 196 \times 7.5 = 1470 \text{ watt} \div 75 = 2 \text{ horses}$$

Q(16) Two bodies of masses of 3 , 5 kg are tied at the two ends of a string which passes round a small smooth pulley. The system is kept in equilibrium with the two parts of the string hanging vertically. If the system was left to move ,when the two bodies are on the same horizontal level (a) find the magnitude of its acceleration (b)Find the pressure on pulley.
(c) what is the vertical distance between them after one second.
(d)Find the speed of the body of larger mass when it has descended 40cm. (Take g=9.8m/sec^2)

The larger math will move downwards $5g - T = 5a \rightarrow (1)$

The smaller math will move Upwards $T - 3g = 3a \rightarrow (2)$



$\therefore 5g - 3g = 5a + 3a \quad \therefore 8a = 2g \therefore a = \frac{2g}{8} = \frac{2\times 9.8}{8} = 2.45 m/sec^2$

$\therefore T - 3\times 9.8 = 3\times 2.45 \quad \therefore T - 29.4 = 7.35$

$\therefore T = 29.4 + 7.35 = 36.75 \quad \therefore P = 2T \quad \therefore P = 73.5N$

After one second $S = Ut + \frac{1}{2}at^2 = 0 + \frac{1}{2}\times 2.45\times 1^2 = 1.225m$

$\therefore$the vertical distance between them $= 2\times 1.225 = 2.45m$

If V is the speed of the body of large mass after descending 40cm, we have :

The mass start its motion from rest downwards

$V^2 = U^2 + 2aS \quad \therefore V^2 = 0^2 + 2\times 2.45\times 0.4 = 1.96 m/sec^2$

$\therefore V = \sqrt{1.96} = 1.4 m/sec^2$

Q(17) A train of mass 245 tons (the mass of the engine and the train) moving on a horizontal straight road with a uniform acceleration of 15cm/sec^2 if the air resistance as well as the friction is 75Kg.wt per ton of the train mass find the force of the engine in Kg.wt . if the last car of the train of mass 49 ton is released after the train had traveled for 4.9 minutes from rest find the time taken by the released car till it comes to rest

<u>Before the car released</u>

$F - r = ma \quad \therefore F = r + ma$

$F = 75\times 9.8\times 245 + 245\times 1000\times 0.15 = 216825N = 22125Kg.wt$

<u>After 4.9 minutes the velocity of the train is V</u>

$V = 0 + 4.9\times 60\times 0.15 = 44.1 m/sec$

<u>With respect to the separated car</u>

$-r = m'a' \qquad \therefore -75\times 9.8\times 49 = 49\times 1000a'$

$\therefore a' = -0.735 m/sec^2 \qquad \therefore 0 = 44.1 - 0.735t \qquad \therefore t = 60sec$

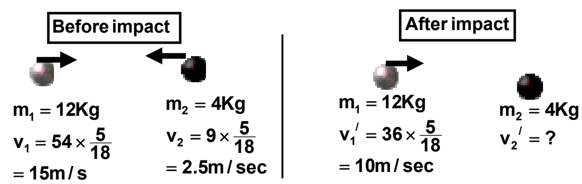
Q(18) A sphere of mass 12Kg is moving along a straight line with velocity 54Km/hour impinge on Another sphere of mass 4Kg moving along the same line but in the opposite direction with velocity 9Km/hour . if the velocity of the first body after impact is 36Km/hour in the same direction as before calculate: _(1)Find the velocity of the second sphere after impact (2)Find the impulse of the two sphere on the other (3)Find the kinetic energy of the two spheres before impact

$m_1V_1 + m_2V_2 = m_1V_1^{/} + m_2V_2^{/}$

$12 \times 15 - 4 \times 2.5 = 12 \times 10 + 4V$

$170 = 120 + 4V$

$\therefore 50 = 4V \therefore V = 12.5 m/s$



The impulse of the two sphere on the other $I = m(V^{/} - V)$

Impulse of the first on the second $I_1 = m_2(V_2^{/} - V_2) = 4(12.5 + 2.5) = 60$ Kg m/sec

Impulse of the second on the first $I_2 = m_1(V_1^{/} - V_1) = 12(10 - 15) = -60$ Kg m/sec

Q(19) A train of mass (m) ton moves on a horizontal road with the maximum velocity of magnitude60 km/h. The last car of mass 15 tons is separated from the train and the maximum velocity of the train increases at a magnitude of 7.5 km/h. Find the power of the engine in horse and the mass of the train given that the resistance is equal to 9 kg.wt per each ton of mass.

before separated:

$$P_1 = m \times 9 \times \left(60 \times \frac{5}{18}\right) = 1470m \text{ watt}$$

After separated:

$$P_2 = (m - 15) \times 9 \times 9.8 \times \left((60 + 7.5) \times \frac{5}{18}\right) = 1653.75m - 24806.25$$

$$P_1 = P_2 \quad \therefore 1470m = 1653.75m - 24806.25 \quad \therefore m = 135 ton$$

the power $= 1470 \times 135 = 198450$ watt =270 horses

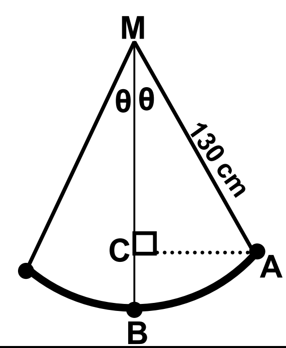
Q(20) The figure show a simple pendulim(a ball suspended at th end of a string) Whose string is 130cm long the pendulum starts its motion from rest at the point A and left free to oscillte through an angle of measure 2θ Where $\tan\theta = \frac{5}{12}$ find the speed of the ball atB(B is the mid point of the path)

draw $\overline{AC} \perp \overline{MB}$

$MC = 130\cos\theta = 130 \times \frac{12}{13} = 120cm$, $CB = 10cm$

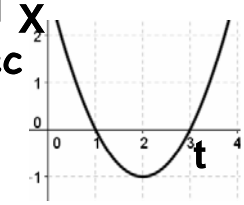
$P_A + T_A = P_B + T_B \quad \therefore \quad mg \times 10 + 0 = 0 + \frac{1}{2}mV^2$

$V_B = 140 cm/sec$



Q(1) A particle moves in a straight line such that its position X at any time t is given by the relation $X(t) = (t^2 - 4t + 3)\hat{C}$
the average velocity vector of the particle when t $\in [0, 2]$

① 2m/sec ② 1m/sec ③ 3m/sec ④4m/sec



$V = 2t - 4 = 0 \quad \therefore t = 2$

Displacement from[0,1] (S(0)-S(1)=3-0

Displacement from[1,2] (S(2)-S(1)=-1 average speed =1m/sec

Q(2) A particle starts to move in a straight line from the origin point with initial velocity of magnitude 8m/sec and the acceleration second is given by the relation(3 t -2) , then displacement after 2 sec from the starting of motion.

①15m ②20m ③16m ④18m

$$a = \frac{dV}{dt} = 3t - 2 \quad \therefore \ dV = (3t - 2)dt \ \therefore \int dV = \int (3t - 2)dt \quad \therefore V = \frac{3}{2}t^2 - 2t + C$$

$$V_o = 8 \ \text{when} \ t = 0 \ \therefore C = 8 \quad \therefore V = \frac{3}{2}t^2 - 2t + 8$$

$$X = \int \left(\frac{3}{2}t^2 - 2t + 8\right)dt = \frac{1}{2}t^3 - t^2 + 8t + d \quad , d = 0 \quad \text{at} = 2 \ \therefore X = 16m$$

Q(3) If $X = t^2 - 3t + 2$ then the particle changes its motion when :t=……

① 1or 2 ② 1 ③ 1.5 ④ 2

$$V = \frac{dX}{dt} = 2t - 3 \quad \therefore \ t = 1.5$$

Q(4) A body moves in a straight line such that the acceleration of its motion (a) is given as a function of time t by the relation a = 2t - 6 where a is measured in m/sec2, unit and time t in second. then the momentum of the body in the time interval $[3,5]$ if the mass of the body is 8 kg.

①32Kg.m/sec ②35Kg.m/sec ③36Kg.m/sec ④40Kg.m/sec

$$H = \int_3^5 ma\,dt \quad = \int_3^5 8(2t - 6)\,dt \quad = 8\left[t^2 - 6t\right]_3^5 = 8[(25 - 30) - (9 - 18)] = 32Kg.m/sec$$

Q(5) body of mass 10kg slides a distance 6 m on a rough plane and the coefficient of the kinetic friction between them is 0.2 and inclined at 30^o to the horizontal, Find in Kg.Wt.m unit the work done by: Friction force….Kg.wt.m

① $-5\sqrt{3}$ ② $-6\sqrt{3}$ ③ $-2\sqrt{3}$ ④ $-10\sqrt{3}$

$$W = -\mu_K \times (mg\cos\theta) \times S = \frac{-0.2 \times 10 \times 9.8 \times \cos 30^o \times 6}{9.8} = -6\sqrt{3}Kg.wt.m$$

Q(6) A body moves in a straight line under the action of three forces $\overrightarrow{F_1} = 4\hat{i} + 3\hat{K}$ and $\overrightarrow{F_2} = -\hat{i} + 4\hat{j} - 15\hat{K}$ and $\overrightarrow{F_3}$,displacement a function of time by $S = 2t\,\hat{i} - t\,\hat{j} + \hat{k}$ then $F_3 = \ldots\ldots$

① 14 ② 13 ③ 15 ④ 16

$a = 0 \quad \therefore \overrightarrow{F_3} = -\overrightarrow{F_1} - \overrightarrow{F_2} = (-3, -4, 12) \quad \therefore F = \sqrt{9 + 16 + 144} = 13$

Q(7) A force F acts on a body of mass 1 kg at rest, moving in a straight line starting from the origin point "O" on the straight line and F = 5X + 6 where X is the distance between the body and point "o" measured in meter and F in Newton. Then the displacement of the body when V = 9 m/sec

① $3 \text{ or } -\frac{27}{5}$ ② $3 \text{ or } \frac{4}{5}$ ③ $3 \text{ or } -3$ ④ $1 \text{ or } \frac{4}{5}$

$F = ma = 1 \times V\frac{dV}{dX} = 5X + 6 \quad \therefore VdV = (5X + 6)dX \quad \therefore \int_0^V VdV = \int_0^X (5X + 6)dX$

$\frac{V^2}{2} = \frac{5X^2}{2} + 6X$ when $V = 9 \quad \therefore \frac{81}{2} = \frac{5X^2}{2} + 6X \quad \therefore 5X^2 + 12X - 81 = 0$

$\therefore X = 3$ or $\therefore X = -\frac{27}{5}$

Q(8) A body is projected horizontally with velocity 2.8 m/sec on a rough horizontal plane and the coefficient of friction between it and the body is $\frac{1}{10}$, then the distance traveled by the body on the plane before it rests is equal to .... meters.

① 3 ② 4 ③ 5 ④ 6

$-\mu R = ma \quad \therefore a = -\frac{1}{10} \times 9.8 = -0.98$

$V^2 = V_o^2 + 2aS \quad \therefore 0 = 2.8^2 - 2 \times 0.98 \times S \quad \therefore S = 4$

Q(9) A man of mass 80 kg is inside a lift. in Kg.Wt the pressure of the man on the floor of the left is Moving upwards with a uniform acceleration of magnitude 49 cm/ sec^2.

① 84Kg.wt ② 70Kg.wt ③ 80Kg.wt ④ 76Kg.wt

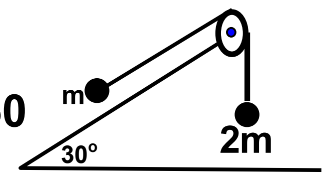
$N = m(g + a) = 80(9.8 + 0.49) = 84 \text{Kg.wt}$

Q(10) A variable force F (measured in Newton) acts up on a body where $F = 3S^2 - 4$, find the work done by this force in the interval from S = 2 m to S = 5 m.

① 100 ② 105 ③ 1105 ④ 120

$$F = \int_2^5 F\,dS = \int_2^5 \left(3S^2 - 4\right)dS = \left[S^3 - 4S\right]_2^5 = \left[(125 - 20) - (8 - 8)\right] = 105\,\text{joule}$$

Q(11) m, 2m start motion when they were in same horizontal line Each of them move a distance (20) then the vertical distance between Them is ……cm



①20 ②30 ③40 ④50

$$20 + 10\sin 30^\circ = 30\text{cm}$$

Q(12) If $F = 1 + (t-2)^2$ then The impulse of the force F within the first three second.

①4N.sec ②5 N.sec ③6 N.sec ④7 N.sec

$$I = \int_0^3 F\,dt = \int_0^3 \left(1 + (t-2)^2\right)dt = \int_0^3 \left(t^2 - 4t + 5\right)dt = \left[\frac{t^3}{3} - 2t^2 + 5t\right]_0^3 = 6\text{N.sec}$$

Q(13) A sphere of mass $\frac{1}{2}$Kg move with velocity 3m/sec collide with another sphere of equal mass at rest and form one body after impact then the velocity of the one body equals ……m/sec

①1.4 ②1.5 ③1.6 ④2

$$m_1V_1 + m_2V_2 = m'V' \quad \therefore \frac{1}{2}\times 3 + \frac{1}{2}\times 0 = \left(\frac{1}{2} + \frac{1}{2}\right)V' \quad \therefore V' = 1.5\text{m/sec}$$

Q(14) If the algebraic measure of the velocity of a body is given by the relation $V = (8 - 2t)$ cm/sec then the covered distance during the 4^{th} second only from starting its motion =….cm

①1 ②2 ③3 ④ 4

$$\int_3^4 (8 - 2t)dt = \left[8t - t^2\right]_3^4 = 16 - 15 = 1$$

Q(15) A mass of 2Kg falls from rest from a height 10m and then brought to rest by penetrating 5cm into some sand find in Kg wt the resistance of the sand supposing it to be uniform

$V^2 = 0 + 2 \times 9.8 \times 10 \quad \therefore \ V = 14 m/sec$

$0 = 14^2 + 2 \times a \times 0.05 \quad \therefore \ a = -1960 m/sec^2$

$\therefore mg - r = ma \therefore \ 2 \times 9.8 - r = -1960 \times 2 \quad \therefore \ r = 3939.6N \quad \div 9.8 = 402 Kg.wt$

Q(16) A spring balance is fixed to the floor of a lift moving vertically . body is suspended from it If the balance records 17 Kg.wt when the lift is ascending with a uniform acceleration of magnitude ''$\frac{3}{2}a$'' m/sec^2 and records 16Kg.wt when the lift is descending with uniform deceleration of magnitude ''a'' m/sec^2 find ''a'' and the mass of the man

$17 \times 9.8 = m\left(9.8 + \frac{3}{2}a\right) \rightarrow (1) \qquad , 16 \times 9.8 = m(9.8 + a) \rightarrow (2)$

$\text{by dividing}: \ \therefore \frac{m\left(9.8 + \frac{3}{2}a\right)}{m(9.8 + a)} = \frac{17}{16} \qquad \therefore \ 16\left(9.8 + \frac{3}{2}a\right) = 17(9.8 + a)$

$\therefore 156.8 + 24a = 166.6 + 17a \quad \therefore \quad 7a = 9.8 \quad \therefore a = 1.4 m/sec^2 \quad , \ m = 14Kg$

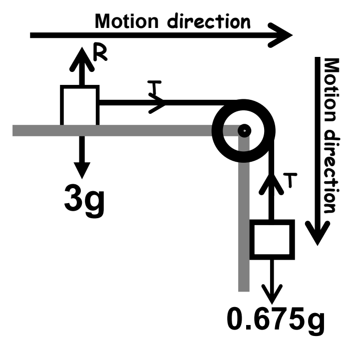
Q(17) body of mass 25 kg is placed on a smooth plane inclines with an angle of measure θ where $\tan\theta = \frac{4}{3}$. A horizontal force of magnitude 30 Kg.Wt, acts in the direction of the plane and its line of action lies in the vertical plane passing through the line of the greatest slope to the plane .Find the acceleration generated acceleration and the magnitude of the reaction force of the plane.

$mg\sin\theta = 25 \times 9.8 \times \frac{4}{5} = 196N \quad , \ F = 30 \times 9.8 = 294N$

$\because F > mg\sin\theta \quad \therefore$ the body is move up the plane

$294 - 196 = 25 \times a \quad \therefore \ a = 3.92 m/sec^2$

Q(18) A body of mass 3kg placed on a smooth horizontal table, is connected by a string passing over a pulley at the table's edge to a body of mass 0.675kg. The horizontal part of the string is perpendicular to the table's edge. Find the acceleration of the system. If the motion starts from rest,
Find : (a) the system's acceleration.
(b) The tension is the string. (c) The pressure on the pulley
(d) If the motion starts from rest, when the body of large mass is at a distance of 250 cm from the pulley, find its speed when just about to hit the pulley.



Equation of motion of the (3Kg) $T = 3a \rightarrow (1)$

Equation of motion of the (0.675Kg)

$0.675 \times 9.8 - T = 0.675a \rightarrow (2)$

By adding 1,2 $\therefore 0.675 \times 9.8 = 3a + 0.675a$

$\therefore a = \dfrac{0.675}{3+0.675} \times 9.8 = 1.8 m/sec^2$

Part (b) By substituting in (1)

$\therefore T = 3a = 3 \times 1.8 = 5.4N$

Part (c) $P = \sqrt{2}T = 5.4\sqrt{2}N$

$V^2 = 0 + 2 \times 1.8 \times 2.5 = 9 \quad \therefore V = 3m/sec$

Q(19) A force of magnitude 48 gm.wt acting on a body which placed on a horizontal plane for interval of certain time at the end of this time interval the body gains kinetic energy of magnitude 18900 gm.wt cm and the momentum of the body at this moment equals 176400 gm.cm/sec. the force is ceased and the body came to rest again after it cover 10.5 m Find the mass of the body and the resistance of the plane assuming that it is constant. find also the time of force effect.

$\frac{1}{2}mV^2 = 18900 \times 980 \rightarrow (1) \quad , \quad mV = 176400 \rightarrow (2)$

By dividing $\therefore \frac{1}{2}V = 105 \qquad \therefore V = 210 cm/sec \qquad \therefore m = 840gm$

After the force is ceased:

$T - T_o = -rS \quad \therefore -18900 \times 980 = -r \times 1050 \quad \therefore r = 17640 dyne = 18 gm.wt$

During the acting of the force

$F - r = ma \quad \therefore 48 \times 980 - 18 \times 980 = 840a \quad \therefore a = 35 cm/sec^2$

$210 = 0 + 35t \quad \therefore t = 6 sec$

Q(20) A body of mass 1 kg moves with a uniform velocity of magnitude 12 m/sec. A resistance force of magnitude $6X^2$ (Newton) where X is the distance which the body travels under the action of the resistance (meter) acts on it.
(a)Find the work done by the resistance when X = 4
(b) Find the velocity of the body and its kinetic energy X = 2

$$W = \int_0^4 F dX = \int -6X^2 dX = \left[-2X^3\right]_0^4 = -128 \text{joule}$$

Change in kinetic energy = work done

$$\frac{1}{2}m\left(V^2 - V_o^2\right) = \int_0^2\left(-6X^2\right)dX \quad \therefore \frac{1}{2}\left(V^2 - 144\right) = \left[-2X^3\right]_0^2 \quad \therefore V = 4\sqrt{7}$$

$$T = \frac{1}{2}mV^2 = 56 \text{joule}$$

Q(21) body of mass 20kg is let to descend on the line of the greatest slope to a smooth plane inclined at 30° to the horizontal. Find the velocity of the body after it travels 5 meters on

$$mg\sin\theta = ma \quad \therefore a = g\sin\theta = 9.8 \times \sin 30^\circ = 4.9 m/sec^2$$

$$V^2 = V_o^2 + 2aS \quad \therefore V^2 = 0^2 = 2 \times 4.9 \times 5 = 49 \quad \therefore V = \sqrt{49} = 7 m/sec$$

Q(22) Calculate the velocity of a body of mass 300 gm placed at the top of an inclined plane of height 2 m reaches the bottom of the plane if the magnitude of work done against the resistance is equal to 2.13 joule.

$$P = T + W \qquad \therefore mgh = \frac{1}{2}mV^2 + 2.13$$

$$0.3 \times 9.8 \times 2 = \frac{1}{2}mV^2 + 2.13$$

$$\frac{1}{2} \times 0.3 \times V^2 = 3.75 \quad \therefore V^2 = 25 \quad \therefore V = 5 m/sec$$

Q(23) A truck of mass 6 tons moves on a horizontal road with a uniform velocity of magnitude 54 km/h when the power of its engine is 300 horses. Calculate the resistance of the road in Kg.Wt per ton of mass.

$$P = F \times V \quad \therefore 300 \times 75 = F \times 54 \times \frac{5}{18} \quad \therefore F = r = 1500 kg.wt$$

Q(1) If the algebraic measure of the displacement of a particle moving in a straight line is given by the relation $S = t^3 - 6t^2 + 9t$ where s is measured in meter and t in second the velocity of the particle when the acceleration vanishes.

① 9m/sec ② 4m/sec ③ 3m/sec ④ 6m/sec

$$V = 3t^2 - 12t + 9 \quad \therefore a = \frac{dV}{dt} = 6t - 12 = 0 \quad \therefore t = 2$$
$$V = 3(2)^2 - 12(2) + 9 = |-3| = 3m/sec$$

Q(2) If $X = 6t - t^2$, then the distance traveled within the time interval $0 \le t \le 6$

① 0 ② 9 ③ 18 ④ 36

$$V = 6 - 2t \quad \therefore 6 - 2t = 0 \quad \therefore t = 3$$
$$S = \int_0^6 |6 - 2t|dt = 2\int_0^3 (6 - 2t)dt = 2\left[6t - t^2\right]_0^3 = 2(18 - 9) = 18 \text{ units length}$$

Q(3) Car of mass 1.5 tons, moves in a straight line such that a (t) is given by the relation $a = 12t - t^2$ where (a) is measured in m/sec², unit and time t in sec, then :The change of momentum of the car during the first six seconds ....Kg.m/sec

① 2160000 ② 216 ③ 21600 ④ 36000

$$H = \int_0^6 1.5 \times 10^3 (12t - t^2)dt \qquad 1.5 \times 10^3 \left[6t^2 - \frac{t^3}{3}\right]_0^6 = 216000$$

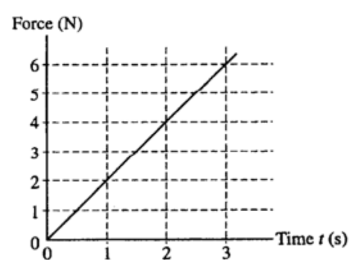
Q(4) The time taken by a car of mass 1200 kg to reach the velocity 126 km/h from rest. If the power of the engine is constant and equal to 125 horses.

① 3sec ② 4sec ③ 7sec ④ 8sec

$$W = \int_0^t (\text{power})dt = 125 \times 735t = \text{change in kinetic energy}$$
$$\frac{1}{2} \times 1200\left(\left(126 \times \frac{5}{18}\right)^2 - 0\right) = 125 \times 735t \quad \therefore t = 8sec$$

Q(5) A block of mass 3 kg, initially at rest, is pulled along a frictionless, horizontal surface with a force shown as a function of time t by the graph above. The acceleration of the block at t = 2 s is

① $\frac{3}{4} m/sec^2$ ② $\frac{4}{3} m/sec^2$ ③ $2 m/sec^2$ ④ $3 m/sec^2$



at t=2 F=4 $F = ma \quad \therefore a = \frac{4}{3} m/sec^2$

Q(6) Tram car is pulled by a rope inclined at 60° to the railroad. If the tension force is 500 Kg.Wt and the car moved from rest with acceleration 5 cm/sec^2 for 30 seconds, then the work done by the tension force……….joule

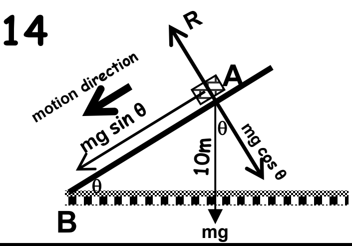
① 5050 ② 55124 ③ 55125 ④ 1252

$$F = 500 \times 9.8 \times \cos 60^\circ = 2450N \quad S = V_o t + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 0.05 \times 30^2 = 22.5m$$

$$W = F \times S = 2450 \times 22.5 = 55125 \text{joule}$$

Q(7) A body placed on a <u>smooth</u> inclined plane of height10meters is left to move from rest along a line of greatest slope .then the velocity when it reaches the bottom of the plane equal ……………. m/sec

①14 ②17 ③15 ④14



$$P_A = T_B \quad \therefore mgh = \frac{1}{2}mV^2 \therefore \quad \frac{1}{2}V^2 = 9.8 \times 10$$

$$\therefore V^2 = 196 \quad \therefore V = 14m/sec$$

Q(8) A machine using for lifting water it work by rate 294 joule per second then the power of its engine equal ……..horses

①0.4 ②3.92 ③4.15 ④24

$$\frac{294}{75 \times 9.8} = 0.4 \text{ horses}$$

Q(9)2 bodies of masses 5gm and 2gm are connected by the ends of a string passing over a smooth pulley if a system moves with an acceleration then the acceleration =

①g ②$\frac{3}{7}g$ ③$\frac{7}{3}g$ ④$\frac{1}{2}g$

$$5g - T = 5a \to (1) \quad , T - 2g = 2a \to (2) \quad \therefore 3g = 7a \quad \therefore a = \frac{3}{7}g$$

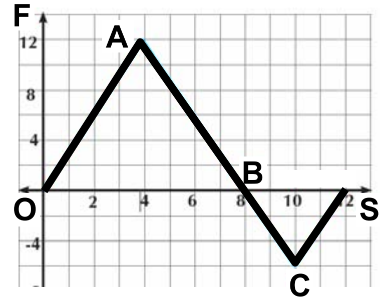
Q(10) A body moves starting from a fixed point in a straight line with an initial velocity 10m/secsuch that its acceleration $a = 2X + 3$ then its speed at X= 14m is …..m/sec

①24 ②34 ③476 ④576

$$V\frac{dV}{dX} = 2X + 3 \quad \therefore \int_{10}^{V} VdV = \int_{0}^{14} (2X + 3)\, dX \quad \therefore \frac{V^2}{2} - 50 = X^2 + 3X \text{ when } X=14$$

$$\therefore \frac{V^2}{2} - 50 = 14^2 + 3 \times 14 \quad \therefore V = 24 \text{ m/sec}$$

Q(11) The opposite illustrates the action of a variable force on a body, then the work done in Erg by this force in the When the body move from $S=0$ to $S=12$



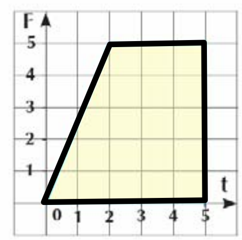
① 34joules ② 35joules ③ 36joules ④ 38joules

$W = \int_0^{12} F dS =$ area under the curve

$\frac{1}{2} \times 8 \times 12 - \frac{1}{2} \times 4 \times 6 = 36$joule

---

Q(12) The opposite figure represents the force-time graph The impulse of the force F within first five seconds where the force F is in Newton and the time t is in second …………..N/sec



① 10 ② 20 ③ 30 ④ 40

$I = \int_0^5 F.dt =$ Area under the curve $= \frac{1}{2}(5+3) \times 5 = 20$

Q(13) A worker whose job is to load boxes each of mass 30 kg on a truck. If the height of the truck is 0.9 meter, then the number of boxes which the worker can load in time of magnitude 1 minute if his average power is equal to 0.6 horse.

① 100 ② 200 ③ 50 ④ 300

number of boxes $= \frac{P}{W} = \frac{0.6 \times 9.8 \times 75}{30 \times 9.8 \times 0.9} = 100$

Q(14) If $X = t^2 - 3t + 2$ then the particle change its direction of motion when ……..

① t=1 ② t=2 ③ t=1 or 2 ④ t=1.5

$V = \frac{dX}{dt} = 2t - 3$ $\therefore$ the particle changes its direction of motion when t=1.5

Q(15) A smooth small sphere of mass 30gm is moving in a straight line with a uniform velocity of 12cm/sec. and after 4 seconds from passing by a certain point another sphere of mass 10gm. Moved from this point and in the same direction of motion of the first sphere with initial velocity of magnitude 4cm/sec and with uniform acceleration of magnitude $2\text{cm}/\sec^2$ if the two spheres form one body after impact determine its velocity just after impact and calculate the loss in the kinetic energy due to impact

Let the time taken by the second to catch the first $= t$ $\therefore$ time of the first $= t + 4$

(it moves with a uniform velocity $\therefore S_1 = tv$) $\therefore S_1 = 12(t+4) = 12t + 48$

$S_2 = Ut + \frac{1}{2}at^2 = 4t + \frac{1}{2} \times 2t^2$

The two sphers will impact after they covers the same diatance

$S_1 = S_2 \qquad \therefore \quad 4t + \frac{1}{2} \times 2t^2 = 12t + 48 \quad \therefore 4t + t^2 = 12t + 48$

$\therefore \; t^2 - 8t - 48 = 0 \qquad \therefore t = 12\text{sec} \qquad \Rightarrow V_2 = 4 + 12 \times 2 = 28\text{m/sec}$

$30 \times 12 + 10 \times 28 = (30 + 10)V' \Rightarrow V' = 16\text{cm/sec}$

$T_o(\text{before impact}) = \frac{1}{2} \times 30 \times (12)^2 + \frac{1}{2} \times 10 \times (28)^2 = 6080\text{erg}$

$T(\text{After impact}) = \frac{1}{2} \times 40 \times (16)^2 = 5120\text{erg} \Rightarrow T_o - T = 6080 - 5120 = 960\text{erg}$

Q(16) A train of mass 112.5 tons (the mass of the engine and the train) moving on a horizontal straight road with a uniform velocity 66.15m/ if the last car of the train of mass 7.5 ton is released and stopped after covering 135sec find (1) The resistance for each ton of the mass of the train assuming it is constant (2) The engine force of the train (3) The distance between the separated car and the train after one minutes from separation moment

With respect to the separated car

$U = 66.15\text{m/sec} \;, V = 0 \,, t = 135\text{sec} \qquad \because V = U + at$

$\therefore 0 = 66.15 + a(135) \quad \therefore a = -0.49\text{m/sec}^2$

$-r = ma \quad \therefore -r = 7.5 \times 1000 \times -0.49 \quad \therefore \; r = 3675\text{N} = 375\text{Kg.wt} \; = \frac{375}{7.5} = 50 \text{ /ton}$

$F = r \quad \therefore F = 50 \times 9.8 \times 112.5 = 55125 \text{ Newton}$

After separation the train will move with acceleration to get this acceleration

The mass of the train will be $112.5 - 7.5 = 105$ tons

$F - r = ma' \quad \therefore \quad 55125 - 50 \times 9.8 \times 105 = 105000a' \quad \therefore \; a' = 0.035\text{m}/\sec^2$

With respect to the train after 1 minute : $S_1 = 66.15 \times 60 + \frac{1}{2} \times 0.035 \times 60^2 = 4032 \text{ m}$

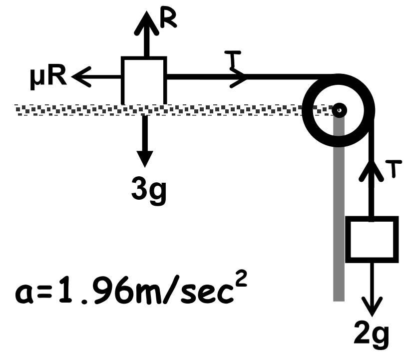
With respect to the car after 1 minute : $S_1 = 66.15 \times 60 + \frac{1}{2} \times -0.49 \times 60^2 = 3087 \text{ m}$

The distance between them after one minute $= 4032 - 3087 = 945 \text{ m}$

Q(17) A body of mass 3kg placed on a rough horizontal plane is connected by a string which passes round a smooth pulley at the plane's edge, to a mass of2kg. If the coefficient of friction is $\frac{1}{3}$ find (a)The acceleration of the system

(b)The distance traversed in one second.

(c) If the system starts motion from rest and the hanged body is at a height 50 cm above the ground, find the distance traversed by the body on the plane before it comes to rest.



$T-\mu R=3a \ , R=3g \quad \therefore T-\frac{1}{3}(3g)=3a \rightarrow (1)$

$2g-T=2a \rightarrow (2)$ By adding 1,2

$\therefore 2g-g=5a \therefore g=5a \quad \therefore a=1.96 m/sec$

$U=0 \quad \because S=Ut+\frac{1}{2}at^2 \qquad \therefore \quad S=0+\frac{1}{2}\times 1.96\times 1^2=0.98m$

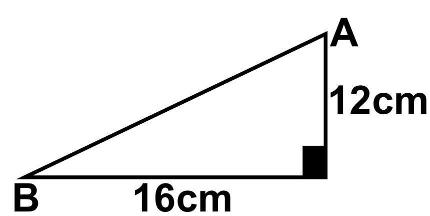
With respect to the body 2Kg $V_o=0$, $S=0.5m$, $a=1.96 m/sec^2$

$V^2=0^2+2\times 1.96\times 0.5 \quad \therefore V=\frac{7}{5} m/sec^2$

After the 2Kg reached the ground the 3Kg now is moving against Friction force only $\therefore -\mu R=ma \therefore -\frac{1}{3}\times 3\times 9.8=3\times a \ \therefore a=-\frac{9.8}{3} m/sec^2$

$V^2=U^2+2aS \quad \therefore 0^2=\left(\frac{7}{5}\right)^2-2\times\frac{9.8}{3}\times S \ \therefore S=0.3m$

Q(18) A body of mass 60 kg ascends from rest on the line of the greatest slope to an inclined plane of length 20 m and height 12 m. If the body starts its motion from the highest point on the plane and the coefficient of friction between the body and the plane is $\frac{3}{16}$, find the kinetic energy of the body when it reaches the plane base.



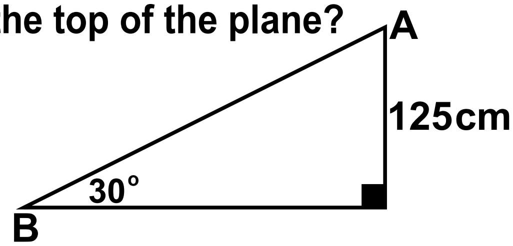
$P_A=T_B+W$

$mgh=T_B+\mu mg\cos\theta\times S$

$T_B=60\times 9.8\times 12-\frac{3}{16}\times 60\times 9.8\times\frac{16}{20}\times 20$

$T_B=5292$ joules

Q(19) A body is placed on the highest point of a slope of height 125 cm and inclined at 30° to the horizontal. The body moves in the direction of the line of the greatest slope to the plane downwards against a constant resistance estimated $\frac{1}{4}$ the weight of the body. Calculate the velocity by which the body reaches the lowest point of the plane. What is the velocity by which the body is projected by to hardly reach the top of the plane?



From A to B

$AB = 125 \times 2 = 250cm = 2.5m \quad \because P_A = T_A + W$

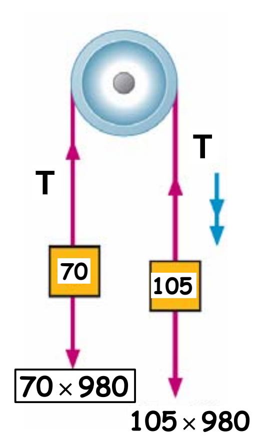
$\therefore m \times 9.8 \times 1.25 = \frac{1}{2}mV^2 + \frac{1}{4} \times m \times 9.8 \times 2.5$

$\therefore 12.25 = \frac{1}{2}V^2 + 6.125 \quad \therefore \frac{1}{2}V^2 = 6.125 \quad \therefore V = 3.5m/sec$

From B to A

$\frac{1}{2}mV^2 = m \times 12.5 \times 9.8 + \frac{1}{4} \times m \times 9.8 \times 2.5 \ \therefore V = \frac{7\sqrt{21}}{2}$

Q(20) Two bodies of masses 105 gm and 70 gm are connected by the two ends of a light string of constant length passing over a smooth small pulley and suspended vertically. If the system starts to move from rest when the two masses are on one horizontal plane, find the magnitude of the acceleration of motion of the system. If the first body is impinged against the ground after it traveled 50 cm, find the total time taken by the second body from the beginning of motion until it instantaneously rests.



$105 \times 980 - T = 105a \rightarrow 1 \quad , \ T - 70 \times 980 = 70a \rightarrow 2$

By adding 1,2

$\therefore 175a = 34300 \quad \therefore a = \frac{34300}{175} = 196cm/sec^2$

At the moment the body of mass 105 gm impinges against The ground, it takes time t_1

$V^2 = V_o^2 + 2aS \quad \therefore V^2 = 0 + 2 \times 196 \times 50 \quad \therefore V = 140cm/sec$

$V = V_o + at \quad \therefore 140 = 0 + 196t \quad \therefore t = \frac{140}{196} = \frac{5}{7}sec$

When the body of mass 105 gm impinges against the ground, the body of mass 70 gm, moves vertically upwards with a gravitational acceleration beginning with velocity V0 = 140 cm/sec. to rest instantaneously after time

$0 = 140 - gt \quad \therefore t = \frac{1}{7}sec$ The body of mass 70 gm takes time of magnitude t to reach the instantaneous rest from $t = \frac{1}{7} + \frac{5}{7} = \frac{6}{7}$

Q(21) A train moves with constant velocity 72Km/h the last carriage of mass 16 tons separated from the train the velocity of the train increased to be 96Km/h find the power of the engine of the train in horse and the mass of the train knowing that the resistance is 6Kg.wt for each ton of the moving mass

Before separate : $F = R = 6 \times 9.8 \times m \rightarrow (1)$

After separate: $F^{/} = 6 \times 9.8 \times (m - 16) \rightarrow (2)$

$\because$ the power is fixed $\therefore 72F = 96F^{/} \quad \therefore F^{/} = \frac{3}{4}F$

$\therefore \frac{3}{4}F = F - 6 \times 16 \times 9.8 \qquad \therefore F = 384$ Kg.wt

The power $= 102.4$ horse $\qquad 384 \times 9.8 = 6 \times 9.8m \quad \therefore \quad m = 64\text{Ton}$

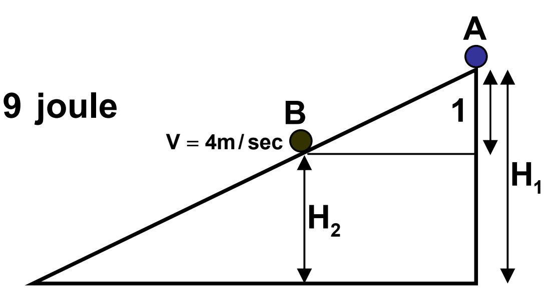
Q(22) A , B are two points on the line of greatest slope such that B below A on an inclined smooth plane a body of mass 500gm start motion from rest from the point A to B to move a vertical distance of one meter if the velocity of the body when it reached B was 4m/sec find in joule :

(1) lost potential energy (2) Work done against resistance

Lost potential energy

$= mgh_1 - mgh_2 = mg(h_1 - h_2) = \frac{500}{1000} \times 9.8(1) = 4.9$ joule

$P_A = T_B + W \quad \therefore W = 4.9 - 4 = 0.9$ joule



Q(1) particle moves in a straight line such that its acceleration (a) is given in terms of the algebraic measure of its position X by the relation $a = 2X + 5$, given that the initial velocity of the particle is 2m/sec then x when V = 4 m/sec

① -6 or 1 ② 6 or 1 ③ 6 or 5 ④ -3 or 2

$$\because a = V\frac{dV}{dX} \quad \therefore V\frac{dV}{dX} = 2X + 5 \ \therefore \int_2^V V\,dV = \int_0^X (2X+5)\,dX \quad \therefore \left[\frac{V^2}{2}\right]_2^V = X^2 + 5X$$

$$\frac{V^2}{2} - 2 = X^2 + 5X \quad \therefore \frac{V^2}{2} = X^2 + 5X + 2 \ \text{when } V = 4 \ \therefore X^2 + 5X + 2 = 8 \ \therefore X^2 + 5X - 6 = 0$$

Q(2) If V (t) = 9.8t + 5 where X (0) = 10 , then X (10)

① 0 ② 530 ③ 540 ④ 550

$$\frac{dX}{dt} = 9.8t + 5 \quad \therefore \int_{10}^X dX = \int_0^t (9.8t+5)\,dt \quad \therefore [X]_{10}^X = \left[4.9t^2 + 5t\right]_0^t$$

$$X - 10 = 4.9t^2 + 5t \quad \therefore X = 4.9t^2 + 5t + 10 \quad \therefore X(10) = 550$$

Q(3) The momentum of a car whose mass is 2 tons moving in a straight line at velocity 54km/ h is:................

① 108ton.m/sec ② 3000Kg.m/sec ③ 30000Kg.m/sec ④ 10800Kg.m/sec

$$H = MV = 2000 \times \left(54 \times \frac{5}{18}\right) = 30000$$

Q(4) If a body of mass 20 Kg.wt lands with a uniform velocity on an inclined plane to the horizontal with angle of measure 30º, then the resistance of the plane in Kg.Wt equals:

① 0 ② 10 ③ $10\sqrt{3}$ ④ 20

$$r = mg\sin\theta = 20\sin 30^\circ = 10$$

Q(5) If a body of mass 30 gm is let to fall from a height of 10 meters above the ground surface, then the kinetic energy of this body = ... Joules when it is about to collide with the ground.

① 3 ② 2.94 ③ 2940 ④ 300

$$mgh = 0.03 \times 9.8 \times 10 = 2.94 \text{ joule}$$

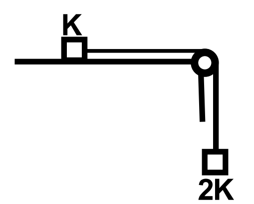
Q(6) body is suspended by a string in a spring scale fixed at the top of a lift moving upwards. If the magnitude of tension in the string during ascending with an increasing acceleration of magnitude 2.45 m/sec^2 is equal to 50 Kg.Wt, then the mass of the body equal ....?

①70 ②40 ③60 ④50

$50 \times 9.8 = m(9.8 + 2.45) \quad \therefore m = 40Kg$

Q(7) In the opposite figure : smooth pully and the plane is smooth :
The acceleration of the system when moving equlas

① $\frac{2}{3}g$ ② $\frac{3}{2}g$ ③ $\frac{1}{2}g$ ④ $2g$



$2Kg - T = 2Ka \to (1) \;,\; T = Ka \to (2) \therefore 2Kg = 3ka \quad \therefore a = \frac{2g}{3}$

Q(8) A body is paced on a horizontal plane it attached by two horizontal ropes the angle between them60^o if the tension forces are 3 Newton and 5 Newton. The body moves in a straight with uniform motion. Then the magnitude the resistance.

①7Newtons ②8Newtons ③9Newtons ④10Newtons

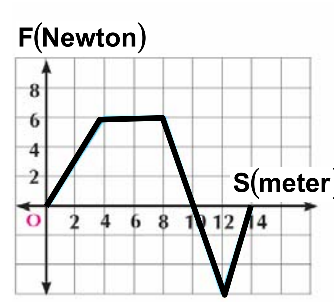
$F = r = \sqrt{3^2 + 5^2 + 2 \times 5 \times 3 \times \cos 60^o} = 7Newtons$

Q(9) Two spheres of masses 2Kg and 3Kg moving in a straight line in the same direction with velocities 3m/sec , 2m/sec they collide and form one body , the velocity of this body equals ....m/sec

①5m/sec ②4m/sec ③2.4m/sec ④2m/sec

$2 \times 3 + 3 \times 2 = (2 + 3)V' \quad \therefore V' = 2.4m/sec$

Q(10) The opposite figure illustrates the action of a variable force on a body, then the total work done by this force
From S = 8 to S = 14



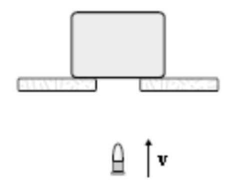
① -6joule ② 15joule

③ 12joule ④ 16joule

$W = \int_8^{14} F dS =$ area under the curve

$\frac{1}{2}\times 2\times 6 - \frac{1}{2}\times 4\times 6 = -6$

Q(11) A 10gm bullet moving with velocity 1000m/sec strikes and passes through a 2 Kg block the bullet emerges from the block with a speed 400m/sec then the maximum height will the block rise above its initial position ……..m



① $\frac{45}{98}$ ② $\frac{43}{98}$ ③ $\frac{23}{90}$ ④ $\frac{49}{98}$

$0.01\times 1000 + 2\times 0 = 2\times V + 0.01\times 400 \quad \therefore V = 3m/sec$

$V^2 = V_0^2 - 2gS \quad \therefore 0^2 = 3^2 - 2\times 9.8\times S \quad \therefore S = \frac{45}{98}m$

Q(12) A body is placed on the top of a smooth inclined plane of height 90 cm , then its velocity as it reaches the bottom of the plane =............................ m/sec

① 4.5m/sec ② 4m/sec ③ 4.2m/sec ④ 4.1m/sec

$mgh = \frac{1}{2}mV^2 \therefore 9.8\times 0.9 = \frac{1}{2}V^2 \quad \therefore V = 4.2m/sec$

Q(13) If the power of an engine at any time measured in seconds is equal to $(9t^2 + 4t)$, , then the work done during the fourth second.=……..joules

① 120 ② 124 ③ 125 ④ 130

$W = \int_3^4 (9t^2 + 4t)dt = 125$

Q(14) A cannon of mass 250Kg shots a bullet of mass 10Kg with a velocity 100m/sec then the reaction velocity of the cannon equals

① 0.4m/sec ② 4m/sec ③ 100m/sec ④ 10m/sec

$250\times V = 10\times 100 \quad \therefore V = 4m/sec$

Q(15) A horizontal force of magnitude 42Kg.wt acts on a body at rest placed on a rough horizontal ground .the body move a distance 22.05meters in 3 seconds .then the force is removed and the body came to rest after covering another 44.1meter find <u>First</u> : the mass of the body <u>Second</u> : the magnitude of the resistance in Kg.wt

$V_o = 0$, $S = 22.05$, $t = 3\,sec$ $\therefore S = V_o t + \frac{1}{2}at^2$ $\therefore 22.05 = 0\times3 + \frac{1}{2}a\times3^2$

$\therefore 22.05 = \frac{9}{2}a$ $\therefore a = 4.9 m/sec^2$, $V = V_o + at \therefore V = 0 + 4.9\times3 = 14.7 m/sec$

$F - r = ma$ $\therefore 42\times9.8 - r = m\times4.9 \rightarrow (1)$

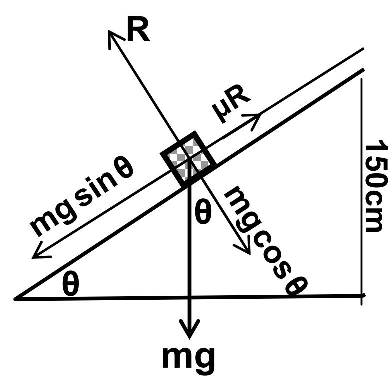
<u>After removing the force</u> $\therefore -r = ma'$ and to get a'

$V_o = 14.7$, $V = 0$, $S = 44.1$ $\therefore V^2 = V_o^2 + 2aS$ $\therefore 0 = 14.7^2 + 2\times a\times44.1 \therefore a = -2.45 m/sec^2$

$\therefore r = 2.45m$ substitut in (1)

$411.6 - 2.45m = 4.9m$ $\therefore 7.35m = 411.6$ $\therefore m = 56Kg \therefore r = 2.45\times56 = 137.2N = 14Kgwt$

Q(16) **A body is placed on the top of a rough inclined plane of length 250cm. and height 150cm. The body starts sliding down the plane, if the coefficient of friction is $\frac{1}{2}$, find the acceleration of the body ,its speed after it has moved 200 cm on the plane , and if the body be projected from the lowest point, find the minimum speed of projection so that the body reaches the highest point.**



$R = mg\cos\theta$ $\therefore mg\sin\theta - \mu R = ma$

$mg\times\frac{3}{5} - \frac{1}{2}\times mg\times\frac{4}{5} = ma$ $\div$ m

$\frac{3}{5}g - \frac{4}{10}g = a$ $\therefore a = 1.96 m/sec^2$

Its speed after 250cm

$V^2 = 2\times1.96\times2$ $\therefore V = 2.8 m/sec$

<u>If the body projected to reach heights point</u> :

$-\mu R - mg\sin\theta = ma'$

$-\frac{1}{2}\times mg\times\frac{4}{5} - mg\times\frac{3}{5} = ma'$ $\therefore a' = -9.8 m/sec^2$

$U = ?$, $V = 0$, $S = 2.5m$, $a = -9.8 m/sec^2$

$V^2 = U^2 + 2aS$ $\therefore$ $0^2 = U^2 - 2\times9.8\times2.5 \therefore U = \sqrt{49} = 7m/sec^2$

Q(17) A ball of mass 1500 gm falls down from a height of 2.5 meters on a viscous liquid surface to embed in it with a uniform velocity and travels for a distance of 70 cm in 0.2 of a second. Calculate the magnitude of the impulse of the liquid on the ball.

$V^2 = V_o^2 + 2gS$ $\therefore V^2 = 0 + 2\times9.8\times2.5 = 49$ $\therefore V = \sqrt{49} = 7m/sec$

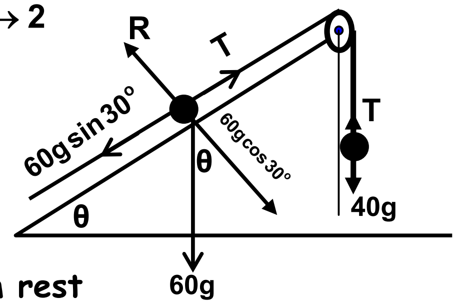
inside the liquid :

$V = \frac{0.7}{0.2} = 3.5 m/sec$ $\therefore I = 1.5(3.5 - 7) = -5.25 Kg.m/sec$

Q(18) A body of mass 60gm is tied to a string and placed on a smooth plane which makes an angle of measure 30^o with the horizontal. The string passes over a small smooth pulley at the top of the plane, and holds a body of mass 40gm vertically below the pulley, find (a) The tension in the string. (b) Find the acceleration of the system, (c)Find also the pressure on the pulley.
(d)If the system starts its motion from rest when the body on the plane is at a distance 196cm from the pulley, when does the body reach the pulley?

<u>With respect to40gm</u> | <u>With respect to 60gm</u>

$40\times980 - T = 40a \rightarrow 1$ | $T - 60g\sin30^o = 60a \rightarrow 2$



By adding 1,2 $\therefore 40\times980 - 60\times980\times\frac{1}{2} = 40a + 60a$

$9800 = 100a \quad \therefore a = 98cm/sec^2 \therefore T = 35280$ dyne

Part (d) With respect to the body 60gm

The mass will now move with acceleration $98cm/sec^2$

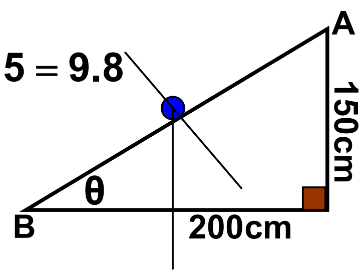
To cover the distance 196cm $\because$ the motion start from rest

$S = Ut + \frac{1}{2}at^2 \quad \therefore \quad 196 = 0 + \frac{1}{2}\times98t^2 \quad \therefore 49t^2 = 196$

$\therefore t^2 = 4 \quad \therefore \quad t = \sqrt{4} = 2\sec$

$P = 2T\cos\frac{60}{2} = 35280\sqrt{3}$dyne

Q(19) A rough inclined plane of length 250 cm and height 150 cm, body at rest is placed on it to slide downwards the plane and the acceleration of motion is equal to 196 cm/sec^2. Find the coefficient of the kinetic friction, then find the velocity of the body after it travels (cuts) 200 cm on the plane.



velocity at B $V^2 = V_o{}^2 + 2aS \quad \therefore V^2 = 0^2 + 2\times1.96\times2.5 = 9.8$

$P_A = T_B + W$

$\therefore mg\times1.5 = \frac{1}{2}mV^2 + \mu_K(mg\cos\theta)\times2.5$

$\therefore 9.8\times1.5 = \frac{1}{2}\times9.8 + \mu_K\times9.8\times\frac{200}{250}\times2.5$

$1.5 = 0.5 + 2\mu_K \quad \therefore \mu_K = \frac{1}{2}$

$V^2 = 0 + 2\times1.96\times200 \therefore V = 28m/sec$

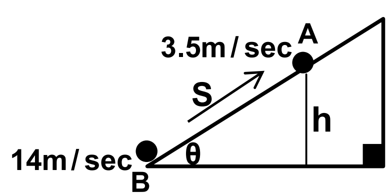
Q(20) an inclined smooth plane a body of mass 400gm is projected from the lowest point with a velocity 14m/sec up the plane find its potential energy when its velocity become 3.5m/sec then find its height from ground it this moment

$T_B = P_A + T_A$

$\frac{1}{2}\times0.4\times14^2 = P_A + \frac{1}{2}\times0.4\times3.5^2$

$\therefore P_A = 36.75$ joule

$0.4\times9.8\times h = 36.75$ j $\qquad \therefore h = 9.375m$



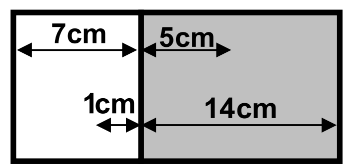
Q(21) A body of mass 300 gm is placed at the top of an inclined plane whose height is 1m. Find the velocity with which the body reaches the bottom of the plane knowing that the work done by the resistance force of the plane to the motion is equal to 1.59 Joules.

$$P_A = T_B + W \quad \therefore 0.3 \times 9.8 \times 1 = \frac{1}{2} \times 0.3 \times V^2 + 1.59$$
$$\therefore V^2 = 9 \quad \therefore V = 3\text{m/sec}$$

Q(22) Vertical target formed of two layers the thickness of the first 7cm and the thickness of the second 14cm Two bullets of equals mass are fired on the target with the same velocity in two opposite directions the first penetrate the first layer and penetrate 5cm from the second the second bullet penetrate the second and cover 1cm in the first find the ratio between the resistance of the two layers

$$\frac{1}{2}mV^2 = 7r_1 + 5r_2 \quad , \quad \frac{1}{2}mV^2 = 14r_2 + r_1$$

$$\therefore 7r_1 + 5r_2 = 14r_2 + r_1 \quad \therefore 6r_1 = 9r_2 \quad \therefore \frac{r_1}{r_2} = \frac{9}{6} = \frac{3}{2}$$



Q(23) A car of mass 5 tons moves with uniform velocity of magnitude 36 km/h ascending aslope inclined at tangle of sine $\frac{1}{40}$ to the horizontal against the resistance equivalent to2.5% of the car's weight. Find the power of the engine in horse. If the power of engine suddenly increases to 50 horses, find the magnitude of the car's acceleration directly after this increase

$$F = mg\sin\theta + \frac{2.5}{100}mg\sin\theta$$
$$\therefore F = 5000 \times 9.8 \times \frac{1}{40} + 5000 \times \frac{2.5}{100} \times 9.8 = 1225 + 1225 = 2450$$
$$P = F \times V = 2450 \times 36 \times \frac{5}{18} = \frac{24500}{9.8 \times 75} = \frac{100}{3}\text{horse}$$
$$50 \times 75 = F' \times 10 \qquad \therefore F' = 375\text{Kg.wt}$$
$$F' - R - mg\sin\theta = ma$$
$$375 \times 9.8 - 125 \times 9.8 - 5000 \times \frac{1}{40} \times 9.8 = 5000a \quad \therefore a = 0.245\text{m/sec}^2$$

Q(1) A particle moves in a straight line its velocity vector is given by The relation $V = \frac{1}{20}\left(400 - X^2\right)$ where x expresses the algebraic measure of the position, the algebraic measure of the acceleration of motion when X=10

①20 ②15 ③-25 ④-15

$a = \frac{dV}{dt} = \frac{dV}{dX} \times \frac{dX}{dt} = V\frac{dV}{dX} = \frac{1}{20}\left(400 - X^2\right) \times -\frac{1}{10}X$ at $X = 10$

$\therefore a = -15$

Q(2) The force $\vec{F} = 2\hat{i} + 7\hat{j}$ acts on a body of mass 5 kg for 10 seconds when its velocity vector $V = \hat{i} - 2\hat{j}$. then its velocity after the action of the force is ……..

①10m/sec ②11m/sec ③12m/sec ④13m/sec

$\vec{F} \bullet t = m(V - V_o)$ $\therefore 10(2\hat{i} + 7\hat{j}) = 5\left[V - (\hat{i} - 2\hat{j})\right]$ $\therefore 20\hat{i} + 70\hat{j} = 5V - (5\hat{i} - 20\hat{j})$

$\therefore 5V = 25i + 60j$ $\therefore V = 5\hat{i} + 12\hat{j}$ $\therefore V = \sqrt{5^2 + 12^2} = 13$

Q(3) A body of a mass 500 gm is let to fall from a height of 4.9 meters on the ground surface, then its momentum as it comes the ground is:

①2.45Kg.m/sec ②4.9Kg.m/sec ③2450Kg.m/sec ④4900Kg.m/sec

$V_o = 0$ $\because V^2 = 0^2 + 2 \times 9.8 \times 4.9$ $\therefore V = 9.8\text{m/sec}$

$H = mV = 0.5 \times 9.8 = 4.9\text{Kg.m/sec}$

Q(4) A car of mass 8 tons moves with a uniform velocity under the action of a constant resistance of a magnitude 6 Kg.Wt per each ton of its mass. Then the force of the car's engine equal …………Kg.wt

①45 ② 48 ③98 ④109

$6 \times 8 = 48$

Q(5) A variable force F (measured in Newton) acts up on a body where $F = 3S^2 - 4$, find the work done by this force in the interval from S = 2 m to S = 5 m.

①107 joule ② 105 joule ③106 joule ④100 joule

$W = \int_2^5 F dS = \int_2^5 \left(3S^2 - 4\right) dS = \left[S^3 - 4S\right]_2^5 = 105\text{joule}$

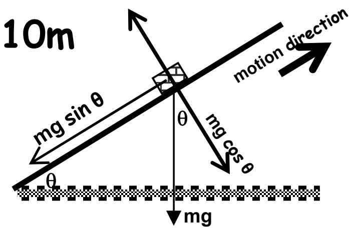
Q(6) A man of mass 70 kg is inside an electrical lift of mass 420 kg. If the lift moves vertically upwards with an acceleration of magnitude 70 cm/sec^2, then in Kg.Wt the tension in the rope carrying the lift equals ….Kg.Wt

① 455 ② 450 ③ 525 ④ 400

$T = m(g + a) = (70 + 420)(9.8 + 0.7) = 5145 \div 9.8 = 525 Kg.wt$

Q(7) A body of mass 2Kg is projected with velocity 1.4m/sec upwards along the line of greatest slope of a smooth inclined plane whose inclination to the horizontal is θ where $\sin\theta = \frac{1}{98}$ then the distance covered by the body until it stop

① 13m ② 12m ③ 9.8m ④ 10m

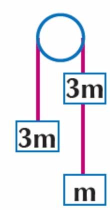


$-mg\sin\theta = ma \quad \therefore a = -g\sin\theta \quad \therefore a = -9.8 \times \frac{1}{98} = -0.1 m/sec^2$

$V^2 = V_o^2 + 2aS \quad \therefore 0^2 = 1.4^2 - 2 \times 0.1 \times S \quad \therefore S = 9.8m$

Q(8) In the opposite figure, 3 m and 3m are two masses connected by two ends of a string passing over a smooth small pulley. An additional mass m is attached to one of the two masses. If the system is let to move from rest, then the velocity of the system after 2 seconds = ...cm/sec.

① 140 ② 280 ③ 980 ④ 490



$a = \frac{m_1 - m_2}{m_1 + m_2} g \quad \therefore a = \frac{4m - 3m}{4m + 3m} g = \frac{1}{7} g = 1.4 m/sec^2 \quad \therefore V = 0 + 1.4 \times 2 = 28$

Q(9) body of mass 4 kg placed at rest on a smooth horizontal plane and is acted upon by a horizontal force of magnitude 5 new tons for 8 seconds. Then the impulse magnitude on the body and the velocity magnitude of the body after 8 seconds. Equals …….m/sec

① 9.8 ② 4.9 ③ 19.6 ④ 10

$5 \times 8 = 4(V - V_o) \quad \therefore 40 = 4(V - 0) \quad \therefore V = 10 m/sec$

Q(10) The time taken by a car of mass 1200 kg to reach the velocity 126 km/h from rest. If the power of the engine is constant and equal to 125 horses.

① 5sec ② 6sec ③ 7sec ④ 8sec

$$W = \int_0^t P dt = \int_0^t (125 \times 75 \times 9.8) dt = 91875\, t$$

$\because$ work = change in kinetic energy

$$\frac{1}{2} m (V^2 - V_o^2) = 91875t \quad \therefore \frac{1}{2} \times 1200 \left(126 \times \frac{5}{18}\right)^2 = 91875t \quad \therefore t = 8 sec$$

Q(11) A force of magnitude 5Kg.wt acts on a body at rest of mass 5Kg for 3 seconds the velocity of the body after this period equals…..

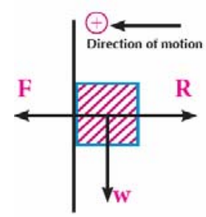
①28.4m/sec ②27.4m/sec ③30m/sec ④29.4m/sec

$5\times 9.8 = 5a \therefore a = 9.8$

$V = V_o + at \to V = 0 + 9.8\times 3 = 29.4 m/sec$

Q(12) A ball of mass 100 gm moves horizontally with velocity 9 m/sec to collide with a vertical wall and rebound back with velocity of magnitude 7.2 km/ h If the contact time of the ball with the wall is $\frac{1}{10}$ of second, then the pressure of the ball on the wall………………N

①11 ②11.98 ③11 ④11.1



$I = F\times t = m(V - V_o) \quad \therefore F\times\frac{1}{10} = 0.1\left(9 + 7.2\times\frac{5}{18}\right)$

$\therefore F = 11N \quad \therefore P = F = 11$

Q(13) A sphere of mass 5Kg move in a straight line with velocity 6m/sec collide with another sphere at rest of mass 8Kg it move it with velocity 5m/sec then the velocity of the first sphere after collide equals

①5m/sec ②-2 m/sec ③3 m/sec ④-4 m/sec

$5\times 6 + 8\times 0 = 8\times 5 + 5\times V_1^{/} \quad \therefore V_1^{/} = -2m/sec$

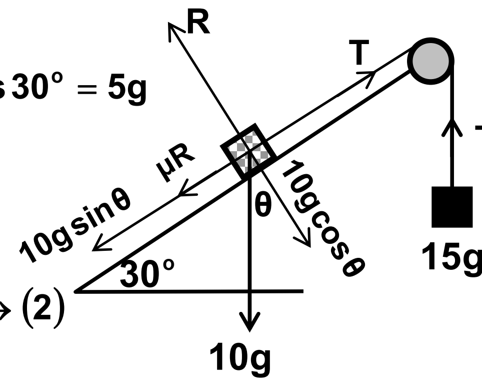
Q(14) A force F = 3t + 1acts upon a body at rest of mass, 4 kg starting its motion at the origin point "O" on the straight line. The velocity of the body after 2secons equals

① 2m/sec ② 4m/sec ③ 6m/sec ④ 8m/sec

$m\frac{dV}{dt} = 3t + 1 \quad \therefore \int m dV = \int (3t+1)dt \quad \therefore 4V = \frac{3}{2}t^2 + t$

after 2seconds $\quad \therefore 4V = \frac{3}{2}\times 2^2 + 2 = 8 \quad \therefore V = 2m/sec$

Q(15) A body of mass 10gm rests on a rough plane inclined by an angle of measure 30^o to the horizontal. The body is connected by a string which passes round a small smooth pulley fixed at the plane's top, to a body of mass 15gm which hangs vertically. If the coefficient of friction is $\frac{1}{\sqrt{3}}$, find the time which passes before the first body moves a distance 100cm on the plane, and obtain its speed then.



$R = 10g\cos\theta = 10g \times \cos 30^\circ \therefore \mu R = \frac{1}{\sqrt{3}} \times 10g \times \cos 30^\circ = 5g$

$mg\sin\theta = 10g \times \sin 30^\circ = 5g \therefore T = 15g$

$\because T > \mu R + mg\sin\theta$ the system move

10 move up and 15 move down

$\therefore T - \mu R - 10g\sin\theta = 10a \to (1)$, $15g - T = 15a \to (2)$

By adding

$15g - -\mu R - 10g\sin\theta = 25a$

$\therefore\ 15g - -5g - 5g = 25a \ \therefore\ 5g = 25a \ \therefore a = 1.96 m/sec^2$

<u>To get the time required to traverse a distance of 100cm starting from rest</u>

$S = Ut + \frac{1}{2}at^2 \qquad \therefore \quad 1 = \frac{1}{2} \times 1.96t^2 \quad \therefore t = \frac{5\sqrt{2}}{7}$ sec

---

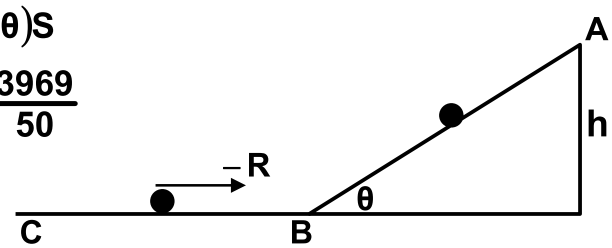
Q(16)A body was left to slide along an inclined plane which ends by a horizontal plane with the same rough , if the coefficient of friction equals $\frac{1}{4}$, the length of inclined plane is 9 meters and the inclined plane inclines by angle of measure θ where $Tan\theta = \frac{3}{4}$. Find the maximum distance covered by the body on the horizontal plane before come to rest. given that: the velocity of the body does not change in the two planes.

$P_A = T_B + W \qquad \therefore mgh = \frac{1}{2}mV^2 + \mu(mg\cos\theta)S$

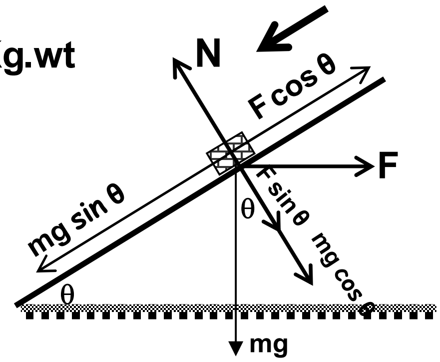
$\therefore 9.8 \times 5.4 = \frac{1}{2}V^2 + \frac{1}{4} \times 9.8 \times \frac{3}{5} \times 9 \qquad \therefore V^2 = \frac{3969}{50}$

$T_B - T_C = W = -rS = -\mu mg \times S$

$\therefore -\frac{1}{2}mV^2 = -\frac{1}{4}m \times 9.8 \times S \quad \therefore 16.2m$



Q(17) A body of mass 25 kg is placed on a smooth plane inclines with an angle of measure e where tan $\theta = \frac{4}{3}$. A horizontal force of magnitude 30 Kg.Wt, acts in the direction of the plane and its line of action lies in the vertical plane passing through the line of the greatest slope to the plane. Find the acceleration generated acceleration and the magnitude of the reaction force of the plane.



$F\cos\theta = 30\times\frac{3}{5} = 18\text{Kg.wt}$, $mg\sin\theta = 25\times\frac{4}{5} = 20\text{Kg.wt}$

$\because mg\sin\theta > F\cos\theta$

$\therefore$ The body moves downwards the plane with a uniform acceleration a where

$mg\sin\theta - F\cos\theta = ma$

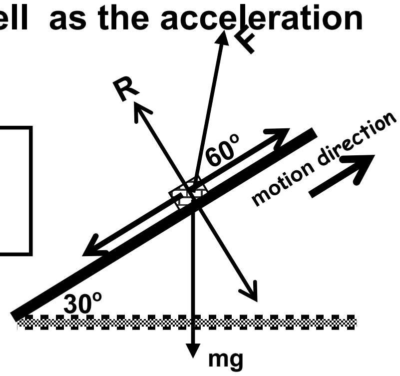
$\therefore 20\times 9.8 - 18\times 9.8 = 25a \quad \therefore a = \frac{98}{125}\text{m/sec}^2$

$N = F\sin\theta + mg\cos\theta$

$N = 39\text{Kg.wt}$

Q(18) A body of mass 2Kg was placed on a smooth plane inclined to the horizontal with an angle 30° the body was acted upon by a force of magnitude 14.7 Newton and directed upwards with an angle of measure 60° with the line of the greatest slope find in Kg.wt the magnitude of the reaction of the plane as well as the acceleration

$m = 2\text{Kg}$
$\theta = 30°$
$F = 17.4\text{N}$



$R = ?$
$a = ?$

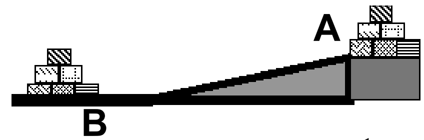
$R + F\sin 60° = mg\cos 30° \quad \therefore R + 17.7\times\frac{\sqrt{3}}{2} = 2\times 9.8\times\frac{\sqrt{3}}{2}$

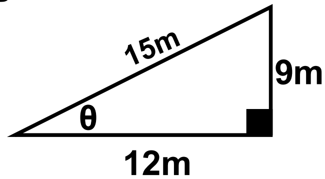
$\therefore R = 2.45\sqrt{3}\text{Newton} = 0.433\text{Kg.wt}$

$F\cos 60° - mg\sin 30° = ma$

$14.7\times\frac{1}{2} - 2\times 9.8\times\frac{1}{2} = 2a \qquad \therefore a = -1.225\text{m/sec}^2 = 1.225$ down wards

Q(19) **The boxes at a factory are transported by sliding them on an inclined plane of length 15 m and height 9 m. Find the velocity of the box which starts it motion from rest at the top of the plane at the base of the plane if the plane is smooth and the coefficient of the kinetic frictions equal to $\frac{1}{4}$**





$$P_A = T_B + W$$
$$mgh = \frac{1}{2}mV^2 + mg\cos\theta \times \mu \times S$$
$$9.8 \times 9 = \frac{1}{2}V^2 + 9.8 \times \frac{12}{15} \times \frac{1}{4} \times 15$$
$$88.2 = \frac{1}{2}V^2 + 29.4$$
$$\therefore \frac{1}{2}V^2 = 58.8 \quad \therefore V = \frac{14\sqrt{15}}{5}$$

Q(20) **A train of mass 625 tons ascend an inclined plane incline to the horizontal by an angle of sine $\frac{1}{5}$ with a uniform velocity if its engine done a work of magnitude 3×10^7 Kg.wt .m until it reach the top of the plane if the work done against the resistance equals 5×10^6 Kg.wt .m find the length of the plane and the value of the force and work done by the gravity and resistance per each ton Of its mass**

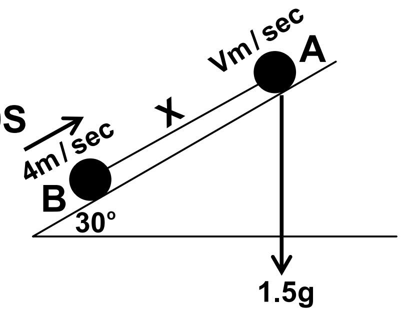
The train moves upwards with a uniform velocity

$$\therefore F = r + mg\sin\theta \quad \therefore FS = rS + mg\sin\theta S$$
$$\therefore 3 \times 10^7 = 5 \times 10^6 + 625000 \times \frac{1}{5}S \quad \therefore S = 200\text{m}$$
$$FS = 3 \times 10^7 \quad \therefore \quad F \times 200 = 3 \times 10^7 \quad \therefore F = 15 \times 10^4\text{Kg.wt}$$
$$\text{The weight work} = mg\sin\theta \times S = 625 \times 10^3 \times 9.8 \times \frac{1}{5} \times 200 = 25 \times 10^6$$
$$rS = 5 \times 10^6 \quad \therefore R = 40\text{Kg.wt/ton}$$

Q(21) **A body of mass 200 gm is placed at a top of an inclined plane of height 3 meters. Calculate the velocity by which the body reaches the bottom of the plane given that the work done by the resistance force of the plane to the motion is 4.48 Joule.**

$$P_A = T_B + W$$
$$0.2 \times 9.8 \times 3 = T + 4.48$$
$$\therefore T = 1.4 \quad \therefore \frac{1}{2}mV^2 = 1.4 \quad \therefore \frac{1}{2} \times 0.2V^2 = 1.4 \quad \therefore V = \sqrt{14}\text{m/sec}$$

Q(22) A ball of mass 1.5kg is projected up a rough plane inclined at an angle of 30º to the horizontal with a speed of 4 m/sec Given that the coefficient of friction between the particle and the plane is 0.2 find the distance the particle moves up the plane before coming to rest.



$T_B = P_A + W$

$\frac{1}{2}mV^2 = mgh + \mu RS \qquad \therefore \frac{1}{2}mV^2 = mgh + \mu mg\cos\theta S$

$\frac{1}{2}\times 4^2 = 9.8\times S\sin 30^\circ + 0.2\times 9.8\times\cos 30^\circ\times S$

$8 = 4.9S + 1.7S$

$8 = 6.6S \qquad \therefore S = 1.21m$

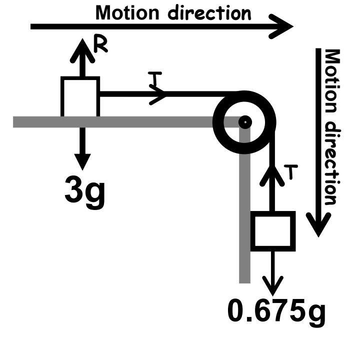
Q(23) A body is left to slide down a rough inclined plane along the line of greatest slope the plane incline to the horizontal by an angle its sine $= \frac{3}{5}$ if its velocity reached 4.9m/sec after 2.5 sec from start motion find the coefficent of friction between the body and the plane

$U = 0$, $V = 4.9m/sec$, $t = 2.5 \quad \therefore V = U + at \quad \therefore 4.9 = 0 + a(2.5) \quad \therefore a = 1.96 \ m/sec^2$

$mg\sin\theta - \mu R = ma \qquad \therefore mg\sin\theta - \mu(mg\cos\theta) = ma \ \div m$

$\therefore a = g\sin\theta - \mu g\cos\theta \qquad \therefore 1.96 = 9.8\times\frac{3}{5} - \mu\times 9.8\times\frac{4}{5} \qquad \therefore \mu = \frac{1}{2}$

Q(24) A body of mass 3kg placed on a smooth horizontal table, is connected by a string passing over a pulley at the table's edge to a body of mass 0.675kg. The horizontal part of the string is perpendicular to the table's edge. Find the acceleration of the system. If the motion starts from rest, Find : (a) the system's acceleration.
(b) The tension is the string. (c) The pressure on the pulley
(d) If the motion starts from rest, when the body of large mass is at a distance of 250 cm from the pulley, find its speed when just about to hit the pulley.



Equation of motion of the (3Kg) $T = 3a \rightarrow (1)$

Equation of motion of the (0.675Kg)

$0.675\times 9.8 - T = 0.675a \rightarrow (2)$

By adding 1,2 $\therefore 0.675\times 9.8 = 3a + 0.675a$

$\therefore a = \frac{0.675}{3+0.675}\times 9.8 = 1.8m/sec^2$

Part (b)By substituting in (1)

$\therefore T = 3a = 3\times 1.8 = 5.4N$

Part (c)$P = \sqrt{2}T = 5.4\sqrt{2}N$

Q(1) A particle moves in a straight line such that the relation between V and X is given in the form $V = \frac{5}{4+X}$ then the acceleration of motion when X = 6 meter

① $-\frac{1}{40}$ ② $-\frac{1}{20}$ ③ $-\frac{1}{20}$ ④ $-\frac{1}{10}$

$$a = V\frac{dV}{dX} = \frac{5}{4+X} \times \frac{-5}{(4+X)^2} \text{ at } X = 2 \quad \therefore a = -\frac{1}{40}$$

Q(2) particle moves in a straight line with initial velocity of a magnitude 8m/sec from a constant point on the straight line such that $a = 40\,e^{-x}$, Then The maximum velocity of the particle.

①12 ②10 ③14 ④16

$$a = V\frac{dV}{dX} \quad \therefore V\frac{dV}{dX} = 40e^{-X} \quad \therefore \int_8^V VdV = \int_0^X 40e^{-X}dX \quad \therefore \left[\frac{V^2}{2}\right]_8^V = -\left[40e^{-X}\right]_0^X$$

$$\therefore \frac{V^2}{2} - \frac{8^2}{2} = -40e^{-X} + 40 \quad \therefore \frac{V^2}{2} = -40e^{-X} + 72 \quad \therefore V^2 = -80e^{-X} + 144$$

$$\therefore V^2 = 144 - \frac{80}{e^X} \quad , \ e^X > 0 \quad , V \text{ maximum when } \frac{80}{e^X} \to 0 \quad \therefore V^2 = 144 \ \therefore V = 0$$

Q(3) A rocket of mass 4 tons including the fuel is launched at velocity 200 m/sec, and it throws out the fuel at a constant rate of a magnitude 100 kg per second. If the momentum is constant, then the velocity of the rocket after 20 seconds in km/h unit is:

① 800 ②500 ③960 ④ 400

$m = 4000 - 100t$ after 20seconds $m = 4000 - 100 \times 20 = 2000Kg$

$200 \times 4000 = 2000 \times V \ \therefore V = 400m/sec$

Q(4) An engine of mass 30 tons and force 51 ton.wt pulls a number of train cars each of 10 tons to ascend a slope inclined at 30º to the horizontal with a uniform velocity. If the resistance of the motion of the engine and the cars is 10 Kg.Wt per ton of the mass, then the number of cars is

① 7 ② 8 ③ 8 ④ 10

$$F = r + m\sin\theta \quad \therefore 51 \times 1000 = 10(30 + 10X) + (30000 + 10000X) \times \frac{1}{2}$$

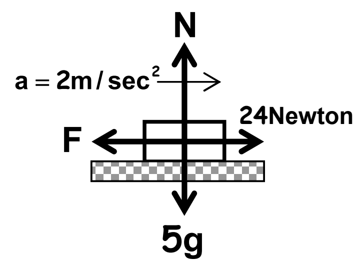
$$51000 = 300 + 100X + 15000 + 5000X \quad \therefore X = 7$$

Q(5) body of mass 70 kg is placed on a pressure scale on the floor of a lift moving with a uniform acceleration 1.4 m/sec^2 downwards, then the reading of the scale is......................... Kg.Wt.

① 60 ② 80 ③ 70 ④ 50

$$N = m(g-a) = 70(9.8-1.4) = 588N \div 9.8 = 60Kg.wt$$

Q(6) In the figures, a body of mass 5 kg is placed on a rough horizontal plane and the coefficient of the kinetic friction between the body and the body is μ_K each case, F is the friction force. Then μ_K =.......



① $\frac{5}{7}$ ② $\frac{4}{7}$ ③ $\frac{2}{7}$ ④ $\frac{3}{7}$

$F - \mu_K N = ma \quad \therefore 24 - 5g\mu_K = 5\times 2 \quad \therefore \mu_K = \frac{2}{7}$

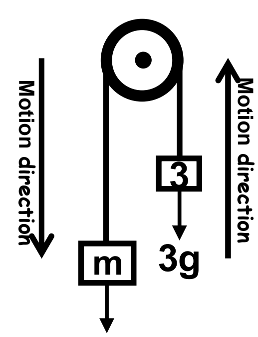
Q(7) a body is suspended in spring balance moving upwards with deceleration $\frac{2}{5}g$ then move downwards with acceleration $\frac{1}{5}g$ where g is the gravity acceleration then the ratio between the two reading of the balance in the two cases =........

① 1:2 ② 3:4 ③ 7:4 ④ 7:3

$$R_1 = m\left(g - \frac{2}{5}g\right) = \frac{3}{5}g \quad , \quad R_2 = m\left(g - \frac{1}{5}g\right) = \frac{4}{5}g \qquad \therefore \frac{R_1}{R_2} = \frac{3}{4}$$

Q(8) One end of a mass less rope is attached to a mass m; the other end is attached to a mass of 3 kg. The rope is hung over smooth pulley as shown in the figure. Mass m accelerates downward at 2.45 m/s^2 them the value of M=......Kg

① 3Kg ② 4Kg ③ 5Kg ④ 6Kg



$$mg - T = 2.45m \rightarrow (1) \quad , \quad T - 3g = 3\times 2.45 \rightarrow (2)$$

$$mg - 3g = 2.45m + 3\times 2.45 \quad \therefore 9.8m - 29.4 = 2.45m + 7.35$$

$$\therefore 7.35m = 36.75 \quad \therefore m = 5$$

Q(9) The work done to lift a mass of magnitude 200 gm placed on the ground surface a distance of 10 meters above the ground is equal to ………………… Joules.

① 0 ②9.8 ③19.6 ④29.4

$$W = F \times S = mg \times S = 0.2 \times 9.8 \times 10 = 19.6 \text{joule}$$

Q(10) A train of mass 375 tons and the power of its engine is 625 horses moves on horizontal ground with maximum velocity of magnitude 90 km/h, then the resistance which it encounters per ton of the train's mass = …………………………… Kg.Wt.

① 3 ② 4 ③ 5 ④ 6

$$P = F \times V \quad \therefore 625 \times 75 = F \times 90 \times \frac{5}{18} \quad \therefore F = 1875 \text{Kg.wt} = \frac{1875}{375} = 5 \text{ Kg/ton}$$

Q(11) A body of mass 500 gm is projected vertically upwards from a point on the ground surface with velocity 14.7 m/sec, then its potential energy after one second from projection= …………………………joule

①9.8 ②4.9 ③ 48.02 ④96.04

$$S = V_o t - \frac{1}{2} g t^2 \quad \therefore S = 14.7 \times 1 - \frac{1}{2} \times 9.8 \times 1^2 = 9.8 \text{m}$$

$$P = mgh = 0.5 \times 9.8 \times 9.8 = 48.02 \text{ joules}$$

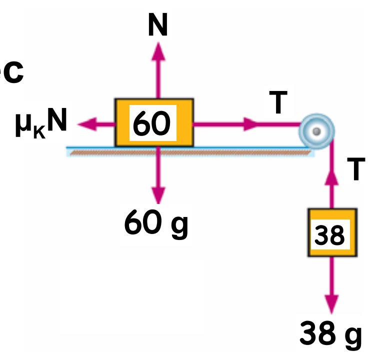
Q(12) The vertical distance between two bodies connected by the end of a light string passing over a smooth pulley fixed and suspended vertically is 100 cm after 2 seconds from the beginning of the motion. Then the velocity of each on that instant = ………………………cm/sec.

①49 ②25 ③100 ④50

$$S = V_o t + \frac{1}{2} a t^2 \quad \therefore \frac{100}{2} = 0 + \frac{1}{2} a (2)^2 \quad \therefore aa = 25 \text{cm/sec}^2$$

$$V = V_o + at = 0 + 25 \times 2 = 50 \text{cm/sec}$$

Q(13) A body of 60 gm is placed on a rough horizontal table, then connected by a string passing over a smooth pulley at the edge of the plane and a body of mass 38 gm is connected by the other end of the string. If the system moves from rest to travel a distance of 70 cm in one second, calculate the coefficient of friction if the string is cut at this moment. Calculate the distance which the first mass moves after that on the plane until it rests.



$S = V_o t + \frac{1}{2}at^2 \quad \therefore 70 = 0 + \frac{1}{2} \times a \times 1^2 \quad \therefore a = 140 cm/sec$

Equation of motion

$38g - T = 38a \rightarrow (1) \quad , \quad T - \mu_K N = 60a \rightarrow (2)$

$38g - \mu_K \times 60g = 96 \times 140 \qquad \therefore \mu_K = \frac{2}{5}$

After one second

$V = V_o + at \quad \therefore \quad V = 0 + 140 \times 1 = 140 cm/sec$

After the string is cut the mass 60 gm moves with deceleration on the rough plane until it rests

$-\mu_K N = 60a' \quad \therefore -\frac{2}{5} \times 60 \times 980 = 60a' \quad \therefore a' = -392 cm/sec^2$

$V^2 = V_o^2 - 2aS \quad \therefore 0 = 140^2 - 2 \times 392 \times S \quad \therefore S = \frac{140^2}{2 \times 392} = 25cm$

Q(14) A truck of mass 6 tons is moving at a maximum velocity of 54 Km/h *ascending* a road inclined to the horizontal with an angle of sine $\frac{1}{100}$ the truck was then reloaded at the top of the road with an additional weight of 1.5 tons , then returned to *descend* the same inclined road with a maximum velocity of 108Km/h find the magnitude of the resistance in Kg.wt assuming that it is constant as well as engine horse power

(b)during the ascend $\quad V_1 = 54 \times \frac{5}{18} = 15$

$\therefore P_1 = \left(r + 6000 \times \frac{1}{100} \right) \times 15 \qquad \therefore \quad P_1 = 15r + 900 \rightarrow (1)$

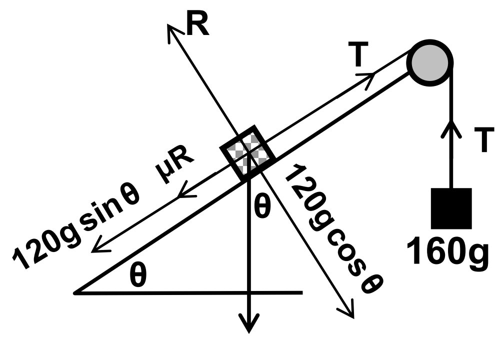
during descend: $\quad V_2 = 108 \times \frac{5}{18} = 30 m/sec$

$\therefore P_2 = \left(r + 7500 \times \frac{1}{100} \right) \times 30 \qquad \therefore \quad P_2 = 30r + 2250 \rightarrow (2)$

$15r + 900 = 30r + 2250 \qquad \therefore 15r = 1350N \qquad \therefore r = 90Kg.wt$

$P = 15 \times 90 + 900 = 2250 \div 75 = 30H$

Q(15) A body of mass 120gm rests on a rough plane inclined to the horizontal by an angle whose tangent is $\frac{3}{4}$ The body is connected, by a string which passes over a smooth pulley fixed at the top of the plane, to a body of mass 160gm. If the coefficient of friction is $\frac{2}{3}$, and the system starts its motion from rest, determine the distance traversed in three seconds.



$R = 120g\cos\theta = 120 \times \frac{4}{5}g = 96g$

$\mu R = \frac{2}{3} \times 96g = 64g$

$120g\sin\theta = 120 \times \frac{3}{5}g = 72g \quad , T = 160g$

$\because 160g > 64g + 72g$

$\therefore$ 120 move up , 160move down

$T - \mu R - 120g\sin\theta = 120a \rightarrow (1) \qquad 160g - T = 160a \rightarrow (2)$

by adding

$-\mu R - 120g\sin\theta + 160g = 280a$

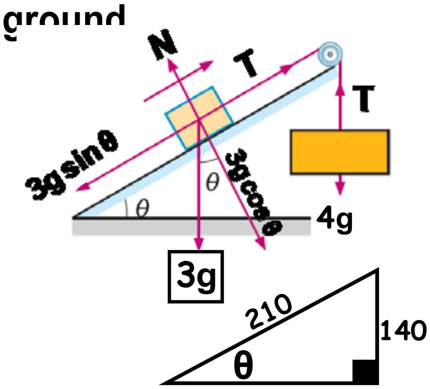
$-64g - 72g + 160g = 280a \qquad \therefore\ 24g = 280a \qquad \therefore a = 84\text{cm/sec}^2$

$U = 0 \quad , \quad t = 3\text{sec} \quad , a = 84\text{cm/sec}^2$

$S = \frac{1}{2} \times 84 \times 3^2 = 378\text{cm}$

---

(16) A body of mass 3 kg is placed at the lowest point of a smooth inclined plane of length 210cm and height 140 cm. This body is connected with another body of mass 4 kg by a string of length 210 cm, coincident to the line of the greatest slope of the plane and the other body is suspended at the upper edge of the plane. If the system starts to move from rest until the greater mass reaches the ground and gets at rest, find the distance which the small mass moves on the plane before it stops supposing that its motion is not acted as the greater mass impinges against the ground



$\because 4g > 3g\sin\theta$

Equation of motions :

$4g - T = 4a \rightarrow (1) \qquad T - 3g\sin\theta = 3a \rightarrow (2)$

$4g - 3g\sin\theta = 7a$

$$\therefore \quad a = \frac{4 \times 9.5 - 3 \times 9.8 \times \frac{2}{3}}{7} = 2.8\text{m/sec}^2$$

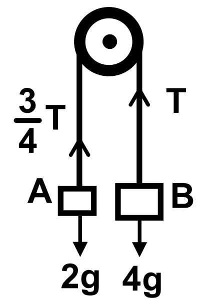
$\sin\theta = \frac{2}{3}$

After the body 4 kg reaches the ground, the body 3 kg moves on the plane with deceleration.

Q(17) A and B are Two bodies of masses of 2, 4 kg are tied at the two ends of a string which passes round a small rough pulley and as a result of roughness the tension in the string between the body A and the pulley equals $\frac{3}{4}$ the tension between the body B and the pulley

$4g - T = 4a \rightarrow (1)$, $\frac{3}{4}T - 2g = 2a \rightarrow (2) \rightarrow \times -2$

$4g - T - \frac{3}{2}T + 4g = 0 \qquad T = 31.36$, $a = 1.96 m/sec^2$



Q(18) An iron hammer of mass 210 kg falls down from a height of 90 cm on a foundation pole of mass 140 kg to push it in the ground for a distance of 18 cm. If the hammer and pole move as one body directly after collision, find the common velocity of each, then find in Kg.Wt the
average of the ground resistance supposing it is constant.

<u>For the hummer</u>

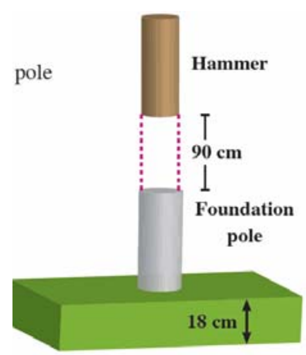
$V^2 = V_o{}^2 + 2gS \qquad \therefore V^2 = 0^2 + 2 \times 9.8 \times 0.9$

$V^2 = 17.64 \quad \therefore V = 4.2 m/sec$

After impact

$m_1V_1 + m_2V_2 = (m_1 + m_2)V'$

$210 + 4.2 + 140 \times \underbrace{0}_{\text{cylinder}} = 350V'$



$U = 2.52 \quad , V = 0 \quad , S = 0.18$

$V^2 = V_o{}^2 + 2aS \quad \therefore \quad 0 = 2.52^2 + 2a \times 0.18 \quad \therefore \quad a = -17.64 m/sec^2$

$mg - r = ma \quad \therefore \quad 350 \times 9.8 - r = 350 \times -17.64$

$3430 - r = -6174 \qquad \therefore \quad r = 9604N \quad \div 9.8 = 980 Kg.wt$

Q(19) A smooth sphere of mass 16gm moves in a straight line on a horizontal plane and when its velocity is 210 cm/sec it collides with another smooth sphere of mass 32gm at rest if the two spheres move after collision as one body find its velocity after collision . if this body moves after collision under the influence of a constant resistance of magnitude 24gm.wt find the distance which it travels until it comes to rest

$16\times 210+32\times 0=(16+32)V^{/}\Rightarrow V^{/}=70cm/sec$

The one body now moves under the action of a resistance 24gm.wt

$-r=ma \qquad \therefore -24\times 980=48a \qquad \therefore a=-490cm/sec^2$

$0=70^2-2\times 490\times S\Rightarrow S=5cm$

Q(20) The power of a machine is given by the relation $(8t-5)K$ and if the work done when t=3sec is 24 work unit then the work done when t=1sec=…

$P=\frac{dW}{dt}=8t-5 \quad \therefore dW=(8t-5)dt \quad \therefore W=\int(8t-5)dt \quad \therefore W=4t^2-5t+C$

$24=36-15+C \quad \therefore C=3 \quad \therefore W=4t^2-5t+3$ **when t=1** $\therefore W=2$

Q(21) A body slides from the top of an inclined plane of length 4.5m and height 2.7m starting from rest determine its speed and the time needed it to reach the bottom given that the coefficent of friction is 0.5

$mgh=\frac{1}{2}mV^2+\mu mg\cos\theta\times S \quad \div m$

$9.8\times 2.7=\frac{1}{2}V^2+0.5\times 9.8\times\frac{4}{5}\times 4.5 \qquad \therefore V=4.2m/sec$

$U=0 \quad , \quad V=4.2m/sec \quad , \quad S=4.5$

$\therefore V^2=U^2+2aS \quad \therefore 4.2^2=0+2a(4.5) \quad \therefore a=1.96m/sec^2$

$V=U+at \quad \therefore 4.2=0+1.96t \quad \therefore t=\frac{15}{7}sec$

Q(1) particle moves in a straight line such that the relation between V and X is given in the form $V^2 = 5(9 - X^2)$. then the acceleration of motion when the velocity vanishes

① ± 3 ② ± 15 ③ ± 10 ④ ± 150

$2V\frac{dV}{dX} = -10X \quad \therefore V\frac{dV}{dX} = -5X \quad \therefore a = -5X$ acceleration vanish when V=0

$\therefore 9 - X^2 = 0 \quad \therefore X = \pm 3 \quad \therefore a = \pm 15$

Q(2) If $V = 3t^2 - 2t$, $X = 1$ when $t = 0$ then :X=….

① $6t - 2$ ② $3t^2 - 2t + 1$ ③ $t^3 - t^2 + 1$ ④ $t^3 - t^2 - 1$

$X = \int (3t^2 - 2t)dt = t^3 - t^2 + C \quad \therefore C = 1 \quad \therefore X = t^3 - t^2 + 1$

Q(3) A clay ball of mass 1kg fell down from a height of 40cm on a pressure scale and the collision (impact) time is $\frac{1}{7}$ of seconds, then the scale reading given that the ball did not rebound after the impact….Kg.wt

① 1 ② 2 ③ 3 ④ 4

$V^2 = V_o{}^2 + 2gS \quad \therefore V^2 = 0 + 2 \times 9.8 \times 0.4 \quad \therefore V = 2.8\text{m/sec}$

$F \times t = m(V' - V) \quad \therefore F \times \frac{1}{7} = 1(0 - 2.8) \quad \therefore F = \frac{19.6}{9.8} = 2\text{Kg.wt}$

scale reading $= 1 + 2 = 3\text{Kg.wt}$

Q(4) A body of mass m kg moves under the action of the , where F is in Newton, then the magnitude of the $3m\hat{i} + 4m\hat{j}$ force acceleration of motion in m/sec$_2$ unit is:……….

①3 ②4 ③5 ④7

$F = ma \quad \therefore \sqrt{(3m)^2 + (4m)^2} = 5m = ma \quad \therefore a = 5\text{m/sec}^2$

Q(5) The work done to move a mass of magnitude 600 gm a distance 4m with acceleration of magnitude 20 cm / sec^2 is equal to ……joules

①4.8 ②4.5 ③2 ④3.2

$F = ma = 600 \times 20 = 12000\text{Dyne} \quad \therefore W = F \times S = 120000 \times 400$

$48000000 \div 10^7 = 4.8\text{joules}$

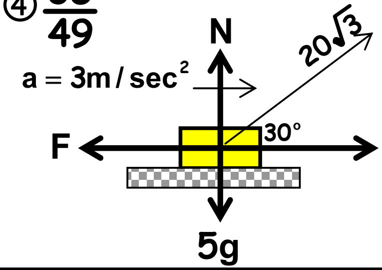
Q(6) The power of a train's engine is 504 horses and its mass is 216 tons moves on a horizontal railway with its maximum velocity against resistances equivalent to 5 Kg.Wt per each ton of its mass, then its maximum velocity in km /h. equals …………………

① 35 ② 126 ③ 200 ④ 105

$F = r = 5 \times 216 = 1080 \text{ Kg.wt} \quad \therefore V = \frac{P}{F} = \frac{504 \times 75}{1080} = 35 m/sec \times \frac{18}{5} = 126 \, Km/h$

Q(7) In the figures, a body of mass 5 kg is placed on a rough horizontal plane and the coefficient of the kinetic friction between the body and the body is μ_K each case, F is the friction force. Then μ_K =…….

① $\frac{35}{48}$ ② $\frac{30}{48}$ ③ $\frac{35}{49}$ ④ $\frac{35}{49}$



$F\cos\theta - \mu_K N = ma \quad \therefore 40\cos 30^\circ - \mu_K 5g = 5 \times 3$

$\mu 5g = 20\sqrt{3}\cos 30^\circ - 15 \quad \therefore \mu 5g = 30 \quad \therefore \mu = \frac{6}{g} = \frac{30}{49}$

Q(8) A body of mass 300 gm placed at the top of an inclined plane of height 2 m reaches the bottom of the plane if the magnitude of work done against the resistance is equal to 2.13 joule. Then its velocity when it reach the bottom of the plane equal …………………..

①4 ②5 ③25 ④7

$P = T + W \quad \therefore 0.3 \times 9.8 \times 2 = \frac{1}{2} \times 0.3 \times V^2 + 2.13 \quad \therefore 0.15V^2 = 3.75 \quad \therefore V = 5 m/sec$

Q(9) A body of weight 40Kg.wt descends with uniform velocity on an inclined plane , making an angle of measure 30° with the horizontal then the resistance of the plane equals …………Kg.wt

① 10 ② 15 ③ 20 ④ 30

$r = mg\sin\theta \quad \therefore \quad r = 40 \times 9.8 \times \sin 30^\circ = 20 Kg.wt$

Q(10) The force $F = 2i + 7\,j$ acts on a body of mass 5 kg for 10 seconds when its velocity vector V=i-2j Find its velocity after the action of the force if the force magnitude is in Newton unit and the velocity is in m/sec unit.

① 10 ② 12 ③ 13 ④ 14

$I = F \times t = 10\left(2\hat{i} + 7\hat{j}\right) = 20\hat{i} + 70\hat{j}$, $I = m(V - V_o) = 5\left(V - \left(\hat{i} - 2\hat{j}\right)\right)$

$\therefore 20\hat{i} + 70\hat{j} = 5\left(V - \left(\hat{i} - 2\hat{j}\right)\right) \ \therefore V - \left(\hat{i} - 2\hat{j}\right) = 4\hat{i} + 14\hat{j} \ \therefore V = 5\hat{i} - 12\hat{j} \therefore V = \sqrt{5^2 + 12^2} = 13$

Q(11) The forces $F_1 = 2i - j$, $F_2 = i + 5j$ act in a body of unit mass for $\frac{1}{2}$sec then The impulse of the force in Newton .sec=…….

① 5.5 ② 3 ③ 1.5 ④ 2.5

$F \times t = \sqrt{3^2 + 4^2} \times \frac{1}{2} = 2.5$

Q(12) A tank moves with a uniform velocity on a horizontal road against resistance equals 90Kg.wt per each ton of its mass if the force of motor of the tank =4500Kg.wt then the mass of the tank equals

① 20 ② 30 ③ 40 ④ 50

$F = r \therefore 90 \times 9.8m = 4500 \times 9.8 \ \therefore m = 50Kg$

Q(13) A body of mass m=$(2t + 5)$Kg and its position vector $r = \left(\frac{1}{2}t^2 + t - 5\right)C$ The magnitude of the force acting on the body when t= 10seconds equals r measured in meter then F=….Newton

① 25 ② 47 ③ 55 ④ 1375

$F = \frac{d}{dt}mv = \frac{d}{dt}(2t + 5)(t + 1) = 2(t + 1) + (2t + 5)$ at t=10 F=47N

Q(14) **Train of mass 220 tons moves a long horizontal straight railroad with a uniform velocity of magnitude 29.4 m/sec. During the train's motion, the last car of mass 24 tons is separated and moves with a uniform retardation to stop completely after one minute of the separation moment. Find The distance between the remaining part of the train and the separated car at the moment the car is completely at rest given that the remaining part of the train moves with a uniform acceleration**

first with respect to the separated car

$V = V_o + at \quad \therefore 0 = 29.4 + a \times 60 \quad \therefore a = -0.49 m/sec^2$

$S = V_o t + \frac{1}{2} at^2 \quad \therefore S = 29.4 \times 60 - \frac{1}{2} \times 0.49 \times 60^2 = 882m$

$-r = ma \quad \therefore -r = 24000 \times -0.49 \quad \therefore r = 11760N = 1200 Kg.wt = \frac{1200}{24} = 20/ton$

Second: study the motion of the train before separation
a The train was moving with a uniform velocity before separation m = 220 ton`
The moving force = the total resistances resistance $F = 50 \times 220 = 11000$
Third: study the motion of the remaining part of the train after the last car has been separated

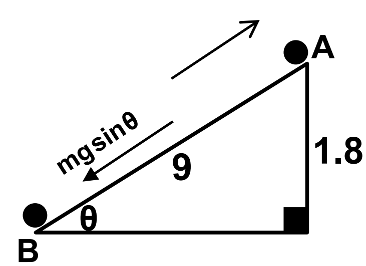
$F - r = ma \quad \therefore 11000 \times 9.8 - 196 \times 50 \times 9.8 = 196000a \quad \therefore a = \frac{3}{50} m/sec^2$

$S = V_o t + \frac{1}{2} at^2 \quad \therefore S = 29.4 \times 60 + \frac{1}{2} \times \frac{3}{50} \times 60^2 = 1872$

The distance between the remaining part of the train and the separated car at the moment of its rest= 1872 - 882= 990 meters

Q(15) A body of mass 15Kg descends from the state of rest alng the line of the greatest slope of an incline plane of height 1.8m and length 9m starting from the top of the plane given that magnitude of the plane resistance equals 600gm.wt find the work done by the resultant force acting on the body and magnitude of its velocity when it reaches the bottom of the plan

Work againest resistance



Work by the weight $= \frac{600}{1000} \times 9.8 \times 9 = 52.92$ joules

$= 15 \times 9.8 \times \frac{1.8}{9} \times 9 = 264.6 joules$

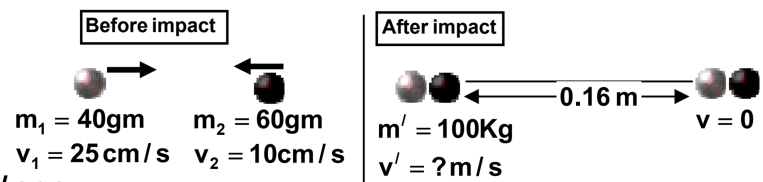
Resultant work =264.6-52.92=211.68 joules

$P_A = T_B + P_B + W$ (agaiest resiratnce)

$15 \times 9.8 \times 1.8 = \frac{1}{2} mV^2 + 52.92 \quad \therefore \frac{1}{2} \times 15 \times V^2 = 211.68$

$V = 5.3 m/sec$

Q(16) Two spheres of mass 40gm , 60gm move in a horizontal straight line in opposite directions the two spheres collide when their velocities were 25cm/sec and 10cm/sec respectively to form one body which came to rest after traveling a distance of 16cm under the influence of a constant resistance . find the velocity of the one formed body directly after collision (4cm/sec) The resistance to the one formed body



$40 \times 25 - 60 \times 10 = 100 \times V' \quad \therefore \; V' = 4cm/sec$

The one body now moves with a velocity 4cm/sec and cover a distance 10cm till come to rest

$U = 4 \;,\; S = 10 \;, V = 0$

$\therefore V^2 = U^2 + 2aS \quad \therefore \; 0 = 4^2 + 2 \times a \times 16 \quad \therefore \; 0 = 16 + 32a \quad \therefore \quad 32a = -16 \; \because a = -0.5 \; cm/sec^2$

The equation of motion of the one body is $-r = ma$ r is the resistance

$\therefore -r = 100 \times -0.5 = -50 \quad \therefore \quad r = 50 \; dyne$

Q(17) A body slides on a rough plane inclined at 45o to the horizontal . if the coefficient of the kinetic friction between the body and the plane is equal to $\frac{3}{4}$ prove that the time taken by the body to travel any distance is equal twice the time taken by the body to travel the same distance if the plane is smooth supposing the body starts to slide from rest in both cases

first : on the smooth plane :

$$a = g\sin\theta = 9.8 \times \frac{\sqrt{2}}{2} m/sec^2$$

$$\therefore S = V_o t + \frac{1}{2}at^2 \qquad \therefore S_1 = \frac{1}{2} \times 9.8 \times \frac{\sqrt{2}}{2} t_1^{\,2} \rightarrow (1)$$

second : on the rough plane :

$$mg\sin\theta - \mu N_K = ma \quad \therefore 9.8 \times \frac{\sqrt{2}}{2} - \frac{3}{4} \times 9.8 \times \frac{\sqrt{2}}{2} = a \quad \therefore a = \frac{1}{4} \times 9.8 \times \frac{\sqrt{2}}{2}$$

$$\therefore S = V_o t + \frac{1}{2}at^2 \qquad \therefore S_2 = \frac{1}{2} \times \frac{1}{4} \times 9.8 \times \frac{\sqrt{2}}{2} t_2^{\,2} \rightarrow (2)$$

$$\because S_1 = S_2 \qquad \therefore t_1^{\,2} = \frac{1}{4} t_2^{\,2} \qquad \therefore t_2^{\,2} = 4t_1^{\,2} \qquad \therefore t_2 = 2t_1$$

Q(18) ball of mass 100 gm is let to fall down of a height 3.6 m on horizontal ground to collide with it and rebounds vertically upwards. If the loss in the kinetic energy of the ball due to the collision with the ground is 1.96 Joules, calculate the distance by which the ball rebounded back after it collided with the ground

$V^2 = V_o{}^2 + 2gS \quad \therefore V^2 = 0^2 + 2\times 9.8\times 3.6 = 70.56 \quad \therefore V = 8.4\text{m/sec}$

$T = \frac{1}{2}mV^2 = \frac{1}{2}\times 0.1\times 8.4^2 = 3.528 \text{ joules}$

The ball impact the ground and lost 1.96 joules

$T = 3.528 - 1.96 = 1.568 \text{ joules}$

$\frac{1}{2}mV^2 = 1.564 \quad \therefore \frac{1}{2}\times 0.1\times V^2 = 1.568 \quad \therefore V^2 = 31.36 \quad \therefore V = 5.6\text{m/sec}$

$V^2 = V_o{}^2 + 2gS \quad \therefore 0^2 = 5.6^2 - 2\times 9.8\times S \quad \therefore S = 1.6\text{m}$

(19)A car of mass 4 tons moves with a maximum velocity of 72Km/h <u>on a horizontal</u> straight road the resistance of which is 30Kg.wt for every ton of the car calculate the horsepower of its engine if the car *<u>ascends</u>* a road inclined to the horizontal with an angle θ such that $\sin\theta = \frac{1}{20}$ find the maximum velocity of the car in Km/h if the resistance is the same on both roads

<u>**on the horizontal**</u>

$F = r = 4\times 30 = 120\text{KG.wt} \quad , V = 72\times\frac{5}{18} = 20\text{m/sec}$

$\text{power} = 2400\text{Kg.wt.m/sec} \qquad = 2400 \div 75 = 32\text{horses}$

<u>**on the inclined plane**</u>

$F' = r + mg\sin\theta \qquad \therefore F' = 120 + 4000\times\frac{1}{20} = 320\text{Kg.wt}$

$320V' = 32\times 75 \qquad \therefore V' = 7.5\text{m/sec}$

(20)A body of mass 1Kg . is placed on a smooth horizontal surface . A force of magnitude 8 Newton's acts on this body for $\frac{1}{2}$second. During the absence of the force action this body collides with another body of mass 2Kg. and the first body rebounds with velocity 2m/sec find the velocity of the second body directly after collision

$I = F\times t = m(V' - V) \quad \therefore 8\times\frac{1}{2} = 1(V' - 0) \quad \therefore V' = 4\text{m/sec}$

$\therefore 1\times 4 + 2\times 0 = 1\times -2 + 2\times V \quad \therefore V = 3\text{m/sec}$

Q(21)A balloon is ascending vertically upward A body of mass 5Kg fell down from the balloon when its height was 40.4m from the ground . if the kinetic energy of the body when hitting the ground was 2940 joules (neglecting the air resistance to its motion) find :

(1)The velocity of the balloon at the instant that the body fall down form it

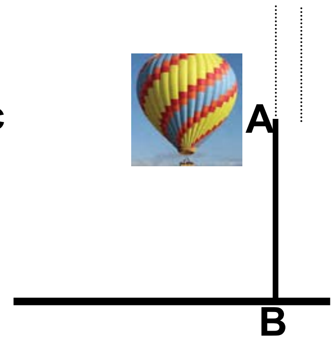
(2)The distance traveled by the body from the instant of its fall till it hits the ground

$T_A + P_A = T_B + P_B$

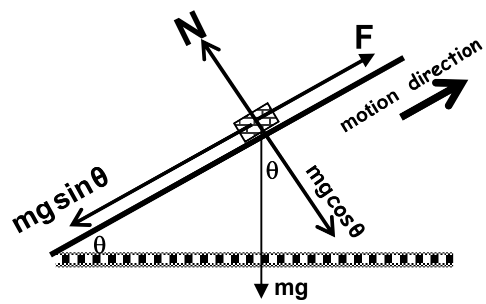
$\frac{1}{2} \times 5 \times V^2 + 5 \times 9.8 \times 40.4 = 2940 + 0 \quad \therefore V = 19.6 m/sec$

$V^2 = V_o{}^2 - 2gS \quad \therefore S = \frac{(19.6)^2}{2 \times 9.8} = 19.6m$

Total distance $= 2 \times 19.6 + 40.4 = 79.6m$



Q(22) body of mass 12 kg is placed on a smooth plane inclines at 30°, to the horizontal. A force of magnitude 88.8 Newton acts in the direction of the line of the greatest slope upwards the plane. Find the velocity of this body after 14 seconds from the beginning of the motion. If the force acting on the body is ceased at this moment, find the distance which the body moves on the plane after that until it is at rest.



$mg\sin\theta = 12 \times 9.8 \times \sin 30^o = 58.8N$

$\because F > mg\sin\theta \therefore$ the motion is upward

$F - mg\sin\theta = ma$

$\therefore 88.8 - 58.8 = 12a \quad \therefore a = 2.5 m/sec^2$

After 14 seconds

$V = V_o + at \quad \therefore V = 0 + 2.5 \times 14 = 35 m/sec$

If the force acting on the body is ceased

$a' = -g\sin\theta = -4.9 m/sec^2$

The body travels a distance S until it reaches the instantaneous rest where

$V^2 = V_o{}^2 + 2aS \quad \therefore \quad 0 = 35 - 2 \times 4.9 \times S \quad \therefore S = 125m$

Q(1) A particle moves in a straight line such that $V = 3e^{t+2}$ then its starting (initial) velocity is equal to

① 3 ② 3e ③ $3e^2$ ④ e^2

Put t=0 $\therefore V = 3e^2$

Q(2) If V = 3t - 2 , then s in the interval [0 , 2] is….. unit length

① 1 ② 2 ③ 3 ④ 4

$$X = \int_0^2 (3t-2)dt = \left[\frac{3}{2}t^2 - 2t\right]_0^2 =$$

Q(3) A particle moves in a straight line such that its displacement S is given as by the relation $S = t^3 - 6t^2 + 9t$ where is measured in meter and t in second. Then the distance covered during the first five seconds.

① 28m ② 20m ③ 29m ④ 25m

$V = 3t^2 - 12t + 9 = 0 \quad \therefore V = 0$ when t=3 or t=1

$$\left[t^3 - 6t^2 + 9t\right]_0^1 + \left[t^3 - 6t^2 + 9t\right]_1^3 + \left[t^3 - 6t^2 + 9t\right]_3^5 = 4 + 4 + 20 = 28$$

Q(4) A body of mass 48 gm, moves in a straight line such that a = (3t - 12) m/sec2. then the change of momentum in the following time intervals:[1,3]

① 576 ② 12 ③ 500 ④ 600

$$48\int_1^3 (3t-12)dt = 576$$

Q(5) A body of mass $m = (0.2t + 1)$ where gm. Moves with a constant velocity 10m/sec Then the magnitude of the acting force on the body at any moment t is ……..Dyne

① 2 ② 3 ③ 4 ④ 5

$$F = \frac{dH}{dt} = \frac{d}{dt}(mV) = \frac{d}{dt}10(0.2t+1) = 2$$

Q(6) A bullet of mass 7 gm is shot vertically from the barrel of a pistol with velocity 245 m/sec on a vertical barrier of wood to embed in it for 12.25 cm before being at rest. Then the wood resistance to the bullet given that it moves in a retarded motion equals …………

① 17.15N ② 175Kg.wt ③ 175N ④ 1715Kg.wt

$r \times S = \frac{1}{2}mV^2 \quad \therefore r \times 0.1225 = \frac{1}{2} \times 7 \times 10^{-3} \times 245^2 \quad \therefore r = 175\text{Kg.wt}$

Q(7) A , B are two bodies move with velocities 80 km/h, 100 km/h respectively If the distance between them is 30 km. then:
The time taken to meet if they move in opposite direction….. minutes.

① 5 ② 10 ③ 20 ④ 30

$V = (80+100) \times \frac{5}{18} = 50\text{m/sec} \quad \therefore t = \frac{S}{V} = \frac{30000}{50} = 600\,\text{sec} = 10\,\text{minutes}$

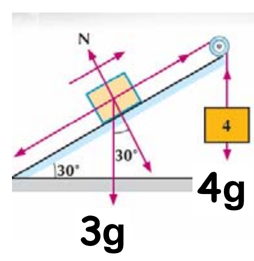
Q(8) A force F acts on a body of mass 500gm .if the body gains the acceleration $a = 6i + 8j$ where a is measure in m/sec^2 then F=…..Newton

① 2 ② 4 ③ 5 ④ 10

$F = ma = 0.5(6,8) = (3,4) \quad \therefore F = \sqrt{3^2 + 4^2} = 5$

Q(9) The body 3 kg is placed on the smooth inclined plane and connected by the body 4 kg suspended vertically : the tension in the string equal

① 50 ② 52.2 ③ 49.2 ④ 32.2

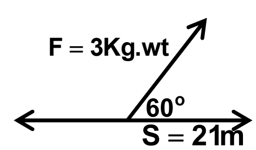


$4g - T = 4a \rightarrow (1) \quad , T - mg\sin\theta = 3a \rightarrow (2)$

$4g - 3g\sin 30^\circ = 7a \quad \therefore 2.5g = 7a \quad \therefore a = 3.5\text{m/sec}^2$

$T - 3 \times 9.8 \times 0.5 = 3 \times 3.5 \quad \therefore T = 52.2$

Q(10) In the opposite figure: a constant force of 3Kg.wt in direction incline to the horizontal 60° upwards it move it a distance 21 m then the work done by this force equals ……joules



① 30 ② 31.5 ③ 41.5 ④ 63

$W = 3\cos 60^\circ \times 21 = 31.5$ joules

Q(11) A body of mass 140gm placed on rough plane a horizontal force of magnitude 4900dyne acts make it move with acceleration 105cm/sec^2 then The coefficient of friction equals ………..

① $\frac{1}{3}$ ② $\frac{1}{4}$ ③ $\frac{1}{2}$ ④ $\frac{1}{5}$

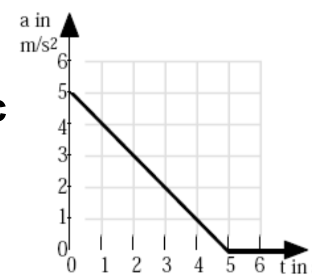
$F - \mu R = ma \quad \therefore 49000 - \mu \times 140 \times 980 = 140 \times 105 \quad \therefore \mu = \frac{1}{4}$

Q(12) Two spheres of masses 3Kg and 4Kg moving in a straight line in the opposite direction with velocities 5m/sec , 4m/sec they collide the second rebounded after 1impact with velocity 3m/sec then the velocity of the second equals ….m/sec

①1 ②2 ③3 ④4

$3 \times 5 - 4 \times 4 = 3 \times -3 + 4 \times V_2^{/} \quad \therefore V_2^{/} = 2\text{m/sec}$

Q(13) Starting from rest at time t = 0, a car moves in a straight line with an acceleration given by the opposite graph. What is the speed of the car at t = 3 s?



①1m/sec ②2m/sec ③6m/sec ④10.5m/sec

$V = \int_0^3 a\,dt = \frac{2+5}{2} \times 3 = 10.5 m/\sec$

Q(14) A body of mass 200 gm is projected vertically upwards with velocity 49 m/sec, then its potential energy at the maximum height the body reaches = ...joule

①300 ②4900 ③9.8 ④240.1

$\frac{1}{2} mV^2 = \frac{1}{2} \times 0.2 \times 49^2 = 240.1$

Q(15) A zeppelin of mass 105 kg, moves vertically downwards with a uniform acceleration of magnitude 98 cm/ sec^2. Find the magnitude of the air rising force acting on the zeppelin in kg. If a body of mass 35 kg is let to fall from the zeppelin when the velocity of the zeppelin was 490 cm/sec, find the distance between the zeppelin and the fallen body after $\frac{20}{7}$ seconds from the separation moment.

before falling the body : $mg - F = ma$

$105 \times 9.8 - F = 105 \times 0.98 \quad \therefore F = 926.1$ newton

after falling the body : $mg - F = ma$

$70 \times 9.8 - 926.1 = 70a \quad \therefore a = -3.43 m/sec^2$

the distance of the zeppelin from the instant of falling of the body

$$S = V_o + \frac{1}{2}at^2 \quad = 4.9 \times \frac{20}{7} + \frac{1}{2} \times -3.43 \times \left(\frac{20}{7}\right)^2 = 0$$

i.e. The zeppelin moves by deceleration till stop instantaneously

then return to the point of projection after $\frac{20}{7}$sec

<u>The motion of the falling body</u>

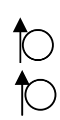
$$S = V_o + \frac{1}{2}at^2 \quad = 4.9 \times \frac{20}{7} + \frac{1}{2} \times 9.8 \times \left(\frac{20}{7}\right)^2 = 54m$$

Q(16) A body of mass $\frac{1}{2}$Kg projected vertically upwards with a velocity 20m/sec After one second another body of equal mass is projected vertically upwards with a velocity 25.3m/sec the two bodies collide at a distance (S) m from the point of projection Find(S) and the velocities of the two bodes before impact .if the second body rebound after impact with velocity equal half the velocity of the first after impact find this velocity and the impulse of the two spheres on the other

$S_1 = S_2 \qquad \therefore 20(t+1) - \frac{1}{2} \times 9.8(t+1)^2 = 25.3t - \frac{1}{2} \times 9.8t^2$

$20t + 20 - 4.9(t^2 + 2t + 1) = 25.3t - 4.9t^2$

$\therefore 20t + 20 - 4.9t^2 - 9.8t - 4.9 = 25.3t - 4.9t^2 \quad \therefore 15.1t = 15.1 \quad \therefore t = 1sec$



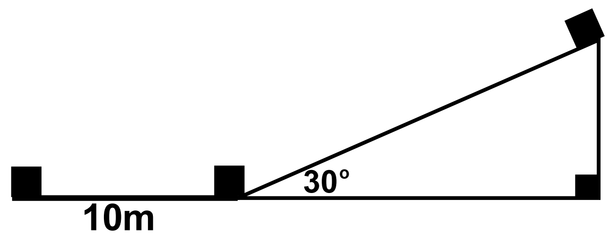
They will collide: when S= 20.4m

$V_1 = \sqrt{20^2 - 2 \times 9.8 \times 20.4} = 0.4 m/sec$, $V_2 = \sqrt{25.3^2 - 2 \times 9.8 \times 20.4} = 15.5 m/sec$

$0.5 \times 0.4 + 15.5 \times 0.5 = \frac{1}{2}V - \frac{1}{2} \times \frac{1}{2}V \quad \therefore V = 31.8 m/sec$

$I = 0.5(31.8 - 0.4) = 15.7$

Q(17) A body of mass 60Kg is at the top of an inclined plane with the horizontal angle 30^o initially at rest it begins to move down under influence of gravity And travels 50m on the frictionless surface before the surface becomes level the level surface is frictionless for 10 meters then has a friction if the object is to stop in less than 20 m from the point where it level the frictionless surface find the coefficient of friction



$a = g\sin 30^\circ = 4.9 m/sec^2$

$U = 0$, $a = 4.9 m/sec^2$, $S = 50$

$V^2 = 0^2 + 2 \times 4.9 \times 50 = 490$

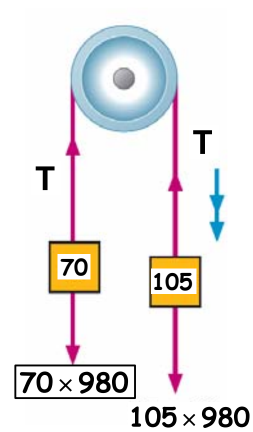
$0^2 = 490 + 2 \times a \times 20 \quad \therefore a = -12.25 m/sec^2$

$-r = ma \quad \therefore \quad -r = 60 \times -12.25$

$\therefore r = 735N$

$\mu(mg) = 735 \quad \therefore \quad \mu = 1.25$

Q(18) Two bodies of masses 105 gm and 70 gm are connected by the two ends of a light string of constant length passing over a smooth small pulley and suspended vertically. If the system starts to move from rest when the two masses are on one horizontal plane, find the magnitude of the acceleration of motion of the system. If the first body is impinged against the ground after it traveled 50 cm, find the total time taken by the second body from the beginning of motion until it instantaneously rests.



$105 \times 980 - T = 105a \rightarrow 1 \quad , \quad T - 70 \times 980 = 70a \rightarrow 2$

By adding 1,2

$\therefore 175a = 34300 \quad \therefore a = \frac{34300}{175} = 196 cm/sec^2$

At the moment the body of mass 105 gm impinges against
The ground, it takes time t_1

$V^2 = V_o^2 + 2aS \quad \therefore V^2 = 0 + 2 \times 196 \times 50 \quad \therefore V = 140 cm/sec$

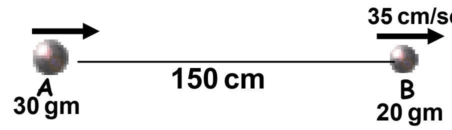
$V = V_o + at \quad \therefore 140 = 0 + 196t \quad \therefore t = \frac{140}{196} = \frac{5}{7} sec$

When the body of mass 105 gm impinges against the ground, the body of mass 70 gm, moves vertically upwards with a gravitational acceleration beginning with velocity V0 = 140 cm/sec. to rest instantaneously after time

$0 = 140 - gt \quad \therefore t = \frac{1}{7} sec$ The body of mass 70 gm takes time of magnitude t to reach the instantaneous rest from $t = \frac{1}{7} + \frac{5}{7} = \frac{6}{7}$

Q(19) A , B are two points on the same smooth horizontal plane and the distance between them 150cm .A smooth sphere of mass 30gm starts motion from from rest with unifrom acceleration $10cm/sec^2$ from the point A towards B And at the same instant another smooth sphere of mass 20gm starts motion with uniform velocity of magnitude35cm/sec from the point B in the same direction of the first sphere prove that the two sphere will collide find the magnitude of the velocity of the one body after impact

Let the time taken by each sphere until impact (t) sec



$S_1 = Ut + \frac{1}{2}at^2 \quad \therefore S_1 = \frac{1}{2} \times 10t^2 = 5t^2$

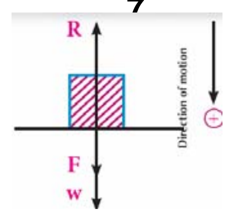
$S_2 = Vt \quad = 35t$

$S_1 - S_2 = 150 \quad \therefore 5t^2 - 35t = 150 \quad \therefore 5t^2 - 35t - 150 = 0 \quad \therefore t = 10 sec$

$V_1 = U + at = 10 \times 10 = 100 cm / sec$

$30 \times 100 + 20 \times 35 = (30 + 20)V \quad \therefore V = 74 cm/sec$

Q(20) Rubber ball of mass 200 gm falls down from a height of 3.6 m above the ground and it rebounds back after collision at a height of 2.5 m. Find the ground reaction on the ball in Kg.Wt given that the collision time with the ground is $\frac{1}{7}$sec



<u>From A to B</u>

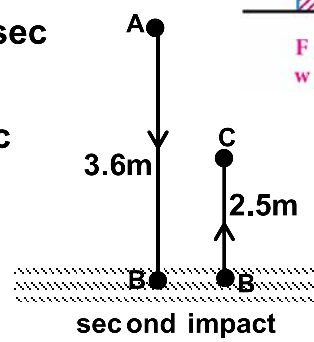
$V^2 = V_o{}^2 + 2gS \quad \therefore V^2 = 0^2 + 2 \times 9.8 \times 3.6 \quad \therefore V = 8.4 m/sec$

<u>From A to B</u>

$V^2 = V_o{}^2 + 2gS \quad \therefore 0 = V_o{}^2 - 2 \times 9.8 \times 2.5 \quad \therefore V = 7 m/sec$

$I = 0.2\ (7 + 8.4) = F \times \frac{1}{7} \quad \therefore F = 21.56N$

$R = F + W = 21.56 + 0.2 \times 9.8 = 23.52N$



Q(21) A bullet is fired on a target of thickness 9 cm and exits from the other side with half velocity before it enters the target. What is the least thickness needed for a target of the same material in order the bullet not to exit from if it is fired with its previous velocity?

$\frac{1}{2}mV^2 - \frac{1}{2}m\left(\frac{1}{4}V^2\right) = r \times 9 \quad \therefore \frac{3}{8}mV^2 = 9r \to (1) \quad , \quad \frac{1}{2}mV^2 = Sr \to (2)$

by dividing : $\frac{4}{3} = \frac{S}{9} \quad \therefore S = 12cm$

Q(1) particle moves in a straight line and the equation of its motion $X = \tan t$ then the acceleration of motion a is equal to

① $\sec^2 t$ ② $2\sec t$ ③ 2VX ④ VX

$$V = \frac{dX}{dt} = \sec^2 t \;\therefore a = \frac{dV}{dt} = 2\sec t \sec t \times \tan t = 2\sec^2 t \tan t = 2VX$$

Q(2) If $V = t^3 - 3t^2 + 2t$, then the distance covered within the time interval [0 , 3]

① $\frac{1}{4}$ ② $\frac{1}{2}$ ③ $\frac{9}{4}$ ④ $\frac{11}{4}$

$$V = 0 \;\therefore t\left(t^2 - 3t + 2\right) = 0 \quad \therefore t = 0,\, t = 1,\, t = 2$$

$$S = \int_0^3 V.dt = \int_0^1 V.dt + \int_1^2 V.dt + \int_2^3 V.dt = \frac{1}{4} + \left|-\frac{1}{4}\right| + \frac{9}{4} = \frac{11}{4}$$

Q(3) A particle moves in a straight line such that its displacement S is given as by the relation $S = t^3 - 6t^2 + 9t$ where is measured in meter and t in second. then the displacement covered during the first five seconds.

① 28m ② 20m ③ 29m ④ 25m

$V = 3t^2 - 12t + 9 = 0 \;\therefore V = 0$ when t=3 or t=1

$$\left[t^3 - 6t^2 + 9t\right]_0^1 + \left[t^3 - 6t^2 + 9t\right]_1^3 + \left[t^3 - 6t^2 + 9t\right]_3^5 = 4 - 4 + 20 = 20$$

Q(4) The momentum of a body of mass 700 gm moving in a straight line starting with velocity of magnitude 15 m/sec and with a uniform acceleration 2.5 m/sec^2 in the same direction of its initial velocity after 12 sec from the beginning of motion is equal to ....kg.m/sec.

① 31.5 ② 31500 ③ 315 ④ 300

$$V = V_o + at \quad \therefore V = 15 + 2.5 \times 12 = 45 \text{m/sec}$$

$$\therefore H = MV = \frac{700}{1000} \times 45 = 31.5 \text{ Kg.m/sec}$$

Q(5) An engine does work of magnitude 15000 kg.wt.m during 10 seconds, then the power of the engine in horse ....

①7350 ②10 ③20 ④735

$$\frac{15000}{10 \times 75} = 20 \text{horse}$$

Q(6) If a body of mass m =(2t +3) kg moves in a straight line and its displacement vector as a function of time is given by the relation $S = \left(\frac{3}{2}t^2 + 2t\right)\hat{C}$, S is measured in meter and (t) in second, then the magnitude of the force acting upon the body after 1sec equals

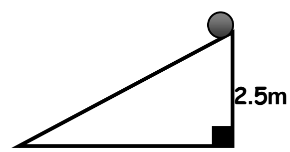
① 20 ② 25 ③ 30 ④ 35

$V = 3t + 2 \quad , H = mV \quad , F = \frac{d}{dt}H = \frac{d}{dt}(2t+3)(3t+2)$

$2(3t+2) + 3(2t+3) = 10 + 15 = 25$

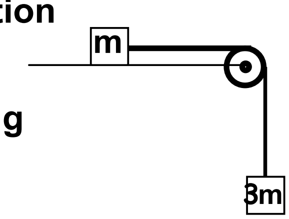
Q(7) In the opposite figure: A smooth inclined plane of height 2.5 m. A body is placed at the top of the plane and is let to descend on the plane, then it reaches the base of the plane with velocity

① 7 ② 14 ③ 24 ④ 30



$\frac{1}{2}mV^2 = mgh \quad \therefore \frac{1}{2} \times V^2 = 9.8 \times 2.5 \quad \therefore \; V = 7\text{m/secc}$

Q(8) In the opposite figure: the small pulley and the plane are smooth. If the system moves from rest, then the magnitude of the acceleration of the system = ……………………m/sec^2.



① g ② $\frac{1}{4}g$ ③ $\frac{3}{4}g$ ④ $\frac{1}{2}g$

$a = \frac{3m}{3m+m}g = \frac{3}{4}g$

Q(9) If a force of magnitude 90 Newton acts upon a body of mass 10 kg for five seconds, then the magnitude of the change of the velocity of the body in the same direction of the force is equal to:

① 45m/sec ② 50m/sec ③ 90m/sec ④ 120m/sec

$I = F \times t = m(V' - V) \quad \because 90 \times 5 = 10(V' - V) \quad \therefore (V' - V) = 45\text{m/sec}$

Q(10) the least acceleration by which a man of mass 75 kg can slide on a survival rope from a fire if the rope cannot stand tension more than 50 Kg.Wt. Find the velocity of the man after landing 30 meters given that the acceleration is uniform.

① 14m/sec ② 196m/sec ③ 4.9m/sec ④ 19.6m/sec

$T = m(g - a) \quad \therefore 50 \times 9.8 = 75(9.8 - a) \quad \therefore a = \frac{49}{15}\text{m/sec}^2$

$V^2 = 0^2 + 2 \times \frac{49}{15} \times 30 \quad \therefore V = 14\text{m/sec}$

Q(11) If a constant force of magnitude 5 Kg.Wt acts on a rested body of mass 49 kg for 3 seconds, then the velocity of the body by the end of this time = ...m/sec

① 1m/sec ② 2m/sec ③ 3m/sec ④ 4m/sec

$F \times t = m(V - V_o) \quad \therefore 5 \times 9.8 \times 3 = 49(V - 0) \quad \therefore V = 3\text{m/sec}$

Q(12) Machine does work at a uniform rate = 18000 Kg.Wt. m per minute, then the power of the machine = ...horses.

① 4 ② 5 ③ 6 ④ 10

$P = \frac{18000}{60 \times 75} = 4\text{horses}$

Q(13) A ball of mass 300 gm moves horizontally to collide with a vertical wall when its velocity is60 m/sec. If it rebounds after losing $\frac{2}{3}$ of its velocity, then the change of its momentum due to the collision with the wall= ....Kg. m/sec.

① 20 ② 21 ③ 24 ④ 28

After impact V= $\frac{1}{3} \times 60 = 20\text{m/sec} \quad \Delta H = 0.3(20 + 60) = 24\ \text{Kg.m/sec}$

Q(14) A bullet of mass 20 gm collides with a constant barrier of wood when its velocity was 700 m/sec to embed in it for a distance of 5 cm. Calculate the resistance of wood supposing it is constant in Kg.Wt.

① 100 ② 1000 ③ 10000 ④ 98000

$\frac{1}{2}mV^2 = r \times S \quad \therefore \frac{1}{2} \times 0.02 \times 700^2 = r \times 0.05 \quad \therefore r = 98000$ Newton

$= \frac{98000}{9.8} = 10000\text{Kg.wt}$

Q(15) A box slides across a frictionless floor with an initial speed v = 3.5 m/s. It encounters a rough region where the coefficient of friction is = 0.5
1) What is the shortest length of rough floor which will stop the box?

$-r = ma \quad \therefore \ -\mu mg = ma \quad \therefore \ a = -\mu g = -0.5 \times 9.8 = -4.9 m/sec^2$
$U = 3.5 m/sec \quad , \ V = 0 \quad , \ a = -4.9$
$V^2 = U^2 + 2aS \quad \therefore \ 0 = 3.5^2 - 2 \times 4.9 \times S \quad \therefore \ S = 1.25m$

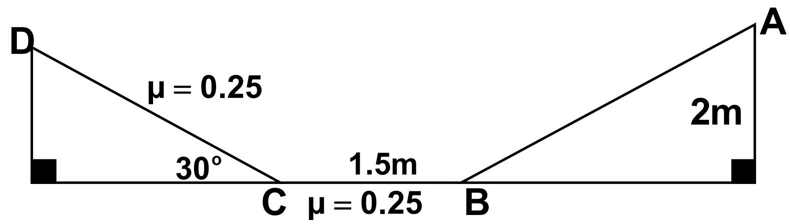
Q(16)A smooth sphere of mass 16gm moves in a straight line on a horizontal plane and when its velocity is 210 cm/sec it collides with another smooth sphere of mass 32gm at rest if the two spheres move after collision as one body find its velocity after collision . if this body moves after collision under the influence of a constant resistance of magnitude 24gm.wt find the distance which it travels until it comes to rest

$16 \times 210 + 32 \times 0 = (16 + 32)V' \Rightarrow V' = 70 cm/sec$
The one body now moves under the action of a resistance 24gm.wt
$-r = ma \quad \therefore -24 \times 980 = 48a \quad \therefore a = -490 cm/sec^2$
$0 = 70^2 - 2 \times 490 \times S \Rightarrow S = 5cm$

Q(17) A body of mass 94.5 kg is placed in a box of mass 52.5 kg, then raised vertically upwards by a movable rope with an acceleration of magnitude 1.4 m/sec^2. Find the magnitude of the pressure of the body on the box base and the magnitude of the tension in the rope carrying the box. If the rope is cut, find the pressure of the body on the box base on that time.

(1) $N = m(g + a) = 94.5(9.8 + 1.4)N = 108 Kg.wt$
(2) $T = m(g + a) = 147(9.8 + 1.4) = 168 Kg.wt$
(3) $N = m(g - g) = 0$

Q(18) A block of mass 6 kg slides from rest at a height of 2 m down to a horizontal surface where it passes over a 1.5 m rough patch. After crossing this patch it climbs up another incline which is at an angle of 30° to the ground. The rough patch has a coefficient of friction = 0.25. What height does the block reach on the incline before it comes to rest



From A to B:

$P_A = T_B$

$mgh = \frac{1}{2}mv^2$

$6 \times 9.8 \times 2 = \frac{1}{2} \times 6V^2 \quad \therefore V^2 = 39.2$

From B to C:

$-r = ma \quad \therefore -\mu mg = ma \quad \therefore \ a = -0.25 \times 9.8 = -2.45 m/sec^2$

$V^2 = U^2 + 2aS \quad \therefore \ V^2 = 39.2 + 2 \times -2.45 \times 1.5 = 31.85$

From C to D:

$-mg\sin\theta - r = ma \quad \therefore -mg\sin 30° - \mu mg\cos\theta = ma$

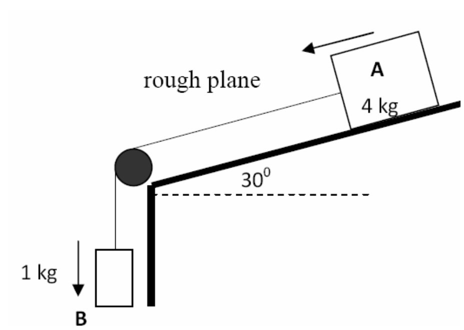
$-9.8 \times \sin 30° - 0.25 \times 9.8 \times \cos 30° = a \quad \therefore a = -7.022 m/sec^2$

$V^2 = U^2 + 2aS \quad \therefore \quad 0 = 31.85 - 2 \times 7.022 \times S \quad \therefore S = 2.27m$

Q(19) A 4 kg block A on a rough 30°inclined plane is connected to a freely hanging 1 kg block B by a mass-less cable passing over the frictionless pulley as shown in the figure . When the objects are released from rest, object A slides down the inclined plane with a friction force of 6 N. Calculate:

(a) The acceleration of the objects and

(b) The tension in the cable.



The body 4Kg :

$mg\sin\theta + T - 6 = 4a \rightarrow 4 \times g \times \frac{1}{2} + T - 6 = 4a$

$2g + T - 6 = 4a$

The body 1Kg :

$1g - T = 1a \rightarrow (2)$

$3g - 6 = 5a \quad \therefore \quad a = 4.68 m/sec^2$

Q(20) A car of mass one ton moves with uniform velocity of magnitude 54Km/h along a horizontal road . If this car ascends with the same velocity another inclined to the horizontal with an angle of $\sin e = \frac{1}{50}$ find the increase of the power of the car in horse assuming that the resistance on the two roads are equal

The motion on the horizontal road

$V = 54 \times \frac{5}{18} = 15 m/sec$

$F = R \quad \therefore \quad power = 15R watt$

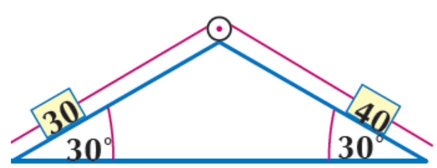
The motion on the inclined plane

$F' = R + mg\sin\theta = R + m \times 9.8 \times \frac{1}{50}$

$power = \left(R + 1000 \times 9.8 \times \frac{1}{50}\right) \times 15$

Increase of the power $= 15R + 20 \times 15 \times 9.8 - 15R = 4$ horse

Q(21) In the opposite figure, two masses of 40 gm, 30 gm connected by the two ends of a light string passing over a smooth small pulley fixed at the top of two smooth opposite planes inclined at 30° to the horizontal as shown in the figure. The system is being kept in equilibrium when the two bodies are on one horizontal line and the two parts of the string are tensioned. If the system is let to move from rest, find the acceleration and the vertical distance between the two bodies after one second from the beginning of the motion.



with respect to 40

$40g\sin 30^\circ - T = 40a \rightarrow (1)$

with respect to 40

$T - 30g\sin 30^\circ = 30a \rightarrow (2)$

$40g\sin 30^\circ - 30g\sin 30^\circ = 70a$

$10g\sin 30^\circ = 70a \quad \therefore a = 0.7 m/sec^2$

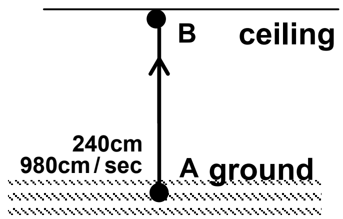
After one second $\therefore V = V_o + at \quad \therefore V = 0 + 0.7 \times 1 = 0.7$

$V^2 = V_o^2 + 2aS \quad \therefore 0.7^2 = 0 + 2 \times 0.7 \times S \quad \therefore S = 0.35m$

vertical distance $0.35 \times \sin 30^\circ = 0.175$

vertical distance between them is 0.35m

(22) from a point 240cm under the ceiling of a room a ball of mass 40gm projected with a velocity 980cm/sec vertically upwards it collide with the ceiling If the change in momentum as a result of impact is 40000gm.cm/sec Find the rebound velocity



$U = 980cm/sec$, $g = -980cm/sec^2$, $S = 240cm$

$V^2 = U^2 - 2gS \quad \therefore \; V = \sqrt{980^2 - 2 \times 980 \times 240} = 700cm/sec$

$H = m(V' + V) \quad \therefore \; 40000 = 40(700 + V') \quad \therefore V' = 300cm/sec$

Q(23) The power of an engine is 1080 horses and its mass is 50 tons pulling a train of mass 130 tons on a rough horizontal plane with acceleration 49 cm/sec^2. If the air resistance and friction are equivalent to 10 Kg.Wt per each ton of the mass, calculate the maximum velocity the train can travel in km/h.

on the horizontal : $F = R + ma$

$\therefore F = 10 \times 9.8 \times 180 + 130 \times 10^3 \times 0.49 \quad \therefore F = 105840$ Newton

$P = 1080 \times 735$ watt

$V = \frac{P}{F} = \frac{1080 \times 735}{105840} = 7.5m/s \quad \times \frac{18}{5} = 27Km/h$

Q(24) A force of magnitude 12.6 Newton's acts on a rested body placed on a horizontal plane for a period of time to acquire kinetic energy of magnitude 9 Kg.Wt.m by the end of this time. At this instant, the momentum of the body reaches 42 kg.m/sec, then this force is ceased and the body returns back to rest once again after it traveled a distance of 21m from the instant of ceasing the force. Find the mass of the body and the resistance of the plane to the motion of the body in Newton supposing it is constant, then find the time of action of this force.

$T = \frac{1}{2}mV^2 = 9 \times 9.8 \rightarrow (1)$, $H = mV = 42 \rightarrow (2)$

by dividing 1,2 $\therefore \frac{1}{2}V = 2.1 \quad \therefore V = 4.2m/sec$, $m = 10Kg$

$V^2 = V_o^{\,2} + 2aS \quad \therefore \; 0 = (4.2)^2 + 42A \quad \therefore a = -0.42m/sec^2$

$-r = ma' \quad \therefore \; 12.6 - 4.2 = 10a \quad \therefore a' = 0.84m/sec^2$

$V = V_o + at \quad \therefore 4.2 = 0 + 0.24t \quad \therefore t = 5$

Q(1) If V = 3X then the value of (a) when X = 2 equals..............

① 4 ② 5 ③ 6 ④ 8

$$\frac{dV}{dX}=3\,,\ a=V\frac{dV}{dX}=3X \ \text{ when } X=2 \quad \therefore a=3\times 2=6$$

Q(2) A body of mass (K) Kg moves under the action of a force F=3Ki+4Kj where F is measure by Newton then its acceleration equals ……m/sec^2

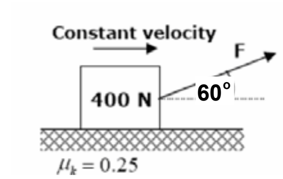
① 4 ② 5 ③ 6 ④ 8

$$\|F\|=\sqrt{(3K)^2+(4K)^2}=5K \quad , \because F=ma \quad \therefore 5K=Ka \quad \therefore \ a=5m/sec^2$$

Q(3) A 400 N block is pushed along a rough horizontal surface ($\mu_K=0.25$) by an applied force F as shown the block moves at a constant velocity then the magnitude of F is …..Newton's

① 100 ② 101 ③ 200 ④ 400

$$F\cos 60^\circ=0.25\times 400 \quad \therefore F=200N$$



Q(4) If a body of mass the unity moves in a straight line such that the acceleration of the body is given by the relation a = 4t + 2 where a is measured in m/sec^2 , t in second , then the change of momentum of the body in the time interval [2, 6] is equal to .... kg m/sec.

① 74 ② 70 ③ 72 ④ 75

$$\int_2^6 (ma)dt=\int_2^6 (4t+2)dt=\left[2t^2+2t\right]_2^6=72$$

Q(5) A force F = 3t + 1 acts upon a body at rest of mass, 4 kg starting its motion at the origin point "O" on the straight line. then V when t = 2 seconds.

① 0.5 m/sec ② 1 m/sec ③ 2 m/sec ④ 4 m/sec

$$\int_0^2 F\,dt = m(V - V_o) \quad \therefore \left[\frac{3t^2}{2} + t\right]_0^2 = 4V \quad \therefore 4V = 8 \quad \therefore V = 2\text{m/sec}$$

Q(6) A body is suspended in a hook of a spring scale fixed at the top of a lift moving vertically upwards and the apparent weight of the body is twice the actual weight, then the acceleration then a = ...m/sec^2

① $\frac{1}{2}$g ② 2g ③ $\frac{1}{4}$g ④ g

$$R = mg + ma \qquad \because R = 2mg \qquad \therefore\ 2mg = mg + ma \qquad \therefore a = g$$

Q(7) A body of mass K kg is suspended in a spring balance fixed in the ceiling Of a lift moving upwards with an acceleration 0.2m/sec^2 if the reading of the spring balance equal 5Kg wt then the mass of the body equals .....

① 4.1Kg ② 9.8Kg ③ 4.8Kg ④ 4.9Kg

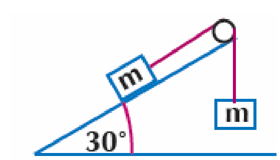
$$R = m(g + a) \quad \therefore 5 \times 9.8 = m(9.8 + 0.2) \quad \therefore \quad m = 4.9\text{Kg}$$

Q(8) In the opposite figure: the plane and pulley are smooth. When this system moves, then its acceleration =....

① mg ② $\frac{1}{4}$mg ③ 4mg ④ $\frac{1}{3}$mg

$$mg - T = ma \rightarrow (1) \quad , \quad T - mg\sin 30^\circ = ma \rightarrow (2)$$

$$mg - \frac{1}{2}mg = 2ma \quad \therefore \frac{1}{2}mg = 2ma \quad \therefore a = \frac{1}{4}mg$$



Q(9) If a constant force of magnitude 5 Kg.Wt acts on a rested body of mass 49 kg for 3 seconds, then the velocity of the body by the end of this time = ...m/sec.

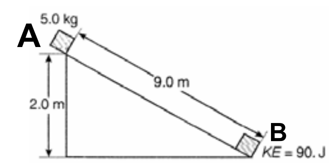
① 28.5 ② 20 ③ 3 ④ 29.4

$$I = F \times t = m(V - V_o) \quad \therefore 5 \times 9.8 \times 3 = 5(V - 0) \quad \therefore V = 29.4 m/sec$$

Q(10) 5Kilogram mass sliding 9meters down an inclined from a height of 2meters in 3 seconds the object gain 90joules kinetic energy while sliding Then the work is done against friction as the mass slides the 9 meters….joules

① 0 ② 90 ③ 8 ④ 45

$$P_A = T_B + W$$
$$5 \times 9.8 \times 2 = 90 + W \quad \therefore W = 8$$



Q(11) A particle of mass 2 kg is moving with velocity (5i + j) m/sec when it receives an impulse of (–6i + 8j) N S. Find the kinetic energy of the particle immediately after receiving the impulse.

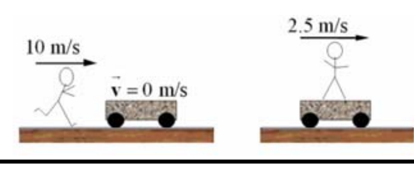
①23 ②24 ③29 ④30

$$I = (-6\hat{i} + 8\hat{j}) = 2(V - (5\hat{i} + \hat{j})) \quad \therefore -3\hat{i} + 4\hat{j} = V - 5\hat{i} - \hat{j} \quad \therefore V = 2\hat{i} + 5\hat{j}$$
$$T = \frac{1}{2} m \|V\|^2 = \left(\sqrt{2^2 + 5^2}\right)^2 = 29$$

Q(12) A 50Kg boy run at a speed of 10m/sec and jump onto a cart the cart is initially at rest if the speed of the cart with the boy on it is 2.5m/sec then the mass of the cart is ……Kg

①50 ②150 ③200 ④250

$$50 \times 10 + m \times 0 = (m + 50) \times 2.5$$
$$500 = 2.5 \times (m + 50) \quad \therefore m + 50 = 200$$
$$\therefore m = 150$$



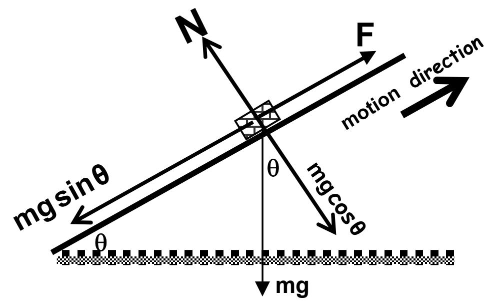
Q(13) A force of magnitude 20 Newton and its direction making acute angle of sine $\frac{3}{5}$ to the vertical downwards acts on a body of mass 2 kg placed on a smooth horizontal table. Find the acceleration of the body generated from this action and the perpendicular reaction of the table.

$$20 \times \frac{4}{5} = 2a \quad \therefore a = 8 m/sec^2$$

Q(14) man of mass 70 kg is inside an electrical lift of mass 420 kg. If the lift moves vertically upwards with an acceleration of magnitude 70 cm/sec^2, find in Kg.wt the magnitude for each of the tension in the rope carrying the lift and the pressure of the man on the floor of the lift.

$$T = m(g + a) = (70 + 420)(9.8 + 0.7) = 5145N = 525Kg.wt$$
$$R = 70(9.8 + 0.7) = 75Kg.wt$$

Q(15) body of mass 12 kg is placed on a smooth plane inclines at 30^o, to the horizontal. A force of magnitude 88.8 Newton acts in the direction of the line of the greatest slope upwards the plane. Find the velocity of this body after 14 seconds from the beginning of the motion. If the force acting on the body is ceased at this moment, find the distance which the body moves on the plane after that until it is at rest.



$$mg\sin\theta = 12 \times 9.8 \times \sin 30^o = 58.8N$$

$\because F > mg\sin\theta \therefore$ the motion is upward

$$F - mg\sin\theta = ma$$

$$\therefore\ 88.8 - 58.8 = 12a \quad \therefore a = 2.5 m/sec^2$$

After 14 seconds

$$V = V_o + at \quad \therefore V = 0 + 2.5 \times 14 = 35 m/sec$$

If the force acting on the body is ceased

$$a^{/} = -g\sin\theta = -4.9 m/sec^2$$

The body travels a distance S until it reaches the instantaneous rest where

$$V^2 = V_o^{\ 2} + 2aS \quad \therefore \quad 0 = 35 - 2 \times 4.9 \times S \quad \therefore S = 125m$$

Q(16) A rubber ball of mass 14 kg fell down from a height of 10 meters above the ground and rebounded after collided with the ground for a height of 2.5 meters. Find the impulse resulted from the collision (impact) of the ball with the ground and identify the reaction of the ground on the ball if the contact time of the ball with the ground is $\frac{1}{10}$ of second.

Solution

Studying the phase of falling down

$\because v^2 = v_{.}^2 + 2g\,s$

$\therefore v^2_1 = 0 + 2 \times 9.8 \times 10$

$\therefore v_1 = 14$ m/sec

It is the velocity of the ball be for it contacts directly with the ground.

Studying the phase of rebound back

$\because v^2 = v2. + 2g\,s$

$\therefore 0 = v_2^2 - 2 \times 9{,}8 \times 2{,}5$

$\therefore v_2 = 7$m/sec

$\therefore$ The velocity of rebound back = 7m/sec vertically up wards

impulse = Change of momentum $= m(v_2 - v_1)$

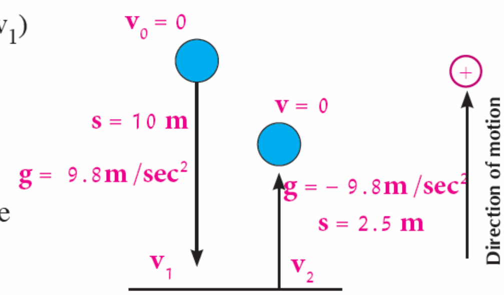
$= \frac{1}{4}[7 - (-14)] = 5.25$ kg . m/sec

$\because$ impulse = F . t $\quad \therefore 5.25 = F \times \frac{1}{10}$

$\therefore$ F = 52.5 newton

The reaction of the ground on the ball = impulsive force + weight of the ball

$= 52.5 + \frac{1}{4} \times 9.8 = 54.95$ newton

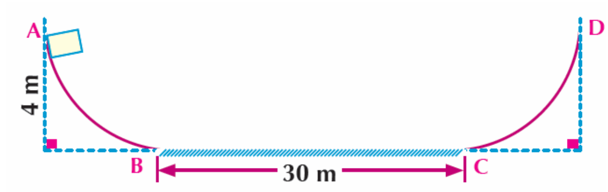


Q(17) <u>In the opposite figure</u> :a cube of wood of mass 2Kg at A slides on a surface where AB ,, CD are two smooth curves surface . the horizontal plane BC is rough its length is 30m and its coefficient of kinetic friction is $\frac{1}{5}$. if the cube starts motion from rest and it is 4m height at which distance does the cube rest on $\overline{BC}$

<u>From A to B</u>

$P_A = T_B \quad \therefore \ mgh = \frac{1}{2}mV^2$

$9.8 \times 4 = \frac{1}{2}V^2 \qquad \therefore V^2 = 78.4$



<u>From B to C</u>

$T_B = W = rS = \mu_K RS = \mu_K mgS$

$\therefore \frac{1}{2} \times 2 \times 78.4 = \frac{1}{5} \times 2 \times 9.8 \times S$

$S = 20m$

Q(18) A car of mass 9 tons ascends a slope inclined at an angle of sine $\frac{1}{125}$ to the horizontal with maximum velocity of magnitude 45 km/h against resistances equivalent to 200 Kg.Wt per each ton of the mass. Calculate the power of its engine in horse.

$$F = R + mg\sin\theta = 200\times 9\times 9.8 + 9\times 1000\times 9.8\times\frac{1}{125} = 2520\times 9.8N$$

=2520Kg.wt

maximum velocity $= V = 45\times\frac{5}{18} = 12.5 m/sec$

$$\text{maximum power} = F\times V = \frac{2520\times\frac{25}{2}}{75} = 420 \text{horse}$$

(19) a car of mass 5 tons moves with a uniform velocity of magnitude 36Km/h ascend an inclined plane to the horizontal by an angle of sine $\frac{1}{40}$ Against a resistance equals 2.5% of its weight . find its horse power . if the power is increased to 50horses find the acceleration of the train then

$$P = \left(5000\times 9.8\times\frac{1}{40} + \frac{2.5}{100}\times 5000\times 9.8\right)\times 36\times\frac{5}{18} = \frac{100}{3}\text{horse}$$

$50\times 75\times 9.8 = 36750 \qquad \therefore 36750 = F\times 36\times\frac{5}{18} \qquad \therefore F = 3675$

$F - mg\sin\theta - r = ma \qquad \therefore\ a = 0.245 m/sec^2$

(20) A car descends a slope from rest. When it traveled a distance of 180 m, it is found that it descended a vertical distance of 10 m. If it is given that $\frac{3}{4}$ of the potential energy is lost due to overcoming the resistances against motion and these resistances remain constant during the motion of the car, find the velocity of the car after it traveled the previous distance of 180 m

$$\frac{1}{4}mgh = \frac{1}{2}mV^2 \quad \therefore \frac{1}{4}\times 9.8\times 10 = \frac{1}{2}V^2 \quad \therefore V^2 = 49 \quad \therefore V = 7 m/sec$$

Q(21) A particle of mass the unity moves under the action of the force $\overrightarrow{F} = (2t-1)\hat{i} + (5t+2)\hat{j}$, where its displacement vector is given as a function of time by the relation $\overrightarrow{S} = (3t^2+1)\hat{i} + 4t\hat{j}$, If F is measured in Newton , S in meter and t in sec find

(1) The work done during the third and fourth and fifth seconds

(2) The average power during the third and fourth and fifth seconds

(3) The force power when t=5sec

$W = \overrightarrow{F} \bullet \overrightarrow{S} = (2t-1, 5t+2) \bullet (3t^2+t, 4t) = 6t^3 + 19t^2 + 7t$

work done in interval [2,5]

$= \left[6\times 5^2 + 19\times 5^2 + 7\times 5\right] - \left[6\times 2^2 + 19\times 2^2 + 7\times 2\right] = 1122 \text{ joules}$

(2) The average power $= \dfrac{W}{dt} = \dfrac{1122}{3} = 374 \text{ watt}$

(3) The power $= \dfrac{dW}{dt} = 18t^2 + 28t + 7$ at t=5 $\quad P = 647 \text{ watt}$

Q(22) A constant force F acts on a particle such that its displacement vector is given as a function of time t by the relation $\overrightarrow{S} = (3t^2+t)\hat{i} - 4t\hat{j}$ where F is measured in dyne and S in cm and (t) in sec given that the power of the force at the instant t=2sec equals 14 erg/sec and its power at the instant t=3 equals 24erg/sec find F

let $\overrightarrow{F} = a\hat{i} + b\hat{j}$

$W = F \bullet S = at^2 - 3bt$

$P = \dfrac{d}{dt}\left(at^2 - 3bt\right) = 2at - 3b$

at t=2 $\quad \therefore 4a - 3b = 14 \rightarrow (1)$ $\qquad$ at t=3 $\quad \therefore 4a - 3b = 14 \rightarrow (2)$

$\therefore 2a = 10 \quad \therefore a = 5 \quad , \ b = 2 \quad \therefore F = 5\hat{i} + 2\hat{j}$

Q(23) The force $\overrightarrow{F} = 6\hat{i} + 2\hat{j}$ acts on a body to move it from position A to position B in two seconds and the position vector of the body is given by the relation $\overrightarrow{r} = (3t^2 + 2)\hat{i} + (2t^2 + 1)\hat{j}$ calculate the change in the potential energy of the body where the magnitude of F is measured in Newton and r in meter and (t) in sec

$\overrightarrow{S} = \overrightarrow{r} - \overrightarrow{r_o} = (3t^2, 2t^2)$ at t=2 $S = (12,8)$

The work done $= (6,2) \bullet (12,8) = 72 + 16 = 88$ joule

the change in potential energy =-work =-88 joule

Q(24) A body of mass m=$(2t+5)$Kg and its position vector after a time t is $r = \left(\frac{1}{2}t^2 + t - 5\right)C$ find the velocity vector and the acceleration vector of the body at any instant t magnitude of the force acting on the body when t= 10seconds

$\overrightarrow{S} = r - r_o = \frac{1}{2}t^2 + t$, $V = \frac{dS}{dt} = t + 1$, $a = \frac{dV}{dt} = 1$

$H = mV = (2t+5)(t+1) = 2t^2 + 2t + 5t + 5 = 2t^2 + 7t + 5$

$F = \frac{d}{dt}H = 4t + 7$, when $t = 10$ $\therefore$ $F = 4 \times 10 + 7 = 47$

Q(25) A body of mass 3 Kg moves under the action of three forces $\overrightarrow{F_1} = 2\hat{i} + 5\hat{j}$, $\overrightarrow{F_2} = a\hat{i} + 3\hat{j}$, $\overrightarrow{F_3} = 2\hat{i} + b\hat{j}$ such that its displacement vector is given as a function of time t by the relation $\overrightarrow{S} = (t^2 + t)\hat{i} - (2t^2 + 3)\hat{j}$ then determine the value of each of a and b , calculate the work done by the resultant of these forces during 5 sec from the start If F is measured in Newton , S in meter and t in sec

$F = (4 + a , 8 + b)$

$V = \frac{dS}{dt} = (2t)\hat{i} + (-4t)\hat{j}$ $\therefore a = \frac{dV}{dt} = (2,-4)$

$\because F = ma = 3(2,-4) = (6,-12) = (4 + a , 8 + b)$ $\therefore a = 2$, $b =$ -20

$W = F \bullet S = (6,-12) \bullet (t^2 + 1, -2t^2 - 3)$ after 5sec

$W = F \bullet S = (6,-12) \bullet (26,-53) = 792$ joule