3rd year secondary

Dynamics

last look 2017

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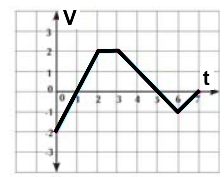
Q(1) A stone is projected vertically upwards and its height (X) after (t) second from the projection is given by the relation $X = 49\,t - 4.9\,t^2$ where X is in meters. Then the maximum height the projected body can reach.

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

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

Q(2) From the velocity-time graph in the opposite figure,
The magnitude of displacement is equal to ....



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

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

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

Q(4) 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

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

Q(5) 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 ....

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

Q(6) 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.

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

Q(7) A body of weight 1Kg.wt fall from a height 4.9m above the ground then its momentum when its reach ground =................Kg/sec

$V^2 = V_o^2 + 2gS$ $\therefore V^2 = 0 + 2 \times 9.8 \times 4.9$ $\therefore V = 9.8m/sec$

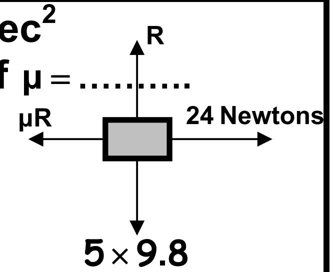
$H = mV == 1 \times 9.8 = 9.8\,Kg.m/sec$

Q(8) 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

$$W=\int P dt=\int(8t-5)dt=4t^2-5t+C \quad \therefore\ 24=4(3)^2-5\times3+C$$

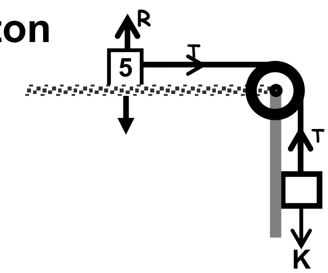
$$\therefore C=3 \quad \therefore W=4t^2-5t+3 \quad \text{when } t=1\ \therefore W=4-5+3=2$$

Q(9) If the show body move with an acceleration $2m/sec^2$ On a rough horizontal plane Then the value of $\mu=$……….



$$24-\mu R=ma \quad \therefore 24-\mu\times5\times9.8=5\times2 \quad \therefore \mu=\frac{2}{7}$$

Q(10) 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



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

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

Q(11) 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.

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

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

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

Q(12) 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.

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

Q(13) 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=…….

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

Q(14) 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.

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

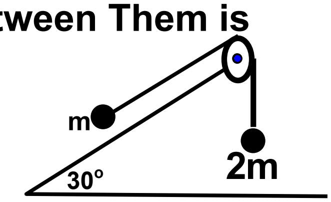
$V^2 = V_o{}^2 + 2aS \quad \therefore 0 = 2.8^2 - 2 \times 0.98 \times S \quad \therefore S = 4$

Q(15) 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.

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

Q(16) 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

$20 + 10\sin 30^\circ = 30cm$



Q(17) If $F = 1 + (t-2)^2$ then The impulse of the force F within the first three second.

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

Q(18) 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

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

Q(19) 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

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

Q(20) 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

$$V^2 = 0 + 2 \times 9.8 \times 10 \quad \therefore\ V = 14 \text{m/sec}$$
$$0 = 14^2 + 2 \times a \times 0.05 \quad \therefore\ a = -1960 \text{m/sec}^2$$

Q(21) 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.

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

Q(22) If $X = 6t - t^2$, then the distance traveled within the time interval $0 \le t \le 6$

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

Q(23) 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

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

Q(24) 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.

$$W = \int_0^t (\text{power})dt = 125 \times 735t = \textit{change in kinetic energy}$$

$$\frac{1}{2} \times 1200\left(\left(126 \times \frac{5}{18}\right)^2 - 0\right) = 125 \times 735t \quad \therefore t = 8 \text{sec}$$

Q(25) Tram car is pulled by a rope inclined at 60^{o} 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

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

$$W = F\times S = 2450\times 22.5 = 55125\,joule$$

Q(26) 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

$$P_{A} = T_{B} \quad \therefore mgh = \frac{1}{2}mV^{2} \therefore \quad \frac{1}{2}V^{2} = 9.8\times 10$$

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

Q(27) A machine using for lifting water it work by rate 294 joule per second then the power of its engine equal ……..horses

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

Q(28)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 =

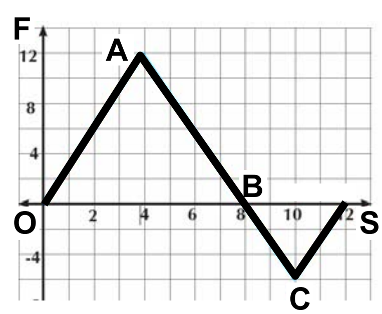
$$5g - T = 5a \rightarrow (1) \quad ,T - 2g = 2a \rightarrow (2) \quad \therefore 3g = 7a \quad \therefore a = \frac{3}{7}g$$

Q(29) 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

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

$$\therefore \frac{V^{2}}{2} - 50 = 14^{2} + 3\times 14 \quad \therefore V = 24 \text{ m/sec } 5$$

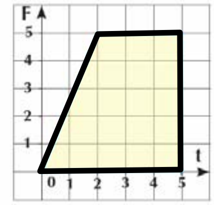
Q(30) The opposite illustrates the action of a variable force on a body, then the work done in Erg by this force in the When the body move from S=0 to S=12



$$W = \int_{0}^{12} FdS = \text{area under the curve}$$

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

Q(31) 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



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

Q(32) 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.

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

Q(33) If V (t) = 9.8t + 5 where X (0) = 10 , then X (10)

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

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

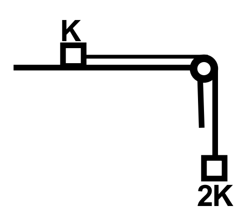
Q(34) The momentum of a car whose mass is 2 tons moving in a straight line at velocity 54km/ h is:……………

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

Q(35) 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:

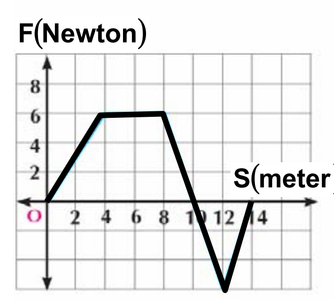
$$r = mg\sin\theta = 20\sin 30^{\circ} = 10$$

Q(36) In the opposite figure : smooth pully and the plane is smooth : The acceleration of the system when moving equlas



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

Q(37) **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



$$W=\int_{8}^{14} F\,dS = \text{area under the curve}$$

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

Q(38) A cannon of mass 250Kg shots a bullet of mass 10Kg with a velocity 100m/sec then the reaction velocity of the cannon equals

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

Q(39) 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 ……..

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

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

Q(40) 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.

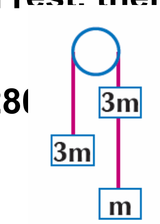
$$W=\int_{2}^{5} F\,dS=\int_{2}^{5}(3S^2-4)\,dS=[S^3-4S]_2^5=105\text{joule}$$

Q(41) 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

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

Q(42) 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.

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



Q(43) 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.

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

$\because$ work = change in kinetic energy

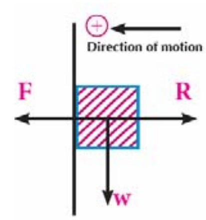
$$\frac{1}{2} m (V^2 - V_o^2) = 91875t \quad \therefore \quad \frac{1}{2} \times 1200 \left(126 \times \frac{5}{18}\right)^2 = 91875t \qquad \therefore t = 8\,\text{sec}$$

Q(44) 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…..

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

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

Q(45) 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



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

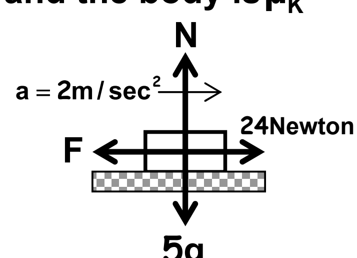
$$\therefore F = 11N \qquad \therefore P = F = 11$$

Q(46) 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

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

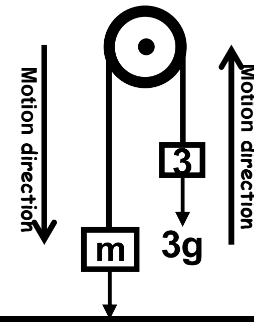
after 2seconds $\qquad \therefore 4V = \frac{3}{2} \times 2^2 + 2 = 8 \quad \therefore V = 2m/sec$

Q(47) 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 =…….



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

Q(48) 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



$$mg - T = 2.45m \rightarrow (1) \quad , \quad T - 3g = 3 \times 2.45 \rightarrow (2)$$
$$mg - 3g = 2.45m + 3 \times 2.45 \quad \therefore 9.8m - 29.4 = 2.45m + 7.35$$
$$\therefore 7.35m = 36.75 \quad \therefore m = 5$$

Q(49) 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

$$S = V_o t - \frac{1}{2} g t^2 \quad \therefore S = 14.7 \times 1 - \frac{1}{2} \times 9.8 \times 1^2 = 9.8m$$
$$P = mgh = 0.5 \times 9.8 \times 9.8 = 48.02 \text{ joules}$$

Q(50) 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.

$$S = V_o t + \frac{1}{2} a t^2 \quad \therefore \frac{100}{2} = 0 + \frac{1}{2} a (2)^2 \quad \therefore aa = 25 cm/sec^2$$
$$V = V_o + at = 0 + 25 \times 2 = 50 cm/sec$$

Q(51) 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

$$V^2 = V_o^2 + 2gS \quad \therefore V^2 = 0 + 2 \times 9.8 \times 0.4 \quad \therefore V = 2.8 m/sec$$
$$F \times t = m\left(V' - V\right) \quad \therefore F \times \frac{1}{7} = 1(0 - 2.8) \quad \therefore F = \frac{19.6}{9.8} = 2 Kg.wt$$
$$\text{scale reading} \quad = 1 + 2 = 3 Kg.wt$$

Q(52) A body of mass m kg moves under the action of the force $3m\hat{i} + 4m\hat{j}$, where F is in Newton, then the magnitude of the acceleration of motion in m/sec$_2$ unit is:……….

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

Q(53) 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 …………………

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

Q(54) 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 …………………..

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

Q(55) 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

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

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

$$V = 3t^2 - 12t + 9 = 0 \quad \therefore V = 0 \text{ when } t=3 \text{ or } t=1$$
$$\left[t^3 - 6t^2 + 9t\right]_0^1 + \left[t^3 - 6t^2 + 9t\right]_1^3 + \left[t^3 - 6t^2 + 9t\right]_3^5 = 4 + 4 + 20 = 28$$

Q(57) 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 …………

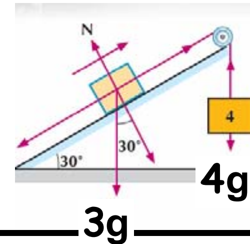
$$r \times S = \frac{1}{2}mV^2 \quad \therefore r \times 0.1225 = \frac{1}{2} \times 7 \times 10^{-3} \times 245^2 \quad \therefore r = 175 Kg.wt$$

Q(58) 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

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

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

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



Q(59) particle moves in a straight line and the equation of its motion $X = \tan t$ then the acceleration of motion a is equal to

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

Q(60) 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.

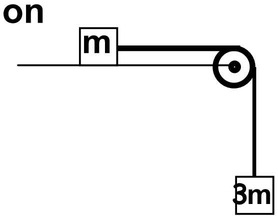
then the displacement covered during the first five seconds.

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

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

Q(61) 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.

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



Q(62) 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

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

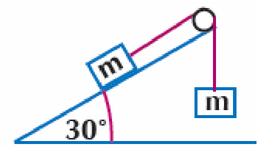
Q(63) If a body of mass the unity moves in a straight line such that the acceleration of the body is given by the relation $a = 4t + 2$ where a is measured in m/sec^2 , t in second , then the change of momentum of the body in the time interval [2, 6] is equal to .... kg m/sec.

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

Q(64) 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.

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

Q(65) In the opposite figure: the plane and pulley are smooth.
When this system moves, then its acceleration =….



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

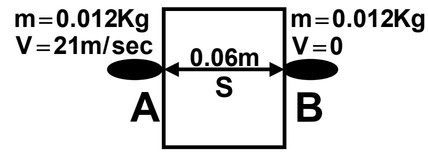
$$mg - \frac{1}{2}mg = 2ma \quad \therefore \frac{1}{2}mg = 2ma \quad \therefore a = \frac{1}{4}mg$$

Q(66) A particle of mass 2 kg is moving with velocity (5i + j) m/sec when it receives an impulse of (–6i + 8j) N S. then the kinetic energy of the particle immediately after receiving the impulse.

$$I = \left(-6\hat{i} + 8\hat{j}\right) = 2\left(V - \left(5\hat{i} + \hat{j}\right)\right) \quad \therefore -3\hat{i} + 4\hat{j} = V - 5\hat{i} - \hat{j} \quad \therefore V = 2\hat{i} + 5\hat{j}$$

$$T = \frac{1}{2}m\|V\|^2 = \left(\sqrt{2^2 + 5^2}\right)^2 = 29$$

Q(67) 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



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

Q(68) 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

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

Q(69) 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.

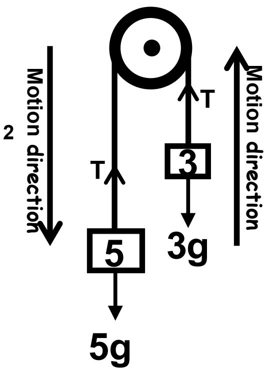
after one minute :(when the cyclist stop peddiling)

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

when moving with maximum velocity

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

Q(70) 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(71) 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

Before the car released

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

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

After 4.9 minutes the velocity of the train is V

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

With respect to the separated car

$-r = m^{/}a^{/} \qquad \therefore -75\times 9.8\times 49 = 49\times 1000a^{/}$

$\therefore a^{/} = -0.735 \, m/sec^2 \qquad \therefore 0 = 44.1 - 0.735t \qquad \therefore t = 60sec$

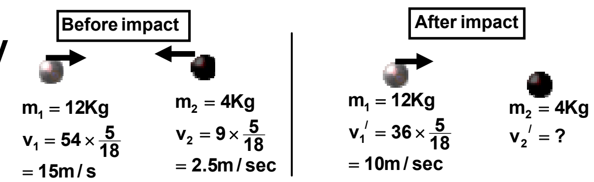
Q(72) A sphere of mass 12Kg is moving along a straight line with velocity 54Km/hour impinge on Another sphere of mass 4Kg moving along the same line but in the opposite direction with velocity 9Km/hour . if the velocity of the first body after impact is 36Km/hour in the same direction as before calculate: _(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(73) 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

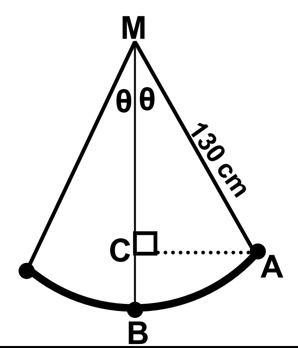
Q(74) The figure show a simple pendulim(a ball suspended at th end of a string) Whose string is 130cm long the pendulum starts its motion from rest at the point A and left free to oscillte through an angle of measure 2θ Where $\tan\theta = \frac{5}{12}$ find the speed of the ball atB(B is the mid point of the path)

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

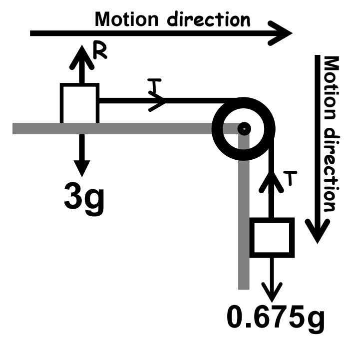
$MC = 130\cos\theta = 130 \times \frac{12}{13} = 120cm$, $CB = 10cm$

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

$V_B = 140 cm/sec$



Q(75) 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 $\therefore 0.675 \times 9.8 = 3a + 0.675a$

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

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(76) 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 $\therefore \frac{1}{2}V = 105 \qquad \therefore V = 210 cm/sec \qquad \therefore m = 840 gm$

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(77) 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(78) 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(79) 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(80) 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 $2cm/sec^2$ 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

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

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

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

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

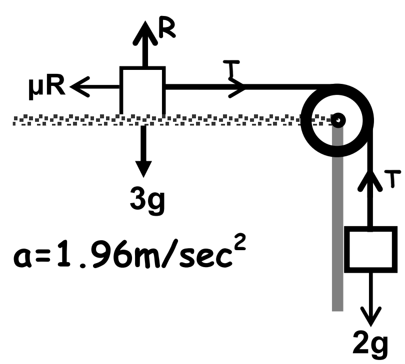
$T(\text{After impact}) = \frac{1}{2}\times 40\times(16)^2 = 5120erg \Rightarrow T_o - T = 6080 - 5120 = 960erg$

Q(81) 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

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

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

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

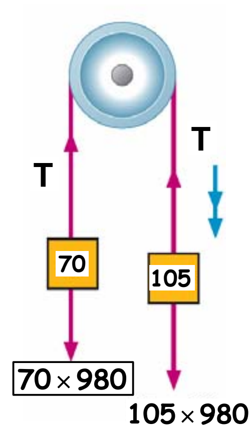
$V^2 = 0^2 + 2\times 1.96\times 0.5 \quad \therefore V = \frac{7}{5}m/sec^2$

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(82)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.



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

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

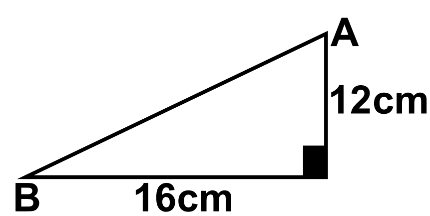
$V^2 = V_o^2 + 2aS \quad \therefore V^2 = 0 + 2 \times 196 \times 50 \quad \therefore V = 140 cm/sec$

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

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(83) 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.



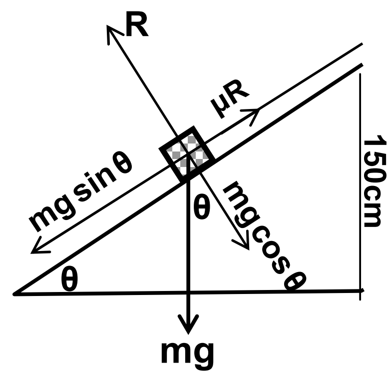
$P_A = T_B + W$

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

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

$T_B = 5292$ joules

Q(84) 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.



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

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

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

Its speed after 250cm

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

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

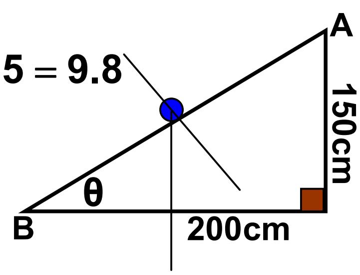
$-\mu R - mg\sin\theta = ma'$

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

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

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

Q(84) 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 $V^2 = V_o^2 + 2aS \quad \therefore V^2 = 0^2 + 2\times1.96\times2.5 = 9.8$

$P_A = T_B + W$

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

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

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

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

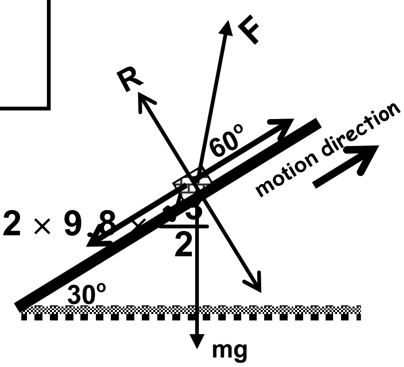
Q(86) **A body of mass 300 gm is placed at the top of an inclined plane whose height is 1m. Find the velocity with which the body reaches the bottom of the plane knowing that the work done by the resistance force of the plane to the motion is equal to 1.59 Joules.**

$$P_A = T_B + W \quad \therefore 0.3 \times 9.8 \times 1 = \frac{1}{2} \times 0.3 \times V^2 + 1.59$$

$$\therefore V^2 = 9 \quad \therefore V = 3m/sec$$

Q(87)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

$m = 2Kg$
$\theta = 30°$
$F = 17.4N$



$R = ?$
$a = ?$

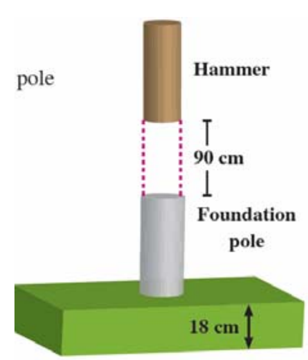
$$R + F\sin 60° = mg\cos 30° \quad \therefore R + 17.7 \times \frac{\sqrt{3}}{2} = 2 \times 9.8 \times \frac{\sqrt{3}}{2}$$

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

$$F\cos 60° - mg\sin 30° = ma$$

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

Q(88) **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>

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

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

After impact

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

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

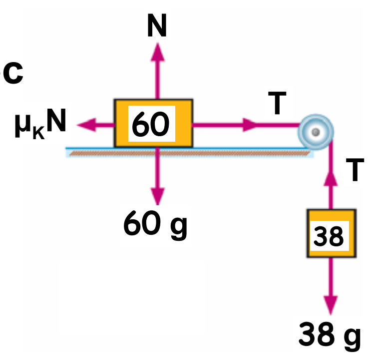
$$U = 2.52 \quad , V = 0 \quad , S = 0.18$$

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

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

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

Q(89) 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

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

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

Q(90) 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: $\quad V_2 = 108 \times \frac{5}{18} = 30 m/sec$

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

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

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

Q(91) 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

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

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

Q(92) 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

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

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

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

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

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

Q(93) 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 :

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

Q(94) 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

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

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

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

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

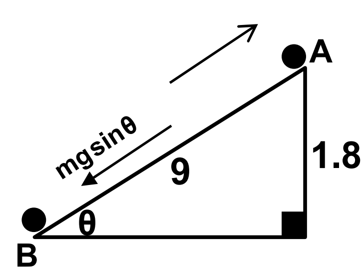
$F - r = ma \quad \therefore 11000 \times 9.8 - 196 \times 50 \times 9.8 = 196000a \quad \therefore a = \frac{3}{50} m/sec^2$

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

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

Q(95) 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)

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

$V = 5.3m/sec$

(96)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>

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

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

<u>on the inclined plane</u>

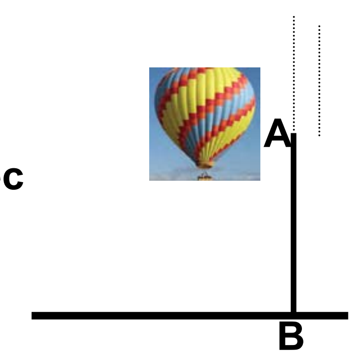
$F^{/} = r + mg\sin\theta \qquad \therefore F^{/} = 120 + 4000 \times \frac{1}{20} = 320Kg.wt$

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

Q(97)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



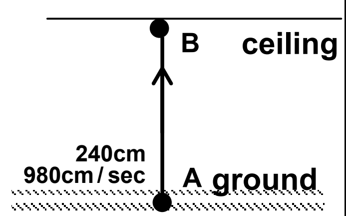
$T_A + P_A = T_B + P_B$

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

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

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

(98) 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



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

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

$H = m(V^{/} + V) \qquad \therefore 40000 = 40(700 + V^{/}) \quad \therefore V^{/} = 300cm/sec$

Q(99) 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

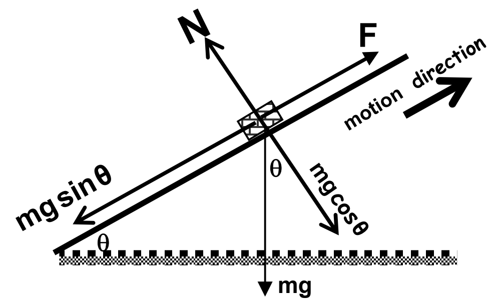
$$S = V_o + \frac{1}{2}at^2 \quad = 4.9 \times \frac{20}{7} + \frac{1}{2} \times -3.43 \times \left(\frac{20}{7}\right)^2 = 0$$

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(100) 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

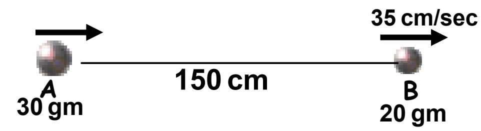
$a' = -g\sin\theta = -4.9 m/sec^2$

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(101) 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



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

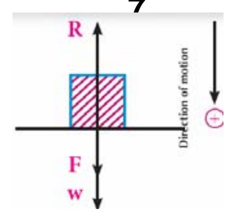
$S_2 = Vt \quad = 35t$

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

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

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

Q(102) 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



From A to B

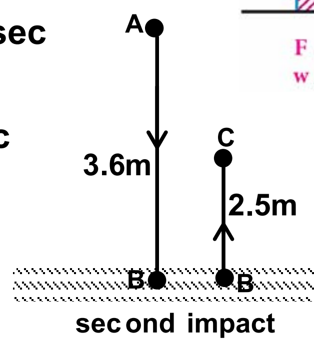
$V^2 = V_o^2 + 2gS \quad \therefore V^2 = 0^2 + 2\times9.8\times3.6 \quad \therefore V = 8.4m/sec$

From A to B

$V^2 = V_o^2 + 2gS \quad \therefore 0 = V_o^2 - 2\times9.8\times2.5 \quad \therefore V = 7m/sec$

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

$R = F + W = 21.56 + 0.2\times9.8 = 23.52N$

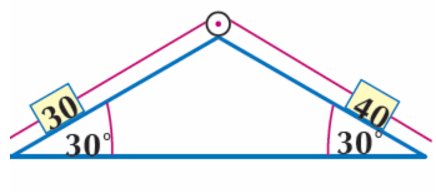


Q(103) A bullet is fired on a target of thickness 9 cm and exits from the other side with half velocity before it enters the target. What is the least thickness needed for a target of the same material in order the bullet not to exit from if it is fired with its previous velocity?

$\frac{1}{2}mV^2 - \frac{1}{2}m\left(\frac{1}{4}V^2\right) = r\times9 \quad \therefore \frac{3}{8}mV^2 = 9r \rightarrow (1) \qquad , \quad \frac{1}{2}mV^2 = Sr \rightarrow (2)$

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

Q(104) <u>In the opposite figure</u>, 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.



<u>with respect to 40</u>

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

with respect to 40

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

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

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

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

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

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

vertical distance between them is 0.35m

Q(105) 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.

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

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

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

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

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

Q(106) 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

$\because v^2 = v_0^2 + 2g\,s$

$\therefore v_1^2 = 0 + 2 \times 9.8 \times 10$

$\therefore v_1 = 14$ m/sec

It is the velocity of the ball be for it contacts directly with the ground.

Studying the phase of rebound back

$\because v^2 = v_0^2 + 2g\,s$

$\therefore 0 = v_2^2 - 2 \times 9.8 \times 2.5$

$\therefore v_2 = 7$m/sec

$\therefore$ The velocity of rebound back = 7m/sec vertically up wards

impulse = Change of momentum $= m\,(v_2 - v_1)$

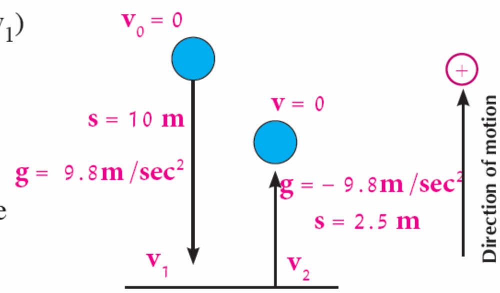
$= \frac{1}{4}[7 - (-14)] = 5.25$ kg . m/sec

$\because$ 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

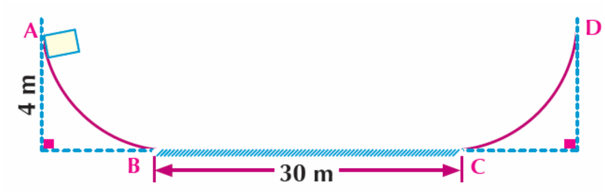


Q(107) <u>In the opposite figure</u> :a cube of wood of mass 2Kg at A slides on a surface where AB ,, CD are two smooth curves surface . the horizontal plane BC is rough its length is 30m and its coefficient of kinetic friction is $\frac{1}{5}$. if the cube starts motion from rest and it is 4m height 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(108) A particle of mass the unity moves under the action of the force $\vec{F} = (2t-1)\hat{i} + (5t+2)\hat{j}$, where its displacement vector is given as a function of time by the relation $\vec{S} = (3t^2+1)\hat{i} + 4t\hat{j}$, 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

$W = \vec{F} \bullet \vec{S} = (2t-1, 5t+2) \bullet (3t^2+t, 4t) = 6t^3 + 19t^2 + 7t$

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 $= \frac{W}{dt} = \frac{1122}{3} = 374 \text{ watt}$

(3) The power $= \frac{dW}{dt} = 18t^2 + 28t + 7$ at t=5 $P = 647 \text{ watt}$

Q(109) A constant force F acts on a particle such that its displacement vector is given as a function of time t by the relation $\vec{S} = (3t^2+t)\hat{i} - 4t\hat{j}$ 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 $\vec{F} = a\hat{i} + b\hat{j}$

$W = F \bullet S = at^2 - 3bt$

$P = \frac{d}{dt}(at^2 - 3bt) = 2at - 3b$

at t=2 $\therefore 4a - 3b = 14 \rightarrow (1)$ at t=3 $\therefore 4a - 3b = 14 \rightarrow (2)$

$\therefore 2a = 10 \quad \therefore a = 5 \quad , \ b = 2 \quad \therefore F = 5\hat{i} + 2\hat{j}$

Q(110) 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 $\overrightarrow{r} = \left(3t^2 + 2\right)\hat{i} + \left(2t^2 + 1\right)\hat{j}$ 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

$\overrightarrow{S} = \overrightarrow{r} - \overrightarrow{r_o} = \left(3t^2, 2t^2\right)$ 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(112)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(113) 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 $\overrightarrow{S} = \left(t^2 + t\right)\hat{i} - \left(2t^2 + 3\right)\hat{j}$ 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

$F = (4 + a, 8 + b)$

$V = \frac{dS}{dt} = (2t)\hat{i} + (-4t)\hat{j}$ $\therefore a = \frac{dV}{dt} = (2,-4)$

$\because F = ma = 3(2,-4) = (6,-12) = (4 + a, 8 + b)$ $\therefore a = 2$, $b = -20$

$W = F \bullet S = (6,-12) \bullet \left(t^2 + 1, -2t^2 - 3\right)$ after 5sec

$W = F \bullet S = (6,-12) \bullet (26,-53) = 792$ joule