IMPULSE AND MOMENTUM &COLLISION OF TWO BODIES

Ex 1) A 2kg particle is acted upon by the force, expressed in newton $F=(8-6t)i+(4-t^2)j+(4+t)k$.

Knowing that the velocity of the particle is $V=150i+100j-250k$ at $t=0$, determine

a) The time at which the velocity of the particle is parallel to the YZ plane.

b) Corresponding velocity of the particle.

ANS- $V_t = [-125.5j-194.5k]$ m/s

Ex 2)The subway train shown is travelling at a speed of 50km/hr. When the brakes are fully applied on wheels of car B and car C, causing them to slide on the track, but are not applied on the wheels of car A. Knowing that $\mu_k=0.35$ between the wheels and the track, determine

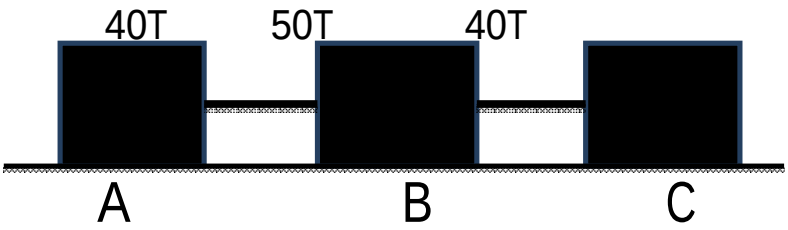
a)The time required to bring the train to stop.

b)Force in each coupling.

ANS- t= 5.84sec

F_{BC}= 42.2 KN (Tension)

F_{AB}= 94.95 KN (Tension)



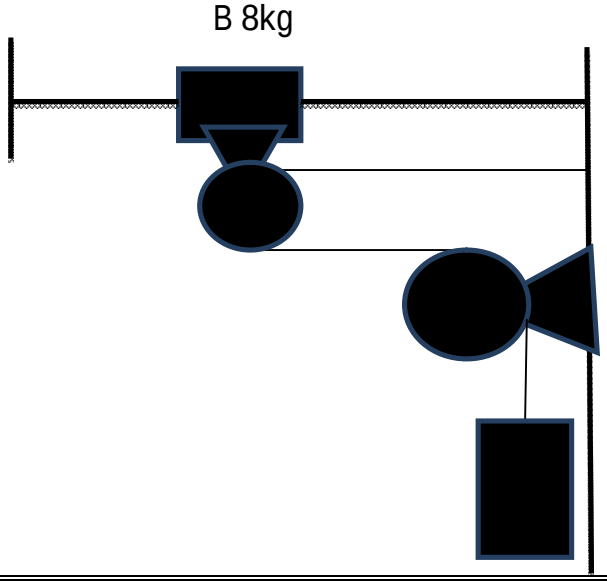
Ex 3)The system shown is at rest when a constant 150N force is applied to collar B. Neglect the effort of friction, determine

a) The time at time at which the velocity of collar B will be 2.5 m/s to the left.

b)The corresponding tension in the cable.

ANS- t= 0.548 sec

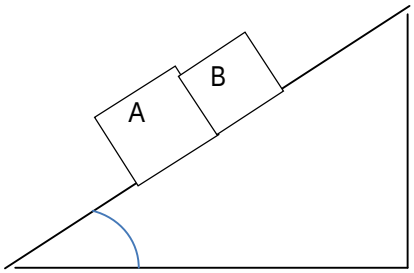
T= 56.7 N



Ex 4) Two package are placed on as shown. The U_S=0.3 and U_K=0.25 between the inclined plane and the block A. Theμ_S=0.2 and μ_K=0.15 between incline and block B.Knowing that the package are intact when released, determine

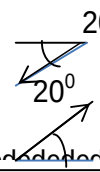
a) The velocity of each package after 3sec.
b) The force exerted by package A on package B.

Angle of inclination is20^0



ANS- V=4.81 m/s

P=3.31



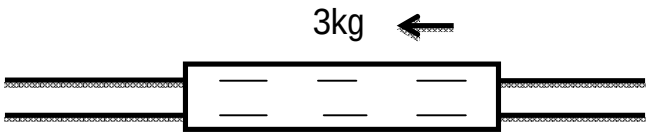
Ex 5) A 4kg particle is acted upon by a force expressed in newton, F=2t i +(3-t)j+t^3k. Knowing that velocity of particle at t=0 is V=8m/s i+5m/s j-20m/s k, determine the velocity of the particle at t=4sec.

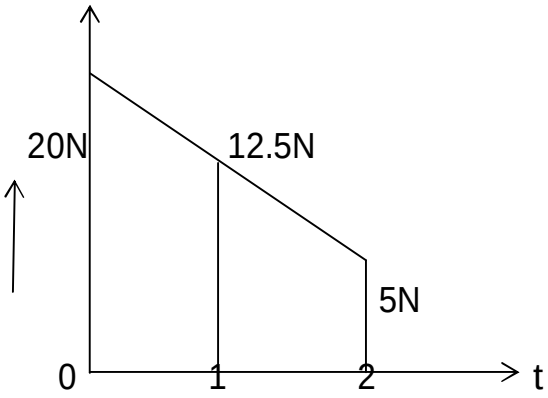
Ans. - V= (-4i+6j-4k) m/s

Ex 6)A 3kg collar is initially at rest and is acted upon by the force Q which varies as shown. Knowing that μ_k=0.25, determine the velocity of collar at

a) t = 1 sec
b) t = 2 sec
c) The maximum velocity reached by the collar and the corresponding time
d) The time at which the collar comes to rest.

Q





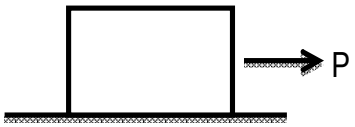
Ans. - V_1= 2.964 m/s ← V_2= 3.428 m/s ←

V_{max}= 3.552 m/s ←at t= 1.68 sec

V_o= 0 at t= 3.37 sec

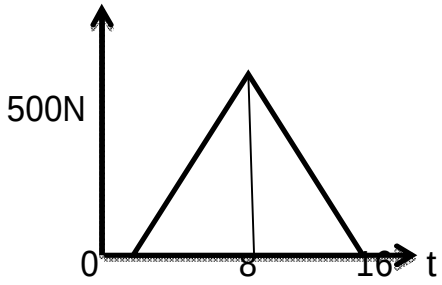
Ex 7) A 30kg block initially at rest is acted upon by a force P which varies as shown. Knowing that the μ_s=0.5 and μ_k=0.4 between the block and the horizontal surface, determine

a) The time at which the block will start moving.
b) The max^m velocity reached by the collar.
c) The time at which the block will stop moving.



P(N

Ans. – t_1=2.350, V_{max}=69.13 m/s, t_2=35sec



Ex 8)A 1300kg car with velocity of 4 km/hr hits a garage wall and is brought to rest in 75 milliseconds. Determines the average impulsive force exerted by the wall on car bumper.

Ans. - 19.24KN

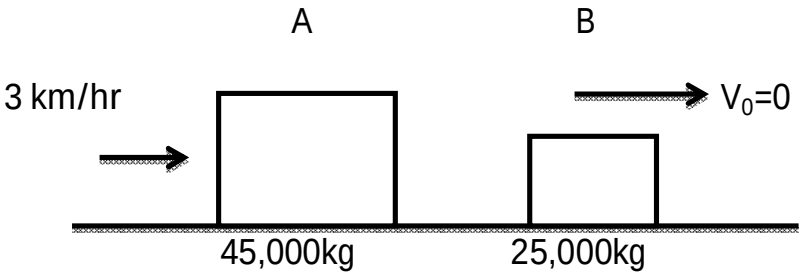
Ex 9) After sealing a wall a man tests himself drop 3m to the ground. If his body comes to a complete stop 0.15 sec after his feet first touch the ground , determine the vertical component of the average impulsive force exerted by the ground on his feet.

Ans. – 5.21N

Ex 10) A45,000kg road car moving with a velocity of 3Km/hr is to be coupled to a 25,000kg car which is at rest. Determine

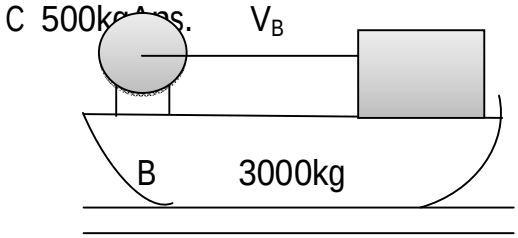
a) The final velocity of the couple car.
b) The average impulsive force acting on each car if the coupling is completed in 0.3sec.

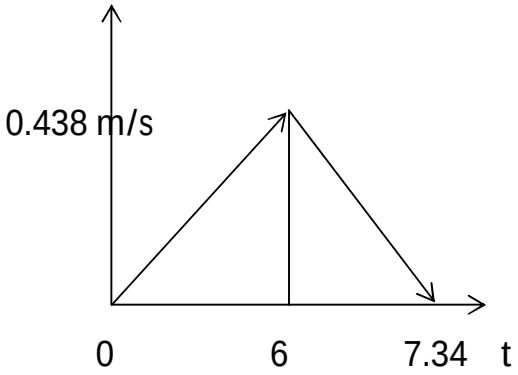
Ans. - P=44.625



Ex 11) A 3000kg barrage is initially at rest and carries a 500kg crate. The barrage is equipped with a winch exerts a constant 1200N force on the crate for 6sec. The crate then slide along the deck until it comes to rest (μ_k=0.2)

a) Draw the V-T graph for the barrage.
b) Determine the final position of the barrage.
c) Determine the final position of the crate on the deck of the barrage.



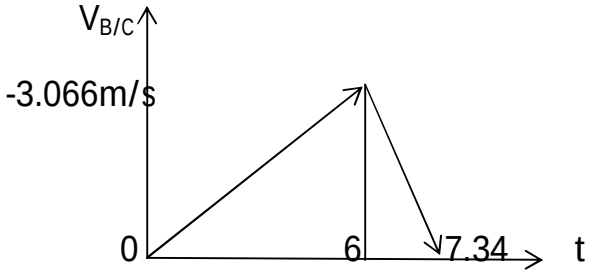


Ans. – S= 1.607 m, A_V^{0-t}=7.34×0.438×1/2

$S_{C/B}$= $-A_V^{0-t}$

=- 1/2×7.34×3.066

=-11.25, or 11.25 ←



Ex 12)Car A travelling due north through an intersection when it was hit broad side by car B which was travelling due east. While drives admitted having ignored the four way stop signs at the intersection, each claimed that he was travelling at the 55 km/hr speed limit and that the other car was travelling much faster. Knowing that car A has a mass of 900kg, car B of 1600kg and that inspection of the scene of the accident showed that as a result of the impact, the two car got stuck together and skidded in a direction, 40^0 north of east, determine

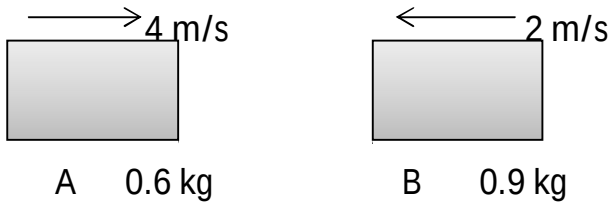
a) Which of the two car was actually travelling at 55 km/hr.
b) How fast the other car was moving?

Ans. – V_A= 15.28 m/s, V_B=10.24 m/s

if V_B= 15.28 m/s, V_A=22.79 m/s

IMPACT OF TWO BODIES

Ex 1) The velocities of two steel blocks before impact areas shown. If after impact, the velocity of block B is observed to 2.5m/s to the right. Determine the coefficient of restriction between the two blocks.



Ans. – e=0.875

Ex 2) Two identical cars B and C are at rest on a loading deck with their brake released. Car A of the same model which has been pushed by deck, hit car B with a velocity of 1.5 m/s, causing a series of collision among the three cars. Assuming a coefficient of restitution between A and B are 0.5 and B and C are 1.0.

Ans.- 1st collision – A &B 2nd collision – B &C 3rd collision –A & B

After first collision- V_A^I= 0.375 m/s ⟶

V_B^I= 1.125 m/s ⟶

After second collision- V_C^I = 1.125 m/s ⟶

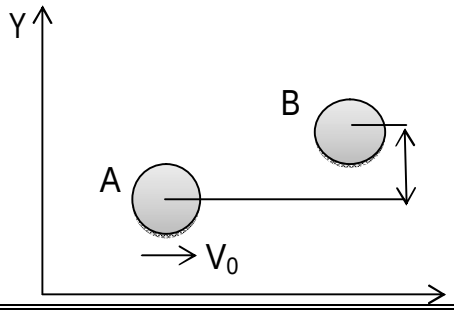
V_B^I= 0

After third collision- V_B^I= 0.281 m/s ⟶

V_A^I= 0.094 m/s ⟶

Ex 3)Two identical pucks A and B of 76 mm diameter may move freely on a hockey ring. Puck B is at rest and puck A has an initial velocity V= V_0i.

a) Knowing that b=38 mm and e=0.8, determine the velocity of each puck after impact.
b) Show that if e=1, the final velocities of the pucks from a right angle for all values of b.



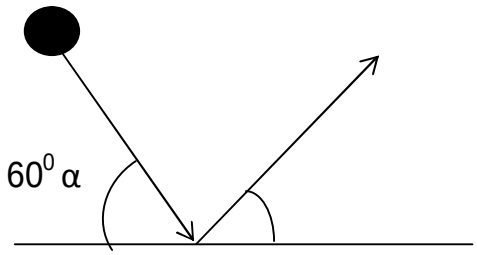
Ans. – V_A= 0.507 V_0 30.17^0

V_B= 0779 V_0

30^0

X

Ex 4) A ball is thrown against a wall at angle of 60^0 with a speed of 17 m/s. What is angle of rebound α, if e=0.7



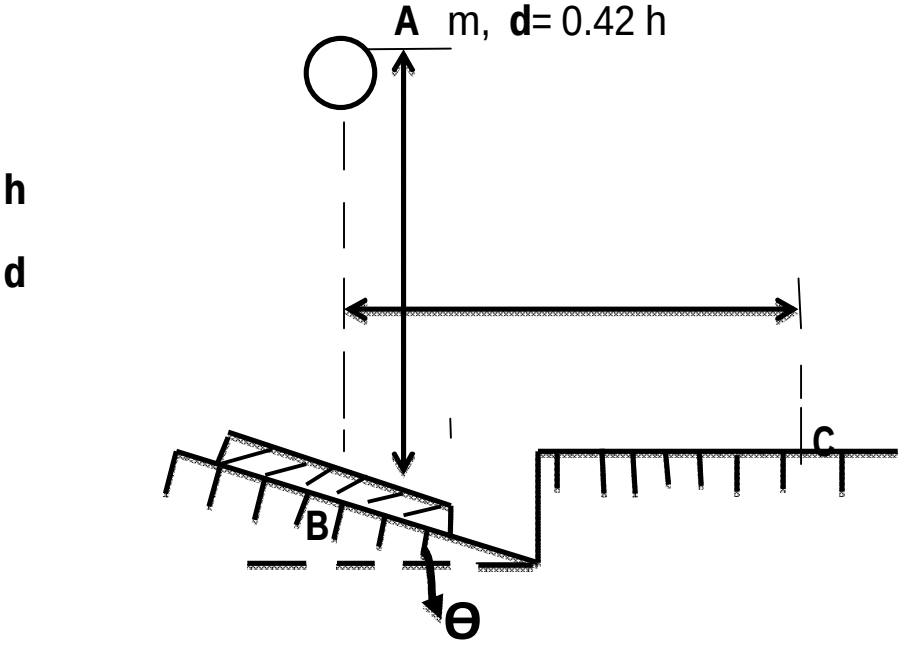
Ans.–α=50.48^0

Ex 5) One of the requirement of tennis balls to be used in official competition is that when dropped onto a rigid surface from a height of 2.5m, the height of the first bounce of the ball must be in the range of 1.325<= h <= 1.45 m. Determine the range of the coefficient of restitution of the tennis balls satisfying this requirements.

Ans.- 0.664

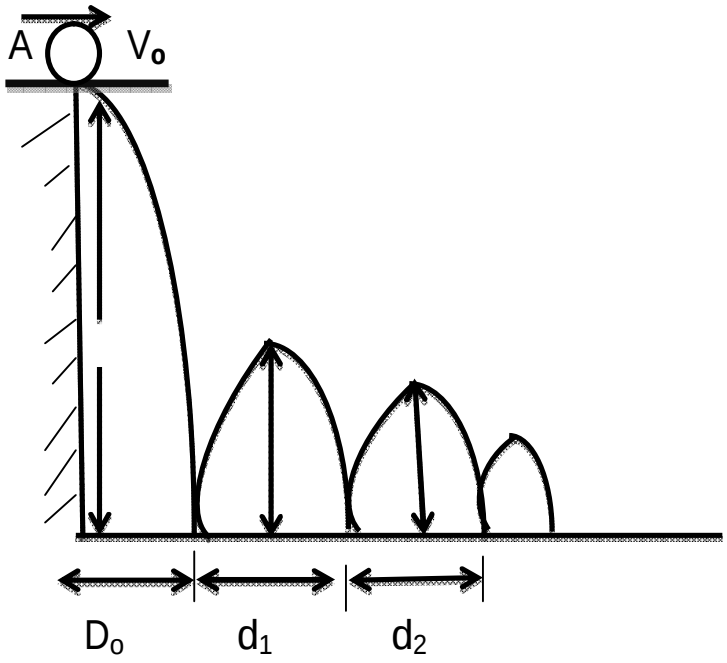
Q.(6) A ball drops from a ceiling of a room after rebounding twice the floor ,it reaches a height equal to one fifth of the ceiling .find e. ANS ➡ e = 0.669

Q.(7) A small ball A is dropped from a height onto a rigid, frictionless plate at B and between to point C at the same elevation as B knowing that Θ = 20 and e between ball and plate is 0.4 , determine the distance d.



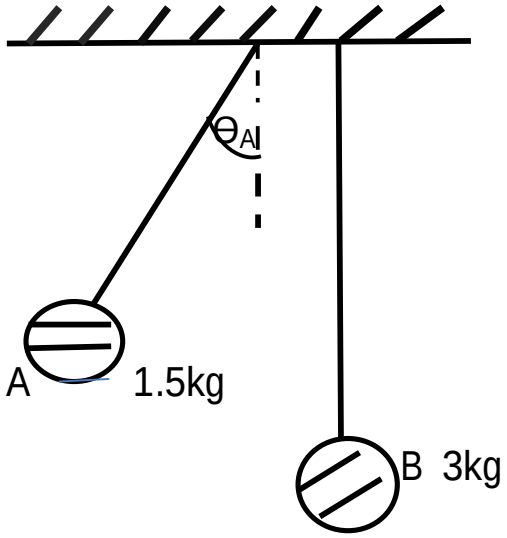
Q.(8) A small ball A dropped from a height h onts a right, frictionlen plate at B and comes to point C at the same elevation as B (fig of ex 7) . determine the value Θ for which the distance d is maximum and the corresponding value of d . assuning that coefficient of restitriation between the ball and plant is (a) e =1 (b) e = 0.5. ANS ➡(a) $\Theta = 22.5^{o}$, $d_{mar} = 2h$ (b) Θ =

Q.(9) A ball moving with a horizontal velocity v_o drops from A through the vertical distance h_o =625mm to a frictionless floor knowing that the ball hits the floor at a distance d_o= 125mm from B and that the height of the 1st bounce is h=400mm,determine (a) e (b) the length d of the 1st bounce. ANS ➡ e = 0.8, d_1 = 200mm.

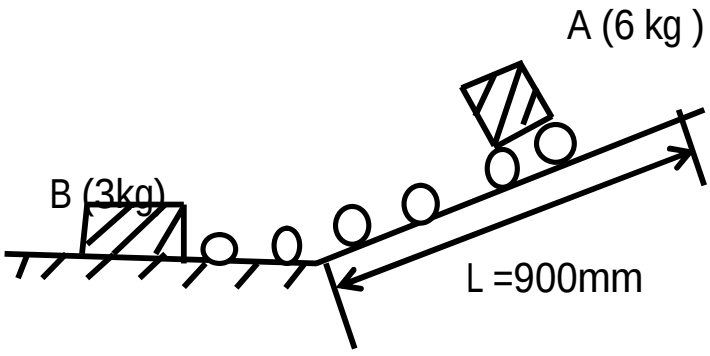


Q.(10) A 1.5 kg sphere A is released from rest $\Theta_A = 45^{O}$ and strikes a kg sphere B which is at rest knowing that e = 0.75 , determine the value if

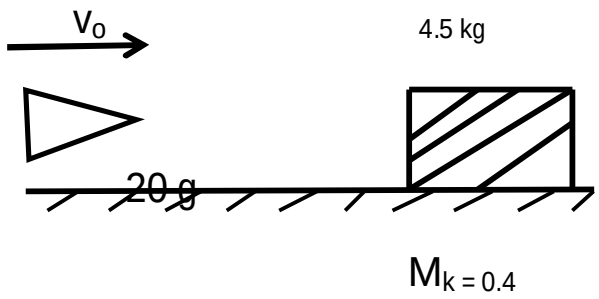
Θ_A and Θ_B corresponding to the height position to which the sphere rise after impact. ANS ➡ $\Theta_B = 25.83^o$, $\Theta_A = 7.3^O$,



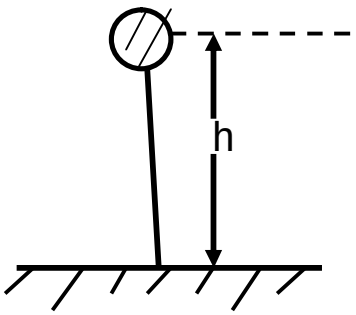
Q.(11) A 6 kg block A is released from rest l= 900mm, moves down the 30 degree incline ,and strikes a 3 kg block B which is at rest .Small rollers are attached to the incline and friction between A and incline may be neglected after the impact each block slides to the left and comes to rest knowing e =0.60 and M_k = 0.4 between each block and the horizontal surface determine the distance through which each block will slide , Ans➡280mm



Q.(12) A 20 g bullet is fired with a velocity v of magnitude v_o=600 m/s into a 4.5 kg block of wood knowing that M_k between block and floor is 0.4 determine (a) how far the block will move (b) the % of initial energy lost in friction between the block and the floor .ANS s =0.895m , 0.441 %



Q.(13) A particle falls from a height h open a fixed horizontal described by the particle before it has finished rebounding is [$1+e^2/1-e^2$]h (b) the him that elapses is [1+e/1-e]$\sqrt{2h/g}$ sec.



Q.(14) ball B is hanging from an initial inextensible cord. An identical ball A is released from rest when it is just touching the cord and drops through the vertical distance h_A= 0.2 m before striking ball B . assuming perfectly elastic impact (e= 1) and no friction, determine the resulting maximum vertical distance h_b of ball B
Ans, h_b= 96mm