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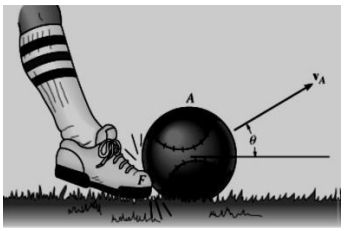
Tripoli - Lebanon

الجامعة اللبنانية
كلية العلوم، الفرع 3
طرابلس – لبنان

Course : Classical Mechanics (P1100)

Tutorial Chap 4 : *Linear momentum and collision*

Exercise 1:



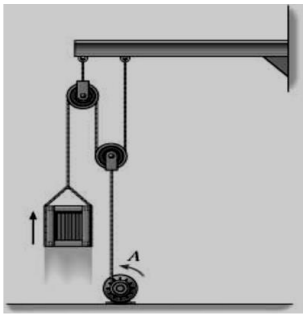
A player kicks a ball with a mass of 200 g. The ball leaves the ground at an angle $\boldsymbol{\theta = 30^o}$ and lands after covering a distance of d=15m.

Determine the impulse (linear momentum) of the foot on the ball.

Exercise 2 :

A block with a mass of 5 kg is thrown downward with an initial velocity of $v_0 = 2\ m/s$ from a height of h=8 m. Upon reaching the ground, it sinks into the sand for 0.9 seconds before coming to a stop. Determine the average force exerted by the sand on the block.

Exercise 3 :

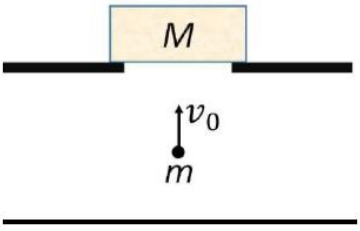


The motor exerts a force on the rope given by $F(t) = 5(30 + t^2)$.

If the 8 kg box is initially at rest, determine its velocity after 4 seconds.

Exercise 4 :

A ball of mass m=200 g strikes the bottom of a stationary block of mass M=1800 g with an initial velocity of magnitude $v_0 = 30\ m/s$ (see figure). The ball sticks to the block as a result of the collision.



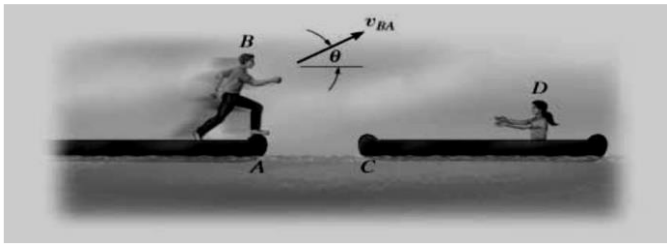
a) To what height does the block rise?

b) What is the loss of energy due to the collision?

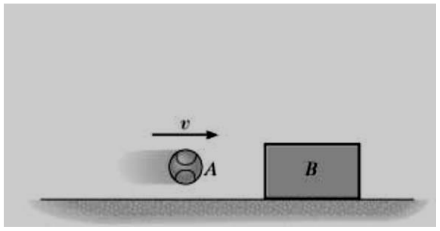
Exercise 5 :

The two boats A and C are initially at rest. The boy B jumps from boat A to boat C with a velocity $v_{B/A} = 5\ m/s$ relative to boat A and reaches boat C. Calculate the velocities of both boats at the moment the boy touches boat C.

Given data: $m_{boy} = 30\ kg$; $m_{girl} = 25\ kg$; $m_{boat} = 40\ kg$ and $\theta = 30^o$.

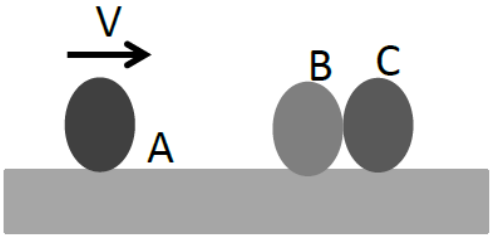


Exercise 6 :



A ball of mass m= 1 kg is launched horizontally with a velocity of v=10 m/s. It collides with a stationary block of mass M= 10 Kg. Determine the force exerted between the ball and the block if the duration of the collision is 0.02 seconds. The coefficient of restitution between the ball and the block is e=0.6.

Exercise 7:



Three balls A, B, and C have the same mass m. If B and C are initially at rest, and A had a velocity v just before a head-on collision with B, the coefficient of restitution between each ball is given as e (where 0<e<1).

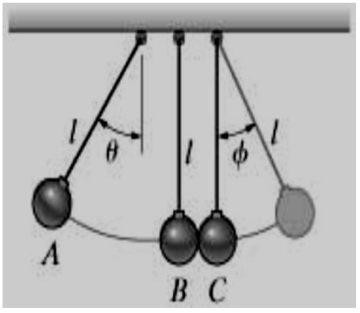
A) <u>Using the expression for e and the conservation of momentum:</u>

- Calculate the speed V_B of ball B just after the collision with A in terms of V and e.
- Calculate the speed V_C of ball C just after the collision with B in terms of V and e.

B) Calculate the total mechanical energy loss after both collisions.

- Deduce the speed V_C and the total mechanical energy loss if e=1.

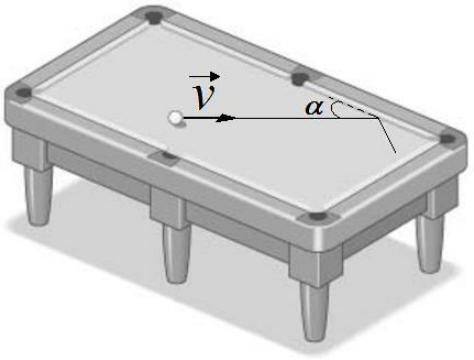
Exercise 8:



Three balls have the same mass m.

Ball A is displaced at an angle θ and released without an initial velocity. Assume the coefficient of restitution between two balls is e. What is the angle by which ball C is displaced after the collision?

Exercise 9:

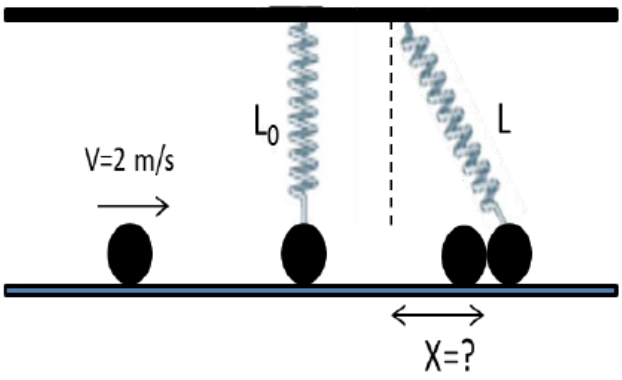


A billiard ball with a velocity of v=2.5 m/s strikes the table cushion at an angle $\alpha = 45^o$. Determine its velocity after the collision if the coefficient of restitution between the ball and the cushion is e=0.6.

Exercise 10:

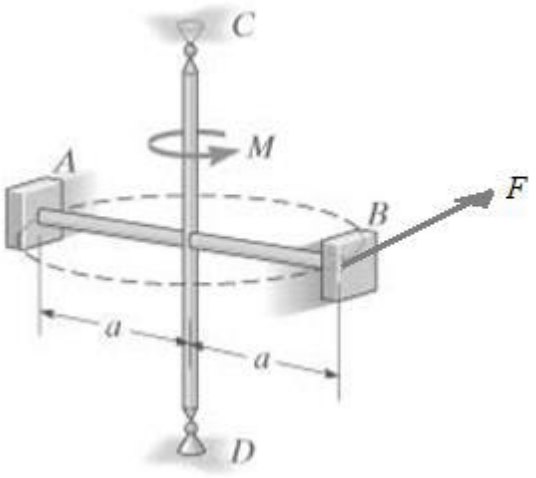
A ball of mass m=5kg moving at a velocity of v=2 m/s collides with a second particle of the same mass, which is initially at rest and attached to a spring with stiffness k=100 N/m and an initial length of $l_0 = 0.9\ m$. The two balls stick together after the collision.

a) Calculate the coefficient of restitution for the collision.
b) Calculate the velocity of the two balls after the collision.
c) Using the conservation of total energy, determine the distance X traveled by the two balls before they come to a stop.



Exercise 11:

The two blocks A and B have the same mass, $m_A = m_B = 400\,g$, and rotate around the axis CD with an initial velocity of v=2 m/s. A torque with a moment magnitude of M=3t is applied on CD, and a force f = 4 N is applied perpendicularly to AB on block B. We give a = 0.3m.



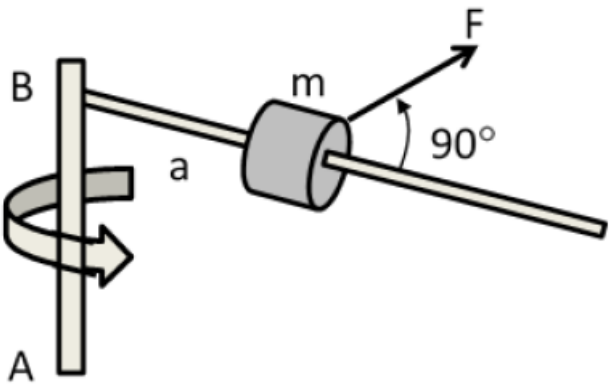
a) Calculate the initial angular momentum of the system.

b) Calculate the moment of force f with respect to point O at t=1 s.

c) Calculate the new velocity of blocks A and B at t=1s.

Exercise 12:

A particle of mass m=0.1 kg can slide without friction on a rod of negligible mass. A force F=2t (N) is applied to the particle, which is located at a distance a=1 m from the axis AB.



a) If the particle is fixed, calculate the angular velocity of the system after 2 seconds.

b) The particle is then released, and the force F is removed. Determine the new position of the particle m when its angular velocity becomes 10 rad/s.

Exercise 13:

A turbo car with a mass of 3000 kg contains 150 kg of benzene. The benzene is consumed at a rate of 4 kg/s and is ejected at a velocity of 250 m/s relative to the car. The air exerts a resistance force on the car given by the relation $F = 60v^2$.

Calculate the maximum speed reached by this car.