Physics I

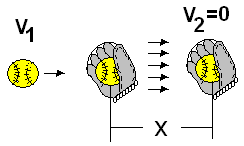
Force

Newton's second law of motion $\sum F_x = ma_x \qquad \sum F_y = ma_y$

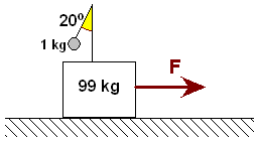
Equations for constant acceleration

$$x = v_1 t + \frac{1}{2}at^2 \qquad v_2 = v_1 + at \qquad v_2^{\,2} = v_1^{\,2} + 2ax \qquad \bar{v} = \frac{v_1 + v_2}{2}$$

Problem 1.- A baseball (**mass = 0.141 kg**) traveling at **v_1=32.5 m/s** strikes the catcher's mitt, which brings the ball to rest by recoiling **x=0.155 m**. Calculate the average force acting on the glove.

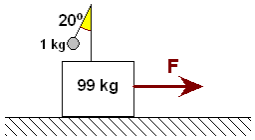


Problem 2.- A crate that has a mass of 99kg is pulled with a force F. A pendulum mounted on the crate has a mass of 1kg and hangs at an angle $\theta = 20^\circ$ off the vertical. Calculate the force F if the coefficient of friction between the crate and the floor is $\mu_k = 0.35$

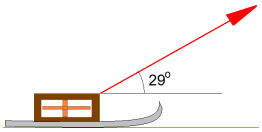


A) 335 N B) 678 N C) 357 N D) 343N E) 700 N

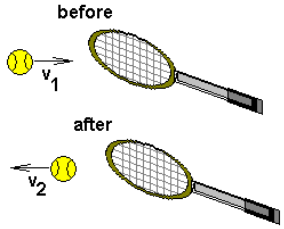
Problem 2a.- A crate that has a mass of 99kg is pulled with a force F. A pendulum mounted on the crate has a mass of 1kg and hangs at an angle $\theta = 20^\circ$ off the vertical. Calculate the force F if there is no friction between the crate and the floor.



Problem 3.- A person pulls a 60 kg sled on an icy surface with a force of 80.0 N at an angle of 29º upward from the horizontal. Calculate the acceleration. Ignore friction in this problem.

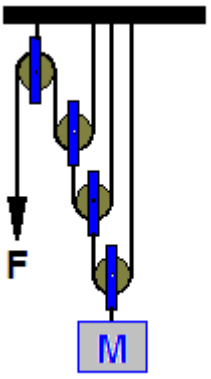


Problem 4.- In playing tennis a ball that had an initial velocity of v_1=26m/s horizontally is returned also horizontally with a speed of v_2=24m/s. Calculate the average force on the ball if its mass is 0.057 kg and the contact with the racket lasted 5 milliseconds.



Problem 5.- A 0.22 kg object follows the path given by $\vec{r} = (3\sin 2t, 4\cos 2t)$. Calculate the force acting on the object.

Problem 6.- What force (F) do you need to apply to lift the block of mass M shown in the figure?



Problem 7.- A bullet of mass 2 g is shot horizontally into a sand bag, striking the sand with a velocity of 600 m/s. It penetrates 20 cm before stopping. What is the average stopping force acting on the bullet?

Problem 8.- If the position of a 1.5 kg particle is described by the vector:

$$\vec{r} = (t^2, 5\cos t)$$

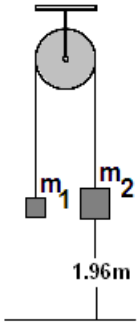
Find the net force acting on the particle as a function of time.

Problem 8a.- If the position of a 2.5 kg particle is described by the vector:

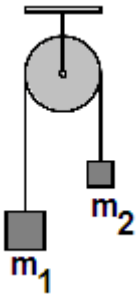
$$\vec{r} = (4t^4, 5\cos 2t)$$

Find the net force acting on the particle at time **t=1.57s**

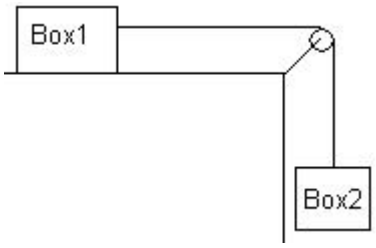
Problem 9.- In the Atwood machine shown in the figure m_2=3 kg and m_1=2.5 kg and you can ignore the mass of the pulley and any friction. Find the speed of m_2 when it hits the ground if you release the masses with zero initial velocity.



Problem 9a.- You want to study acceleration, but your rudimentary instruments only allow you to measure 1m/s^2 or less, so you build an Atwood machine to get less than that. What masses m_1 and m_2 would you choose to accomplish this?



Problem 10.- Ignore friction in the following situation. Calculate how long it will take for box1 to slide 1.5 m if it starts from rest.
Mass of box1 = 1.1 kg
Mass of box2 = 2.2 kg



Problem 11.- The brakes of an 800-kg car apply a force of -4,000N. Calculate the distance needed to stop the car if it is going at 35 miles per hour. [1 mile=1609 m]

Problem 12.- In an experiment with a force table you determine three forces:
F_1= 5N direction = 30°
F_2= 8N direction = 120°
F_3= 10N direction = 150°
Calculate the sum of these three vectors. Give your answer in magnitude and angle.

Problem 13.- An aircraft carrier has a very short runway only 85m long. How much force would you need to apply to a 12,000 kg airplane for it to reach its final take off speed of 55m/s starting from rest?