Name Key Date Partners

HOMEWORK FOR ONE-DIMENSIONAL COLLISIONS

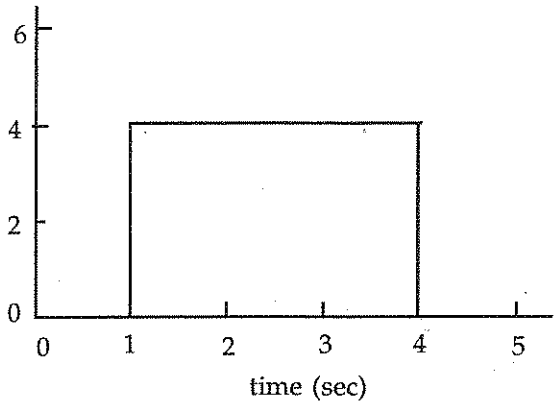
1. Find the impulse of the force shown on the force-time graph below. Explain how you found your answer.

$I = \Delta P = Ft$

$p = m \cdot v$

$\Delta P = m_f \cdot v_f - m_i \cdot v_i$

$4.3 = \boxed{12\ N\cdot s}$



2. An object of mass 2.5 kg is moving in the negative x direction at a velocity of 2.0 m/s. It is acted upon by the force shown above. What is the final velocity after the impulse has acted on the object? Show your calculations.

$12\ N\cdot s = 2.5\ kg\,(v_f - 2\ m/s)$ $\quad \boxed{v_f = 6.8\ m/s}$

3. A ball of mass 1.5 kg is thrown upward. It leaves the thrower's hand with a velocity of 10 m/s. **The following questions refer to the motion after the ball leaves the thrower's hand.** Assume that the upward direction is positive. Show all calculations.

   a. How long does it take for the ball to return to the thrower's hand?

   $I = \Delta P = F\cdot t \rightarrow 1.5(-10_{m/s} - 10\ m/s) = -9.8 \cdot 1.5 \cdot t$ $\quad \boxed{t = 2.04\ s}$

   b. What is the final velocity of the ball just before it reaches the hand?

   $-10\ m/s$

   c. What is the change in momentum of the ball?

   $\boxed{\Delta P = -30\ kg\,m/s}$

   d. What is the impulse calculated from the change in momentum?

   $\boxed{-30\ N\cdot s}$

   e. What is the average force acting on the ball?

   $F = 1.5 \cdot -9.8 = -14.7\ N$

4. After the ball in (3) hits the thrower's hand, it comes to rest in a time of 0.25 sec.

   a. What is the net impulse exerted on the ball?

   $J = \Delta p = 1.5(0 - -10\ m/s) = \boxed{15\ kg\,m/s}$

b. What is the average force exerted by the hand on the ball? (**Hint:** don't forget the gravitational force.)

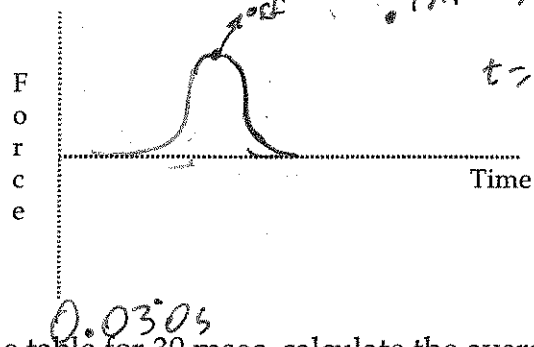
$15\ kg\,m/s = F_{net} \cdot 0.25$

$F_{net} = 60N - (a, 8.1.5)$

$F_{hand} = 45.3N$

5. A superball of mass 0.05 kg is dropped from a height of 10 cm above a table top. It bounces off the table and rises to the same height.

Sketch the shape of the force exerted on the ball by the table as a function of time on the axes on the right.



$.1m = v_0 \cdot t + \frac{1}{2} \cdot 9.8 m/s^2 \cdot t^2$

$t = 0.143\ s$

$v = \frac{.1}{0.143} = 0.699\ m$

0.030 s

6. If the superball was in contact with the table for 30 msec, calculate the average force exerted *on the ball by the table*. Show your work. (**Hint:** calculate the momentum before and after hitting the table. Don't forget the gravitational force.)

Average force: 2.33N

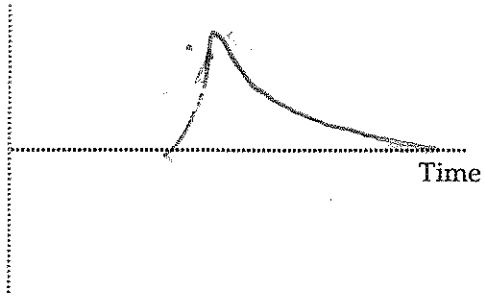
$I = F \cdot \Delta t = 0.05kg(v_f - v_i) = \Delta P$

$F \cdot \Delta t = 0.05\,(0.699 - -0.699)$

$F = 2.33N$

7. The superball is now replaced by a clay ball the same size and mass. The ball is dropped from the same height, and it sticks to the table.

Sketch the shape of the force exerted on the ball by the table as a function of time on the axes on the right.



8. Calculate the impulse exerted on the clay ball, and compare it to that with the superball. Which is larger or are they both the same? Explain.

$I = 0.0349\ Ns$ · $\frac{1}{2}$ of superball

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9. If the collision of the clay ball with the table takes the same 30 ms as the collision of the superball, calculate the average force exerted *by the table on the clay ball*, and compare it to that exerted on the superball. Which is larger or are they the same? Explain.

0.030 s

$F = \frac{I}{\Delta t} = \frac{0.0349}{0.030} = 1.163\ N$

$\frac{1}{2}$ of the other

10. Suppose that the clay has twice the mass and is dropped from the same height. Compare the impulse exerted on the ball to that with the smaller clay ball. Explain your answer.

The impulse will be twice as great since the force will be twice as great

11. Suppose that the original clay ball is dropped from twice the height. Compare the impulse exerted on the ball to that for the smaller height. Explain your answer.

Impulse will be twice as great since the change in momentum will be twice as great