

Problems:

1. A 0.2kg rubber band car is traveling at a speed of 2m/s. After another 0.4 seconds, the speed of the car is 2.8m/s.

a. (2pts) What was the car's initial momentum (when its speed was 2m/s)

$p = mv$

$$p = 0.2\text{kg}(2\text{m/s}) = 0.4\text{kgm/s}$$

b. (2pts) What average force caused the car to speed up from 2m/s to 2.8m/s?

$$Ft = m\Delta v$$
$$F(0.4\text{s}) = 0.2\text{kg}(0.8\text{m/s})$$
$$F = 0.4\text{N}$$

2. A soccer player places a 0.4kg ball on the ground and kicks it at a speed of 24m/s. If the average force of the kick was 80N...

a. (2pts) What impulse was applied to the soccer ball?

$Ft = m\Delta V \rightarrow m\Delta V = 0.4\text{kg}(24\text{m/s}) = 9.6\text{kg m/s}$

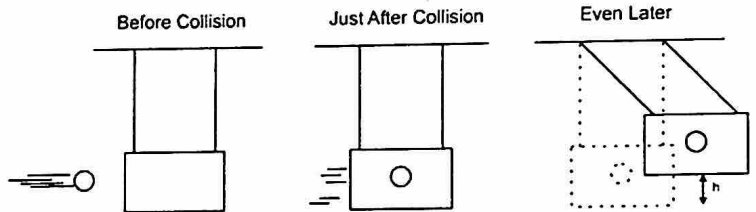
b. (2pts) What was the duration of the impact?

$80\text{N}(t) = 9.6\text{kg m/s} \rightarrow t = 0.12\text{s}$

3. (2pts) An 80kg football player leaps into the air to catch a football. Just before he touches the football, the player's velocity is -0.8m/s, and the velocity of the 0.5kg football is +30m/s. Instead of being caught, the football bounces off of the player's helmet with a velocity of -15m/s. What is the velocity of the football player after the collision?

$(80\text{kg})(-0.8\text{m/s}) + 0.5\text{kg}(30\text{m/s}) = 80\text{kg}(v) + 0.5\text{kg}(-15\text{m/s})$
 $-41.5\text{kg m/s} = 80\text{kg}(v)$
 $v = -0.52\text{m/s}$

4. (4points) A 0.15 kg projectile is fired into a 6kg ballistic pendulum. The projectile embeds in the pendulum and then the pendulum + projectile swing upward to a height (h) of 0.4m before stopping.



a. What is the shared velocity of the pendulum + the projectile just after impact, as they begin the swing (as in figure 2)?

$\frac{1}{2}mv^2 = mgh$
 $v = \sqrt{2gh} = \sqrt{2(9.8\text{m/s}^2)(0.4\text{m})}$
 $v = 2.8\text{m/s}$

b. What was the velocity of the projectile before it hit the pendulum (as in figure 1)?

$0.15\text{kg}(v_0) = 6.15\text{kg}(2.8\text{m/s})$
 $v_0 = 115\text{m/s}$

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5. (4pts) Sphere A is traveling with a velocity of 3m/s when it collides with sphere B, which is traveling with a velocity of -1m/s. After the collision, sphere A has a velocity of 1m/s. If sphere B has a mass of 2kg, and the collision has a coefficient of restitution of 0.5, what is the mass of sphere A, and what is the final velocity of sphere B?

Sphere A mass = 4kg

Sphere B final velocity = 3m/s

$$e = \frac{V_B' - V_A'}{V_A - V_B} = 0.5$$

$$0.5(3m/s - (-1m/s)) = 1 \cdot V_B' - 1m/s$$

$$1m/s + 1.5m/s + 0.5m/s = V_B'$$

$$V_B' = 3m/s$$

$$M_A(3m/s) + 2kg(-1m/s) = M_A(1m/s) + 2kg(3m/s)$$

$$2M_A m/s = 8kg \cdot m/s$$

$$M_A = 4kg$$

Answers ~~is~~

If e=0

$$3+1 = V_B - 1$$

$$V_B = 5m/s$$

$$m(3) + 2(1) = m + 2(5)$$

$$2m = 12$$

$$m = 6kg$$

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