Chapter 3 HW Answers

Review Questions:

3. With your hand extended, you can increase the duration of the impact by bending your arm; when an impact takes more time, the impact force is decreased.

11. If this is a perfectly elastic collision, all momentum is transferred from **A** to **B** during the collision. Thus, $\mathbf{V_B = V_A}$.

12. Together, they would **half the speed** because they have twice the mass.

18. The car would have 16 times more KE.

$$KE = 1/2m(4v)^2 = \tfrac{1}{2}\, m(16)(v^2) = 16 \text{ x (original KE)}$$

24. Can a machine multiply…

Input force? Yes. You can apply a small amount of force to a wrench and get a larger force at the other end.

Input distance? Yes. Look at the lever on page 84.

Input energy? No. It is not possible to get out more energy than is put into a system.

Exercises:

1. Inertia gives the supertanker a lot of momentum and it takes a while to change the momentum.

4. The reason automobiles crumple on impact is to make the time of the impact longer which decreases the impact force.

24. George and Sally each get one throw, and then the game is over.

When George throws Fred, George will gain a velocity in the opposite direction that is equal to the velocity he gave to Fred. If there is no gravity or air to slow George down, he will be out of the game after the first throw (he will be traveling away from the group in a straight line). When Sally catches Fred, Sally and Fred will have1/2 of Fred's original velocity, and they will travel away from George at that velocity. If Sally then throws Fred, Fred will travel in the direction of George but will never catch up to George and Sally will travel in the opposite direction.

27. If they weigh the same and travel the same distance, the work done is the same. The one does the work faster uses more power.

44. They have the same momentum, but different KE.

$p = mv$ $\qquad$ $KE = \frac{1}{2} mv^2$

$p = (1\text{ kg})(2\text{ m/s}) = 2\text{ kg m/s}$ $\qquad$ $KE = \frac{1}{2} (1\text{ kg})(2\text{ m/s})^2 = 4\text{ J}$

$p = (2\text{ kg})(1\text{ m/s}) = 2\text{ kg m/s}$ $\qquad$ $KE = \frac{1}{2} (2\text{ kg})(1\text{ m/s})^2 = 2\text{ J}$

Problems:

3. $m = 8\text{ kg}$
$\Delta v = 2\text{ m/s}$
$t = 0.5\text{ s}$
$F = ?$

This is an impact force.

$$F = \frac{m\,\Delta v}{t} = \frac{(8\text{ kg})(2\text{ m/s})}{0.5\text{ s}} = \mathbf{32\text{ N}}$$

The forces on the pillow and the ball are equal and opposite (Newton's 3rd Law).

9. This is a conservation of momentum question.

$p_{asteroid} = p_{superman}$

$m_a v_a = m_s v_s$

We know that $m_{asteroid} = (1000)m_{superman}$, so m_a becomes $(1000)m_s$ in the equation

$(1000)m_s v_a = m_s v_s$

now the m_s cancels

$(1000)v_a = v_s$

We know that $v_{asteroid} = 800$ m/s, so…

$(1000)(800\text{ m/s}) = v_s$

$v_s = 800{,}000$ m/s $\qquad$ **Superman should not be at rest in the cartoon!**

11. $F_1 = 50\text{ N}$ $\qquad$ $F_2 = ?$
$d_1 = 1.2\text{ m}$ $\qquad$ $d_2 = 0.2\text{ m}$

The torque on each side of the fulcrum must be equal.

$\tau_1 = \tau_2$

$F_1 d_1 = F_2 d_2$ → (50 N)(1.2 m) = F_2 (0.2 m) → **F_2 = 300 N**

Additional:

A. First we need to have standard units.

12 feet = 144 inches = 365.76 cm = 3.66 m

a. GPE = mgh = (34 kg)(9.81 m/s^2)(3.66 m) = **1221 J**

b. **1221 J**

c. P = W/t = (1221 J)/(3 sec) = **3663 W**

d. (10%)KE = 0.10 x 1221 J = **122 J**

e. Need correct units for mom's height.

5 feet = 60 inches = 152.4 cm = 1.24 m

GPE = mgh = (34 kg)(9.81 m/s^2)(3.66 m − 1.24 m) = **807J**

B. Need to think about what each letter in the unit means…

720 kWh = 720 (1000)(J/s)(3600 s) = **2.59 x 10^9 J (2.5 Billion Joules)**

This is a bill for energy.

C. The impact takes longer when there is carpet, so the impact force is decreased.

D. David will reach the bottom first because he travels a shorter distance.

The speed can be found from conservation of energy.

GPE = KE

mgh = ½ mv^2 (mass cancels – gravity acts on all masses equally)

v^2 = 2gh = 2(9.81 m/s^2)(50 meters) = 981 m^2/s^2

v = 31 m/s

Bonus Points: Nothing will change (2 points). Gravity is the same for both skiers; it does not depend on mass, so the results do not change when one mass is doubled (2 points).