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01 - Worksheet - Momentum and Net Force

**Textbook Questions**

Pg 453 #6: Provide an example of a situation in which

- a. Velocity is the dominant factor affecting the momentum of an object.

Light object moving very fast.  
Eg: bullet

- b. Mass is the dominant factor affecting the momentum of an object.

Heavy object moving very slow.  
Eg: Coasting train.

Pg 453 #8: What is the momentum of a 6.0-kg bowling ball with a velocity of 2.2 m/s [S]?

$$m = 6 \text{ kg}$$

$$\vec{v} = 2.2 \text{ m/s [S]}$$

$$\vec{p} = ?$$

$$\vec{p} = m\vec{v}$$

$$= (6 \text{ kg})(2.2 \text{ m/s [S]})$$

$$= 13.2 \text{ kg m/s [S]}$$

Pg 453 #9: The momentum of a 75-g bullet is 9.00 kg\*m/s [N]. What is the velocity of the bullet?

$$m = 0.075 \text{ kg}$$

$$\vec{p} = 9.00 \text{ kg m/s [N]}$$

$$\vec{v} = ?$$

$$\vec{p} = m\vec{v}$$

$$9.00 \text{ kg m/s [N]} = (0.075 \text{ kg})\vec{v}$$

$$\vec{v} = 120 \text{ m/s [N]}$$

Pg 453 #10: A hockey puck has a momentum of 3.8 kg\*m/s [E]. If its speed is 24 m/s, what is the mass of the puck?

$$\vec{p} = 3.8 \text{ kg m/s [E]}$$

$$\vec{v} = 24 \text{ m/s [E]}$$

$$m = ?$$

$$p = mv$$

$$(3.8) = m(24)$$

$$m = 0.158\bar{3} \text{ kg}$$

Pg 453 #14:

- a. A jet flies west at 190 m/s. What is the momentum of the jet if its total mass is 2250 kg?

$$\begin{aligned} \vec{v} &= 190 \text{ m/s [W]} \\ m &= 2250 \text{ kg} \\ \vec{p} &= ? \end{aligned} \quad \begin{aligned} \vec{p} &= m\vec{v} \\ &= (2250)(190) \\ &= \boxed{427,500 \text{ kg m/s [W]}} \end{aligned}$$

- b. What would be the momentum of the jet if the mass was  $\frac{3}{4}$  of its original value and the speed increased to  $\frac{6}{5}$  of its original value?

OPTION #1

$$\begin{aligned} m &= \frac{3}{4}(2250) = 1687.5 \text{ kg} \\ v &= \frac{6}{5}(190) = 228 \text{ m/s} \\ p &= mv \\ &= (1687.5)(228) \\ &= \boxed{384,750 \text{ kg m/s}} \end{aligned}$$

OPTION #2

$$\begin{aligned} p &= mv \\ &= 427,500 \\ p_{\text{new}} &= \left(\frac{3}{4}m\right)\left(\frac{6}{5}v\right) \\ &= \frac{9}{10}(mv) \\ &= \frac{9}{10}(427,500) \\ &= \boxed{384,750 \text{ kg m/s}} \end{aligned}$$

Diploma Worksheet Questions

Use the following information to answer Q2 – Q3:

A particular supertanker is fully loaded with oil and has a mass of  $1.00 \times 10^9$  kg. The supertanker has a cruising speed of 20 km/h. One way to stop the ship is to reverse its engines. At maximum reverse thrust, the ship takes 32.0 min to stop.

Q2: The momentum of the supertanker at cruising speed, expressed in scientific notation, is  $b \times 10^w$  kg\*m/s. The value of  $b$  is \_\_\_\_\_.

(Record your **three digit** answer in the Numerical Response boxes below)

$$\begin{aligned} m &= 1.00 \times 10^9 \text{ kg} \\ v &= \frac{20 \text{ km}}{\text{h}} \times \frac{1 \text{ h}}{3600 \text{ s}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 5.5 \text{ m/s} \end{aligned}$$

$$\begin{aligned} p &= mv \\ &= (1.00 \times 10^9)(5.5) \\ &= 5.555... \times 10^9 \text{ kg m/s} \\ &\approx \frac{5.56}{b} \times 10^9 \text{ kg m/s} \end{aligned}$$

Q3: The kinetic energy of the supertanker at cruising speed, expressed in scientific notation, is  $b \times 10^w$  J. The value of  $b$  is \_\_\_\_\_.

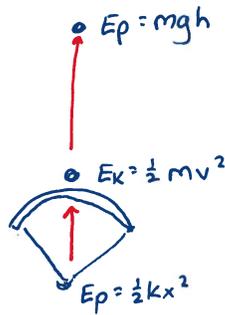
(Record your three digit answer in the Numerical Response boxes below)

1 . 5 4

$$\begin{aligned}
 E_k &= \frac{1}{2}mv^2 \\
 &= \frac{1}{2}(1.00 \times 10^9)(5.5)^2 \\
 &= 1.5432... \times 10^{10} \text{ J} \\
 &\approx \underline{1.54} \times 10^{10} \text{ J} \\
 &\quad \quad \quad \underline{b}
 \end{aligned}$$

Q4: A spring is compressed a distance of  $x$ . When the spring is released, it shoots a marble of mass  $m$  vertically upward from ground level. The maximum height reached by the marble is  $h$ . The magnitude of the marble's momentum at the highest point of the marble's trajectory is equivalent to

- a. 0
- b.  $mgh$
- c.  $m\sqrt{2gh}$
- d.  $x\sqrt{2gh}$



At the highest point, all energy is  $E_p$ .  
Or,  $v_f = 0 \text{ m/s}$  at top.

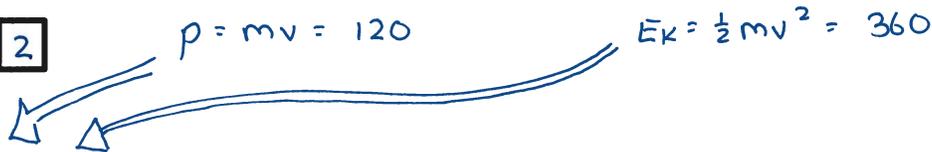
$p = mv$ , so if speed is zero, so is the momentum.

Challenge Question

An object of fixed mass originally has a momentum of  $120.0 \text{ kg}\cdot\text{m/s}$  and a kinetic energy of  $360.0 \text{ J}$ . The object accelerates until it doubles its original kinetic energy. The new momentum of the object is determined to be  $a.bc \times 10^d \text{ kg}\cdot\text{m/s}$ , where  $a$ ,  $b$ ,  $c$ , and  $d$  are \_\_, \_\_, \_\_, and \_\_.

(Record your three digit answer in the Numerical Response boxes below)

1 7 0 2



$$\begin{aligned}
 E_k &= \frac{1}{2}mv^2 \\
 E_k &= \frac{1}{2}(mv)v \\
 360 &= \frac{1}{2}(120)v \\
 360 &= 60v \\
 v &= 6 \text{ m/s}
 \end{aligned}$$

$$\begin{aligned}
 p &= mv \\
 120 &= m(6) \\
 m &= 20 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 E_k &= \frac{1}{2}mv^2 \\
 720 &= \frac{1}{2}(20)v^2 \\
 720 &= 10v^2 \\
 72 &= v^2 \\
 v &= 8.485... \text{ m/s}
 \end{aligned}$$

$$\begin{aligned}
 p &= mv \\
 &= (20)(8.485...) \\
 &= 169.7056... \text{ kg}\cdot\text{m/s} \\
 &= 1.697 \times 10^2 \text{ kg}\cdot\text{m/s} \\
 &\approx 1.70 \times 10^2 \text{ kg}\cdot\text{m/s}
 \end{aligned}$$