

MOMENTUM

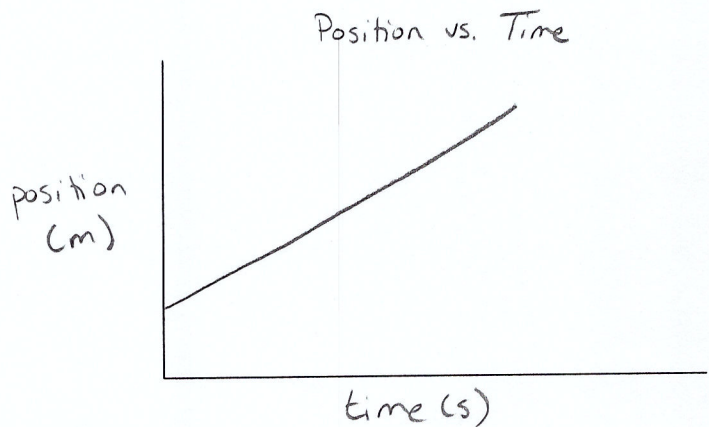
- **Momentum** is defined as the product of the mass and the velocity of an object

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

where \bar{p} is momentum (kg·m/s or N·s)
 m is mass (kg)
 \bar{v} is velocity (m/s)

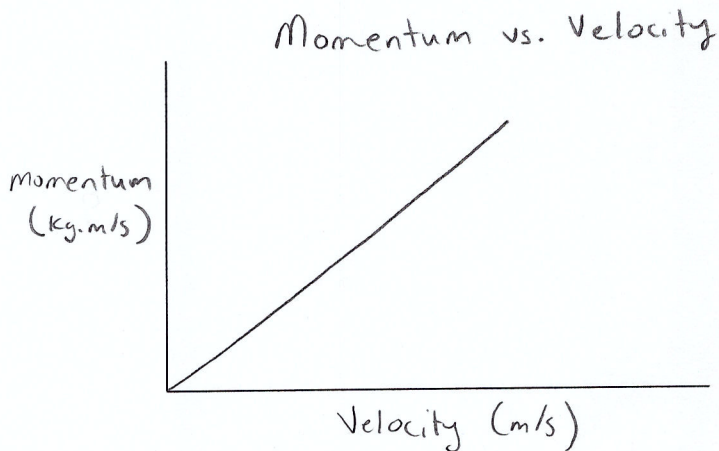
* ○ Momentum is a vector quantity, therefore a direction is needed

- There are different types of graphs that can be used for graphing momentum or graphs that can be used to calculate momentum



$$\text{slope} = \frac{d}{t} = v$$

∴ if mass is known,
momentum can be
calculated $p = mv$



$$\text{slope} = \frac{p}{v} = m$$

OR

$$y = mx + b$$

↓ ↓ ↓ ↓

$$p = m v + 0$$

EXAMPLES:

1. During one part of the liftoff of a model rocket, its momentum increases by a factor of four while its mass is halved. The velocity of the rocket is initially 8.5 m/s, up. What is the final velocity during that time interval?

* ratio question dealing with momentum!

Original

p

m

$$v = 8.5 \text{ m/s}$$

$$p = mv$$

$$\therefore v = \frac{p}{m} = 8.5 \text{ m/s}$$

Modified

$$p' = 4p$$

$$m' = m/2$$

$$v' = ?$$

$$p = mv \Rightarrow v = \frac{p}{m}$$

$$v' = \frac{4p}{\left(\frac{m}{2}\right)} = 4p \left(\frac{2}{m}\right) = 8 \left(\frac{p}{m}\right) \\ = v = 8.5 \text{ m/s}$$

$$\therefore v' = 8(8.5 \text{ m/s})$$

$$v' = 68 \text{ m/s, up}$$

2. A 20g ball is dropped from a height of 10 m. Determine the momentum when it is half-way to the ground.

$$m = 20g \times \left(\frac{10^{-3} \text{ kg}}{1g} \right)$$

$$m = 0.020 \text{ kg}$$

$$d = \frac{10 \text{ m}}{2} = 5.0 \text{ m}$$

$$p = ?$$

$$v_i = 0.0 \text{ m/s}$$

$$a = 9.81 \text{ m/s}^2$$

$$\textcircled{2} \quad p = mv$$

$$\textcircled{1} \quad v_f^2 = v_i^2 + 2ad$$

$$\textcircled{1} \quad v_f^2 = v_i^2 + 2ad$$

$$v_f = \sqrt{2ad}$$

$$v_f = \sqrt{2(9.81 \text{ m/s}^2)(5.0 \text{ m})}$$

$$v_f = 9.9045 \dots \text{ m/s}$$

$$\textcircled{2} \quad p = mv$$

$$p = (0.020 \text{ kg})(9.9045 \dots \text{ m/s})$$

$$p = 0.198 \dots \text{ kg} \cdot \text{m/s}$$

$$p = 0.20 \text{ kg} \cdot \text{m/s, down}$$

Now try pg. 40 #1, 3 (acceptable), 5, 6, 8-10 (intermediate)