

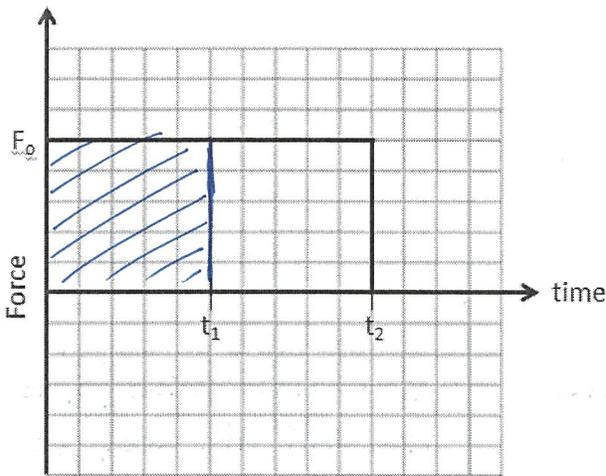
First Name: \_\_\_\_\_

Last Name: \_\_\_\_\_

**Physics 30 - Unit A: Momentum - '03 - Impulse Graphs 2**

The graph below depicts the forces acting on an initially stationary 10kg mass. Use this information to answer the questions below.

$v_i = 0 \text{ m/s}$



$$\underbrace{\vec{F} \Delta t}_{\text{Impulse}} = m \Delta \vec{v}$$

Impulse = Area under graph.

**Q1:** If the 10kg mass is initially stationary, and is travelling at 5m/s at  $t = t_1$ , how fast is the object travelling at  $t = t_2$ ? Record your answer to two-digits.

|   |   |  |  |
|---|---|--|--|
| 1 | 0 |  |  |
|---|---|--|--|

At  $t = t_1$   
 $m = 10 \text{ kg}$   
 $v_i = 0 \text{ m/s}$   
 $v_f = 5 \text{ m/s}$  }  $\Delta v = 5 \text{ m/s}$

$$\begin{aligned} \text{Impulse} &= m \Delta v \\ &= (10 \text{ kg})(5 \text{ m/s}) \\ &= 50 \text{ N}\cdot\text{s} \end{aligned}$$

So the shaded region receives 50 N·s of impulse.

Impulse is area under graph, so unshaded area ( $t_1$  to  $t_2$ ) has the same area, so same impulse.

$\therefore \text{Impulse}(t_1 \text{ to } t_2) = 50 \text{ N}\cdot\text{s}$

$$\begin{aligned} 50 \text{ N}\cdot\text{s} &= m \Delta v \\ 50 \text{ N}\cdot\text{s} &= (10 \text{ kg}) \Delta v \\ \Delta v &= 5 \text{ m/s} \end{aligned}$$

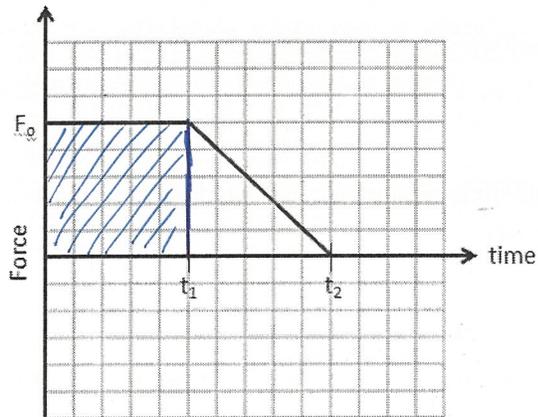
So from  $t_1$  to  $t_2$ , the object speeds up an additional 5 m/s.

$\therefore$  Final speed is 10 m/s.

KEY

The graph below depicts the forces acting on an initially stationary 10kg mass. Use this information to answer the questions below.

$$v_i = 0 \text{ m/s}$$



**Q2:** If the 10kg mass is initially stationary, and is travelling at 5m/s at  $t = t_1$ , how fast is the object travelling at  $t = t_2$ ? Record your answer to two-digits.

|   |   |   |
|---|---|---|
| 7 | . | 5 |
|---|---|---|

Shaded region has

$$m = 10 \text{ kg}$$

$$v_i = 0 \text{ m/s}$$

$$v_f = 5 \text{ m/s}$$

$$\Delta v = 5 \text{ m/s}$$

$$\begin{aligned} \text{Impulse} &= m \Delta v \\ &= (10 \text{ kg})(5 \text{ m/s}) \\ &= 50 \text{ N}\cdot\text{s} \end{aligned}$$

Non-shaded region ( $t_1$  to  $t_2$ ) has half the area, so half the impulse.

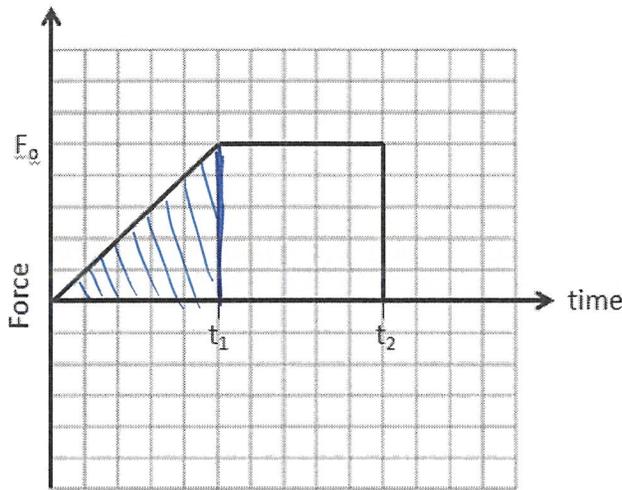
$$\text{Impulse} = 25 \text{ N}\cdot\text{s}$$

$$\begin{aligned} \text{Impulse} &= m \Delta v \\ 25 \text{ N}\cdot\text{s} &= (10 \text{ kg}) \Delta v \\ \Delta v &= 2.5 \text{ m/s} \end{aligned}$$

So the mass gains an additional 2.5 m/s, for a total speed of 7.5 m/s.

The graph below depicts the forces acting on an initially stationary object of unknown mass. Use this information to answer the questions below.

$v_i = 0 \text{ m/s}$



**Q3:** If the unknown mass is initially stationary, and is travelling at  $8 \text{ m/s}$  at  $t = t_1$ , how fast is the object travelling at  $t = t_2$ ? **Record your answer to two-digits.**

|   |   |  |  |
|---|---|--|--|
| 2 | 4 |  |  |
|---|---|--|--|

Impulse =  $m\Delta\vec{v}$

For the shaded region,

Impulse causes  $\Delta\vec{v}$

The non-shaded region has twice the area, so twice the impulse.

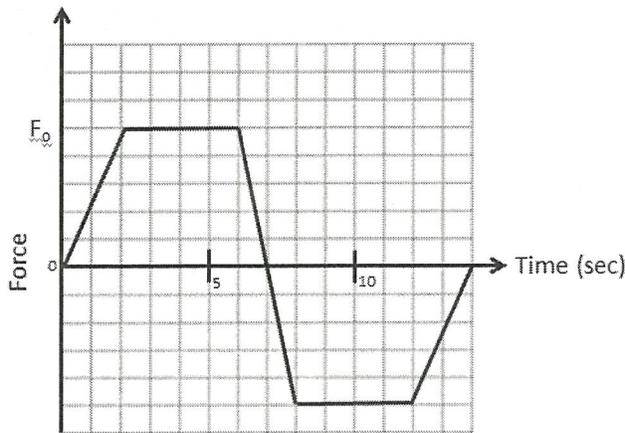
If we double our impulse, we double our change in momentum. Since the mass can't change, the "change in velocity" must double.

$2x$  Impulse causes  $2x \Delta\vec{v}$

So we gain an additional  $16 \text{ m/s}$ , for a total of  $24 \text{ m/s}$ .

KEY

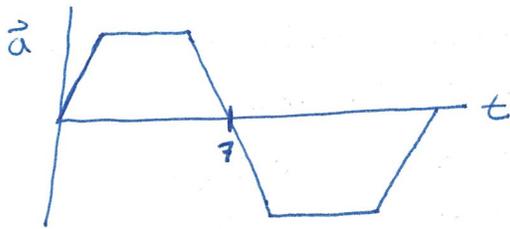
The graph below depicts the forces acting on an initially stationary object of unknown mass. Use this information to answer the questions below.



Q4: At what time is the object travelling the fastest? Record your answer to two-digits.

|   |   |   |  |
|---|---|---|--|
| 7 | . | 0 |  |
|---|---|---|--|

$a = \frac{F_{net}}{m}$ , so an  $a-t$  graph would look like.



The object continues to speed up for the first 7 seconds.

After 7 seconds, the negative acceleration would slow it down.

Because the areas from 0-7sec and 7-14sec are the same, the Impulses are the same (but opposite in direction), and the change in momentums will be the same.

The object will therefore be stationary (stop) when  $t=14$ sec, though it will be a far distance from its starting point.