Momentum & Impulse

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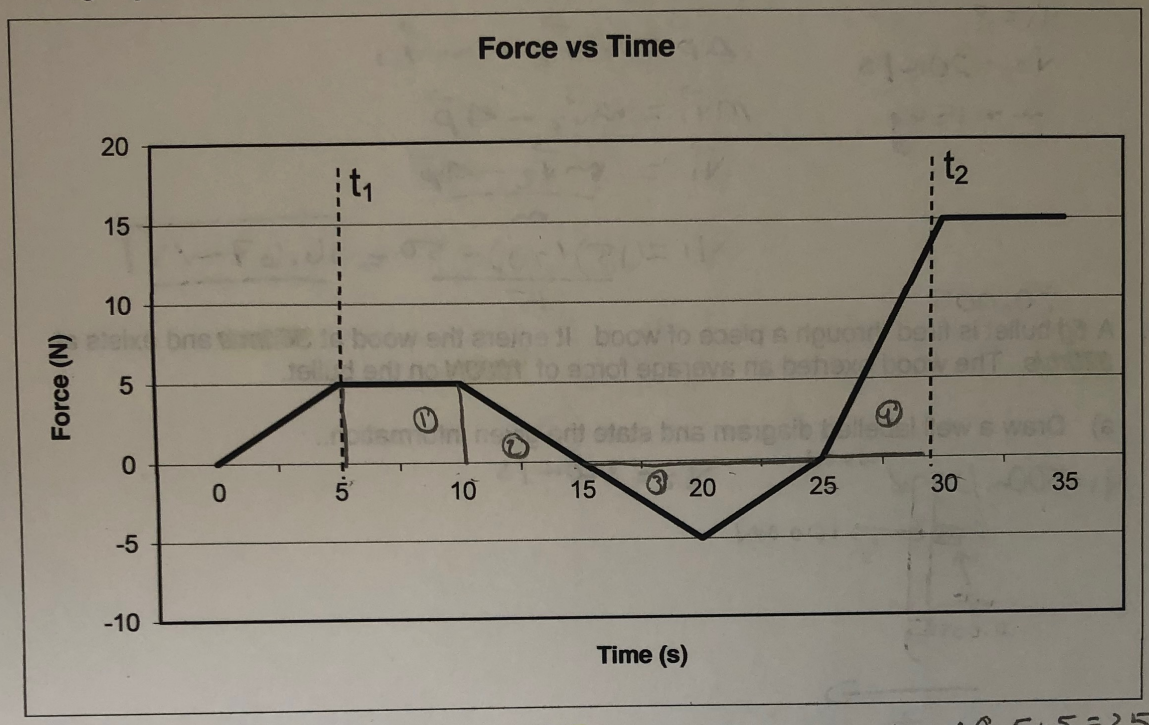
1. A 15kg object has the following time variant force *F(t)* acting on it.



The object has a final velocity, $v(t_2)$, of 20m/s. Determine

Area: ① $5 \times 5 = 25\ N\cdot s$

② $\frac{5 \times 5}{2} = 12.5\ N\cdot s$

③ $-\frac{5 \times 10}{2} = -25\ N\cdot s$

④ $\frac{5 \times 15}{2} = 37.5\ N\cdot s$

$A_T = 50\ N\cdot s$

a) The impulse from t_1 to t_2.

$\vec{I} = \Sigma \vec{F}_{av} \Delta t = \Delta \vec{p}$

$\vec{I} = 50\ N\cdot s.$

from t_1 to t_2

b) The average force over the time interval indicated in a)

$\vec{I} = \Sigma \vec{F}_{av} \Delta t$

$\Sigma \vec{F}_{av} = \frac{\vec{I}}{\Delta t} = \frac{50 Ns}{25 s} = 2N$

c) The initial velocity of the object at t_1.

$v_1 = ?$

$v_2 = 20 m/s$

$m = 15 kg$

$\Delta \vec{p} = m\vec{v}_2 - m\vec{v}_1$

$m\vec{v}_1 = m\vec{v}_2 - \Delta \vec{p}$

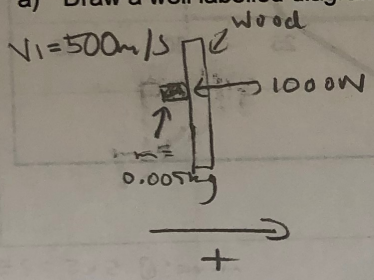
$\vec{v}_1 = \frac{m\vec{v}_2 - \Delta \vec{p}}{m}$

$v_1 = \frac{(15)(20) - 50}{15} = 16.67 m/s$

$\div 0.005$

2. A 5g bullet is fired through a piece of wood. It enters the wood at 500m/s and exists at 320m/s. The wood exerted an average force of 1000N on the bullet.

a) Draw a well labelled diagram and state the given information..



b) Determine the change in momentum.

$\Delta \vec{p} = m\vec{v}_2 - m\vec{v}_1$

$= (0.005)(320) - (0.005)(500)$

$\Delta \vec{p} = -0.9 Ns$

c) Determine how long the bullet was in the wood for.

$\Sigma \vec{F} = m\vec{a}$

$a = \frac{F}{m} = \frac{-1000}{0.005} = -200{,}000 m/s$

$v_2^2 = v_1^2 + 2a\Delta d$

$\Delta d = \frac{v_2^2 - v_1^2}{2a} = \frac{(320)^2 - (500)^2}{2(-200{,}000)} = +0.369 m$

d) Determine how thick the piece of wood is.

$\Delta \vec{p} = \Sigma \vec{F}_{av} \Delta t$

$\Delta t = \frac{\Delta \vec{p}}{\Sigma F_{av}} = \frac{-0.9 N \cdot s}{-1000} = 0.0009 s$