Q5

a) $25\ km/h = 6.944\ ms^{-1}$

$m_1u_1 + m_2u_2 = m_3v_3$

$1500 \times 6.944 + 1000 \times 0 = 2500 \times v_3$

$v_3 = 4.166\ ms^{-1}$

Velocity after collision $= 4.166\ ms^{-1}$

b) A: $t = 0.1\ s$, $u = 6.944\ ms^{-1}$, $v = 4.166\ ms^{-1}$, $a = ?\ ms^{-2}$

$v = u + at$

$a = \frac{v-u}{t}$

For A: $a = -27.78\ ms^{-2}$

B: $t = 0.1\ s$, $u = 0\ ms^{-1}$, $v = 4.166\ ms^{-1}$, $a = ?\ ms^{-2}$

$v = u + at$

$a = \frac{v-u}{t}$

For B: $a = 41.66\ ms^{-2}$

c) A: $F = ma$

$F = 1500 \times -27.78$

$F = 41670\ N$

B: $F = ma$

$F = 1000 \times 41.66$

$F = 41660\ N$

d) Before:

$E_k = \frac{1}{2}mv^2$

$E_k = \frac{1}{2} \times (1500) \times (6.944)^2$

$= 36164.352\ J$

After:

$E_k = \frac{1}{2}mv^2$

$E_k = \frac{1}{2} \times (2500) \times (4.166)^2$

$= 21694.445\ J$

$\Delta E_k = -14.5\ kJ$

e) Velocity lost over 2m:

Frictional Force:

$m = 2500$

$W = 2500g$

$\mu = 0.02$

$F = 2500g \times 0.02 = 490.5\ N$

Deceleration due to friction

$a = \frac{F}{m}$

$a = \frac{490.5}{2500}$

$= 0.1962$

Final Velocity before impact:

$a =$	-0.1962	ms^{-2}
$u =$	4.166	ms^{-1}
$v =$	?	ms^{-1}
$s =$	2	m

$v^2 = u^2 + 2as$

$v^2 = (4.166)^2 + 2 \times -0.1962 \times 2$

$v^2 = 16.57$

$v = 4.07\ ms^{-1}$

Kinetic Energy Before impact:

$E_K = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 2500 \times (4.07)^2$

$= 20706.125\ J$

$= 20.7\ kJ$

After Impact:

Work done against rolling resistance: ($w = Fd$)

$W = 490.5 \times x$

↑ Frictional force found previously

↖ use x so same variable as spring compression equation

Work done compressing barrier

$E = \frac{1}{2} k x^2$

$E = \frac{1}{2} \times 500 \times 10^3 \times x^2$

Total Work done = $\frac{1}{2} \times 500 \times 10^3 \times x^2 + 490.5 x$

ALL KE is lost:

$20.7 \times 10^3 = \frac{1}{2} \times 500 \times 10^3 \times x^2 + 490.5 x$

solve quadratic for x.

$x_1 = 0.2868$ m

$x_2 = -0.288$ m

As compression is being taken as positive ~~then~~, and The barrier will be compressed when it is hit, x_2 which is negative can be ~~closter~~ ignored.

Total barrier deflection = 0.287 m