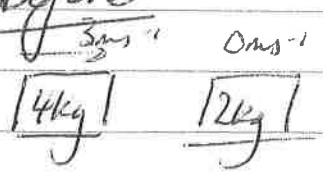
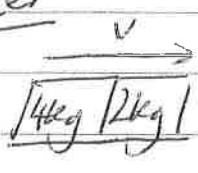
(1) a) Before



After



$p = m_1u_1 + m_2u_2$
$= 6 \times 3 + 2 \times 0$
$= 12 \text{ kgms}^{-1}$

$p = mv$
$= 6v$

$p_{BEFORE} = p_{AFTER}$
$12 = 6v$
$v = 2 \text{ ms}^{-1}$

b) Before

$E_k = \frac{1}{2} m_1 u_1^2$
$= \frac{1}{2} \times 4 \times 9$
$= 18 \text{ J}$

$E_k = \frac{1}{2} m_2 u_2^2$
$= 0 \text{ J}$

After

$E_k = \frac{1}{2} mv^2$
$= \frac{1}{2} \times 6 \times 4$
$= 12 \text{ J}$

6J of kinetic energy lost.

(2)

$p = m_1u_1 + m_2u_2$
$= 0.5u + 0$
$= 0.5u$

$p = mv$
$= 0.7 \times 2$
$= 1.4 \text{ kgms}^{-1}$

$p_{BEFORE} = p_{AFTER}$
$0.5u = 1.4$
$u = 2.8 \text{ ms}^{-1}$

(3)

$p = m_1u_1 + m_2u_2$
$= 2.4 \times 6 + m \times 0$
$= 14.4 \text{ kgms}^{-1}$

$p = mv$
$= (2.4 + m)4.5$
$= 10.8 + 4.5m$

Before	=	After
14.4	=	$10.8 + 4.5m$
3.6	=	$4.5m$
m	=	0.8kg

(4)

$p = m_1u_1 + m_2u_2$
$= m \times 12 + 3000 \times 0$
$= 12m$

$p = mv$
$= (m + 3000)3$
$= 3m + 9000$

Before	=	After
$12m$	=	$3m + 9000$
$9m$	=	9000
m	=	1000kg

(5)

$p = m_1u_1 + m_2u_2$
$= 2 \times 0.5 + m \times 0$
$= 1 \text{ kgms}^{-1}$

$p = mv$
$= (2 + m)0.2$
$= 0.4 + 0.2m$

Before	=	After
1	=	$0.4 + 0.2m$
0.6	=	$0.2m$
m	=	3kg

(6)

$p = m_1u_1 + m_2u_2$
$= 5\times10^{-4}\times u + 0.4\times0$
$= 5\times10^{-4}u$

$p = mv$
$= 0.4005\times0.25$
$= 0.100\ kgms^{-1}$

$p_{before} = p_{after}$
$5\times10^{-4}u = 0.1$
$u = \underline{200\ ms^{-1}}$

(7)

$p = m_1u_1 + m_2u_2$
$= 1500\times8 + 2000\times9$
$= 30\,000\ kgms^{-1}$

$p = mv$
$= 3500\ v$

$p_{before} = p_{after}$
$30\,000 = 3500\ v$
$v = \underline{8.57\ ms^{-1}}$

(8) a)

$p = m_1u_1 + m_2u_2$
$= 0.4\times0.4 + 0.2\times0.25$
$= 0.16 + 0.05$
$= 0.21\ kgms^{-1}$

$p = mv$
$= 0.6v$

$p_{before} = p_{after}$
$0.21 = 0.6v$
$v = \underline{0.35\ ms^{-1}}$

b) $E_k = \frac{1}{2}m_1u_1^2$
$= \frac{1}{2}\times0.4\times0.4^2$
$= 0.032\ J$

$E_k = \frac{1}{2}m_2u_2^2$
$= \frac{1}{2}\times0.2\times0.25^2$
$= 0.00625\ J$

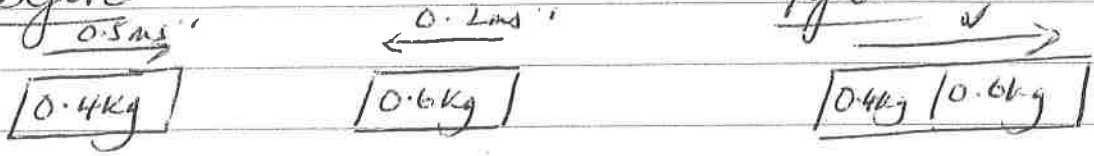
$E_k = \frac{1}{2}mv^2$
$= \frac{1}{2}\times0.6\times0.35^2$
$= 0.037\ J$

Total E_k before $= 0.038\ J$

E_k loss $= \underline{0.001\ J}$

(9)

Before



After

$p = m_1u_1 + m_2u_2$

$= 0.4 \times 0.5 + 0.6 \times -0.2$

$= 0.2 - 0.12$

$= 0.08 \text{ kgms}^{-1}$

$p = mv$

$= v$

$p_{BEFORE} = p_{AFTER}$

$0.08 = v$

$v = 0.08 \text{ ms}^{-1}$

(10)

$p = m_1u_1 + m_2u_2$

$= 0.2 \times 0.4 + 0.3 \times -0.3$

$= 0.08 - 0.09$

$= -0.01 \text{ kgms}^{-1}$

$p = mv$

$= 0.5v$

$p_{BEFORE} = p_{AFTER}$

$-0.01 = 0.5v$

$v = -0.02 \text{ ms}^{-1}$

(11)

$p = m_1u_1 + m_2u_2$

$= 1200 \times 10 + 800 \times 4$

$= 12000 + 7200$

$= 19200 \text{ kgms}^{-1}$

$p = m_1v_1 + m_2v_2$

$= 1200 \times v + 800 \times 11$

$= 1200v + 8800$

$p_{before} = p_{after}$

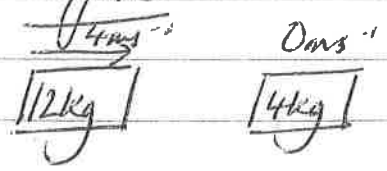
$19200 = 1200v + 8800$

$10400 = 1200v$

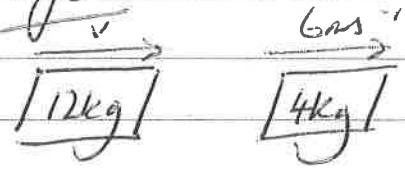
$v = 8.7 \text{ ms}^{-1}$

(12) a)

Before



After



$p = m_1u_1 + m_2u_2$
$= 12 \times 4 + 4 \times 0$
$= 48 \text{ kgms}^{-1}$

$p = m_1v_1 + m_2v_2$
$= 12v + 4 \times 6$
$= 12v + 24$

$p_{\text{before}} = p_{\text{after}}$
$48 = 12v + 24$
$24 = 12v$
$v = 2 \text{ ms}^{-1}$

b)

$E_k = \frac{1}{2} m_1 u_1^2$
$= \frac{1}{2} \times 12 \times 16$
$= 96 \text{ J}$

$E_k = \frac{1}{2} m_1 v_1^2$
$= \frac{1}{2} \times 12 \times 4$
$= 24 \text{ J}$

$E_k = \frac{1}{2} m_2 v_2^2$
$= \frac{1}{2} \times 4 \times 36$
$= 72 \text{ J}$

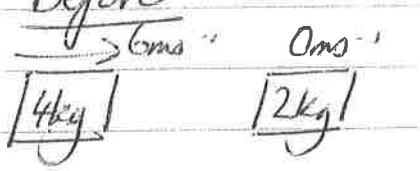
E_k before $= 96 \text{ J}$

E_k after $= 24 + 72$
$= 96 \text{ J}$

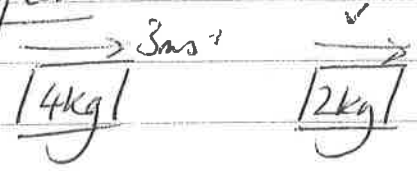
E_k is conserved, therefore collision is elastic.

(13) a)

Before



After



$p = m_1u_1 + m_2u_2$
$= 4 \times 6 + 2 \times 0$
$= 24$ kgms^{-1}

$p = m_1v_1 + m_2v_2$
$= 4 \times 3 + 2v$
$= 12 + 2v$

$p_{before} = p_{after}$
$24 = 12 + 2v$
$12 = 2v$
$v = 6$ ms^{-1}

b)

$E_k = \frac{1}{2} m_1u_1^2$
$= \frac{1}{2} \times 4 \times 36$
$= 72$J

$E_k = \frac{1}{2} m_1v_1^2$
$= \frac{1}{2} \times 4 \times 9$
$= 18$J

$E_k = \frac{1}{2} m_2v_2^2$
$= \frac{1}{2} \times 2 \times 36$
$= 36$J

E_k before $= 72$J

E_k after $= 54$J

E_k lost, therefore collision is inelastic

(14)

$p = m_1u_1 + m_2u_2$
$= 1200u + 1000 \times 0$
$= 1200u$

$p = m_1v_1 + m_2v_2$
$= 1200 \times 6.5 + 1000 \times 16$
$= 7800 + 16,000$
$= 23800$ kgms^{-1}

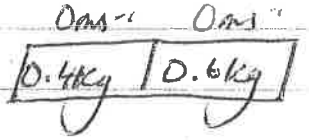
$p_{before} = p_{after}$
$1200u = 23800$
$u = 19.8$ ms^{-1}

(15) $p = m_1 u_1 + m_2 u_2$
$= m_1 \times 12 + 25 \times 0$
$= 12m_1$

$p = m_1 v_1 + m_2 v_2$
$= m_1 \times 8 + 25 \times 16$
$= 8m_1 + 400$

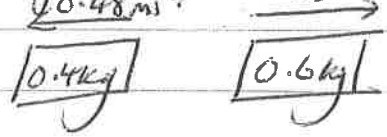
$p_{BEFORE} = p_{AFTER}$
$12m_1 = 8m_1 + 400$
$4m_1 = 400$
$m_1 = 100\ kg$

(16) Before



$p_{BEFORE} = 0$

After



$p_{AFTER} = m_1 v_1 + m_2 v_2$
$= 0.4 \times 0.48 + 0.6 v_2$
$= 0.192 + 0.6 v_2$

$p_{BEFORE} = p_{AFTER}$
$0 = 0.192 + 0.6 v_2$
$v_2 = -\frac{0.192}{0.6}$

$v_2 = -0.32\ ms^{-1}$

(17) $p = 0 \text{ kgms}^{-1}$

$p = m_1 v_1 + m_2 v_2$

$= 0.5 \times 0.24 + m_2 \times 0.15$

$= 0.12 + 0.15 m_2$

$p_{\text{BEFORE}} = p_{\text{AFTER}}$

$0 = 0.12 + 0.15 m_2$

$m_2 = -\frac{0.12}{0.15}$

$= 0.8 \text{ kg}$

(18) Before: 20 kg at 200 ms^{-1}

After: 5 kg at 350 ms^{-1}, 15 kg at v

$p = mu$

$= 20 \times 200$

$= 4000 \text{ kgms}^{-1}$

$p = m_1 v_1 + m_2 v_2$

$= 5 \times 350 + 15v$

$= 1750 + 15v$

$p_{\text{BEFORE}} = p_{\text{AFTER}}$

$4000 = 1750 + 15v$

$2250 = 15v$

$v = 150 \text{ ms}^{-1}$

(19) $p = mu$

$= 24000u$

$p = m_1 v_1 + m_2 v_2$

$= 20000 \times 1200 + 4000 \times 6000$

$= 24\,000\,000 + 24\,000\,000$

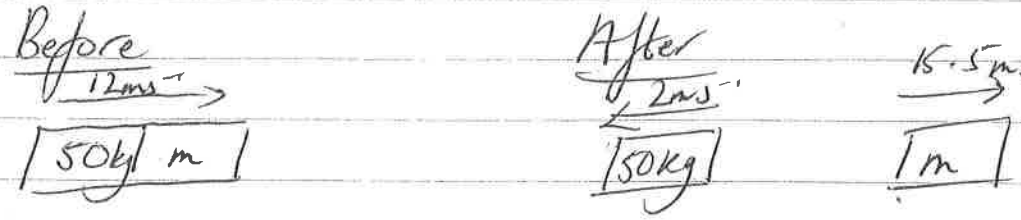
$= 48\,000\,000 \text{ kgms}^{-1}$

$p_{\text{BEFORE}} = p_{\text{AFTER}}$

$24\,000u = 48\,000\,000$

$u = 2000 \text{ ms}^{-1}$

(20)



$p = mu$

$= (50 + m)12$

$= 600 + 12m$

$p = m_1v_1 + m_2v_2$

$= 50 \times -2 + m \times 15.5$

$= -100 + 15.5m$

$p_{\text{BEFORE}} = p_{\text{AFTER}}$

$600 + 12m = -100 + 15.5m$

$700 = 3.5m$

$m = 200\text{ kg}$

(21) a) Impulse $= Ft$

$= 200 \times 0.02$

$= 4\text{ Ns}$

b) $Ft = \Delta mv$

$\Delta mv = 4\text{ kgms}^{-1}$

c) $F = \dfrac{\Delta mv}{t}$

$200 = \dfrac{50v - 50 \times 0}{0.02}$

$4 = 50v - 0$

$v = 0.08\text{ ms}^{-1}$

(22) $F = \frac{\Delta mv}{t}$

$= \frac{0.5 \times 25 - 0.5 \times 0}{0.02}$

$= 625\ N$

(23) $F = \frac{\Delta mv}{t}$

$7 = \frac{0.2v - 0}{0.045}$

$0.315 = 0.2v$

$v = 1.58\ ms^{-1}$

(24) $Ft = \Delta mv$

$4.5t = 0.0075(0.9 - 0)$

$4.5t = 6.75 \times 10^{-3}$

$t = 1.5 \times 10^{-3}\ s$

(25) Ft = area under graph

$= \frac{1}{2} \times 0.02 \times 40$

$= 0.4\ Ns$

$Ft = \Delta mv$

$0.4 = 0.15v - 0$

$0.15v = 0.4$

$v = \underline{2.7\ ms^{-1}}$

(26) a) $\Delta mv = mv - mu$

$= 0.1 \times 25 - 0.1 \times -40$

$= 2.5 + 4$

$= \underline{6.5\ kgms^{-1}}$

b) $Ft = \Delta mv$

$= \underline{6.5\ Ns}$

c) $F = \frac{\Delta mv}{t}$

$= \frac{6.5}{0.13}$

$= \underline{50\ N}$

(27) Area under a $F-t$ graph = Impulse

$= (10 \times 8) + (16 \times 12)$

$= 80 + 192$

$= 272\ Ns$

$Ft = Amv$

$272 = 12v - 0$

$v = 22.7\ ms^{-1}$

(28) a) $E_p = E_k$

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

$0.04 \times 9.8 \times 0.8 = \frac{1}{2} \times 0.04 \times v^2$

$7.84 = \frac{1}{2}v^2$

$v^2 = 15.68$

$v = 3.96\ ms^{-1}$

$E_p = E_k$

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

$0.04 \times 9.8 \times 0.45 = \frac{1}{2} \times 0.04 \times v^2$

$4.41 = \frac{1}{2}v^2$

$v^2 = 8.82$

$v = 2.97\ ms^{-1}$

b) $Ft = Amv$

$2.8t = 0.04(2.97 - (-3.96))$

$t = 0.099$

$t = 0.1\ s$

(29) a) AB – acceleration
BC – deceleration CD – deceleration
DE – acceleration

b) $t = 0.2\,s$

c) $F = \frac{\Delta m v}{t}$

$= \frac{0.4(-4-6)}{0.2}$

$= -20\,N$

d) $E_K = \frac{1}{2} m v^2$
$= \frac{1}{2} \times 0.4 \times 6^2$
$= 7.2\,J$

$E_K = \frac{1}{2} m v^2$
$= \frac{1}{2} \times 0.4 \times 4^2$
$= 3.2\,J$

4 J of energy are lost due to contact.

(30) a)(i) $p = m_1u_1 + m_2u_2$

$= 2 \times 6 + 1 \times 0$

$= 12 \text{ kgms}^{-1}$

$p = mv$

$= 3v$

$p_{before} = p_{after}$

$12 = 3v$

$v = \underline{4 \text{ ms}^{-1}}$

a) (ii) $p = mv$

$= 1 \times 4$

$= \underline{4 \text{ kgms}^{-1}}$

a) (iii) $p = mv$

$= 2 \times 2$

$= \underline{4 \text{ kgms}^{-1}}$

b) $F = \frac{\Delta mv}{t}$

$= \frac{4}{0.5}$

$= \underline{8 \text{ N}}$

(31) Less risk of damage as the force due to impact has been reduced due to the greater time of impact as a result of the air bag.