Mechanics - Jan 2009 Miss Watson's Solutions

1 (i) $0.5 \times 6 = 3$

$0.5 \times 0.8 = 0.4$

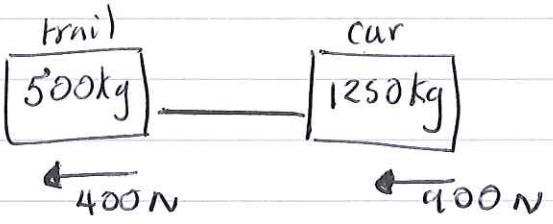
$3 = 0.4 + 4 \times m$

$m = 0.65$ kg. ✓ [3]

(ii) $3 = -0.4 + 4 \times m$

$m = 0.85$ kg ✓ [3]

2



(i) Driving force $= 400 + 900 = \underline{1300\text{N}}$ ✓

tow-bar $= \underline{400\text{N}}$ ✓ [3]

(ii) $F = ma$

$F = 1750 \times 0.6 = 1050$

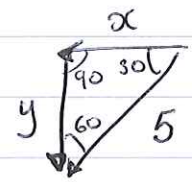
Driving force $= 1050 + 400 + 900 = \underline{2350\text{N}}$ ✓

tow-bar $\Rightarrow F = ma$

$= 500 \times 0.6 = 300\text{N}$

$300 + 400 = \underline{700\text{N}}$ ✓ [6]

3 (i)

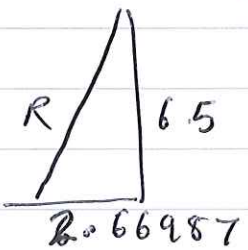


$\frac{5}{\sin 90} = \frac{x}{\sin 60}$ $\quad x = \frac{5\sqrt{3}}{2} = 4.33\text{N}$ ✓

$\frac{5}{\sin 90} = \frac{y}{\sin 30}$ $\quad y = \frac{5}{2} = 2.5\text{N}$ ✓ [2]

(ii) $7 - 5\cos 30 = 2.66987$

$9 - 5\cos 60 = 6.5$



$R = \sqrt{6.5^2 + 2.66987^2} = 7.02696$

$\underline{7.03\text{N}}$ ✓

$\tan^{-1}\left(\frac{6.5}{2.66987}\right) = 67.6696$

$\underline{67.7°}$ ✓ [6]

(4)(i) $20 \times \cos 30 = 10\sqrt{3}$

$F = ma$

$10\sqrt{3} = 3a$

$a = \frac{10\sqrt{3}}{3} = \underline{5.77 ms^{-2}}$ ✓ [3]

(ii) $3 \times 9.8 = 29.4N$

$20 \times \cos 60 = 10$

$R = 29.4 + 10 = \underline{39.4N}$

$F_{lim} = \mu \times R$

$10\sqrt{3} = \mu \times 39.4$

$\mu = 0.4396$

$\mu = 0.440$ ✓ [5]

(5)(i) $a = 0.8t$ ← not constant acceleration

$\int 0.8t\,dt = v = 0.4t^2 + C$ ← $v = 13$, $t = 0$

$v = 0.4t^2 + 13$

$v = \underline{27.4 ms^{-1}}$ ✓ ← $t = 6$ [5]

(ii) $\int 0.4t^2 + 13\,dt = x = \frac{2}{15}t^3 + 13t + C$ ← $x = 0$, $t = 0$, $C = 0$

$x = \frac{2}{15}t^3 + 13t$ ← $t = 6$

$x = 106.8m$ ✓ [5]

(iii)(a) fig 2 ✓ [1]

(b) fig 1 [2]

does not show an initial gradient to show car started at $13 ms^{-1}$

fig 3 shows gradient getting shallower, suggests velocity is decreasing but it should be increasing with time.

6

(i) (a) $a = 9.8 \quad s = 2.5 \quad u = 0 \quad t = ?$

$s = ut + \frac{1}{2}at^2$

$2.5 = 0 + \frac{1}{2} \times 9.8 \times t^2$

$t = \frac{5}{7}$ ✓ 0.714

2

(b) $a = 9.8 \quad s = 2.5 \quad u = 0 \quad t = \frac{5}{7} \quad v = ?$

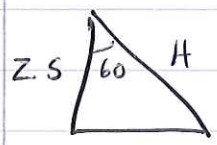
$v = u + at$

$v = 0 + 9.8 \times \frac{5}{7}$

$v = 7$ ✓

2

(ii)

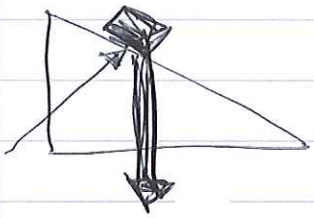


C A H

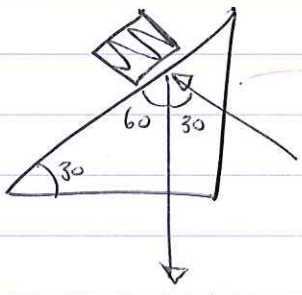
$\frac{2.5}{\cos 60} = \underline{5} \qquad \underline{s = 5}$

$2 \times 9.8 = 19.6$

$19.6 \times \cos 60 = 9.8$



19.6



19.6

$19.6 \times \cos 30 = 16.974 = R$

$F_{lim} = \mu \times R$

$F_{lim} = 0.2 \times 16.974 = 3.394819$

$= 3.3948$

$9.8 - 3.3948 = 6.4052$

$F = ma$

$6.4052 = 2 \times a$

$a = 3.2026 \quad s = 5 \quad u = 0 \quad v = ?$

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

$v^2 = 0 + 2 \times 3.2026 \times 5$

$v = 5.659158$

$\underline{v = 5.66 \text{ ms}^{-1}}$ ✓

9

7 (i) $t = 2 \quad a = -0.4 \quad u = 4 \quad v = ?$

$v = u + at$

$v = 4 + -0.4 \times 2$

(P) $v = 3.2$ ✓

$t = 2 \quad a = -0.4 \quad u = 1 \quad v = ?$

$v = 1 + -0.4 \times 2$

(Q) $v = 0.2$ ✓

combined ⇒

$3.2 \times 0.4 - 0.2 \times 0.3$

$= 2.18$

$0.1 + 0.3 = 1$

$\frac{2.18}{1} = 2.18 \text{ ms}^{-1}$ ✓ [6]

(ii) (a) $t = 3 \quad a = -0.4 \quad u = 4 \quad v = ?$

$v = 4 + -0.4 \times 3$

(P) $v = 2.8$

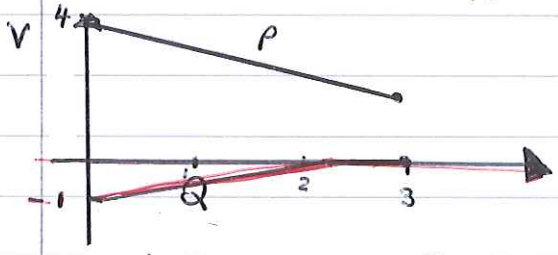
$t = 3 \quad a = -0.4 \quad u = 1 \quad v = ?$

$v = 1 + -0.4 \times 3$

(Q) $v = -0.2$ (collision must happen when Q is stationary.) $v = 1 - 0.4 \times t$

$t = 2.5$

Q has $v = 0$ when $t = 2.5$ secs.



[3]

(b) Q $s = ? \quad t = 2.5 \quad a = -0.4 \quad u = 1$

$s = ut + \frac{1}{2}at^2$

$s = 2.5 + 0.5 \times -0.4 \times 2.5^2$

$s = 1.25 \text{ m}$

P $t = 3 \quad a = -0.4 \quad u = 4 \quad v = 2.8 \quad s = ?$

$s = 4 \times 3 + \frac{1}{2} \times -0.4 \times 3^2 = 10.2 \text{ m}$

11.45m ✓ [6]

Total marks = [12]