Mechanics – June 2010 Miss Watson's solutions

(1) (i) $u = 5 \quad v = 0 \quad a = -1.2 \quad t = ?$

$v = u + at$

$0 = 5 + -1.2 \times t$

$t = 4.1666$

$t = 4.17$ ✓ [2]

(ii) $s = \frac{1}{2}(u+v)t$

$s = 0.5 \times 5 \times 4\frac{1}{6}$

$s = 10.41666$

$s = 10.4$ ✓ [2]

(iii) $F = ma$ $\qquad R = 9.8 \times 3 = 29.4$

$F = 3 \times 1.2$

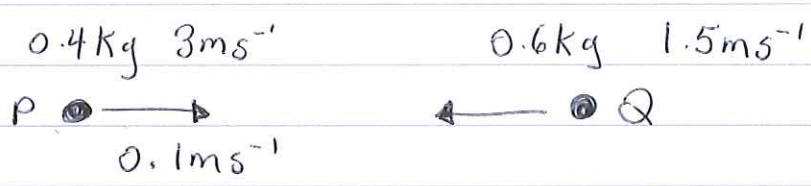
$F = 3.6$

$F/im = \mu \times R$

$3.6 = \mu \times 29.4$

$\mu = 0.122$ ✓ [4]

(2) (i)



$0.4 \times 3 = 1.2$ $\qquad 0.6 \times 1.5 = 0.9$

$1.2 - 0.9 = 0.3$

$0.1 \times 0.4 + v \times 0.6 = 0.3$

$v \times 0.6 = 0.26$

$v = 0.433$ ✓ [4]

(ii) $-0.1 \times 0.4 + v \times 0.6 = 0.3$

$v \times 0.6 = 0.34$

$v = 0.567$ ✓

continued.

(2) (ii) P $n = 0.1$ $t = 3$ Q $n = 0.567$ $t = 3$

distance = speed x time

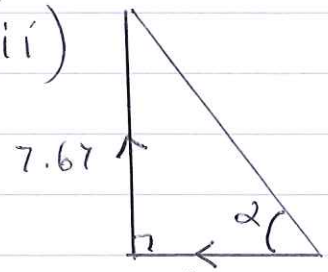
$s = 0.1 \times 3 + 0.567 \times 3$

$s = 2.001$ ✓ [5]

(3) (i) $9 - 5 \times \cos(60) = 6.5\,N$ ✓ [2]

(ii) $12 - 5 \times \cos(30) = 7.67\,N$ ✓ [2]

(iii)



$R = \sqrt{6.5^2 + 7.67^2}$

$R = 10.05\,N$

$\alpha = \tan^{-1}\left(\frac{7.67}{6.5}\right) = 49.72°$

Bearing of $270 + 49.72 = 319.72°$

$= 320°$ ✓ [5]

(4) (i) $r = 3.2 - 0.2t^2$

$0 = 3.2 - 0.2t^2$

$0.2t^2 = 3.2$

$t^2 = 16$

$t = \pm 4$ $\quad \underline{t = 4}$ ✓ [2]

(ii) $a = \frac{dr}{dt} = -0.4t$ ← $t = 4$

$a = -1.6$ ✓ [3]

(iii) $s = \int 3.2 - 0.2t^2 = 3.2t - \frac{1}{15}t^3 + C$

when $t = 0$ $s = 0$ so $c = 0$.

$s = 3.2t - \frac{1}{15}t^3$ $\quad t = 4$

$s = 3.2 \times 4 - \frac{1}{15} \times 4^3$

$s = 8.53$ ✓ [5]

5 (i) Area of the Triangle = distance

$\frac{20 \times -3}{2} = -30$

distance = 30 m ✓ 2

(ii)

Area of a trapezium $= \frac{1}{2}(a+b) \times h$

$30 = 0.5(4+b) \times 3$

$b = 16$

$60 + 16 = 76$ seconds ✓ 4

(iii) $u = 0$ $a = 0.4$ $s = ?$ $v = 3$

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

$9 = 2 \times 0.4 \times s$

$s = 11.25$

Distance = speed × time

Distance = $3 \times 4 = 12$

$30 - 12 - 11.25 = 6.75$

$u = 3$ $v = 0$ $s = 6.75$ $a = ?$

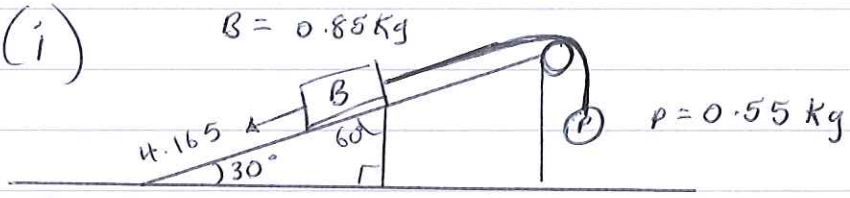
$v^2 = u^2 + 2as$

$0 = 9 + 2 \times 6.75 \times a$

$\frac{-9}{13.5} = a$

$a = -0.667$ or $-2/3$ ✓ 3

6 (i)



(a) P: $0.55 \times 9.8 = 5.39$ N

B: $0.85 \times 9.8 = 8.33$ N

$8.33 \times \cos 60 = 4.165$ N

continued

(6)(i)(a) $F = ma$

$5.39 - 4.165 = (0.85 + 0.55)a$

$a = 0.875$ ✓

$F = ma$

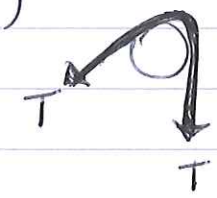
$T - 4.165 = 0.85 \times 0.875$

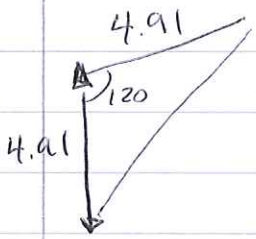
$T = 4.90875$

$= 4.91$ ✓

5

(b)





$a^2 = b^2 + c^2 - 2bc\cos A$

$a^2 = 4.91^2 + 4.91^2 - 2 \times 4.91 \times 4.91 \times \cos 120$

$a^2 = 72$

$a = 8.504$ ✓

2

(ii) $u = 1.3$ $s = 1.5$ $a = 0.875$ $v = ?$

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

$v^2 = 1.3^2 + 2 \times 0.875 \times 1.5$

$v^2 = 4.315$

$v = 2.0773$ ✓

$u = 2.0773$ $v = 0$ $s = ?$ $a =$ ⟶ $F = ma$

$v^2 = u^2 + 2as$ $\quad -4.165 = 0.85a$

$0 = 2.0773^2 + 2 \times -4.9 \times s$ $\quad a = -4.9$ ✓

$s = 0.4403$

total distance $= 1.5 + 0.4403$

$= 1.94$ ✓

6

(7) (i) $R = 12 - 5 \times \cos 60 = 9.5\,N$

$F_{lim} = 4 + 5 \times \cos 30 = 8.3301$

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

$8.3301 = \mu \times 9.5$

$\mu = 0.876855$

$\mu = 0.877$ ✓ 6

(ii) $R = 9 - 5 \times \cos 60 = 6.5$

$F_{lim} = 5 \times \cos 30 = 4.33$

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

$4.33 = \mu \times 6.5$

$\mu = 0.666$ ✓ 2

(iii) upper block.

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

$F_{lim} = 0.1 \times 6.5$

$F_{lim} = 0.65$

$F = ma$ ← $W = mg$, $\frac{a}{9.8} = m$

$4.33 - 0.65 = 0.9184\,a$

$a = 4.00696$

$a = 4.01$ ✓

lower block

$4 + 0.65 = 4.65$

Friction below is 8.3301 at its limit so block cannot move $a = 0$ ✓ 6

Total 72