Mechanics 1. June 2010.

1. $u = 5\,m/s \rightarrow -1.2\,ms^{-2}$

3 g

(i) $v = u + at$

$0 = 5 - 1.2t$

$t = \frac{5}{1.2} = \frac{25}{6}$ seconds

(ii) $S = \left(\frac{u+v}{2}\right)t = \frac{5}{2} \times \frac{25}{6} = \frac{125}{12} = 10.4$ metres

(iii) "$F = ma$" $\quad -F = 3 \times (-1.2)$

$\therefore F = 3.6$ N.

$R = 3gN$ $\qquad$ From $F = \mu R$

$\therefore \mu = \frac{F}{R} = \frac{3.6}{3g} = \frac{1.2}{9.8} = 0.122$

2. $3\,m/s \rightarrow$ $\qquad$ $\leftarrow 1.5\,m/s$

P $\qquad$ Q

0.4 g $\qquad$ 0.6 g

$v_p = 0.1\,m/s$

(i) say $v_p \rightarrow$ then $v_q \rightarrow$ also same direction.

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ conservation of momentum.

$3 \times 0.4 + 0.6 \times (-1.5) = 0.4 \times 0.1 + v_q \times 0.6$

$1.2 - 0.9 = 0.04 + 0.6v_q$

$\therefore 0.3 = 0.04 + 0.6v_q$

$\frac{0.26}{0.6} = v_q = 4.33\dot{3}\,m/s$

(ii) If $\leftarrow P\,(0.1)$ $\qquad v_q \rightarrow Q$

$3 \times 0.4 - 1.5 \times 0.6 = -0.1 \times 0.4 + 0.6v_q$

$\therefore v_q = 0.56\dot{6}$

in 3 seconds $\quad s = ut + \frac{1}{2}at^2 = \left(\frac{u+v}{2}\right)t$ $\quad$ ~~$v = ut + at$~~ $v = u + at$ $\quad v^2 = u^2 + 2as$.

but NOT SUVAT so speed $= \frac{\text{dist}}{\text{time}}$

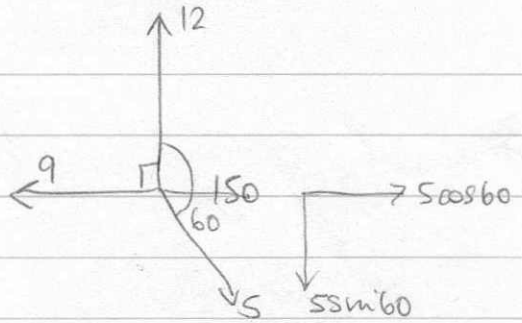
$\therefore$ dist = speed $\times$ time

for P dist $= 0.1 \times 3$

Q dist $= 0.56\dot{6} \times 3$ } total = 2 metres.

$\leftarrow 0.1 \quad \rightarrow 0.56\dot{6}$

3.



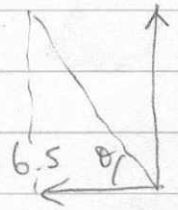
Resolving ↑

$12 - 5\sin 60 = 7.670$

Resolving →

$5\cos 60 - 9 = -6.5$

(i)



$\tan\theta = \frac{7.670}{6.5}$ $\quad \theta = \tan^{-1}\left(\frac{7.670}{6.5}\right) = 49.72°$

$R = \sqrt{7.67^2 + 6.5^2} = 10.05$ N

(ii) & (iii) Bearing is $270 + \theta = 319.72° = 320°$

4. $v = 3.2 - 0.2t^2 \quad 0 \le t \le 5$

(i) $\frac{dt}{}$ rest when $v = 0$

$\therefore t^2 = \frac{3.2}{0.2} = 16 \quad \therefore t = 4$ seconds

(ii) $\frac{dv}{dt}$ is acceleration $\therefore \frac{dv}{dt} = -0.4t = -0.4 \times 4 = -1.6$

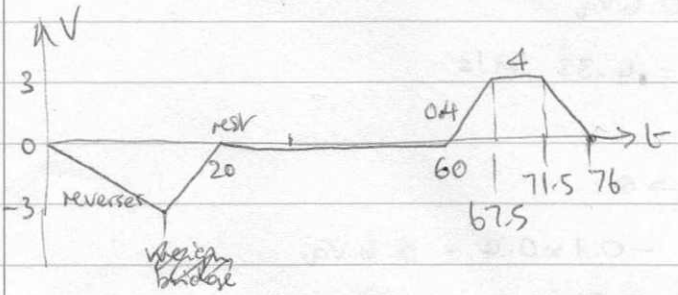
$\therefore a = -1.6$ m/s

(iii) when $v = 0 \quad t = 4$ so greatest distance

is $x = 3.2x - \frac{0.2t^3}{3} + c$ but when $t = 0 \quad x = 0$ so $c = 0$

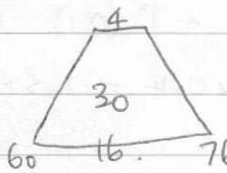
$\therefore$ when $t = 4 \quad x = 3.2 \times 4 - \frac{0.2 \times 4^3}{3} = 8.53$ metres.

5.



(i) $s = \frac{1}{2} b \times h = \frac{1}{2} \times 20 \times 3 = 30$m

(ii)



$\frac{1}{2}(4+x)3 = 30$

$4 + x = 20$

$x = 16.$

$T = 76$ secs.

(iii) $y = mx + c$

$y = 0.4x + c \quad (60, 0)$

$0 = 0.4 \times 60 \quad c = -24$

$v = 0.4t - 24 = 3$

$0.4t = 27$

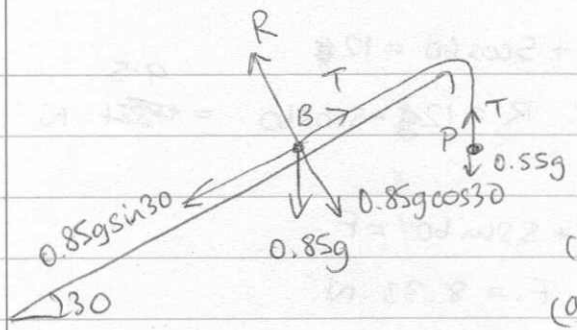
$t = \frac{27}{0.4} = 67.5$

$v = u + at$

$0 = 3 + a \times 4.5$

$a = -\frac{3}{4.5} = -\frac{2}{3}$

6.



P: $0.55g - T = 0.55a$

B: $T - 0.85g\sin 30 = 0.85a$

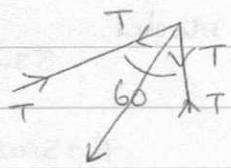
(i) $0.55g - 0.85g\sin 30 = 0.55a + 0.85a$

(a) $\frac{1.225}{1.4} = a = 0.875 \text{ m/s}^2$

$\therefore T = 0.55g - 0.55 \times 0.875$

$\therefore T = 4.91 \text{ N}.$

(b) Force on pulley

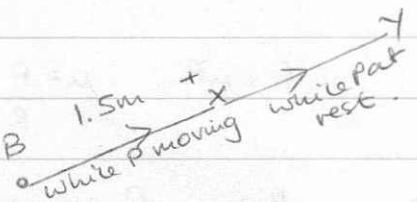


$= T\cos(30) \times 2$

$= 8.502 \text{ N}.$

(ii) $u = 1.3 \text{ m/s}$

$s = 1.5 \text{ m}$ P reaches ground



$v = u + at$

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

$v^2 = 1.3^2 + 2 \times (0.875) \times 1.5 \quad = 4.315 \quad \sqrt{v^2} = 2.07726 \text{ m/s}.$

$\therefore v = 2.08 \text{ m/s}$

So B starts X at $u = 2.077 \text{ m/s}$ $v = 0$

and from $F = ma$ $\quad -0.85g\sin 30 = 0.85a$

$\therefore a = -g\sin 30 = -4.9 \text{ m/s}^2$

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

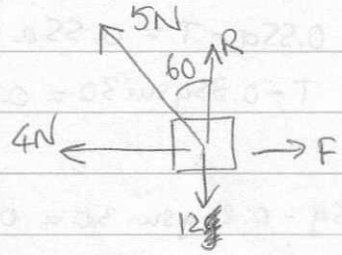
$0 = 4.315 + 2 \times (-4.9) \times s$

$\therefore s = 0.4403 \text{ mm}$

$\therefore$ total distance $= 1.5 + 0.44 = 1.94$ Metres.

7.

(i)



$R + 5\cos 60 = 12$

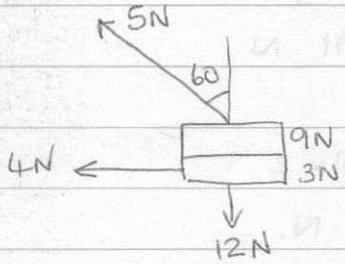
$\therefore R = 12 - 5\cos 60 = 9.5$ N

$4 + 5\sin 60 = F$

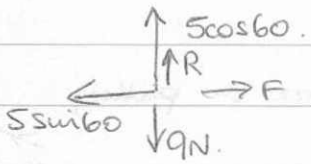
$\therefore F = 8.33$ N

$\therefore F = \mu R$ so $\mu = \frac{F}{R} = \frac{8.33}{9.5} = 0.877$

(ii)



μ between blocks.

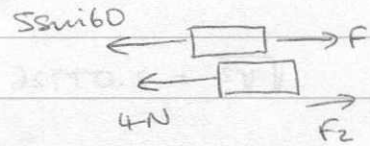


$R + 5\cos 60 = 9 \quad R = 6.5$ N

$F = 5\sin 60 \quad F = 4.33$

$\therefore F = \mu R \quad \mu = \frac{F}{R} = \frac{4.33}{6.5} = 0.666$

(iii) If $\mu = 0.1$ then R same 6.5 N but $m = \frac{9}{9.8}$



$5\sin 60 - F = \frac{9}{g}a$

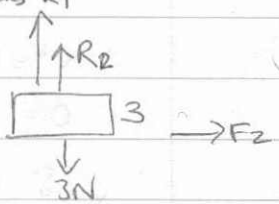
and $F = 0.1\,R = 0.65$

$\therefore \frac{9}{g}a = -3.68 \quad \therefore a = 4.007$ ms^{-2}

On lower block

$\leftarrow 4 + \mu R = 4.65$ this is traction of bottom blocks R_1

Consider friction with plane $= \mu R = 0.877\,R$



but this time $R = R_1 + R_2$

$R = 9 - 5\cos(60) + 3$

$R = 6.5 + 3 = 9.5$

$\therefore F_2 = 0.877 \times 9.5 = 8.3315$ N

So $F_2 > 4.65$ which means bottom block does not move

$\therefore a = 0.$