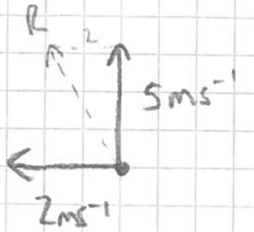
(1)

(a) 

$\sqrt{5^2+2^2} = \sqrt{29}$

$= 5 \cdot 39 \text{ ms}^{-1}$

(b) 

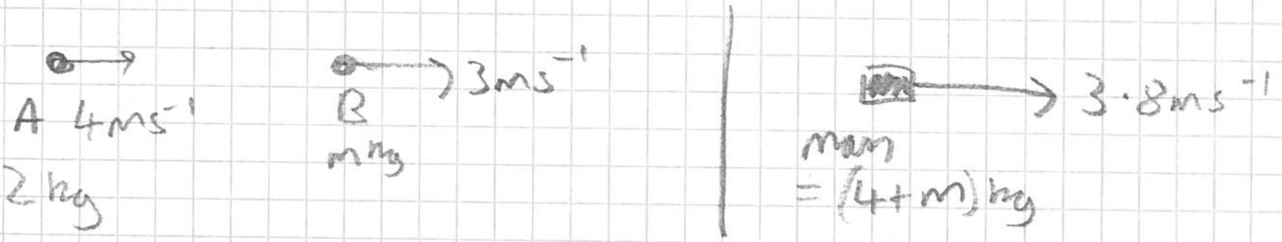
$\tan\theta = \frac{2}{5}$

$\tan^{-1}\left(\frac{2}{5}\right) = 21 \cdot 801°$

Bearing → from North, clockwise

$360 - 21 \cdot 801 = 338 \cdot 199°$

Bearing 338°

(2) 

"mv before = mv after"

$2\times4 + 3m = (2+m)\times3\cdot8$

$8 + 3m = 7\cdot6 + 3\cdot8m$

$0\cdot4 = 0\cdot8m$

$\frac{0\cdot4}{0\cdot8} = m$

$\Rightarrow m = 0\cdot5\text{kg}$

(3) $u = 20ms^{-1}$ constant acceleration

(a) (i) $s = 75$
$u = 20$
$v = 10$
$a = ?$
$t =$

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

$$\frac{v^2 - u^2}{2s} = a$$

$$\frac{10^2 - 20^2}{2 \times 75} = a$$

$$\Rightarrow a = \frac{-300}{150} = -2ms^{-2}$$

(ii) s
$u = 20$
$v = 0$
$a = -2$
$t = ?$

$$v = u + at$$

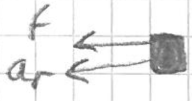
$$\frac{v - u}{a} = t$$

$$\frac{0 - 20}{-2} = t \Rightarrow t = 10s$$

(iii) $F = ma$
$= 1400 \times -2 = -2800N$ (negative b/c it's a resistive force

magnitude is $\underline{\underline{2800N}}$

(b) $F = ma$



← call this direction positive

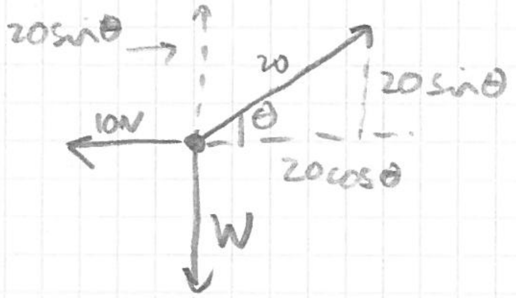
So $a = \underline{\underline{+2}}$
not $\underline{\underline{-2}}$

$F + 200 = ma$ where F is braking force
ar is air resistance

$F + 200 = 1400 \times 2$
$F + 200 = +2800N$
(-200)
$F = +2600N$

$\Rightarrow F = 2600N$

④



We know that ① $10 = 20\cos\theta$

② $20\sin\theta = W$

(a) ① $10 = 20\cos\theta \Rightarrow \frac{1}{2} = \cos\theta \Rightarrow \theta = \cos^{-1}\left(\frac{1}{2}\right)$
$= 60°$

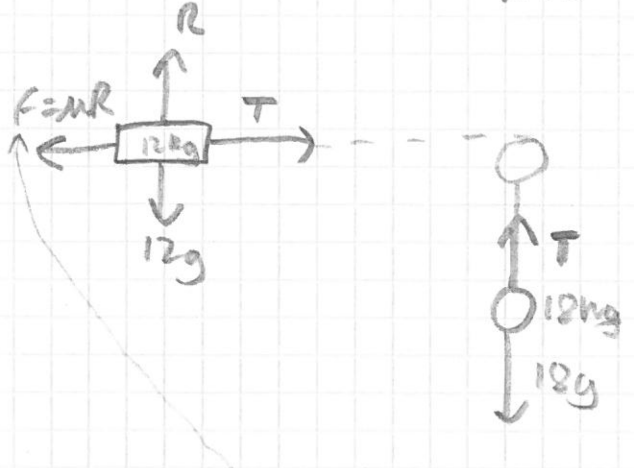
(b) $W = 20\sin\theta = 20\sin 60 = 20 \times \frac{\sqrt{3}}{2} = 10\sqrt{3}$

$\Rightarrow W = 17.3\,N$

(c) $mg = W \Rightarrow m = \frac{10\sqrt{3}}{9.8} = \frac{50\sqrt{3}}{49}$

$m = 1.77\,kg$

⑤



$F = ma$

(a) Smooth so $F = 0$ ① $T = 12a$ (12kg block)

② $18g - T = 18a$ (18kg)

① + ②

$18g = 30a$

$\Rightarrow \frac{18g}{30} = a \Rightarrow a = 5.88\,ms^{-2}$

(b) $F = ma$ $\quad \underline{\underline{a = 3}}$

① $T - \mu R = 12a$ (12kg block)

$\underline{\underline{R = 12g}}$ (resolving vertically)

so ① $T - 12g\mu = 12 \times 3$

$T - 12g\mu = 36$

② $18g - T = 18 \times a$ (18kg)

$18g - T = 18 \times 3$

$\Rightarrow T = 18g - 18 \times 3$

(i) $\boxed{T = \underline{\underline{122.4\ N}}}$

(ii) $R = 12g = 12 \times 9.8 = \underline{\underline{117.6}}\ N$

(iii) use ① $T - 12g\mu = 36$

$122.4 - 12g\mu = 36$

$12g\mu = 122.4 - 36$

$\mu = \dfrac{86.4}{12 \times 9.8} = \dfrac{36}{49}$

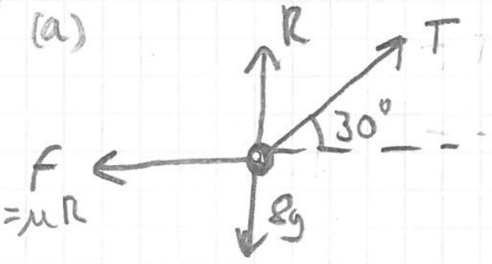
$\underline{\underline{\mu = 0.735}}$

(c) No air resistance

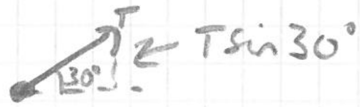
Block is a particle

(can also have that the string is horizontal)

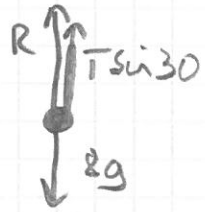
(6) (a)



(b) T has a vertical component



vertically:



So

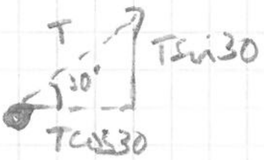
(b) $8g = R + T\sin 30$

$8g = R + \frac{1}{2}T$

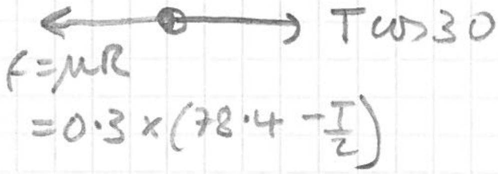
$R = 8g - \frac{1}{2}T$

$= 78.4 - \frac{T}{2}$

(c) Use $F = ma$ F is <u>net force</u>



<u>Horizontally</u>



So: $T\cos 30 - \mu R = ma$

$T\cos 30 - 0.3\left(78.4 - \frac{T}{2}\right) = 8 \times 0.05$

$\frac{\sqrt{3}}{2}T - 23.52 + 0.15T = 0.4$

$\Rightarrow T\left(\frac{\sqrt{3}}{2} + 0.15\right) = 0.4 + 23.52$

$T = \dfrac{23.92}{\frac{\sqrt{3}}{2} + 0.15} = 23.5427$

$\Rightarrow T = \underline{\underline{23.5}}\ N$

7 (a) $\underline{a} = 0.1\underline{i} - 0.2\underline{j}$ $\quad \underline{u} = -1\underline{i} + 3\underline{j}$

$$s = ut + \frac{1}{2}at^2$$
$$= t(-\underline{i} + 3\underline{j}) + \frac{1}{2}t^2(0.1\underline{i} - 0.2\underline{j})$$
$$= -t\underline{i} + 3t\underline{j}$$
$$+ 0.05t^2\underline{i} - 0.1t^2\underline{j}$$
$$= (0.05t^2 - t)\underline{i} + (3t - 0.1t^2)\underline{j}$$

($\underline{r} = \underline{s}$ b/c started at origin)

(b) Due East

so $\underline{j}$ component of position vector $= 0$

so $3t - 0.1t^2 = 0$
$t(3 - 0.1t) = 0$

$\Rightarrow$ $t = 0\,s$ or $3 - 0.1t = 0$
$3 = 0.1t$
$\Rightarrow t = 30\,s$

So $30\,s$

(c) speed when travelling S-E

$\downarrow$

need $\underline{v}$

$$\underline{v} = \underline{u} + \underline{a}t$$
$$\underline{v} = (-\underline{i} + 3\underline{j}) + t(0.1\underline{i} - 0.2\underline{j})$$
$$= (0.1t - 1)\underline{i} + (3 - 0.2t)\underline{j}$$

$\rightarrow$

(c) $\rightarrow$

isosceles triangle

so $\boxed{V_{\underline{i}} = -V_{\underline{j}}}$

when travelling SE.

so solve. $0 \cdot 1t - 1 = -(3 - 0 \cdot 2t)$

$$0 \cdot 1t - 1 = -3 + 0 \cdot 2t$$

$$2 = 0 \cdot 1t$$

$$\Rightarrow \underline{\underline{t = 20s}}$$

so $v = (0 \cdot 1 \times 20 - 1)\underline{i} + (3 - 0 \cdot 2 \times 20)\underline{j}$

$$= 1\underline{i} + 1\underline{j}$$

Speed $= \sqrt{1^2 + 1^2} = \sqrt{2} = 1 \cdot 4142$

so speed $= 1 \cdot 41 \ ms^{-1}$

(8) $u = 22.4\ ms^{-1}$ θ

(a) reaches max height at C
where $V_y = 0$

$v_y = u\sin\theta - gt$

$0 = 22.4\sin\theta - 9.8 \times 2$

$19.6 = 22.4\sin\theta \Rightarrow \sin\theta = \frac{19.6}{22.4} = 0.875$

(b) Find S_y at $t=2$

$S_y = ut\sin\theta - \frac{1}{2}gt^2$

$= 22.4 \times 2 \times 0.875 - \frac{1}{2} \times 9.8 \times 2^2$

$= 19.6m$

(c) at B we know that $\boxed{S_y = 0}$

or can use fact that time at B is $\underline{\underline{t=4}}$

so could find S_x at $\underline{\underline{t=4}}$

$S_x = ut\cos\theta$

$\cos^2\theta + \sin^2\theta = 1 \Rightarrow \cos\theta = \sqrt{1-\sin^2\theta}$

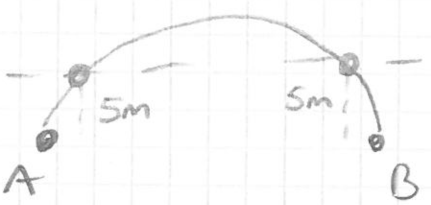
$= \sqrt{1-0.875^2} = \frac{\sqrt{15}}{8}$

$\Rightarrow S_x = 22.4 \times 4 \times \frac{\sqrt{15}}{8}$

$= 43.377$

$\Rightarrow AB = \underline{\underline{43.4m}}$

(d)



Set $S_y = 5m$
we are expecting 2 solutions.

$S_y = ut\sin\theta - \frac{1}{2}gt^2$

$5 = 22.4 \times 0.875 \times t - \frac{1}{2} \times 9.8\, t^2$

$\Rightarrow 0 = -4.9t^2 + 19.6t - 5$

$0 = 4.9t^2 - 19.6t + 5$

$a = 4.9 \quad b = -19.6 \quad c = 5$

$t = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \dfrac{19.6 \pm \sqrt{(19.6)^2 - 4(4.9)(5)}}{2 \times 4.9}$

$= \dfrac{14 \pm \sqrt{146}}{7}$

$t = 0.27385 \qquad t = 3.72615$

So time above 5m is $3.72615 - 0.27385$
$= \underline{\underline{3.45 s}}$

(e) horizontal component is always

$u\cos\theta = 22.4 \times \frac{\sqrt{15}}{8} = 10.844$

This is also the min speed (which is at C, when $V_y = 0$) so $\underline{\underline{10.8 ms^{-1}}}$