1) $F_1 = 4\underline{i} - 5\underline{j}$

$F_2 = 2\underline{i} + \underline{j}$

$F_1 + F_2 = 6\underline{i} - 4\underline{j}$

$\underline{F} = m\underline{a}$ $\quad m = 4\text{ kg}$

i) $\underline{a} = \frac{6}{4}\underline{i} - \frac{4}{4}\underline{j}$

$\underline{a} = 1.5\underline{i} - \underline{j}$ ms^{-2}

ii) Magnitude of acceleration

$= \sqrt{(1.5)^2 + (-1)^2}$

$= 1.80 \text{ ms}^{-2}$ to 3 sig fig

2)

$\underline{P_1} + \underline{P_2} = m\underline{a} = 2(5\underline{i} + 5\underline{j})$

$\underline{P_1} + \underline{P_2} = 10\underline{i} + 10\underline{j}$

i) $\underline{P_1}$ given as $6\underline{i} - \underline{j}$

$\therefore \underline{P_2} = 10\underline{i} + 10\underline{j} - (6\underline{i} - \underline{j})$

$\underline{P_2} = 4\underline{i} + 11\underline{j}$

ii)

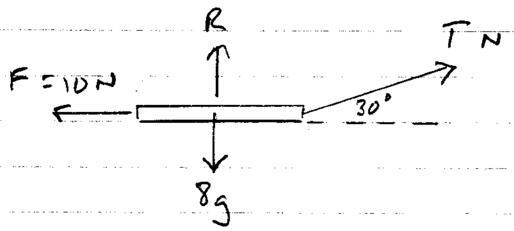
$5\underline{P_2} = 10\underline{i} + 10\underline{j}$

$\Rightarrow \underline{P_2} = 2\underline{i} + 2\underline{j}$

$\underline{P_1} = 8\underline{i} + 8\underline{j}$

3)

i)



ii) Horizontal Forces

Steady speed $\therefore$ resultant = 0

$T\cos 30 = 10$

$T = \frac{10}{\cos 30}$

$T = 11.55\text{N}$ to 4 sig fig

iii)

Horizontal resultant $= 10 - 2 = 8\text{N}$

$F = ma \quad 8 = 8a$

$a = 1 \text{ ms}^{-2}$

Girl must accelerate at 1 ms^{-2}

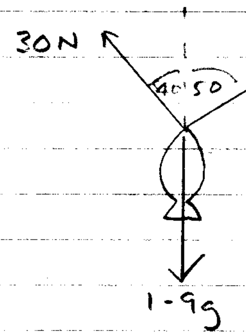
iv) If $a = 1 \text{ ms}^{-2}$

time taken to accelerate from speed of 0.4 ms^{-1} to 0.8 ms^{-1}

$= 0.4 \text{ s}$

4)

i)



ii) $\underline{j}$, $\underline{i}$

Force on fish $(40\sin 50 - 30\sin 40)\underline{i}$

$+ (40\cos 50 + 30\cos 40 - 1.9g)\underline{j}$

$= 11.36\underline{i} + 30.07\underline{j}$

4 iii) $\underline{F} = m\underline{a}$

$$\begin{pmatrix} 11.36 \\ 30.07 \end{pmatrix} = 1.9\begin{pmatrix} a_1 \\ a_2 \end{pmatrix}$$

$$a_1 = \frac{11.36}{1.9} = 5.98$$

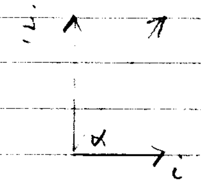
$$a_2 = \frac{30.07}{1.9} = 15.83$$

$$\underline{a} = \begin{pmatrix} 5.98 \\ 15.83 \end{pmatrix}$$

Magnitude of $\underline{a}$

$$= \sqrt{5.98^2 + 15.83^2}$$

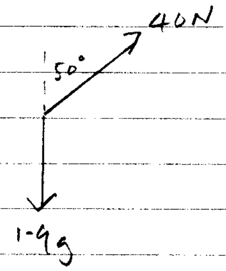
$$= 16.92 \text{ ms}^{-2}$$



$$\alpha = \tan^{-1}\left(\frac{15.83}{5.98}\right) = 69.3°$$

Angle is 69° above horizontal towards Jones

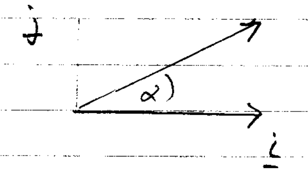
iv)



New resultant force on fish

$$40\sin 50\,\underline{i} + (40\cos 50 - 1.9g)\underline{j}$$

$$= \begin{pmatrix} 30.64 \\ 7.09 \end{pmatrix}$$

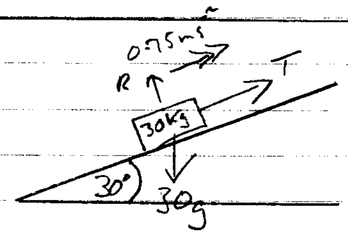


$$\alpha = \tan^{-1}\left(\frac{7.09}{30.64}\right) = 13°$$

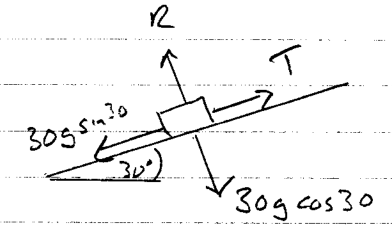
Fish moves towards Jones at an angle 13° above horizontal

5)

i)



ii)



iii) Using $F = ma$

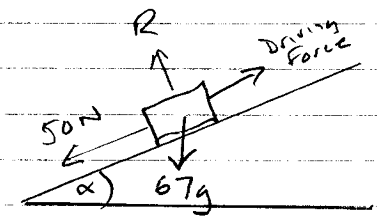
$$T - 30g\sin 30 = 30 \times 0.75$$

$$T = 30 \times 0.75 + 30g\sin 30$$

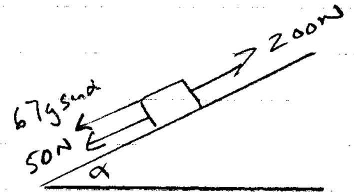
$$T = 169.5 \text{ N}$$

iv) The crate slows down to a stop and then accelerates down the slope.

6)



6 ii)



In line of slope

$200 > 50 + 67g \sin\alpha$

if bike is to accelerate

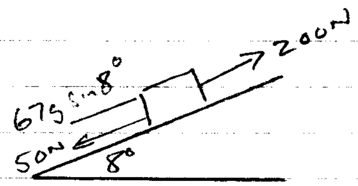
$\frac{150}{67g} > \sin\alpha$

$\Rightarrow \alpha < \sin^{-1}\left(\frac{150}{67g}\right)$

$\alpha < 13.2°$

Slope must be at an angle less than $13.2°$

iii)



Resultant force up slope

$= 200 - 50 - 67g \sin 8°$

$= 58.62$ N

Using $F = ma$

$58.62 = 67a$

$a = 0.875 \text{ ms}^{-2}$

Constant acceleration so use

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

$s = 5 \times 5 + \frac{1}{2} \times 0.875 \times 25$

$s = 35.94$ m

Travels 35.94 m in 5 s

iv)

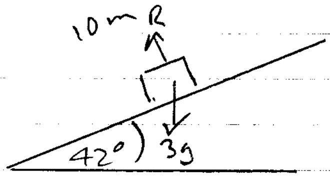
Using $v = u + at$

$v = 5 + 0.875 \times 5$

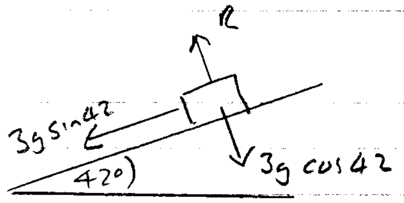
$v = 9.375 \text{ ms}^{-1}$

7)

i)



ii)



Down slope $F = ma$

$3g \sin 42 = 3a$

$\Rightarrow a = 6.56 \text{ ms}^{-2}$

iii) constant acc ∴ can use SUVAT

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

$10 = 0 \times t + \frac{1}{2} \times 6.56 t^2$

$\frac{20}{6.56} = t^2$

$t = \sqrt{\frac{20}{6.56}} = 1.746$ s

iv)

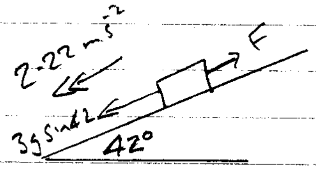
Using $s = ut + \frac{1}{2}at^2$

$10 = 0 \times 3 + \frac{1}{2}a3^2$

7iv cont)

$$10 = 4.5a$$

$$a = 2.22\ ms^{-2}$$



Resultant Force = ma

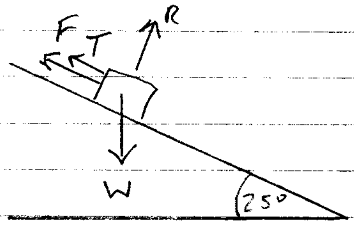
$$3g\sin 42° - F = 3 \times 2.22$$

$$F = 3g\sin 42 - 3\times 2.22$$

$$F = 13.01\ N$$

8)

i)



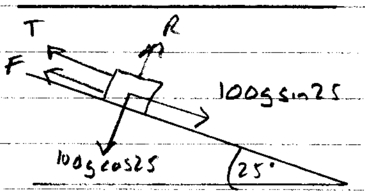
ii) Combined weight = 110g
20% of that = 22g

T is force applied by students

$$= 22g = 215.6$$

$$\approx 216\ N$$

iii)



In equilibrium

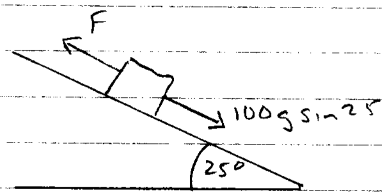
$$\therefore\ 100g\sin 25 = T + F$$

$$100g\sin 25 - 215.6 = F$$

$$F = 198.57\ N$$

$$F = 199\ N$$

iv)



Resultant Force = ma

$$100g\sin 25 - F = 100a$$

$$100g\sin 25 - 199 = 100a$$

$$\Rightarrow a = 2.15\ ms^{-2}$$

Constant acc $\therefore$ using SUVAT eqns

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

$$3 = 0\times t + \tfrac{1}{2}\times 2.15t^2$$

$$\frac{6}{2.15} = t^2$$

$$t = \sqrt{\frac{6}{2.15}}$$

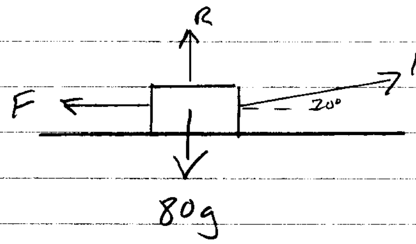
$$t = 1.67\ s$$

Has 1.67 s to move out of way

9)

i) The horizontal force component of the tension in the rope has no balancing component.

ii)



iii) In equilibrium

$$\therefore\ 100\cos 20 = F$$

$$F = 94.0\ N \text{ to 3 sig fig}$$

9iii) cont

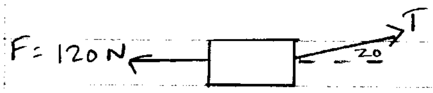
Vertically

$R + 100\sin 20 = 80g$

$R = 80g - 100\sin 20°$

$R = 750$ N to 3 sig fig

iv)



Horizontally travelling at constant speed

$\therefore \quad 120 = T\cos 20$

$T = \dfrac{120}{\cos 20}$

$T = 128$ N to 3 sig fig

v) Horizontally

Resultant Force $= 140\cos 20 - 120$
$= 11.56$ N

Using $F = ma$

$11.56 = 80a$

$\Rightarrow a = \dfrac{11.56}{80}$

$a = 0.145\ ms^{-2}$