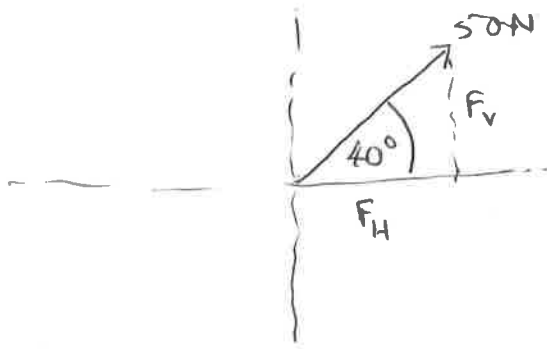


Solutions Example Sheet 1.

(1)

$$g = 10 \text{ ms}^{-2}$$

1.



Horizontal component:

$$\frac{\text{adj}}{\text{hyp}} = \frac{F_H}{50} = \cos 40^\circ$$

$$F_H = 50 \cos 40^\circ$$

$$F_H = \quad \text{N}$$

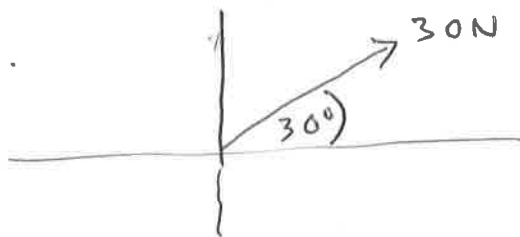
Vertical Component:

$$\frac{\text{opp}}{\text{hyp}} = \frac{F_V}{50} = \sin 40^\circ$$

$$F_V = 50 \sin 40^\circ \quad \left[\text{which is the same as } 50 \cos 50^\circ \right]$$

$$F_V = \quad \text{N}$$

2. (a).



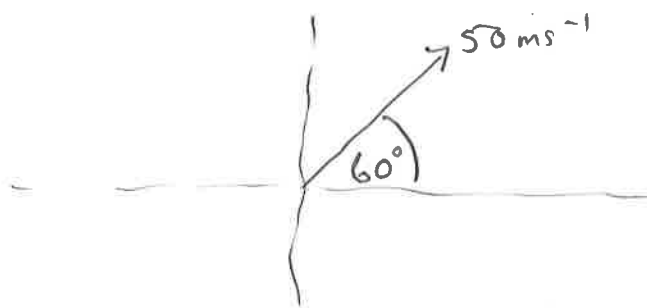
Horizontal component $F_H = 30 \cos 30^\circ = \quad \text{N}$

Vertical component $F_V = 30 \sin 30^\circ \quad \left[\text{or } 30 \cos 60^\circ \right]$

$$F_V = \quad \text{N}$$

2 (b)

(2)



Horizontal Component of velocity

$$V_H = 50 \cos 60^\circ$$

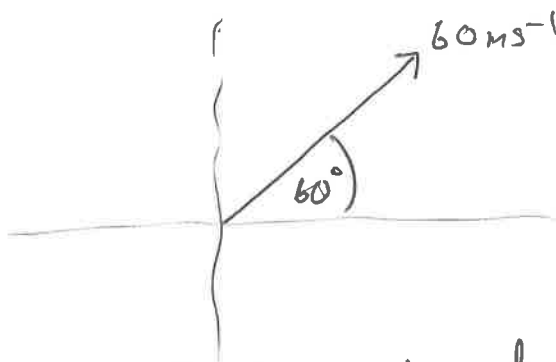
$$V_H = \quad \text{ms}^{-1}$$

Vertical Component of velocity

$$V_V = 50 \sin 60^\circ \text{ or } 50 \cos 30^\circ$$

$$V_V = \quad \text{ms}^{-1}$$

(c)



Horizontal Component of velocity

$$V_H = 60 \cos 60^\circ$$

$$V_H = \quad \text{ms}^{-1}$$

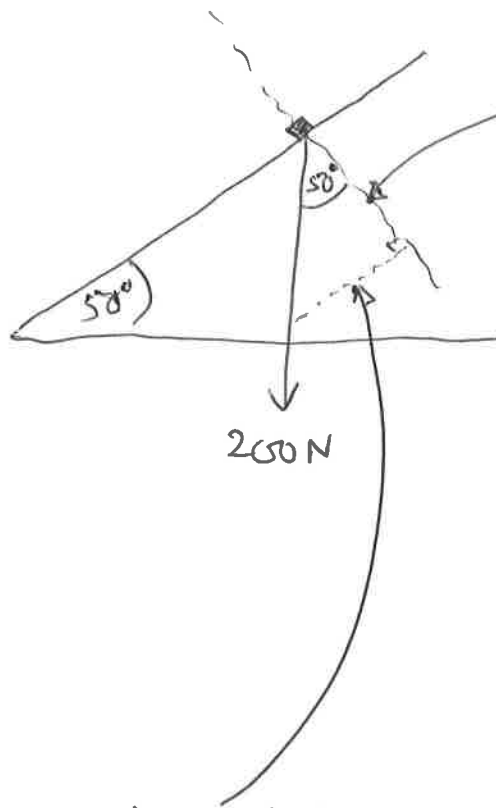
Vertical Component of velocity

$$V_V = 60 \sin 60^\circ \text{ (or } 60 \cos 30^\circ)$$

$$V_V = \quad \text{ms}^{-1}$$

3.

(3)



this side will be component of weight $\perp$ to plane, $W_{\perp}$

$$\frac{W_{\perp}}{200} = \frac{\text{adj}}{\text{hyp}} = \cos 50^{\circ}$$

$$\therefore W_{\perp} = 200 \cos 50^{\circ}$$

$$W_{\perp} = \quad \quad \quad N$$

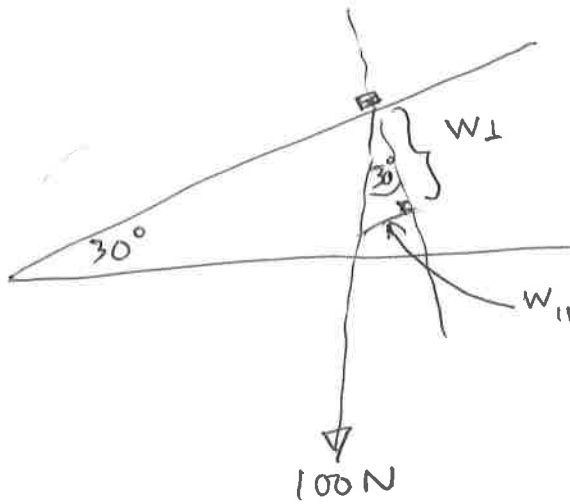
this side will be component of weight $\parallel$ to plane, $W_{\parallel}$

$$\frac{W_{\parallel}}{200} = \frac{\text{opp}}{\text{hyp}} = \sin 50^{\circ}$$

$$\therefore W_{\parallel} = 200 \sin 50^{\circ}$$

$$W_{\parallel} = \quad \quad \quad N$$

4.



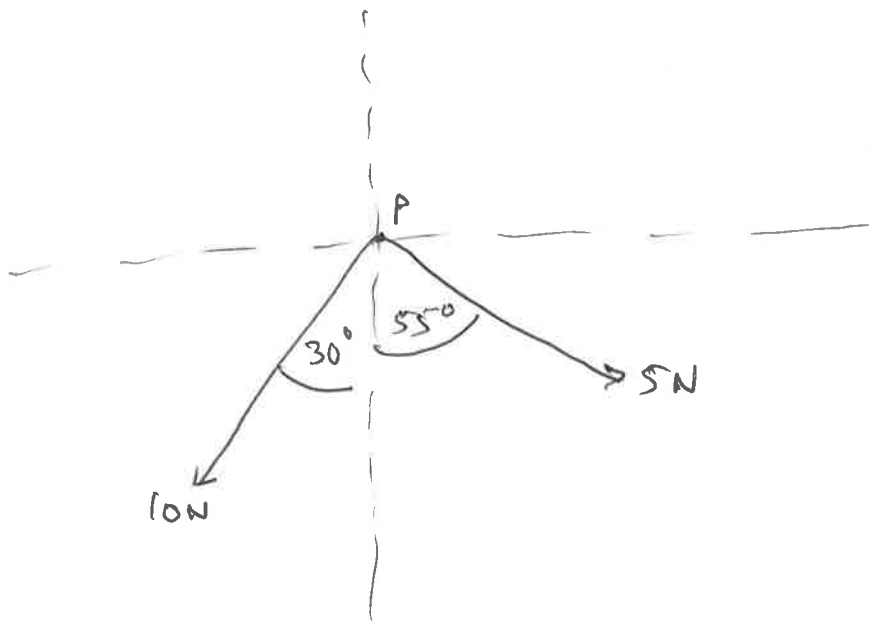
$$W_{\perp} = 100 \cos 30^{\circ}$$

$$W_{\perp} = \underline{\hspace{2cm}} \text{ N}$$

$$W_{\parallel} = 100 \sin 30^{\circ}$$

$$W_{\parallel} = \underline{\hspace{2cm}} \text{ N}$$

5.



Procedure

First we will find Horizontal & Vertical components of resultant force. Next we will take the complement of these components to find the force required to keep point P in static equilibrium:

Horizontal component $F_H = 5 \cos 35^{\circ} - 10 \cos 60^{\circ}$

$$F_H = 4.1 - 5 = \underline{\underline{-0.9 \text{ N}}}$$

Vertical component $F_V = -5 \cos 55^{\circ} - 10 \cos 30^{\circ}$

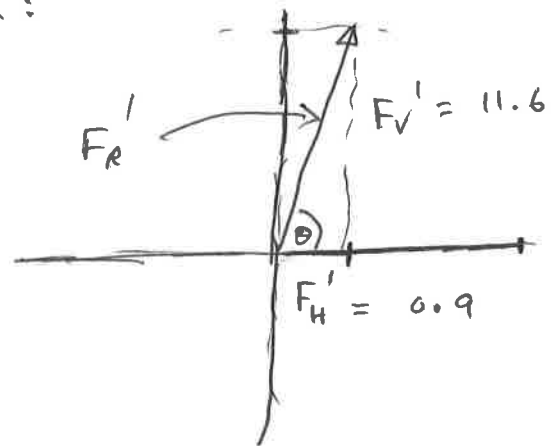
$$F_V = -2.9 - 8.7 = \underline{\underline{-11.6 \text{ N}}}$$

∴ The force required to keep P in static equilibrium ⁽⁵⁾ will be the complement of F_H and F_V i.e. change the signs of F_H and F_V to get F_H' and F_V' which we will call the components of the required force

$$i.e. \quad F_H' = 0.9 \text{ N}$$

$$F_V' = 11.6 \text{ N}$$

Now we find the resultant of these components, F_R'
It helps to draw diagram:



The magnitude is from
Pythagoras

$$F_R' = \sqrt{(F_H')^2 + (F_V')^2}$$

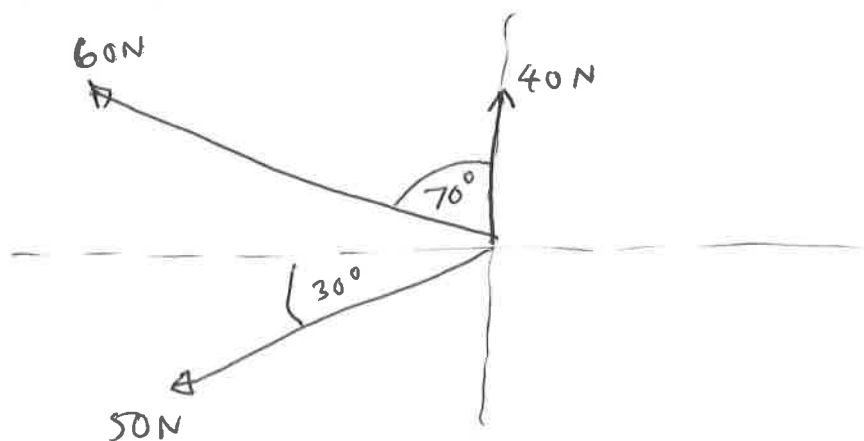
$$F_R' = \sqrt{(0.9)^2 + (11.6)^2} = \underline{11.6 \text{ N}} \quad \text{to 1 d.p.}$$

and this resultant makes an angle θ as shown above

$$\text{where} \quad \theta = \tan^{-1} \left(\frac{F_V'}{F_H'} \right) = \tan^{-1} \left(\frac{11.6}{0.9} \right)$$

$$\underline{\theta = 85.6^\circ} \quad \text{to 1 D.P.}$$

6.



(6)

Horizontal component of forces $F_H = -60 \cos 20^\circ - 50 \cos 30^\circ$

$$F_H = -56.4 - 43.3$$

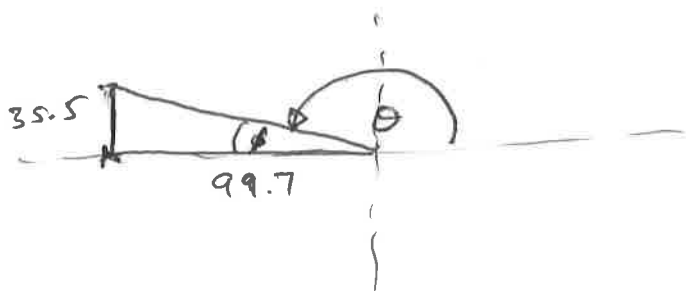
$$F_H = \underline{-99.7 \text{ N}} \quad \text{to 1 d.p.}$$

Vertical Component of forces $F_V = 40 + 60 \cos 70^\circ - 50 \cos 60^\circ$

$$F_V = 40 + 20.5 - 25$$

$$F_V = \underline{35.5 \text{ N}} \quad \text{to 1 d.p.}$$

Draw diagram:



Resultant magnitude

$$F_R = \sqrt{F_V^2 + F_H^2}$$

$$F_R = \sqrt{(-99.7)^2 + (35.5)^2}$$

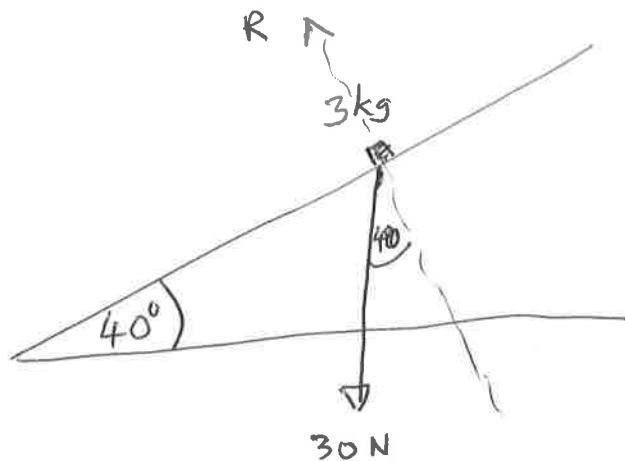
$$F_R = \underline{106.5} \quad \text{to 1 d.p.}$$

Angle required is θ in diagram above. First find angle ϕ in triangle then subtract it from 180° to find θ .

$$\phi = \tan^{-1} \left(\frac{35.5}{99.7} \right) = 19.6^\circ \quad \text{to 1 d.p.}$$

$$\therefore \underline{\theta = 180 - 19.6 = 160.4^\circ}$$

7. (a)

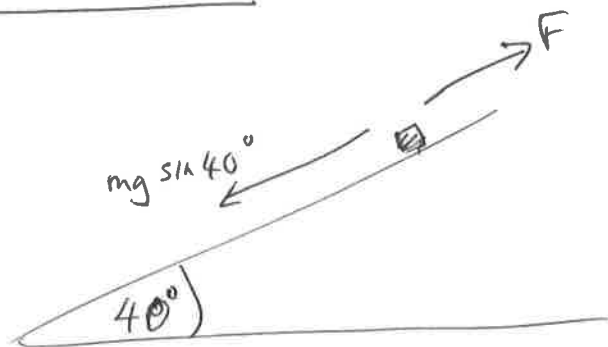


⑦
 mass 3 kg has
 weight 30 N
 remember $g = 10 \text{ ms}^{-2}$

Component of 30 N $\perp$ to plane is $30 \cos 40^\circ$
 i.e. 23.0 N to 1.d.p.

Since mass does not move off plane, the
 reaction force R that plane exerts on mass must
 equal 23.0 N

(b).



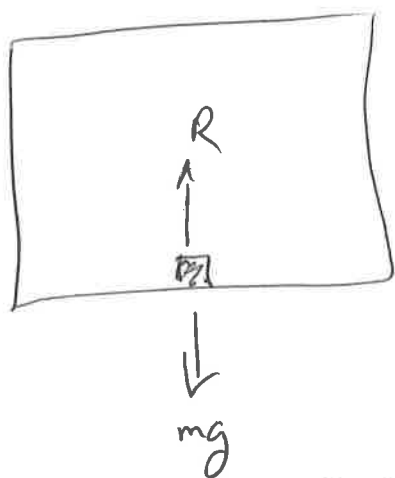
The component of weight $\parallel$ to plane is $mg \sin 40^\circ$
 i.e. $30 \sin 40^\circ = 19.3 \text{ N}$

To keep mass stationary the friction force F must
 also be 19.3 N in opposite direction.

8.

⑧

There are two forces of interest: the weight of the body acting vertically downwards, and the reaction force R that the floor exerts on the body which acts vertically upwards.



We know mg , which is 70 N

(a) Take upwards direction as positive for force & acceleration.
Applying Newton's 2nd Law:

$$F = ma$$

$$\text{Net force} = \text{mass} \times \text{acceleration}$$

$$R - mg = 7 \times 2$$

$$R - 70 = 14$$

$$R = 84 \text{ N}$$

(b) Again take upwards direction as positive for force and acceleration.

Applying Newton's 2nd Law

$$F = ma$$

$$R - 70 = 7 \times (-3)$$

$$R - 70 = -21$$

$$R = 49 \text{ N}$$

8 (c)

Applying Newton's 2nd Law.

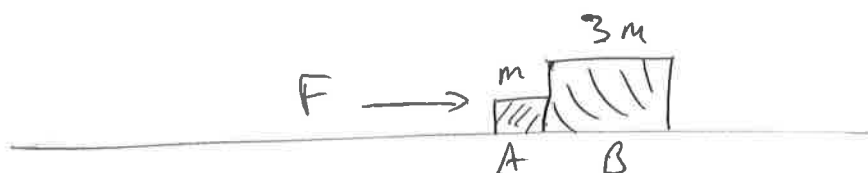
(9)

$$R - 70 = 0$$

[since constant velocity
means zero acceleration]

$$R = 70 \text{ N}$$

9.

(a) Applying Newton's 2nd Law to system.

$$F = 4m \times a$$

$$a = \frac{F}{4m} \quad \text{ms}^{-2}$$

(b). Consider block B

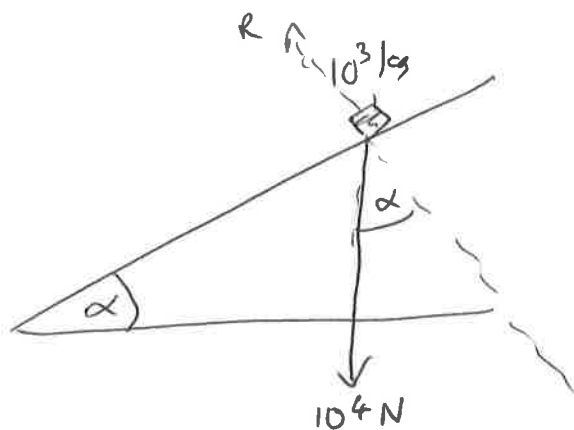
We know acceleration of B from (a)

$$\Rightarrow \text{Force} = \frac{3m \times F}{4m}$$

$$\text{Force} = \frac{3F}{4} \quad \text{N}$$

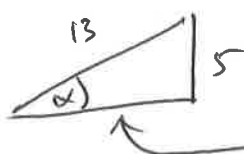
10.

(10)



$$\sin \alpha = \frac{5}{13}$$

When angle given in this style
draw triangle to determine $\cos \alpha$ or $\tan \alpha$



this side is then $\sqrt{13^2 - 5^2}$
 $= \sqrt{169 - 25}$
 $= \sqrt{144}$
 $= 12$

$$\therefore \cos \alpha = \frac{12}{13} \quad \text{and} \quad \tan \alpha = \frac{5}{12}$$

- (a) Consider forces $\perp$ to plane:
 Component of weight acting $\perp$ to plane is $mg \cos \alpha$
 this must equal reaction force R

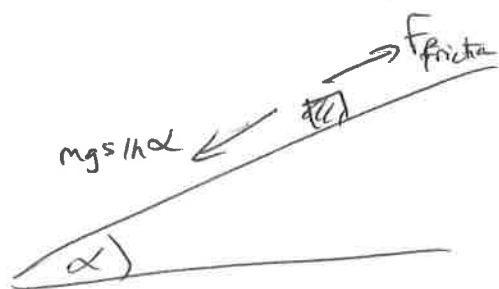
$$\therefore R = mg \cos \alpha$$

$$R = 10^3 \times 10 \times \frac{12}{13}$$

$$\underline{R = 9230.8 \text{ N}} \quad \text{to 1 d.p.}$$

(11)

(b) Consider forces acting $\parallel$ to plane:



We know acceleration of body.

Applying Newton's 2nd Law to motion $\parallel$ to plane:

$$mg \sin \alpha - F_{\text{friction}} = m \times a$$

$$m = 10^3 \text{ kg}, \quad g = 10 \text{ ms}^{-2}, \quad a = 0.025 \text{ ms}^{-2}$$

Take positive direction of forces and acceleration as downwards

$$10^4 \times \frac{5}{13} - F_{\text{friction}} = 10^3 \times 0.025$$

$$\therefore F_{\text{friction}} = \frac{10^4 \times 5}{13} - 10^3 \times 0.025$$

$$F_{\text{friction}} = 3846.2 - 25$$

$$F_{\text{friction}} = 3821.2 \text{ N to 1 d.p.}$$

(c)

$$F_{\text{friction}} = \mu R \quad \therefore \mu = \frac{3821.2}{9230.8} = 0.4 \text{ to 1 d.p.}$$