

Figure 1

$$\tan \alpha = \frac{3}{4}$$

$$\sin \alpha = \frac{3}{\sqrt{3^2+4^2}} = \frac{3}{5}$$

$$\cos \alpha = \frac{4}{\sqrt{3^2+4^2}} = \frac{4}{5}$$

$$\text{Use } g = 9.8 \text{ m s}^{-2}$$

A rough plane is inclined to the horizontal at an angle  $\alpha$ , where  $\tan \alpha = \frac{3}{4}$

A small block  $B$  of mass  $5 \text{ kg}$  is held in equilibrium on the plane by a horizontal force of magnitude  $X$  newtons, as shown in Figure 1.

The force acts in a vertical plane which contains a line of greatest slope of the inclined plane.

The block  $B$  is modelled as a particle.

The magnitude of the normal reaction of the plane on  $B$  is  $68.6 \text{ N}$ .

Using the model,

(a) (i) find the magnitude of the frictional force acting on  $B$ ,

(ii) state the direction of the frictional force acting on  $B$ .

(a)(i)  $R(\perp)$ ,  $F_r = -9.8(1)$ , so  $F_r = 9.8(\text{N})$  : down plane (1 mark)

The horizontal force of magnitude  $X$  newtons is now removed and  $B$  moves down the plane.

Given that the coefficient of friction between  $B$  and the plane is  $0.5$

(b) find the acceleration of  $B$  down the plane.

(a)(i) Resolving ( $\perp$ ),

$R(\perp)$ :

$$5g \sin \alpha - X \cos \alpha$$

$$-F_r = 0$$

$$5(9.8)\left(\frac{3}{5}\right) - X\left(\frac{4}{5}\right)$$

$$-F_r = 0 \quad (1 \text{ mark})$$

$$29.4 - 0.8X - F_r = 0$$

$$\frac{3}{4}$$

(a)(i)  $\cot \alpha$ .

$R(\parallel)$ :

$$5g \cos \alpha - 68.6 + X \sin \alpha = 0$$

$$5(9.8)\left(\frac{4}{5}\right) - 68.6 + X\left(\frac{3}{5}\right) = 0$$

$$39.2 - 68.6 + 0.6X = 0 \quad (1 \text{ mark})$$

(3)

$$\Rightarrow X = 49 \text{ N}$$

(1)

Subst. for  $X$  in equation

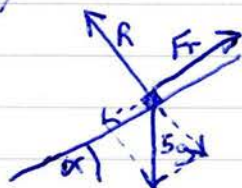
for  $F_r \Rightarrow 29.4 - 0.8(49) - F_r = 0$

$$\Rightarrow F_r = -9.8 \text{ N} \quad (1 \text{ mark})$$

$$|F_r| = 9.8 \text{ N}$$

(6)

(b) Now,



$$R(\parallel): -5g \cos \alpha = R$$

$$-5(9.8)\left(\frac{4}{5}\right) = R$$

$$R = -39.2 \quad (2 \text{ marks})$$

in motion,

$$F_r = \mu |R|$$

$$= 0.5(39.2) \quad (1 \text{ mark})$$

$$= 19.6 \text{ N}$$

$$R(\perp) \text{ Force, } F = 5g \sin \alpha - F_r$$

$$F = 5(9.8)\left(\frac{3}{5}\right) - 19.6$$

$$= 9.8 \text{ N}$$

(1 mark)

$$F = ma$$

$$\Rightarrow 9.8 = 5a$$

$$\Rightarrow a = 1.96 \text{ m s}^{-2} \quad (2 \text{ marks})$$