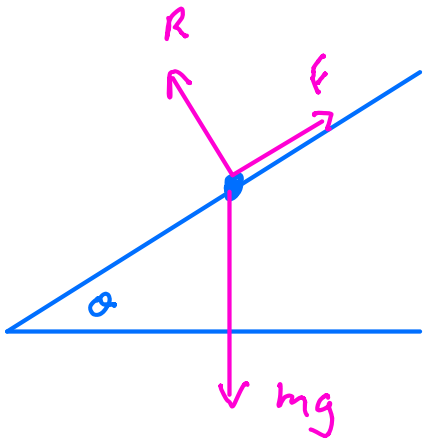
Inclined Planes

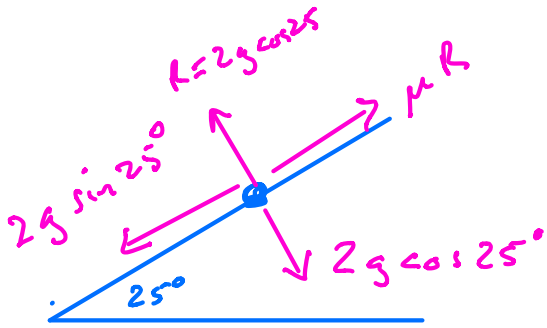


Let $m = 2\,kg$

Let particle be on point of slipping

Let $\theta = 25°$

Find μ



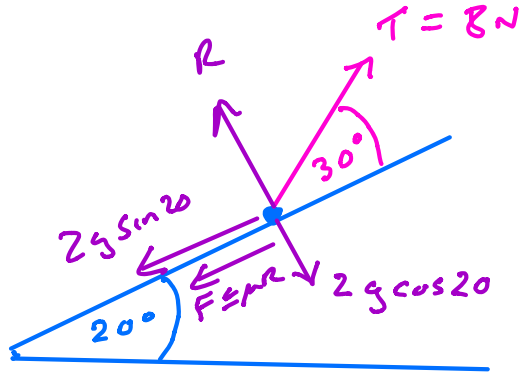
On point of slipping $F = \mu R$

and $2g\sin 25° = \mu\, 2g\cos 25$

$$\frac{2g\sin 25°}{2g\cos 25°} = \mu$$

$$\underline{\tan 25° = \mu}$$

Ex2



$\mu = 0.5$

$m = 2$ kg

$T = 8$ N

Find what happens to particle

$\perp$ to slope $\quad R + T\sin 30 = 2g\cos 20$

$R = 2g\cos 20 - 8\sin 30 = 14.42$ N

Max $F = \mu R = 0.5 \times 14.42 = 7.21$ N

$2g\sin 20 = 6.704$ N

$T\cos 30 = 8\cos 30 = 6.928$ N

Force up slope from T slightly bigger than force down slope from weight

$\therefore$ Friction would actually be in direction down slope. Only $6.928 - 6.704 = 0.224$ N required for equilibrium. Friction can supply up to 7.21 N so particle does not move.

Follow up question. What does T need to be to make particle accelerate up hill?

Max force down slope $= 2g\sin 20 + \mu R$

$= 2 \times 9.8 \sin 20 + 7.21$

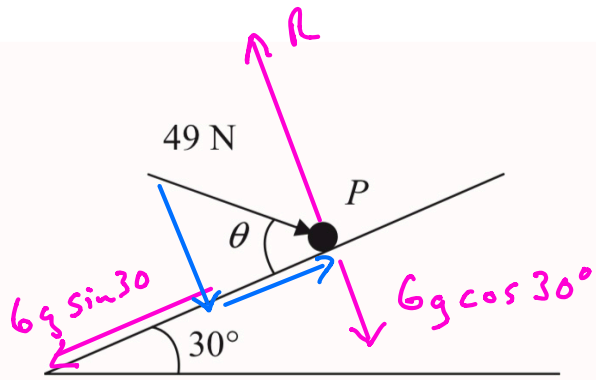
$= 13.91$ N

Particle will accelerate up slope when $T\cos 30 > 13.91$

$$T > \frac{13.91}{\cos 30} = 16.06 \text{ N}$$

when $T > 16.1$ N

4.



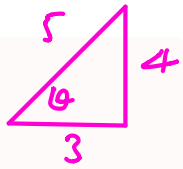


Figure 1

A particle P of mass 6 kg lies on the surface of a smooth plane. The plane is inclined at an angle of 30° to the horizontal. The particle is held in equilibrium by a force of magnitude 49 N, acting at an angle θ to the plane, as shown in Figure 1. The force acts in a vertical plane through a line of greatest slope of the plane.

(a) Show that $\cos\theta = \frac{3}{5}$.

(3)

(b) Find the normal reaction between P and the plane.

(4)

The direction of the force of magnitude 49 N is now changed. It is now applied horizontally to P so that P moves up the plane. The force again acts in a vertical plane through a line of greatest slope of the plane.

(c) Find the initial acceleration of P.

(4)

a) Parallel to slope

$$6g\sin 30 = 49\cos\theta$$

$$\frac{6 \times 9.8 \sin 30}{49} = \cos\theta$$

$$\cos\theta = \frac{3}{5}$$

b) $\perp$ to slope

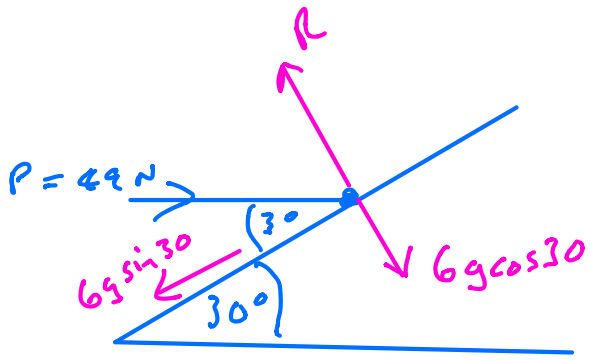
$$49\sin\theta + 6g\cos 30 = R$$

$$49 \times \frac{4}{5} + 6g\cos 30 = R$$

$$R = 90.122$$

$$R = 90.1\ N$$

c)



Resultant Force up slope = mass × acc

$$49\cos 30 - 6g\sin 30 = 6a$$

$$a = \frac{49\cos 30 - 6g\sin 30}{6}$$

$$a = 2.17\ ms^{-2}$$