Cambridge International AS & A Level

---

https://babacambridgesolutions.com

Mathematics 9709/42

Paper 4 Mechanics October/November 2022

Question No (2)

2 A particle P of mass 0.4 kg is in limiting equilibrium on a plane inclined at 30° to the horizontal.

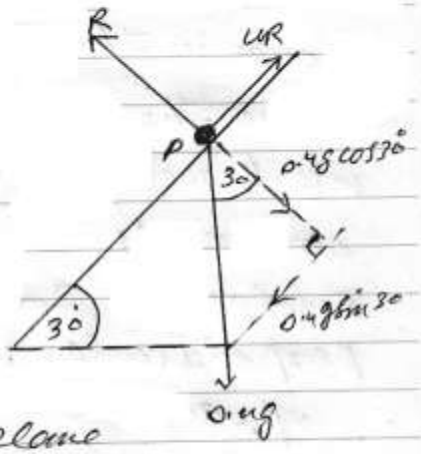
(a) Show that the coefficient of friction between the particle and the plane is $\frac{1}{3}\sqrt{3}$.

A force of magnitude 7.2 N is now applied to P directly up a line of greatest slope of the plane.

(b) Given that P starts from rest, find the time that it takes for P to move 1 m up the plane.

Solution:

(a) The forces are shown in the diagram.



Resolve the forces 0.4g into its rectangular components.

Resolve the forces perpendicular to the plane

upward forces = downward forces

$R = 0.4g\cos 30$

$= (0.4)(10)\left(\frac{\sqrt{3}}{2}\right)$

$R = 2\sqrt{3}\ N$

Resolve the forces along the inclined plane

Right hand forces = ~~down~~ left hand forces

$\mu R = 0.4g\sin 30$

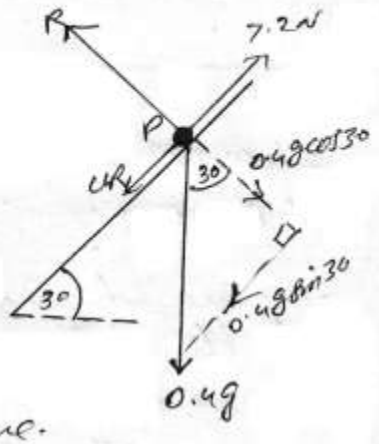
$\mu(2\sqrt{3}) = (0.4)(10)(\frac{1}{2})$

$= \frac{4}{2} = 2$

$\mu = \frac{2}{2\sqrt{3}} = \frac{1}{\sqrt{3}}$

$\mu = \frac{1}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{\sqrt{3}}{3}$

(b) on this case forces are acting are shown in the diagram.



Resolve the force 0.4g into its rectangular components.

Resolve the forces perpendicular to the plane.

upward forces = downward forces

$R = 0.4g\cos 30$

$= (0.4)(10)\left(\frac{\sqrt{3}}{2}\right)$

$R = 2\sqrt{3}$

Applying newton 2nd law of motion

Net force = ma

$7.2 - 0.4g\sin 30 - \mu R = 0.4a$

$7.2 - (0.4)(10)\left(\frac{1}{2}\right) - \left(\frac{\sqrt{3}}{3}\right)(2\sqrt{3}) = 0.4a \quad \because R = 2\sqrt{3}$

$7.2 - 2 - 2 = 0.4a$

$0.4a = 3.2$

$a = \frac{3.2}{0.4}$

$a = 8\ m\ s^{-2}$

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

$1 = (0)(t) + \frac{1}{2}(8)(t^2)$

$1 = 4t^2$

$t^2 = \frac{1}{4}$

$t = \frac{1}{2}$

$t = 0.5\ s$