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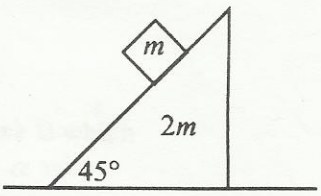
4. **(b)** A smooth wedge of mass $2m$ and slope 45° is placed on a smooth horizontal surface. A particle of mass m is placed on the inclined face of the wedge. The system is released from rest.

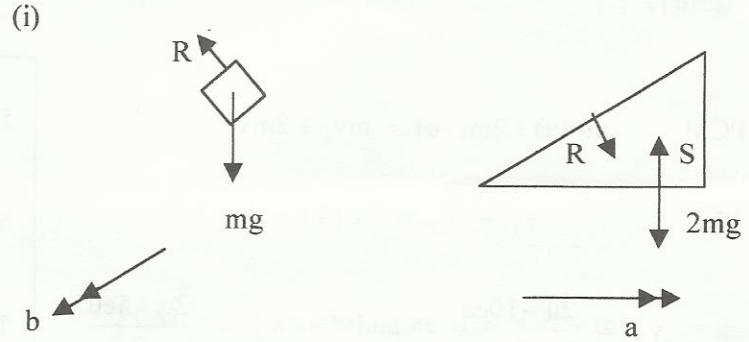


(i) Show on separate diagrams the forces acting on the wedge and the particle.

(ii) Show that the acceleration of the wedge is $\frac{g}{5}$ m/s^2.

(iii) Find the speed of the particle relative to the wedge, when the speed of the wedge is 1 m/s.

(i)



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(ii)

$$R\sin 45 = 2ma \quad (3)$$

$$mg\cos 45 - R = ma\sin 45 \quad (1)$$

$$\frac{mg}{\sqrt{2}} - 2\sqrt{2}\,ma = m\frac{a}{\sqrt{2}}$$

$$\Rightarrow \quad a = \tfrac{1}{5}g \quad (4)$$

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(iii)

$$mg\sin 45 = m(b - a\cos 45) \quad (2)$$

$$\frac{mg}{\sqrt{2}} = m\left(b - \frac{g}{5\sqrt{2}}\right)$$

$$\Rightarrow \quad b = \frac{6g}{5\sqrt{2}}$$

Wedge: $v = u + at$

$$1 = 0 + \tfrac{1}{5}gt \quad \Rightarrow \quad t = \frac{5}{g}$$

Particle: $v = u + bt$

$$v = 0 + \frac{6g}{5\sqrt{2}}\left(\frac{5}{g}\right) = \frac{6}{\sqrt{2}} \text{ or } 3\sqrt{2}$$

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