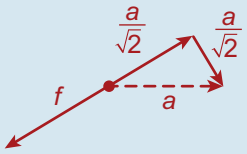
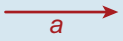
Acceleration of 1 kg mass



Acceleration of wedge



1 kg mass along slope: $F = ma$

$$\Rightarrow \frac{g}{\sqrt{2}} = 1\left(f - \frac{a}{\sqrt{2}}\right)$$

$$\Rightarrow g = f\sqrt{2} - a \quad \ldots ①$$

1 kg mass perpendicular to slope:

$$F = ma$$

$$\Rightarrow \frac{g}{\sqrt{2}} - R = \frac{a}{\sqrt{2}}$$

$$\Rightarrow g - R\sqrt{2} = a \quad \ldots ②$$

Wedge horizontal: $F = ma$

$$\Rightarrow \frac{R}{\sqrt{2}} = 7a$$

$$\Rightarrow R = 7a\sqrt{2} \quad \ldots ③$$

Putting this result into equation ② gives:

$$g - 14a = a$$

$$\Rightarrow 15a = g$$

$$\Rightarrow a = \frac{1}{15}g \text{ m/s}^2 \quad \ldots \text{ acceleration of wedge}$$

Putting this result into equation ① gives

$$g = f\sqrt{2} - \frac{1}{15}g$$

$$\Rightarrow 15g = 15f\sqrt{2} - g$$

$$\Rightarrow 15f\sqrt{2} = 16g$$

$$\Rightarrow f = \frac{16}{15\sqrt{2}}g$$

$$= \frac{8\sqrt{2}}{15}g \text{ m/s}^2 \quad \ldots \text{ acceleration of particle relative to the wedge}$$

$u = 0, \quad v = \sqrt{2}, \quad f = \frac{8\sqrt{2}}{15}g$

$$t = \frac{v - u}{f}$$

$$= \sqrt{2}\left(\frac{15}{8g\sqrt{2}}\right)$$

$$= \frac{15}{8g} \text{ seconds}$$

Now, find speed of wedge when $t = \frac{15}{8g}$

$u = 0, \quad a = \frac{1}{15}g, \quad t = \frac{15}{8g}$

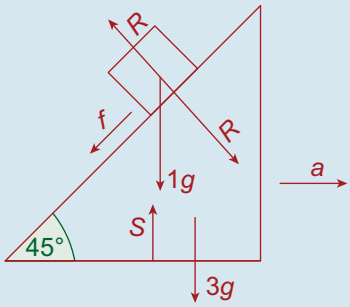
$$v = u + at$$

$$= 0 + \left(\frac{g}{15}\right)\left(\frac{15}{8}\right)g$$

$$= \frac{1}{8}$$

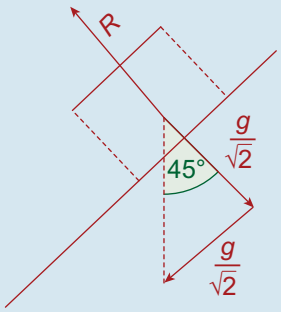
$$= 0.125 \text{ m/s}$$

Q. 3.

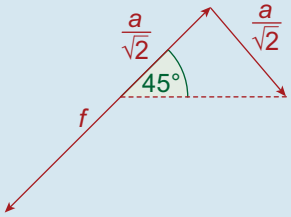


The Particle:

Forces



Acceleration



Parallel to the slope:

$$F = ma$$

$$\Rightarrow \frac{g}{\sqrt{2}} = 1\left(f - \frac{a}{\sqrt{2}}\right)$$

$$\Rightarrow g = \sqrt{2}f - a \quad \ldots. ①$$

Perpendicular to the slope:

$$F = ma$$

$$\Rightarrow \frac{g}{\sqrt{2}} - R = 1\left(\frac{a}{\sqrt{2}}\right)$$

$$\Rightarrow g - \sqrt{2}R = a \quad \ldots ②$$