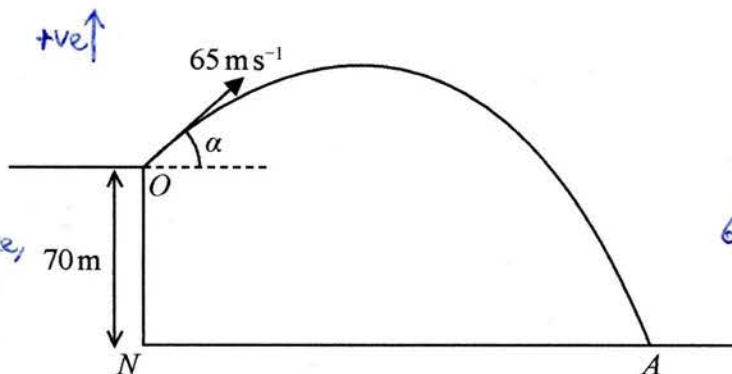


4.

(a) we don't know horizontal distance to A, but we do know vertical distance, so we have to resolve vertically to find t .



$$R(\uparrow): u = 65 \sin \alpha = 65 \left(\frac{5}{13} \right) = 25$$

$$s = -70 \quad t = ?$$

$$a = -10$$

Figure 3 $\tan \alpha = \frac{5}{12} \Rightarrow \sin \alpha = \frac{5}{\sqrt{12^2 + 5^2}} = \frac{5}{13}, \cos \alpha = \frac{12}{13}$

A small stone is projected with speed 65 ms^{-1} from a point O at the top of a vertical cliff.

Point O is 70 m vertically above the point N . (a) cotd $s = ut + \frac{1}{2}at^2$

Point N is on horizontal ground. $\Rightarrow -70 = 25t - 5t^2 \Rightarrow 5t^2 - 25t - 70 = 0 \Rightarrow t^2 - 5t - 14 = 0$
 $\Rightarrow t = \cancel{2}, 7$ -2 not possible, so $t = 7 \text{ s}$. (4 marks)

The stone is projected at an angle α above the horizontal, where $\tan \alpha = \frac{5}{12}$

The stone hits the ground at the point A , as shown in Figure 3.

The stone is modelled as a particle moving freely under gravity.

The acceleration due to gravity is modelled as having magnitude 10 ms^{-2}

(b) "speed" = magnitude of velocity

Using the model, V_{vertical} $V_{\text{horizontal}}$ magnitude of this = $\sqrt{V_{\text{vertical}}^2 + V_{\text{horizontal}}^2}$

(a) find the time taken for the stone to travel from O to A ,

(4)

(b) find the speed of the stone at the instant just before it hits the ground at A .

(5)

One limitation of the model is that it ignores air resistance.

(c) State one other limitation of the model that could affect the reliability of your answers.

(1)

(b) cotd $V_{\text{horizontal}} = 65 \cos \alpha = 65 \left(\frac{12}{13} \right) = 60 \text{ ms}^{-1}$ (no acceleration because moving freely under (vertical) gravity (1 mark))

$$V_{\text{vertical}} = u + at = 65 \sin \alpha + (-10)t$$

$$= 65 \left(\frac{5}{13} \right) - 70 = -45 \text{ ms}^{-1} \quad (2 \text{ marks})$$

$$\text{Speed} = \sqrt{V_{\text{vertical}}^2 + V_{\text{horizontal}}^2} = \sqrt{(-45)^2 + (60)^2} = 75 \text{ ms}^{-1} \quad (2 \text{ marks})$$

(c) g has been modelled as 10 ms^{-2} rather than 9.8 or more accurate OR spin/shape of stone OR wind effects OR dimensions of stone ETC (1 mark)