3. **(a)** A straight vertical cliff is 200 m high.
A particle is projected from the top of the cliff.
The speed of projection is $14\sqrt{10}$ m/s at an angle α to the horizontal.
The particle strikes the level ground at a distance of 200 m from the foot of the cliff.

(i) Find, in terms of α, the time taken for the particle to hit the ground.
(ii) Show that the two possible directions of projection are at right angl es to each other.

(i) $14\sqrt{10}\cos\alpha . t = 200$

$$t = \frac{200}{14\sqrt{10}\cos\alpha}$$ 5

(ii) $14\sqrt{10}\sin\alpha . t - \frac{1}{2}gt^2 = -200$ 5

$$14\sqrt{10}\sin\alpha .\left(\frac{200}{14\sqrt{10}\cos\alpha}\right) - \frac{1}{2}g\left(\frac{200}{14\sqrt{10}\cos\alpha}\right)^2 = -200$$ 5

$$200\tan\alpha - \frac{100}{\cos^2\alpha} = -200$$

$$200\tan\alpha - 100\left(1+\tan^2\alpha\right) = -200$$

$$\tan^2\alpha - 2\tan\alpha - 1 = 0$$

$$\tan\alpha = 1 \pm \sqrt{2}$$

$$\tan\alpha_1 \times \tan\alpha_2 = \left(1+\sqrt{2}\right)\left(1-\sqrt{2}\right)$$

$$= -1$$

directions : are perpendicular 5 | 20