

**1** A particle  $P$  is projected from the ground with velocity  $25\text{ms}^{-1}$  at an angle of  $40^\circ$  to the horizontal.

(a) Find the greatest height of  $P$ .

**(3)**

(b) Find the horizontal distance travelled by  $P$  before it hits the ground.

**(4)**

**(Total for question 1 is 7 marks)**

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**2** A particle  $P$  is projected with a velocity  $(3\mathbf{i} + 4\mathbf{j})\text{ms}^{-1}$  from a point 20m above the ground.

(a) Find the speed of the particle after 2 seconds.

**(4)**

(b) Find the greatest height of  $P$ .

**(3)**

- (c) Find the horizontal distance travelled by  $P$  before it hits the ground.

**(4)**

**(Total for question 2 is 11 marks)**

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- 3** A particle  $P$  is projected from the ground with velocity  $25\text{ms}^{-1}$  at an angle of  $\theta^\circ$  to the horizontal.  $P$  lands after 5 seconds.

(a) Find value of  $\theta$ .

**(4)**

(b) Find the horizontal distance travelled by  $P$  before it lands on the ground.

**(4)**

**(Total for question 3 is 8 marks)**

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- 4** A particle  $P$  is projected with speed  $U \text{ ms}^{-1}$  from the point  $A$ , 20m above the ground.  $P$  is projected at an angle of  $60^\circ$  to the horizontal.  $B$  is the greatest height of  $P$ , 16m above  $A$ .

(a) Find the value of  $U$ .

**(3)**

(b) Find the horizontal distance travelled.

**(6)**

(c) Find the speed of the ball when it hits the ground.

**(3)**

**(Total for question 4 is 12 marks)**

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- 5** A particle  $P$  is projected from the ground with velocity  $k(3\mathbf{i} + 4\mathbf{j})\text{ms}^{-1}$ , where  $k$  is a constant. Given the greatest height reached by  $P$  is 24m above the ground.

(a) Find the exact value of  $k$ .

**(3)**

(b) Find the horizontal distance travelled.

**(6)**

**(Total for question 5 is 9 marks)**

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- 6** A particle  $P$  is projected from a point  $O$  with velocity  $U \text{ ms}^{-1}$  at an angle of  $\theta^\circ$  to the horizontal. When  $P$  has moved a horizontal distance  $x$ , its height above  $O$  is  $y$ .

(a) Show that

$$y = x \tan \theta - \frac{gx^2}{2u^2 \cos^2 \theta}$$

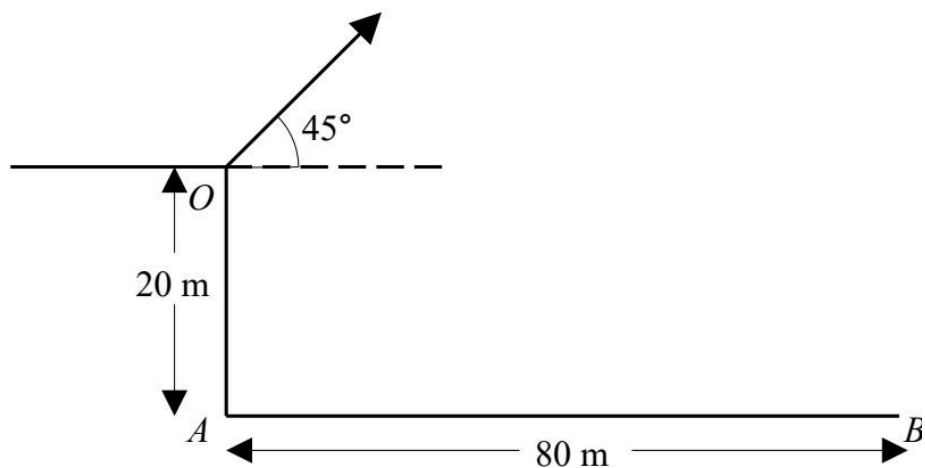
**(4)**

- (b) Given that  $\theta = 45^\circ$  and that when  $x = 6$ ,  $y = 2$ , find the speed of  $P$  at the point where  $x = 6$  and  $y = 2$ .

**(6)**

(Total for question 6 is 10 marks)

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A ball is projected with speed  $U\text{ ms}^{-1}$  from the point  $O$ ,  $20\text{ m}$  above the horizontal ground. The ball is projected at an angle of  $45^\circ$  above the horizontal. The ball hits the ground at the point  $B$ , where  $AB = 80\text{ m}$ . The motion of the ball is modelled as that of a particle moving freely under gravity.

- (a) Find the value of  $U$ .

(6)

(b) Find the maximum height of the ball above the ground.

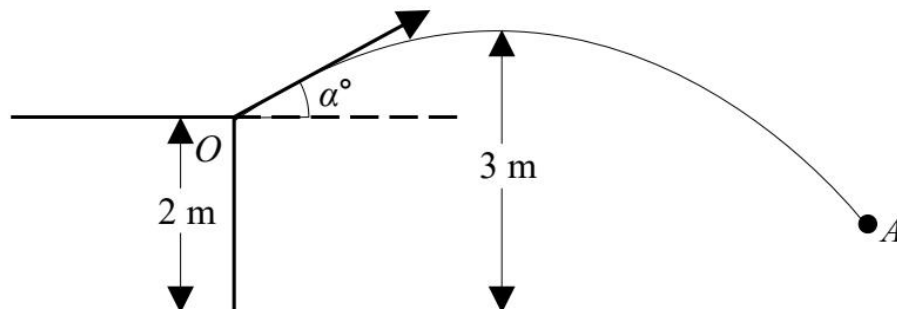
**(3)**

(c) In a refined model the effect of air resistance is included. How would this value compare to your answer in part (a).

**(1)**

**(Total for question 7 is 10 marks)**

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A ball is projected with speed  $U \text{ ms}^{-1}$  from the point  $O$ , 2 m above the ground. The ball is projected from  $O$  at an angle of  $\alpha^\circ$ . In the motion the ball reaches a maximum height 3 m above the horizontal ground and passes through the point  $A$  0.8 m above the ground and a horizontal distance of 10 m from  $O$ .

- (a) Find the value of  $U$ .

(6)

(b) Find the size of angle  $\alpha$ .

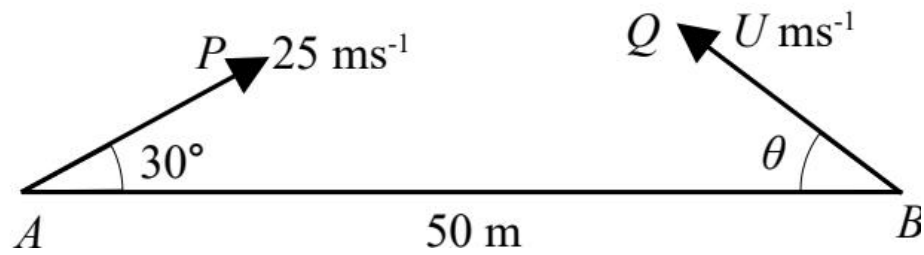
**(3)**

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

**(1)**

**(Total for question 8 is 10 marks)**

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The points  $A$  and  $B$  lie  $50\text{ m}$  apart on horizontal ground. At time  $t = 0$  two balls,  $P$  and  $Q$ , are projected from the points  $A$  and  $B$ . Ball  $P$  is projected with speed  $25\text{ ms}^{-1}$  at an angle of  $30^\circ$  to the horizontal. Ball  $Q$  is projected with speed  $U\text{ ms}^{-1}$  at an angle of  $\theta$  to the horizontal. At time  $t = 2$ ,  $P$  and  $Q$  collide.

- (a) Find the velocity of  $P$  the instant before it collides with  $Q$ .

(6)

(b) Find (i) the size of angle  $\theta$  and (ii) the value of  $U$ .

**(6)**

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

**(1)**

**(Total for question 9 is 13 marks)**

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