A Level Mechanics: Projectiles

1   A particle P is projected from the ground with velocity 25ms^{-1} at an angle of 40° 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)

2   A particle P is projected with a velocity $(3\mathbf{i} + 4\mathbf{j})$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)

3   A particle P is projected from the ground with velocity 25ms^{-1} at an angle of θ° to the horizontal.
P lands after 5 seconds.

(a) Find value of θ **(4)**
(b) Find the horizontal distance travelled by P before it lands on the ground   **(4)**

(Total for question 3 is 8 marks)

4   A particle P is projected with speed Ums^{-1} from the point A, 20m above the ground.
P is projected at an angle of 60° 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)

5   A particle P is projected from the ground with velocity k$(3\mathbf{i} + 4\mathbf{j})$ 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)

6   A particle P is projected from a point O with velocity Ums^{-1} at an angle of θ° to the horizontal.
When P has moved a horizontal distance x, it's height above O is y.

(a) Show that

$$y = x\tan\theta - \frac{g x^2}{2u^2\cos^2\theta}$$ **(4)**

Given that θ = 45° and that when $x = 6$, $y = 2$

(b) Find the speed of P at the point where $x = 6$. and $y = 2$ **(6)**

(Total for question 6 is 10 marks)

7
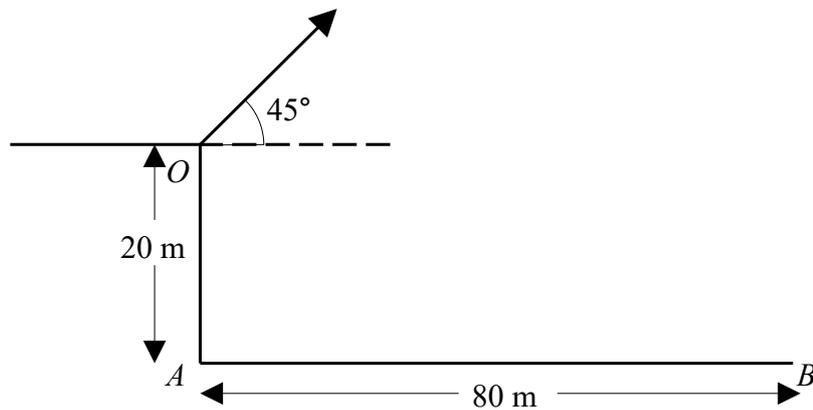
A ball is projected with speed U ms^{-1} from the point O, 20m above the horizontal ground.
The ball is projected at an angle of 45° above the horizontal.
The ball hits the ground at the point B, where $AB = 80$ m.
The motion of the ball is modelled as that of a particle moving freely under gravity.

Using this model,

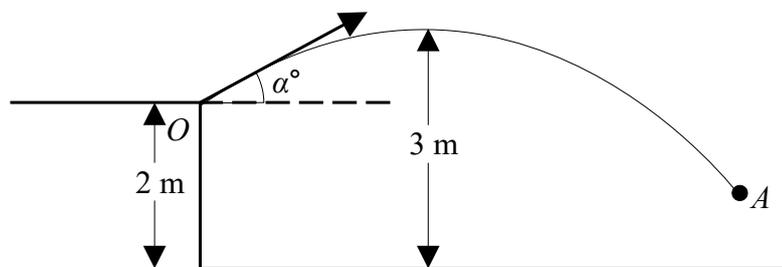(a) Find the value of U. **(6)**
(b) Find the maximum height of the ball above the ground. **(3)**

In a refined model the effect of air resistance is included.
The new model is used to find the value of U

(c) How would this value compare to your answer in part (a). **(1)**

(Total for question 7 is 10 marks)

8

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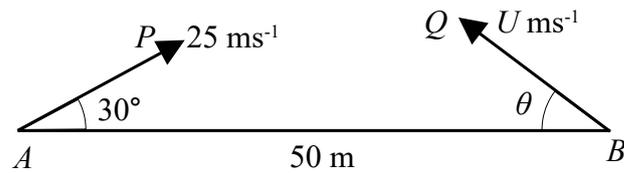through the point A 0.8 m above the ground and a horizontal distance of 10 m from O.

The motion of the ball is modelled as that of a particle moving freely under gravity.

Using this model,

(a) Find the value of U. **(6)**
(b) Find the size of angle α. **(3)**
(c) State one limitation of the model that could affect the accuracy of your answers. **(1)**

(Total for question 8 is 10 marks)

9

The points A and B lie 50 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 ms⁻¹ at an angle of 30° to the horizontal.
Ball *Q* is projected with speed *U* ms⁻¹ at an angle of θ to the horizontal.

At time t = 2, *P* and *Q* collide.

Both balls are modelled as particles moving freely under gravity.

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

(6)

(b) Find
>   (i) the size of angle θ
>   (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)