

Mechanics 23 – suvat and projectiles with vectors

Please **complete** this homework by _____. Start it early. If you can't do a question you will then have time to ask your teacher for help or go to a drop in session.

Section 1 – Review of previous topics.

Please complete all questions.

1)

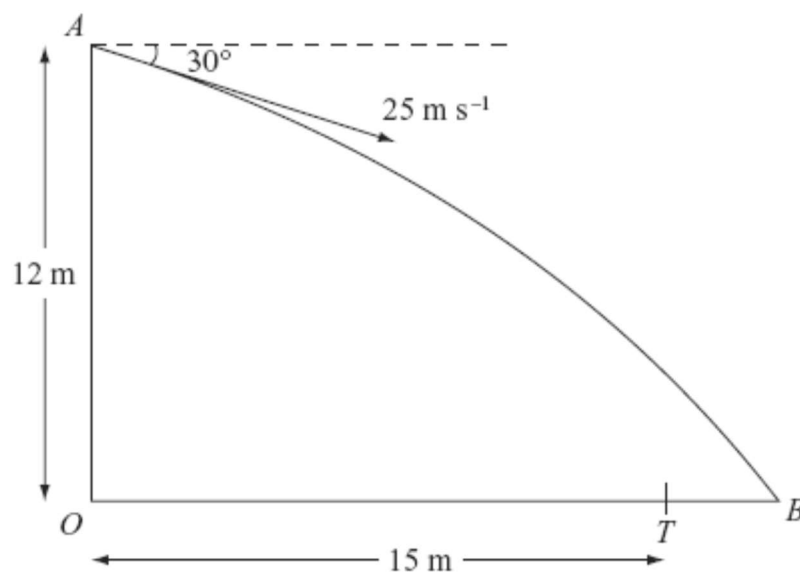


Figure 1

A ball is thrown from a point A at a target, which is on horizontal ground. The point A is 12 m above the point O on the ground. The ball is thrown from A with speed 25 m s^{-1} at an angle of 30° below the horizontal. The ball is modelled as a particle and the target as a point T . The distance OT is 15 m. The ball misses the target and hits the ground at the point B , where OTB is a straight line, as shown in Figure 1. Find

(a) the time taken by the ball to travel from A to B , (5)

(b) the distance TB . (4)

The point X is on the path of the ball vertically above T .

(c) Find the speed of the ball at X . (5)

2) Zain wants to calculate the average daily mean windspeed in Hurn in 2015.

To do this, he takes a simple random sample of the daily mean windspeeds, v knots, on n days in Hurn in 2015 using the large data set. He converts his values for v into miles per hour. He calls the resulting values w .

Given that $\sum w = 194.35$ and $\bar{v} = 8.45$, find the size of Zain's sample.

Section 2 – Consolidation of this week's topic.

Please complete all questions.

- 1) A particle is initially at the point with position vector $\mathbf{r} = (3\mathbf{i} - 2\mathbf{j})$ m and travelling with a velocity $(5\mathbf{i} - \mathbf{j})$ ms^{-1} when it undergoes an acceleration of $(-\mathbf{i} + 2\mathbf{j})$ ms^{-2} for a period of 3 sec. Work out its position at the end of this period. **(5)**

- 2) A particle moving with velocity $(-\mathbf{i} + 2\mathbf{j})$ ms^{-1} undergoes a constant acceleration of $(2\mathbf{i} + \mathbf{j})$ ms^{-2} for 5 sec. Work out its speed and direction at the end of this period. **(6)**

- 3) A boat is moving with speed $2\sqrt{10}$ ms^{-1} in the direction of $3\mathbf{i} + \mathbf{j}$. It undergoes an acceleration of $(-\mathbf{i} - 7\mathbf{j})$ ms^{-2} for 2 sec. Show that, at the end of that time, it is travelling in a direction perpendicular to its original direction and at twice the speed. **(6)**

- 4) Two particles A and B are moving in a plane. Initially A has position vector $(3\mathbf{j})$ m and $\overrightarrow{AB} = (2\mathbf{i} - 2\mathbf{j})$ m. A has initial velocity $(2\mathbf{i} + \mathbf{j})$ ms^{-1} and acceleration $(\mathbf{i} - 2\mathbf{j})$ ms^{-2} . B has initial velocity $(3\mathbf{i} - \mathbf{j})$ ms^{-1} and acceleration $(2\mathbf{i})$ ms^{-2} . Find the distance between the two particles after 6 sec. **(8)**

- 5) A particle P is projected with velocity $(2u\mathbf{i} + 3u\mathbf{j})$ m s^{-1} from a point O on a horizontal plane, where \mathbf{i} and \mathbf{j} are horizontal and vertical unit vectors respectively. The particle P strikes the plane at the point A which is 735 m from O .
 - (a) Show that $u = 24.5$. **(6)**
 - (b) Find the time of flight from O to A . **(2)**The particle P passes through a point B with speed 65 m s^{-1} .
 - (c) Find the height of B above the horizontal plane. **(4)**

6)

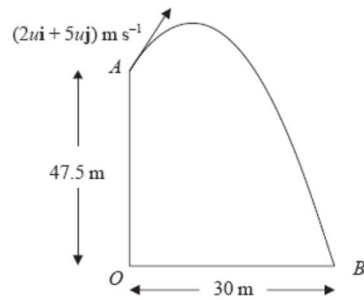


Figure 3

[In this question, the unit vectors \mathbf{i} and \mathbf{j} are in a vertical plane, \mathbf{i} being horizontal and \mathbf{j} being vertical.]

A particle P is projected from the point A which has position vector $47.5\mathbf{j}$ metres with respect to a fixed origin O . The velocity of projection of P is $(2u\mathbf{i} + 5u\mathbf{j})\text{ m s}^{-1}$. The particle moves freely under gravity passing through the point B with position vector $30\mathbf{i}$ metres, as shown in Figure 3.

- (a) Show that the time taken for P to move from A to B is 5 s . **(6)**
- (b) Find the value of u . **(2)**
- (c) Find the speed of P at B . **(5)**

Total mark : 50