



Name: _____

Date: _____

Score: _____ / 65

1 Write each quantity in SI units.

- a. A speed of 90 km h^{-1}
- b. A mass of 1.2 tonnes
- c. A speed of 45 cm per minute

(3 marks)

Answer _____

2 A parcel is pulled across a floor by a rope. In a model of the motion the parcel is modelled as a particle, the rope is modelled as light and inextensible, and the floor is modelled as smooth.

State what each of these words means for the model.

- a. particle
- b. light
- c. inextensible
- d. smooth

(4 marks)

Answer _____

- 3 Amara walks 300 m due east and then 400 m due north. The whole walk takes 500 s.
- Find the total distance Amara walks.
 - Find the magnitude of her displacement from her starting point, and its bearing.
 - Find her average speed and the magnitude of her average velocity.

(5 marks)

Answer _____

- 4 In this question $\mathbf{i}$ and $\mathbf{j}$ are unit vectors due east and due north.

A boat moves with constant velocity $(5\mathbf{i} - 12\mathbf{j}) \text{ m s}^{-1}$.

- Find the speed of the boat.
- Find the direction in which the boat is moving, as a bearing to the nearest degree.

(4 marks)

Answer _____

- 5 A particle P moves with constant velocity $(4\mathbf{i} - \mathbf{j}) \text{ m s}^{-1}$. At time $t = 0$, P is at the point with position vector $(2\mathbf{i} + 3\mathbf{j}) \text{ m}$ relative to a fixed origin O .
- Find the position vector of P when $t = 5$
 - Find the value of t when P is due east of O .
 - Find the distance OP at this time.

(5 marks)

Answer _____

6 In this question $\mathbf{i}$ and $\mathbf{j}$ are unit vectors due east and due north, and position vectors are given relative to a fixed harbour H .

A ship moves with constant velocity. At 09:00 it is at the point with position vector $(3\mathbf{i} + 7\mathbf{j})$ km. At 11:00 it is at the point with position vector $(15\mathbf{i} - 2\mathbf{j})$ km.

- Find the velocity of the ship in km h^{-1} .
- Find the speed of the ship.
- Find the bearing on which the ship is moving.

(6 marks)

Answer _____

7 A particle moves with velocity $(3k\mathbf{i} + (k - 5)\mathbf{j}) \text{ m s}^{-1}$, where k is a constant.

Given that the particle is moving parallel to the vector $(\mathbf{i} - \mathbf{j})$,

- find the value of k ,
- find the speed of the particle, giving your answer to 3 significant figures.

(5 marks)

Answer _____

8 Two forces $\mathbf{F}_1 = (3\mathbf{i} - 2\mathbf{j})$ N and $\mathbf{F}_2 = (p\mathbf{i} + q\mathbf{j})$ N are the only forces acting on a particle of mass 2 kg. The acceleration of the particle is $(4\mathbf{i} + 5\mathbf{j})$ m s⁻².

- Find the values of p and q .
- Find the magnitude of the acceleration.
- Find the angle between the acceleration and the vector $\mathbf{i}$.

(6 marks)

Answer _____

9 A sledge is pulled across a frozen lake by a rope held by a child. In a simple model the sledge is a particle, the ice is smooth and the rope is light and inextensible. The model is used to predict the acceleration of the sledge.

- Explain why the acceleration predicted by the model is likely to be greater than the actual acceleration.
- Give one other limitation of modelling the sledge as a particle.
- Suggest one refinement to the model that would make the prediction more accurate.

(4 marks)

Answer _____

10

In this question $\mathbf{i}$ and $\mathbf{j}$ are unit vectors due east and due north, and position vectors are relative to a fixed point O .

At noon boat A is at O and boat B is at the point with position vector $(10\mathbf{i} + 2\mathbf{j})$ km. Boat A moves with constant velocity $(3\mathbf{i} + 4\mathbf{j})$ km h^{-1} and boat B moves with constant velocity $(-2\mathbf{i} + 5\mathbf{j})$ km h^{-1} .

- Find the distance between the boats at noon.
- Show that, t hours after noon, the position vector of B relative to A is $((10 - 5t)\mathbf{i} + (2 + t)\mathbf{j})$ km.
- Find the time at which B is due north of A , and the distance between the boats at that time.

(7 marks)

Answer

- 11** A drone flies in a straight line with constant velocity. At time $t = 0$ it is at the point with position vector $(-4\mathbf{i} + 6\mathbf{j})$ m relative to its controller at O . At $t = 5$ s it is at the point with position vector $(16\mathbf{i} - 9\mathbf{j})$ m.
- Find the velocity of the drone and its speed.
 - Show that the square of the distance of the drone from O at time t seconds is $25t^2 - 68t + 52$
 - By completing the square, find the shortest distance between the drone and O , and the time at which it happens.

(8 marks)

Answer _____

- 12** In this question $\mathbf{i}$ and $\mathbf{j}$ are unit vectors due east and due north.
- On a training run, Kwame runs 120 m on a bearing of 060° in 30 s, and then 80 m due south in 20 s.
- Find his displacement from his starting point as a vector in terms of $\mathbf{i}$ and $\mathbf{j}$, with numbers to 3 significant figures.
 - Find the distance and bearing of his finishing point from his starting point.
 - Find his average speed and the magnitude of his average velocity for the whole run.
 - Explain why these two answers are different.

(8 marks)

Answer _____

End of questions | Total 65 marks