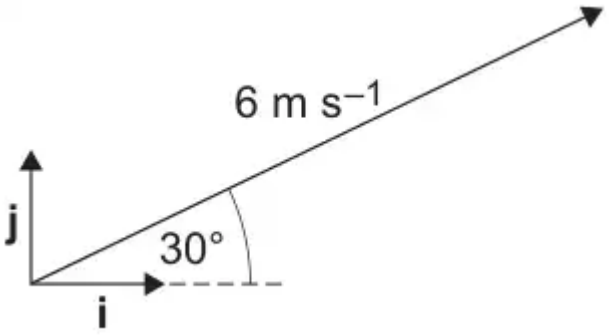
QQQ – Mechanics Year 1 – Chapter 8 – Introduction & Modelling (Version 2)

Total Marks: 22

(22 = Platinum, 20 = Gold, 18 = Silver, 15 = Bronze)

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1. A particle has a speed of 6 m s^{-1} in a direction relative to unit vectors **i** and **j** as shown in the diagram below.



The velocity of this particle can be expressed as a vector $\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$ m s^{-1}

Find the correct expression for v_2

Circle your answer. **[1 mark]**

- $v_2 = 6\cos 30^\circ$
- $v_2 = 6\sin 30^\circ$
- $v_2 = -6\sin 30^\circ$
- $v_2 = -6\cos 30^\circ$

(Total 1 marks)

2. A particle, P, is moving with constant velocity $8\mathbf{i} - 12\mathbf{j}$

A second particle, Q, is moving with constant velocity $a\mathbf{i} + 9\mathbf{j}$

Q travels in a direction which is parallel to the motion of P.

Find a.

Circle your answer. **[1 mark]**

- -6
- -5
- 5
- 6

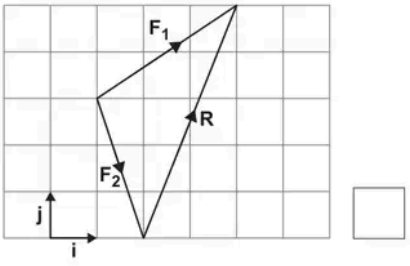
(Total 1 marks)

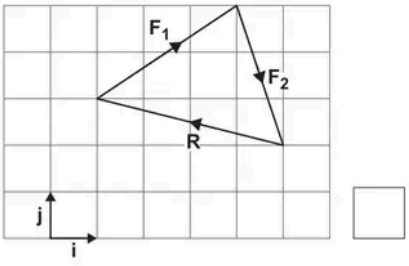
3. Two forces, $\mathbf{F}_1 = 3\mathbf{i} + 2\mathbf{j}$ newtons and $\mathbf{F}_2 = \mathbf{i} - 3\mathbf{j}$ newtons, are added together to find a resultant force, $\mathbf{R}$ newtons.

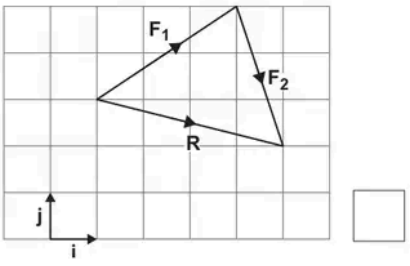
This vector addition can be represented using a diagram.

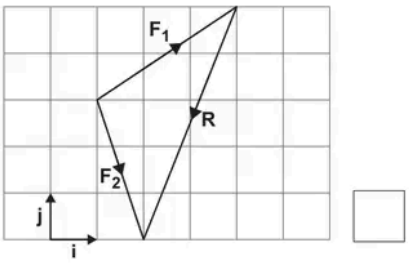
Identify the diagram below which correctly represents this vector addition.

Tick (✓) **one** box. **[1 mark]**









(Total 1 marks)

4. Two forces $\begin{bmatrix} 3 \\ -2 \end{bmatrix}$ N and $\begin{bmatrix} -7 \\ -5 \end{bmatrix}$ N act on a particle.

Find the resultant force.

Circle your answer. **[1 mark]**

- $\begin{bmatrix} -21 \\ 10 \end{bmatrix}$ N
- $\begin{bmatrix} -4 \\ -7 \end{bmatrix}$ N
- $\begin{bmatrix} 4 \\ 3 \end{bmatrix}$ N
- $\begin{bmatrix} 10 \\ 7 \end{bmatrix}$ N

(Total 1 marks)

5. Two forces $\mathbf{F}_1$ N and $\mathbf{F}_2$ N are given by $\mathbf{F}_1 = -6\mathbf{i} + 2\mathbf{j}$ and $\mathbf{F}_2 = -8\mathbf{i} + \mathbf{j}$.

Show that the magnitude of the resultant of these two forces is $\sqrt{205}$ N. **[2]**

(Total 2 marks)

6. In this question, the $\mathbf{i}$ direction is horizontal and the $\mathbf{j}$ direction is vertically upwards.

A particle of mass 3 kg is in equilibrium.

(a) Explain what is meant by a particle. **[1]**

The following forces are acting on the particle:

- the weight of the particle
- a horizontal force of $h\mathbf{i}$ N
- the force $\mathbf{F} = k\mathbf{i} + (k - 5)\mathbf{j}$ N.

(b) Calculate the value of h. **[3]**

(c) The force $\mathbf{F}$ is removed.

State the vector equation of motion of the particle. **[1]**

(Total 5 marks)

7. A particle P is moving with constant velocity $(-3\mathbf{i} + 2\mathbf{j})$ m s^{-1}. At time $t = 6$ s P is at the point with position vector $(-4\mathbf{i} - 7\mathbf{j})$ m. Find the distance of P from the origin at time $t = 2$ s.

(5)

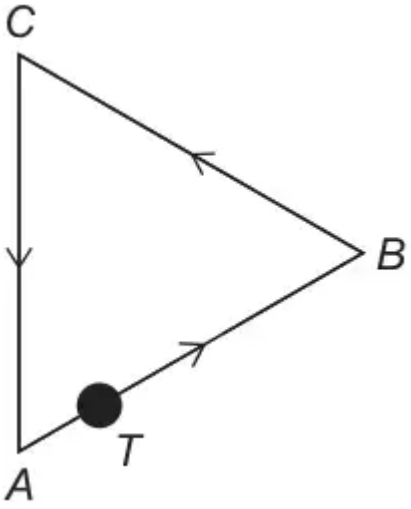
(Total 5 marks)

8. In this question $\mathbf{i}$ and $\mathbf{j}$ are perpendicular unit vectors representing due east and due north respectively.

A particle, T, is moving on a plane at a constant speed.

The path followed by T makes the exact shape of a triangle ABC.

T moves around ABC in an anticlockwise direction as shown in the diagram below.



On its journey from A to B the velocity vector of T is $\left(3\mathbf{i} + \sqrt{3}\mathbf{j}\right)$ m s^{-1}

(a) Find the speed of T as it moves from A to B **[1 mark]**

(b) On its journey from B to C the velocity vector of T is $\left(-3\mathbf{i} + \sqrt{3}\mathbf{j}\right)$ m s^{-1}

Show that the acute angle $ABC = 60°$ **[2 marks]**

(c) It is given that ABC is an equilateral triangle.

T returns to its initial position after 9 seconds.

Vertex B lies at position vector $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ metres with respect to a fixed origin O

Find the position vector of C **[3 marks]**

(Total 6 marks)