

1. Two forces  $\mathbf{P}$  and  $\mathbf{Q}$  act on a particle. The force  $\mathbf{P}$  has magnitude 7 N and acts due north. The resultant of  $\mathbf{P}$  and  $\mathbf{Q}$  is a force of magnitude 10 N acting in a direction with bearing  $120^\circ$ . Find

- (i) the magnitude of  $\mathbf{Q}$ ,
- (ii) the direction of  $\mathbf{Q}$ , giving your answer as a bearing.

(Total 9 marks)

2. A particle  $P$  of mass 0.4 kg moves under the action of a single constant force  $\mathbf{F}$  newtons. The acceleration of  $P$  is  $(6\mathbf{i} + 8\mathbf{j}) \text{ m s}^{-2}$ . Find

- (a) the angle between the acceleration and  $\mathbf{i}$ ,

(2)

- (b) the magnitude of  $\mathbf{F}$ .

(3)

At time  $t$  seconds the velocity of  $P$  is  $\mathbf{v} \text{ m s}^{-1}$ . Given that when  $t = 0$ ,  $\mathbf{v} = 9\mathbf{i} - 10\mathbf{j}$ ,

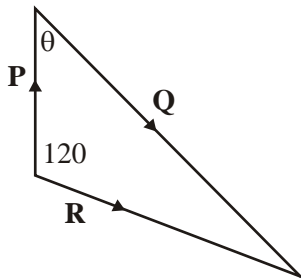
- (c) find the velocity of  $P$  when  $t = 5$ .

(3)

(Total 8 marks)

1.  $\mathbf{R} = 10\sqrt{3}/2 \mathbf{i} - 5\mathbf{j}$  M1 A1  
 Using  $\mathbf{P} = 7\mathbf{j}$  and  $\mathbf{Q} = \mathbf{R} - \mathbf{P}$  to obtain  $\mathbf{Q} = 5\sqrt{3}\mathbf{i} - 12\mathbf{j}$  M1 A1  
 Magnitude =  $\sqrt{[(5\sqrt{3})^2 + 12^2]} \approx \underline{14.8 \text{ N}}$  (AWRT) M1 A1  
 angle with  $\mathbf{i} = \arctan(12/5\sqrt{3}) \approx 64.2^\circ$  M1 A1  
 bearing  $\approx \underline{144^\circ}$  (AWRT) A1 9

Alternative method



- Vector triangle correct B1  
 $Q^2 = 10^2 + 7^2 + 2 \times 10 \times 7 \cos 60$  M1 A1  
 $Q \approx \underline{14.8 \text{ N}}$  (AWRT) A1  
 $\frac{14.8}{\sin 120} = \frac{10}{\sin \theta}$  M1 A1  
 $\Rightarrow \theta = 35.8, \Rightarrow \text{bearing } 144$  (AWRT) M1 A1, A1

[9]

2. (a)  $\tan \theta = \frac{8}{6}$  M1  
 $\theta \approx 53^\circ$  A1 2
- (b)  $\mathbf{F} = 0.4(6\mathbf{i} + 8\mathbf{j}) (= 2.4\mathbf{i} + 3.2\mathbf{j})$  M1  
 $|\mathbf{F}| = \sqrt{(2.4^2 + 3.2^2)} = 4$  M1A1 3  
*The method marks can be gained in either order.*
- (c)  $\mathbf{v} = 9\mathbf{i} - 10\mathbf{j} + 5(6\mathbf{i} + 8\mathbf{j})$  M1A1  
 $= 39\mathbf{i} + 30\mathbf{j} \text{ (m s}^{-1}\text{)}$  A1 3

[8]

1. This question proved to be the most demanding on the paper. The majority attempted it by trying to draw a vector triangle, but the triangles drawn were often unclear and rarely correct (with quite a few right-angled triangles drawn or assumed). Others attempted to use coordinates, though often made mistakes in using the implied equation  $\mathbf{P} + \mathbf{Q} = \mathbf{R}$  (instead simply adding the two given vectors, i.e. assuming  $\mathbf{P} + \mathbf{R} = \mathbf{Q}$ ). The presentation of work here was also very poor, with calculations or numbers often splayed all over the page with no clear justification for what was being attempted. Fully correct solutions were seen, but only occasionally!
2. This question was done well by the vast majority of candidates. Most used trigonometry appropriately in part (a) to find the required angle. In the second part some used  $\mathbf{F} = m\mathbf{a}$  correctly but failed to find the magnitude, whereas others found the magnitude of the given acceleration vector (sometimes labelling it as the force) but did not go on to multiply by the mass. Many used the relevant vector constant acceleration formula to achieve a correct velocity in the final part, although occasionally candidates multiplied the velocity rather than the acceleration by 5, or they tried to convert it all into scalars.