

## Section 1: Motion in two dimensions

### Exercise level 2

1. Particle P is moving in the  $x$ - $y$  plane with the origin at O. The position vector of P with respect to O is  $\mathbf{r} = 2t^3\mathbf{i} + 3t^2\mathbf{j}$ . Find the velocity vector and the acceleration vector for P and hence the magnitudes of the velocity and acceleration when  $t = 3$ .
2. A force  $\mathbf{F} = 4t\mathbf{i} + 6\mathbf{j}$  acts on a particle of mass 2 kg. Given that the particle has an initial velocity of  $5\mathbf{j}$  at the origin find the velocity and displacement when  $t = 3$ .
3. At time  $t$  the position vector of particle P of mass 4 kg is  $\mathbf{r} = 6t\mathbf{i} - 4t^2\mathbf{j}$ . Force  $\mathbf{F}$  acts on P. Find the magnitude of  $\mathbf{F}$ .
4. The position vector of a radio controlled car is  $\mathbf{r} = (2t - 1)\mathbf{i} - t^2\mathbf{j}$ 
  - (i) Find the velocity at time  $t$ .
  - (ii) Find the initial direction of motion.
  - (iii) Show that the acceleration is constant.
  - (iv) Explain why the car can never move in a direction at right angles to the original direction.
  - (v) Find a Cartesian equation for the path of the car.
5. Two forces  $\mathbf{F} = 12\mathbf{i} - 2\mathbf{j}$  and  $\mathbf{T} = 10\mathbf{i} + 12\mathbf{j}$  act on an object of mass 20 kg.
  - (i) Find the resultant force on the object.
  - (ii) Find the acceleration of the object.
  - (iii) Given that the object is initially at rest at a point with position vector  $3\mathbf{j}$  find its position vector after  $t$  seconds.
6. The position vector of a particle P is  $\mathbf{r} = (t^2 - 4t)\mathbf{i} + (t^3 + ft^2)\mathbf{j}$  for  $t > 0$ , where  $f$  is a constant. Given that the particle comes to instantaneous rest, find the value of  $f$ .
7.  $\mathbf{v} = t^2\mathbf{i} + 3t\mathbf{j}$  and when  $t = 0$ ,  $\mathbf{s} = 18\mathbf{i} - 24\mathbf{j}$ .  
Find the acceleration and displacement when  $t = 3$ .