## Section 1: Motion in two dimensions

## Exercise level 1

1. The position vector of a particle at time $t$ is given by $\binom{x}{y}=\binom{3 t+1}{2-t}$.
(i) Find the velocity of the particle.
(ii) Find the acceleration of the particle.
2. A particle is initially at rest at the origin. It experiences a variable acceleration given by $\mathbf{a}=(3 t+2) \mathbf{i}+\left(2 t^{2}-5\right) \mathbf{j}$.
(i) Find an expression for the velocity of the particle at time $t$.
(ii) Find an expression for the position of the particle at time $t$.
3. A particle moves with a velocity given by $\mathbf{v}=2 t \mathbf{i}+\left(3 t^{2}-4 t\right) \mathbf{j} \mathrm{ms}^{-1}$.
(i) Given that at time $t=2 \mathrm{~s}$, the particle is at position $7 \mathbf{i}+4 \mathbf{j}$, find an expression for the position of the particle at time $t$.
(ii) Find the position of the particle after 5 s .
4. In this question take $\boldsymbol{g}$ to be $\mathbf{1 0} \mathrm{ms}^{-2}$.

A ball is fired from a point on level ground with velocity $\mathbf{u}=15 \mathbf{i}+20 \mathbf{j}$.
(i) Write in terms of $\mathbf{i}$ and $\mathbf{j}$ the velocity vector and the position vector of the ball after $t$ seconds.
(ii) Find the time at which the ball will be moving in a direction of $45^{\circ}$ to the horizontal.
(iii) Find the time at which the ball returns to the ground.
5. In this question take $\boldsymbol{g}$ to be $10 \mathrm{~ms}^{-2}$.

A boy fires a stone from the top of a tower 10 m high using a catapult. The initial velocity of the ball is $12 \mathbf{i}$.
(i) Write in terms of $\mathbf{i}$ and $\mathbf{j}$ expressions for the velocity and displacement of the stone at time $t$ seconds after projection.
(ii) How far horizontally from the base of the tower does the stone land?
6. At time $t$ the position vector of particle P is given by $\mathbf{r}=8 t^{3} \mathbf{i}+t^{4} \mathbf{j}$.

Find its velocity and acceleration after 2 seconds.
7. Particle P has velocity vector $\mathbf{v}$, where $\mathbf{v}=2 t \mathbf{i}+3 t^{2} \mathbf{j}$, at time $t$ seconds.

Initially the position vector of $P$ is given by $\mathbf{r}=\mathbf{i}+4 \mathbf{j}$.
Find the position vector of P at time $t$.

