Mixed practice 20

1. A particle is moving with a speed of $12\ \text{m s}^{-1}$ when it starts to accelerate uniformly at $1.6\ \text{m s}^{-2}$.
   - **a** Find how long it takes for the particle's speed to increase to $26\ \text{m s}^{-1}$.
   - **b** How far does the particle travel in that time?
2. A stone is projected vertically upwards from the ground with a speed of $11\ \text{m s}^{-1}$.
   - **a** Find the speed and the direction of motion of the stone after 2 seconds.
   - **b** Find the height of the stone above ground at this time.
3. A cyclist passes point P with a speed of $6.2\ \text{m s}^{-1}$ and starts to decelerate uniformly at $2.1\ \text{m s}^{-2}$. How fast is she moving after she has travelled 8 m?
4. An object is projected vertically upwards with speed $7\ \text{m s}^{-1}$. Calculate
   - **i** the speed of the object when it is 2.1 m above the point of projection,
   - **ii** the greatest height above the point of projection reached by the object,
   - **iii** the time after projection when the object is travelling downwards with speed $5.7\ \text{m s}^{-1}$.

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5. A car travels on a straight horizontal road. It passes point A with a speed of $32\ \text{km h}^{-1}$ and starts to decelerate uniformly until it reaches speed v km/h. It then accelerates uniformly. When it reaches point B its speed is $32\ \text{km h}^{-1}$ again.
   - **a** Draw the velocity–time graph representing the car's journey.
   - **b** Given that the distance AB is 550 m and the journey takes 1.2 minutes, find the value of v.
   - **c** Find the average speed of the car during its journey from A to B.
6. **a** Use the formulae $v = u + at$ and $s = ut + \frac{1}{2}at^2$ to derive the formula $v^2 = u^2 + 2as$.
   - **b** A ball is projected vertically downwards from the top of the building, with a speed of $8.5\ \text{m s}^{-1}$. It reaches the ground with a speed of $110\ \text{m s}^{-1}$. Find the height of the building.

7 Two particles are projected simultaneously with a speed of 15.4 m s^{-1}. The first particle is projected vertically upwards from ground level. The second particle is projected vertically downwards from a height of 20 m. The two particles move on the same straight line. Find:

a the height above ground where the particles collide

b the speed of each particle at the moment they collide.

8 A particle moves with constant acceleration a. When $t = 0$ it passes point O with velocity u. Let s be the displacement from O at time t.

Use integration to show that $s = ut + \frac{1}{2}at^2$.

9 A particle P is projected vertically upwards, from horizontal ground, with speed 8.4 m s^{-1}.

i Show that the greatest height above the ground reached by P is 3.6 m.

A particle Q is projected vertically upwards, from a point 2 m above the ground, with speed u m s^{-1}. The greatest height **above the ground** reached by Q is also 3.6 m.

ii Find the value of u.

It is given that P and Q are projected simultaneously.

iii Show that, at the instant when P and Q are at the same height, the particles have the same speed and are moving in opposite directions.

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10 Two cars start from rest, from the same start line, and accelerate uniformly along a racetrack running perpendicular to the start line. After 5 seconds the first car is 30 m in front of the second car. How far in front is it after another 5 seconds?

11 A ball is projected vertically upwards from ground level with speed u_1. At the moment when this first ball is at its maximum height, a second ball is projected vertically upwards from ground level with speed u_2. The two balls fall back on the ground at the same time without colliding in the air. Find the ratio $u_1 : u_2$.

12 A particle travels in a straight line and decelerates uniformly at 2 m s^{-2}. When $t = 0$ its velocity is u m s^{-1} and when $t = 100$ its velocity is $-v$ m s^{-1} (where $u > v > 0$). The average speed of the particle over the 100 seconds is 62.5 m s^{-1}. Find the values of u and v.

Mixed practice 20

1 **a** 8.75 s **b** 166.25 m

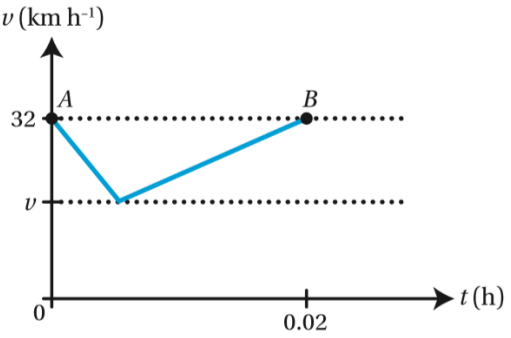
2 **a** 8.6 m s^{-1}, downwards

b 2.4 m

3 2.2 m s^{-1}

4 **a** 2.8 m s^{-1} **b** 2.5 m **c** 1.30 s

5 **a**



b 23 km h^{-1} **c** 27.5 km h^{-1}

6 **a** Proof **b** 614 m

7 **a** 7.93 m

b 9.04 m s^{-1}, 21.8 m s^{-1}

8 Proof

9 **a** Proof **b** 5.6 **c** Proof

10 120 m

11 2 : 1

12 $u = 150$, $v = 50$