1 Fig. 4 illustrates a straight horizontal road. A and B are points on the road which are 215 metres apart and M is the mid-point of AB.

When a car passes A its speed is $12\,\text{m}\,\text{s}^{-1}$ in the direction AB. It then accelerates uniformly and when it reaches B its speed is $31\,\text{m}\,\text{s}^{-1}$.

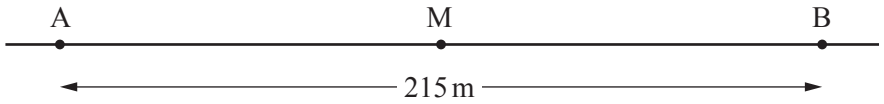

Fig. 4

(i) Find the car's acceleration. **[2]**

(ii) Find how long it takes the car to travel from A to B. **[2]**

(iii) Find how long it takes the car to travel from A to M. **[3]**

(iv) Explain briefly, in terms of the speed of the car, why the time taken to travel from A to M is more than half the time taken to travel from A to B. **[1]**

2 In this question, air resistance should be neglected.

Fig. 2 illustrates the flight of a golf ball. The golf ball is initially on the ground, which is horizontal.

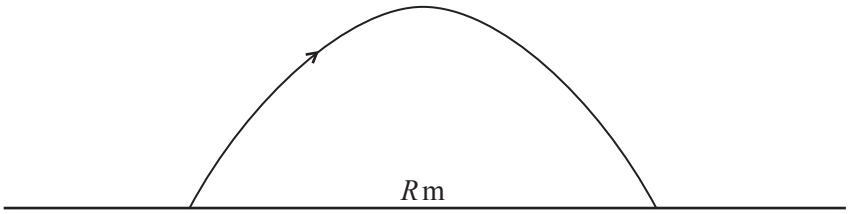

Fig. 2

It is hit and given an initial velocity with components of $15\,\text{m}\,\text{s}^{-1}$ in the horizontal direction and $20\,\text{m}\,\text{s}^{-1}$ in the vertical direction.

(i) Find its initial speed. **[1]**

(ii) Find the ball's flight time and range, R m. **[4]**

(iii) (A) Show that the range is the same if the components of the initial velocity of the ball are $20\,\text{m}\,\text{s}^{-1}$ in the horizontal direction and $15\,\text{m}\,\text{s}^{-1}$ in the vertical direction. **[1]**

(B) State, justifying your answer, whether the range is the same whenever the ball is hit with the same initial speed. **[2]**

3 A particle is moving along a straight line and its position is relative to an origin on the line. At time t s, the particle's acceleration, a m s^{-2}, is given by

$$a = 6t - 12 .$$

At $t = 0$ the velocity of the particle is $+9$ m s^{-1} and its position is -2 m.

(i) Find an expression for the velocity of the particle at time t s and verify that it is stationary when $t = 3$. **[4]**

(ii) Find the position of the particle when $t = 2$. **[3]**

4 Fig. 4 illustrates points A, B and C on a straight race track. The distance AB is 300 m and AC is 500 m.

A car is travelling along the track with uniform acceleration.

Fig. 4

Initially the car is at A and travelling in the direction AB with speed 5 m s^{-1}. After 20 s it is at C.

(i) Find the acceleration of the car. **[2]**

(ii) Find the speed of the car at B and how long it takes to travel from A to B. **[3]**

5 A particle is moving along a straight line and its position is relative to an origin on the line. At time t s, the particle's acceleration, a m s^{-2}, is given by

$$a = 6t - 12 .$$

At $t = 0$ the velocity of the particle is $+9$ m s^{-1} and its position is -2 m.

(i) Find an expression for the velocity of the particle at time t s and verify that it is stationary when $t = 3$. **[4]**

(ii) Find the position of the particle when $t = 2$. **[3]**

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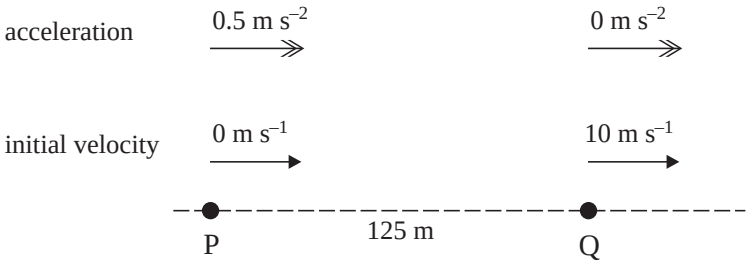

Fig. 4

Particles P and Q move in the same straight line. Particle P starts from rest and has a constant acceleration towards Q of $0.5\,\text{m}\,\text{s}^{-2}$. Particle Q starts 125 m from P at the same time and has a constant speed of $10\,\text{m}\,\text{s}^{-1}$ away from P. The initial values are shown in Fig. 4.

(i) Write down expressions for the distances travelled by P and by Q at time *t* seconds after the start of the motion. [2]

(ii) How much time does it take for P to catch up with Q and how far does P travel in this time? [5]