Quadratics in t, Turning Round, Two Particles

Specification: AQA 7357: Q1, Q3, B3 · Edexcel 9MA0: 7.1, 7.3, 2.3

INDEPENDENT

You do

A · Quadratics in t

Substitute, collect on one side, solve: keep both positive roots.

1 A particle passes O with velocity 18 m s^{-1} and constant acceleration -4 m s^{-2}. Find the times when it is 36 m from O, on the positive side.

2 A particle passes O with velocity 7 m s^{-1} and constant acceleration -2 m s^{-2}. When does it return to O?

3 A particle passes O with velocity 20 m s^{-1} and constant acceleration -4 m s^{-2}. The point A is 42 m from O in its direction of motion.
(a) Find the times when it is at A.
(b) For how long is it beyond A?

4 A particle passes O with velocity 5 m s^{-1} and constant acceleration 2 m s^{-2}. Find the time it takes to travel 24 m.

5 A particle passes O with velocity 12 m s^{-1} and constant acceleration -3 m s^{-2}. Find, to 3 s.f., the times when it is 15 m from O, on the positive side.

B · Turning round and distance

Find where v = 0; distance = out + back.

6 A particle passes O with velocity 14 m s^{-1} and constant acceleration -3.5 m s^{-2}.
(a) Find the time when it returns to O.
(b) Find the total distance it travels in this time.

7 A particle passes O moving in the positive direction with speed 6 m s^{-1}. Its acceleration is a constant 1.5 m s^{-2} in the negative direction.
(a) Find, to 3 s.f., the time when it is 9 m from O on the negative side.
(b) Find the total distance it has travelled by then.

8 A particle passes O with velocity 11 m s^{-1} and constant acceleration -2 m s^{-2}. The point A is 24 m from O in its direction of motion.
(a) Find the times when it is at A.
(b) Find its velocity at each of these times.
(c) Find its greatest distance from O on the positive side.

9 A particle passes O with velocity 15 m s^{-1} and constant acceleration -2.5 m s^{-2}. For how long is it more than 30 m from O on the positive side? Give your answer to 3 s.f.

C · Reasoning

No calculator.

10 A particle passes O with velocity 8 m s^{-1} and constant acceleration -2 m s^{-2}. Use $b^2 - 4ac$ to decide how many times it is at the point on the positive side
(a) 15 m from O
(b) 16 m from O
(c) 20 m from O.

11 True or false? Explain each answer.
(a) If $s = ut + \frac{1}{2}at^2$ gives two positive values of t, one of them must be wrong.
(b) A particle with constant acceleration that passes a point twice turns round exactly halfway between the two times.
(c) A particle with constant acceleration, $u > 0$ and $a < 0$, returns to its start after twice the time it takes to stop.

12 A particle Q passes a point A three seconds after a particle P does, moving in the same direction with speed 5 m s^{-1} and acceleration 2 m s^{-2}. Time t is measured from when P passes A.

(a) Write down the displacement of Q from A at time t.

(b) For which values of t is your expression valid?

(c) Find the displacement of Q from A when $t = 5$.

D · Two particles and "show that"

Same point, same direction, same clock.

13 Two particles P and Q move along the same straight line. At $t = 0$, P passes a point A with speed 2 m s^{-1} and acceleration 1 m s^{-2}. Three seconds later Q passes A in the same direction with speed 4 m s^{-1} and acceleration 4 m s^{-2}.

(a) Show that Q catches P when $3t^2 - 20t + 12 = 0$.

(b) Find the time when Q catches P. Explain why you reject one root.

(c) Find how far from A they are.

14 The points A and B are 30 m apart. At $t = 0$ a particle P passes A moving towards B with speed 6 m s^{-1} and acceleration 3 m s^{-2} towards B. At the same instant a particle Q passes B moving towards A with speed 5 m s^{-1} and acceleration 1 m s^{-2} towards A. Find when and where they meet.

15 A particle passes O with velocity u m s^{-1}, where $u > 0$. Its acceleration is a constant $-k$ m s^{-2}, where $k > 0$.

(a) Show that it returns to O after $\dfrac{2u}{k}$ seconds.

(b) Show that by then it has travelled $\dfrac{u^2}{k}$ metres.

E · Exam-style question

Show your method: marks are for working.

16 A particle P moves along a straight line with constant deceleration 2 m s^{-2}. At time $t = 0$ it passes a point O with speed 16 m s^{-1}, moving towards a point A, where OA = 55 m.

(a) Find the times when P is at A. [3 marks]

(b) Find the total distance P travels between these times. [3 marks]

(c) Find the speed of P when it returns to O. [2 marks]