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QUESTION WORKBOOK

# Motion graphs and the SUVAT equations

Mechanics · Year 12

AQA 3.4.1.3 · CIE 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.1.6, 2.1.7
OCR A 3.1.1(a), 3.1.1(b), 3.1.1(c), 3.1.1(d), 3.1.2(a)(i), 3.1.2(b)(i), 3.1.2(c)

19 questions · 62 marks

PRINT EDITION


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## SECTION A · Warm-up

**A1** Distinguish between the average velocity and the instantaneous velocity of a moving object. [2]

**A2** A car starts from rest and accelerates uniformly at 2.0 m $s^{-2}$ for 6.0 s. Calculate its final velocity. [2]

**A3** State what the gradient and the area under a velocity–time graph each represent. [2]

## SECTION B · Standard

**B1** A car travelling at 8.0 m $s^{-1}$ accelerates uniformly at 1.5 m $s^{-2}$ for 4.0 s. Calculate (a) its final velocity and (b) the distance travelled in this time. [4]

**B2** A car travelling at 20 m $s^{-1}$ brakes uniformly and stops in a distance of 40 m. Calculate (a) its deceleration and (b) the time taken to stop. [4]

**B3** An object accelerates uniformly from rest to 15 m $s^{-1}$ in 5.0 s, then travels at a constant 15 m $s^{-1}$ for a further 10 s. Using the area under the velocity–time graph, calculate the total distance travelled. [3]

**B4** A stone is dropped from rest and falls freely. Taking g = 9.81 m $s^{-2}$, calculate its velocity and the distance fallen after 2.0 s. [3]

## SECTION C · Stretch

**C1** A train starts from rest and accelerates uniformly at 0.50 m $s^{-2}$ for 20 s. The driver then brakes and the train decelerates uniformly to rest in a further 100 m. Calculate (a) the maximum velocity of the train, (b) the deceleration while braking, and (c) the total distance travelled. [5]

**C2** A ball is thrown vertically upwards at 15 m $s^{-1}$. Taking g = 9.81 m $s^{-2}$ and ignoring air resistance, calculate (a) the maximum height reached and (b) the time taken to reach it. [4]

**C3** The velocity–time graph of a journey is a straight line sloping upwards from a non-zero starting velocity. Explain how you would find the acceleration and the displacement from this graph. [3]

## SECTION A · Warm-up

 

**A4** A tram slows uniformly from 12.0 m $s^{-1}$ to 3.0 m $s^{-1}$ in 6.0 s. Calculate its acceleration. [2]

**A5** On a displacement–time graph, state what is represented by (a) the gradient at a point, and (b) a horizontal section of the line. [2]

**A6** State the condition that must be satisfied for the SUVAT equations to be valid. [1]

## SECTION B · Standard

**B5** A student measures a friend's reaction time by dropping a ruler between the friend's open fingers. The friend catches the ruler after it has fallen 28 cm from rest. Taking g = 9.81 m $s^{-2}$, show that the reaction time is about 0.24 s. [3]

**B6** A skateboarder is moving at 1.2 m $s^{-1}$ at the top of a ramp. She accelerates uniformly down the ramp at 2.5 m $s^{-2}$ over a distance of 4.2 m. Calculate her speed at the bottom of the ramp. [3]

**B7** A goods train travels at 90 km $h^{-1}$. The driver applies the brakes and the train decelerates uniformly at 0.75 m $s^{-2}$. Calculate the minimum distance the train travels before stopping. [4]

## SECTION C · Stretch

**C4** A delivery van passes a stationary motorcycle courier, travelling at a constant 16 m $s^{-1}$ along a straight road. At the instant it passes, the courier sets off after it with a uniform acceleration of 2.0 m $s^{-2}$. (a) Show that the courier draws level with the van 16 s after setting off. (b) Go on to calculate the distance travelled and the courier's speed at that moment. [5]

**C5** A car travels at 20 m $s^{-1}$ towards a pelican crossing. When the car is 42 m from the stop line, the lights change and the driver decides to stop. The driver's reaction time is 0.60 s and the car's maximum deceleration is 5.0 m $s^{-2}$. Deduce whether the car can stop before the stop line. [4]

**C6** A ball is released from rest, falls to a hard floor and bounces repeatedly, each bounce reaching a smaller height than the last, until it comes to rest. Air resistance is negligible while the ball is in flight. Taking downward velocity as positive, describe fully the velocity–time graph of the motion from release until the ball stops bouncing. [6]