

Name _____

Date _____

Score: ____ / 41

70 minutes · 41 marks · calculator and data booklet allowed

- Answer all the questions in the spaces provided.
- Show all your working. Marks are given for correct method.
- The marks for each part are shown in brackets [].
- Take $g = 9.8 \text{ m s}^{-2}$.

1. A car on a test track [9 marks]

A car is tested on a straight track. The graph shows how its velocity v varies with time t .



(a) Calculate the acceleration of the car during the first 8.0 s. [1]

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(b) Determine the total distance travelled by the car. [2]

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(c) Calculate the average speed of the car for the whole test. [1]

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(d) **Outline** why the equations of motion cannot be applied to the whole 26 s in one step. [1]

(e) **Sketch**, on a set of axes, the variation of the distance travelled with time for the whole test. [2]

(f) The car brakes with the same deceleration as in the test. **Show that** its braking distance from 30 m s^{-1} is about 110 m. [2]

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2. A ball thrown from a roof [12 marks]

A small ball is thrown vertically upwards at 18 m s^{-1} from the edge of a flat roof. The roof is 20 m above the ground. The ball misses the roof on the way down and lands on the ground. Air resistance is negligible in (a), (b) and (c).

- (a) Calculate** the maximum height of the ball above the ground. [2]

- (b) Show that** the ball reaches the ground about 4.6 s after it is thrown. **[2]**

- (c) Calculate** the speed of the ball just before it hits the ground. [1]

- (d) The experiment is repeated with a lighter ball of the same size. Air resistance is now **not** negligible. [4]

(i) **State and explain** how the maximum height changes.

(ii) **Explain** why the magnitude of the acceleration of the ball on the way up is greater than g .

[illegible]

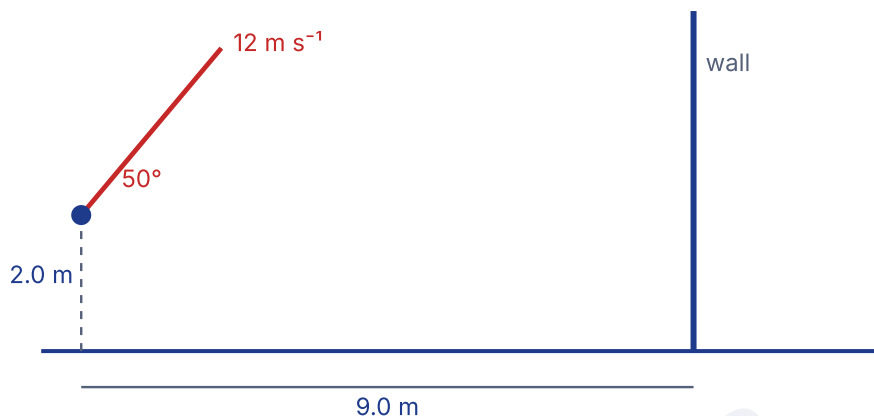
- (e) The lighter ball is now dropped from a tall building. **Explain**, with reference to the forces on the ball, why it reaches a terminal speed.

[3]

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3. A ball thrown at a wall [12 marks]

A ball is thrown from a point 2.0 m above level ground at 12 m s^{-1} , at 50° above the horizontal, towards a vertical wall 9.0 m away. Air resistance is negligible.



- (a) **Calculate** the horizontal and vertical components of the initial velocity. [2]

- (b) **Calculate** the time taken for the ball to reach the wall. [1]

- (c) **Determine** the height above the ground at which the ball hits the wall. [2]

- (d) **Determine** whether the ball is rising or falling when it hits the wall. [2]

(e) **Calculate** the speed of the ball when it hits the wall.

[2]

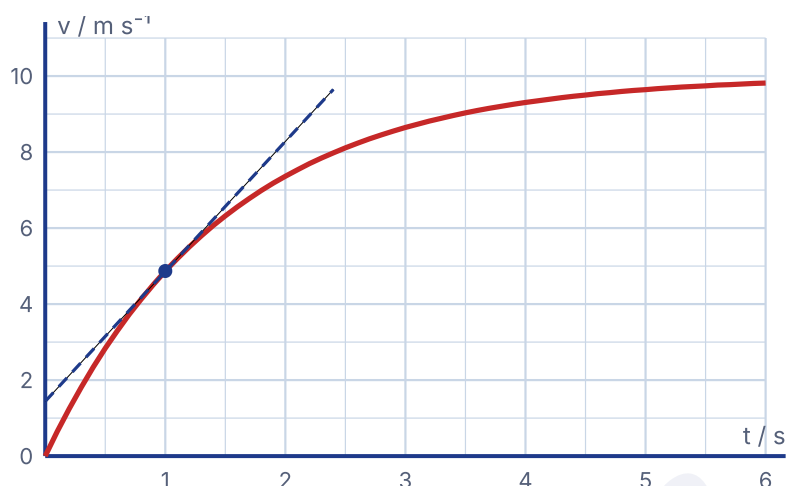
(f) The thrower wants the ball to hit the wall at the highest point of its path. The angle stays at 50° . **Determine** the launch speed needed.

[3]

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4. A sprinter's start [8 marks]

The graph shows how the velocity v of a sprinter varies with time t during the first 6.0 s of a race. The dashed line is the tangent to the curve at $t = 1.0$ s.



- (a) **State** how the graph shows that the acceleration of the sprinter is not constant. [1]

- (b) **Determine** the acceleration of the sprinter at $t = 1.0$ s. [2]

- (c) **Estimate** the distance run in the first 4.0 s. [2]

- (d) A student calculates the distance in the first 4.0 s using $s = \frac{1}{2}(u + v)t$, with $v = 9.3 \text{ m s}^{-1}$ at $t = 4.0$ s. **Explain** why the student's answer is smaller than your answer to (c). [2]

(e) Calculate the average acceleration of the sprinter over the first 4.0 s.

[1]

End of paper

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