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MEGA LECTURE

AQA, Edexcel, OCR

A Level

A Level Physics

MECHANICS: Kinematics

(Answers)

Name:

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MME

Mathsmadeeasy.co.uk

Total Marks: /30

M

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1. Figure 1 shows a segment of Joe's walk. The slope of the line B-C is half that of A-B; C-D has constant curvature and its initial slope is that of B-C.

Total for Question 1: 15

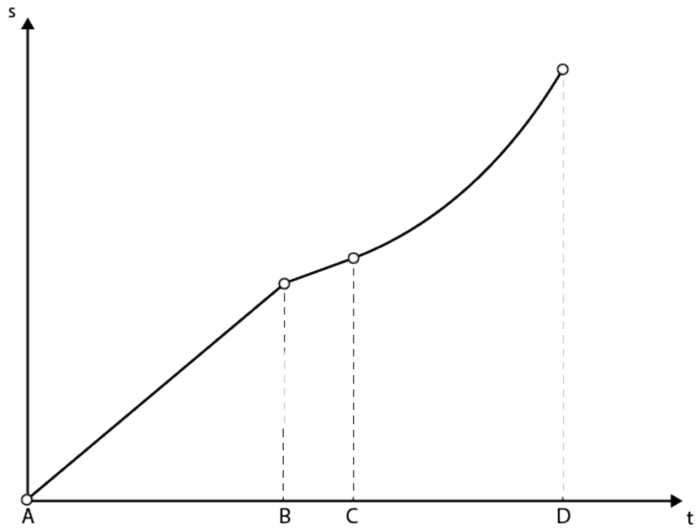

Figure 1: Joe's journey to school represented on a graph of displacement (s) against time (t).

(a) Using the information above, sketch the form of Joe's journey on a velocity-time graph. [3]

Solution: A-B: horizontal
B-C: horizontal, at half the speed of A-B
C-D: constant positive gradient, beginning at velocity of B-C and ending higher than A-B

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Using the section of your v-t graph between C and D, you will now derive some equations for linear motion with constant acceleration. Assume v=final velocity, u=initial velocity, s=displacement, a=acceleration and t=time. For all parts, show your workings.

(b) Acceleration is defined as the rate of change of velocity. By considering the change in Joe's velocity, derive an expression for v in terms of u, a and t only. [2]

Solution: $v = u + at$

(c) Consider the area underneath the line. Show that $s = ut + \frac{1}{2}at^2$. [3]

Solution: N/A

(d) Starting with your answer to Part b, derive an expression for v^2 in terms of u, a and s. [3]

Solution: $v^2 = u^2 + 2as$

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(e) Using your knowledge of the equations of constant acceleration, outline a simple experiment to determine the acceleration due to gravity. Assume that air resistance is negligible. [3]

Solution: Drop an object over a known distance and time its flight. Then use:
$s = ut + \frac{1}{2}at^2 \rightarrow s = \frac{1}{2}gt^2 \rightarrow g = \frac{2s}{t^2}$

(f) To which measurement is the estimate of g most sensitive, and why? [1]

Solution: g is most sensitive to time, since any small errors are magnified when we square t for use in the SUVAT equation.

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2. Karen, who is 1.5 m tall, is throwing a ball and trying to hit a target on a vertical wall in her parents' garden. However, without bouncing, the ball must then be caught exactly where it was thrown. The target is at a height of 11.5m and she is 15 m away from the wall.

You may make the following assumptions: air resistance is negligible; all collisions are elastic; the ball is thrown from a height of 1.5 m.

Total for Question 2: 15

(a) What differentiates scalar and vector quantities? Give an example of each. [2]

Solution: Scalar quantities define only magnitude; vectors define both magnitude and direction. Examples: speed and velocity, respectively.

(b) Which of the following statements is true? [1]

1. The angle at which the ball hits the wall does not affect whether or not it will return to Karen.
2. For the ball to return to Karen's hands, the vertical component of the ball's velocity must be zero when it hits the wall.
3. The ball will return to Karen if it makes an angle $< 60°$ with the wall.

Solution: 2 is true; 1 and 3 are both wrong.

Karen is easily bored and will walk away unless the ball returns to her again within 3 seconds.

(c) Calculate the horizontal component of the velocity. Assume that the flight takes exactly 3 s. [1]

Solution: 10 ms^{-1}

(d) Calculate what the vertical component of the velocity must be when the ball leaves Karen's hands. [2]

Solution: 14 ms^{-1}

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(e) At what speed and at what angle (from the horizontal) should the ball be thrown? [2]

Solution: $54.5°$
$17.2\ \text{ms}^{-1}$

Karen's mother hangs a bed-sheet on the washing line between Karen and the wall. There is a hole in the sheet at a height of 10 m. Karen ignores the sheet and throws the ball at the angle and speed calculated above. To her surprise it passes through the hole, bounces off the wall and returns to her hands having passed through the hole again.

(f) Calculate the time taken for the ball to reach the hole. [2]

Solution: 0.87 s

(g) How far from the wall is the washing line? [2]

Solution: 6.27 m

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(h) How fast is the ball travelling when it passes through the hole? [2]

Solution: 11.4 ms^{-1}

(i) Karen soon gets bored and decides to see how high her father can throw the ball. He throws the ball vertically upwards at 16 ms^{-1}. How high does it go? Assume that this time the ball is thrown from a height of 2 m. [1]

Solution: 16.0 m

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