Key Area 1: Motion – Equations and Graphs

Multiple Choice Questions 1 → 10

1. A train decelerates uniformly from 12·0 ms^{-1} to 5·0 ms^{-1} while travelling a distance of 119·0 m along a straight track. Calculate the deceleration of the train.

   A 0·5 ms^{-2}
   B 0·7 ms^{-2}
   C 1·2 ms^{-2}
   D 7·0 ms^{-2}
   E 14·0 ms^{-2}

2. A ball is projected vertically upwards with an initial speed of 39·2 ms^{-1}. Calculate the total time taken for the ball to rise to its highest point and then return to its starting position.

   A 2·0 s
   B 4·0 s
   C 6·0 s
   D 8·0 s
   E 16·0 s

3. A cyclist is travelling along a straight, level road at 10·0 ms^{-1}. She applies her brakes and comes to rest after travelling a further 20·0 m.
   The braking force applied is constant. Calculate the deceleration.

   A 0·25 ms^{-2}
   B 0·50 ms^{-2}
   C 2·00 ms^{-2}
   D 2·50 ms^{-2}
   E 5·00 ms^{-2}

4. The equation $s = ut + \frac{1}{2}at^2$ represents the displacement of an accelerating object in a straight line with uniform acceleration "a". State the meaning of the term "ut".

   A the initial velocity of the object
   B the initial acceleration of the object
   C the velocity of the object after "t" seconds
   D the acceleration of the object after "t" seconds
   E the displacement of the object after "t" seconds if the acceleration is zero.

5. A helicopter is descending vertically at a constant speed of 3·0 ms^{-1}. A sandbag is released from the helicopter. The sandbag hits the ground 5·0 s later.
   Calculate the height of the helicopter above the ground at the time the sandbag was released.

   A 15·0 m

   B 49·0 m

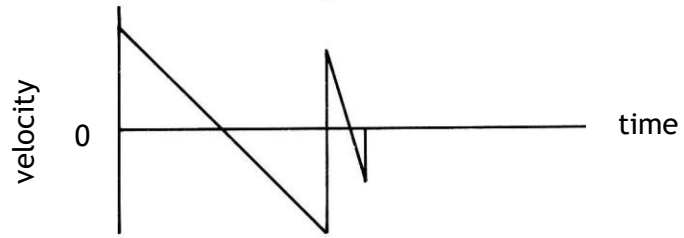
   C 107·5 m

   D 122·5 m

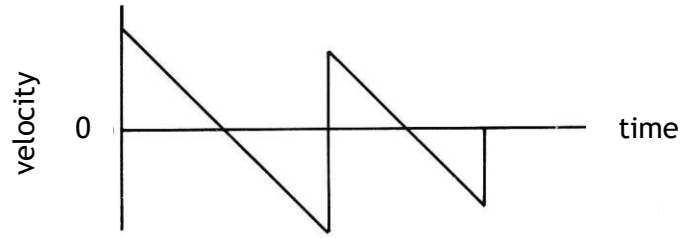
   E 137·5 m

6. A ball is thrown vertically upwards from the ground level. When it falls to the ground, it bounces several times before coming to rest.
   Identify which one of the following velocity-time graphs represents the motion of the ball from the instant it leaves the thrower's hand until it hits the ground for a second time.

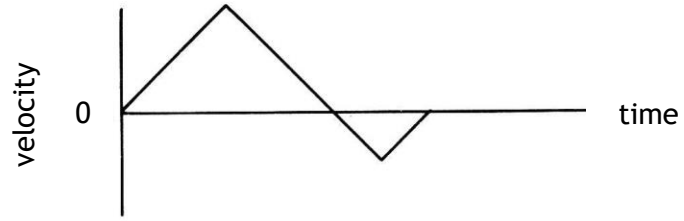
A



B



C



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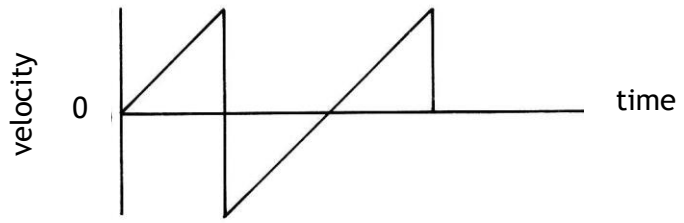
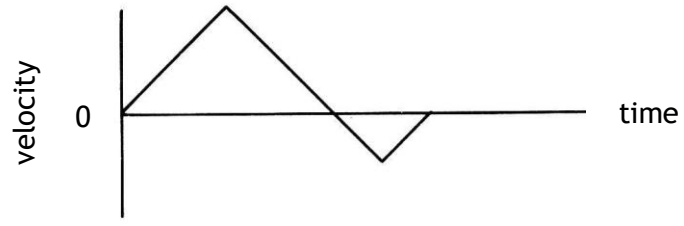
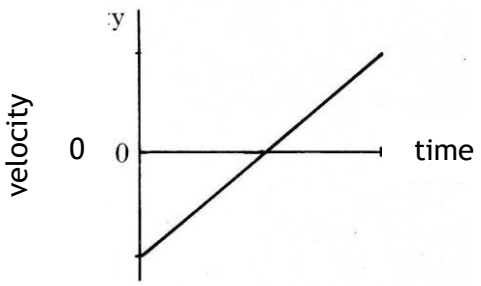


E

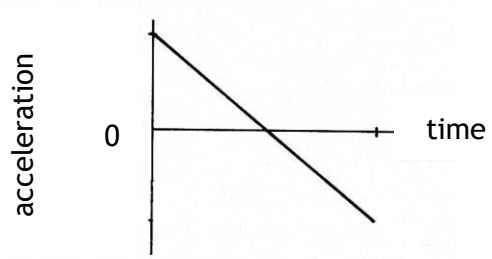


7. The following velocity-time graph represents the motion of a trolley.



Identify which of the following acceleration-time graphs describes the same motion.

A



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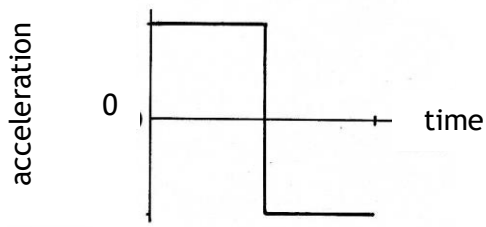

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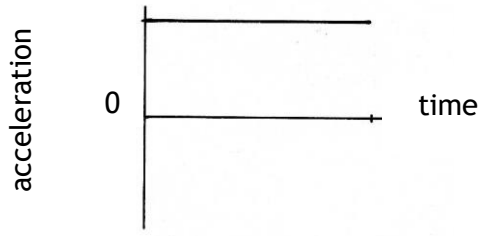

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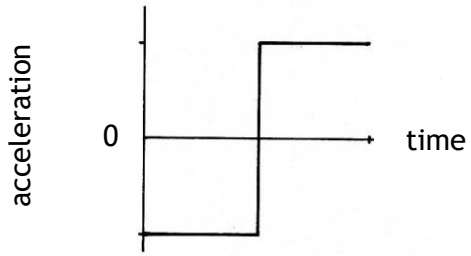

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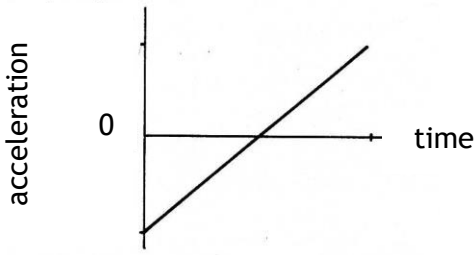
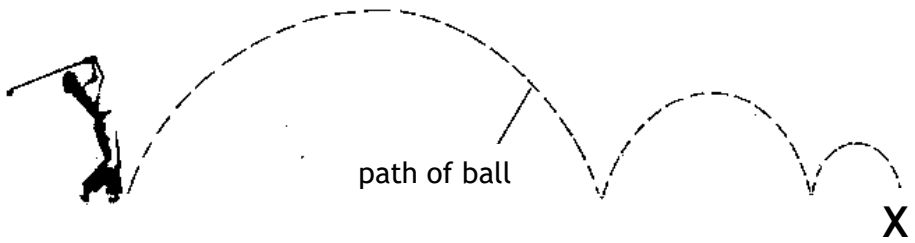
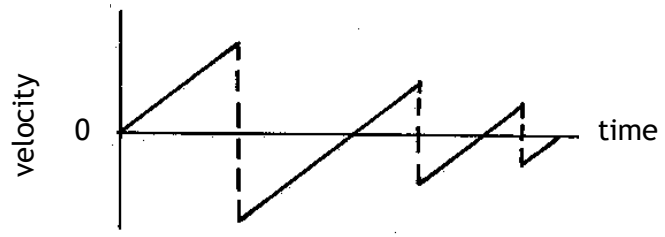


8. A golfer strikes a ball straight down the fairway.

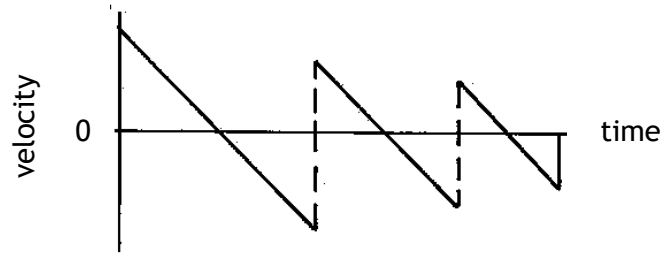


The ball bounces twice before stopping at point X.
Identify which of the following could be a graph of the **vertical** component of its velocity against time, **after** the ball is struck.

A



B



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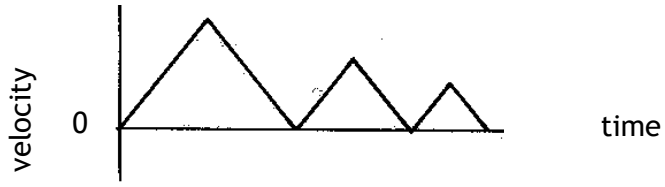
D



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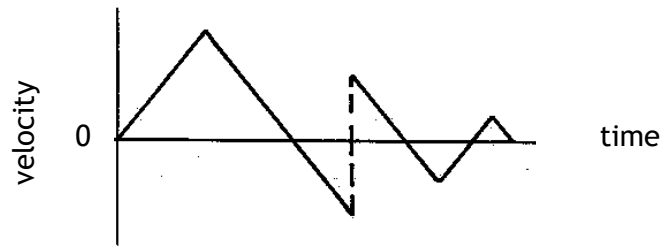
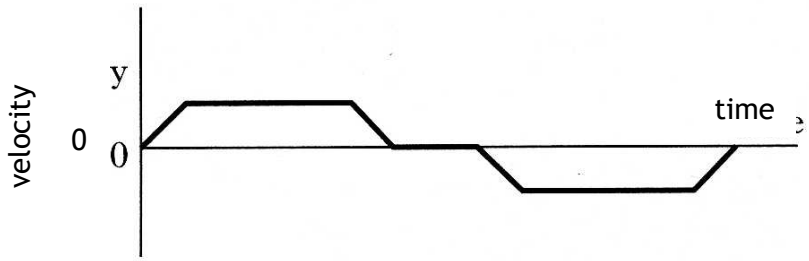
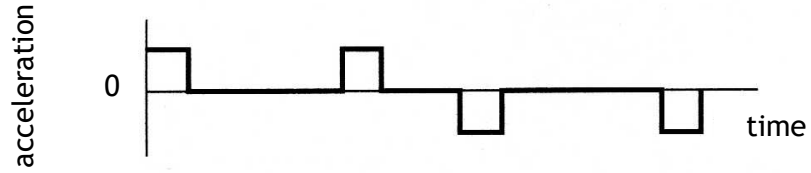


9. A lift in a hotel makes a return journey from the ground floor to the top floor and then back again. The corresponding velocity-time graph is shown below.

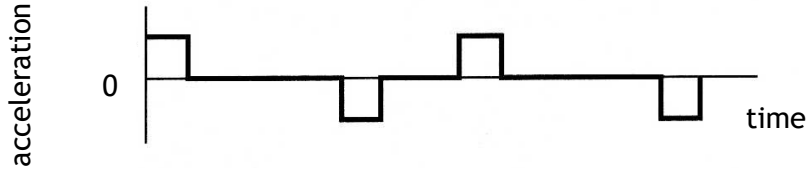


Identify the corresponding acceleration-time graph for the same motion.

A



B



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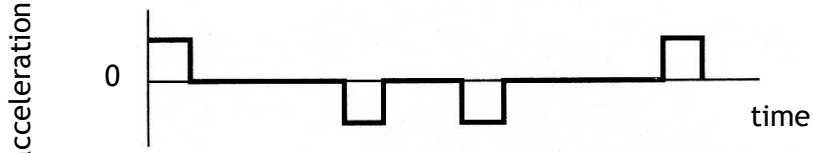
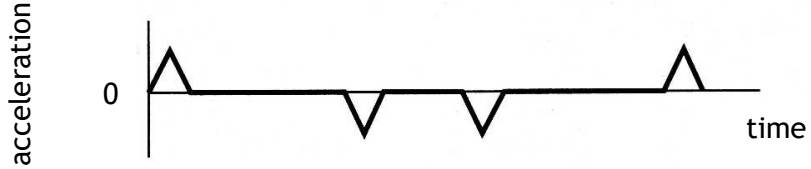
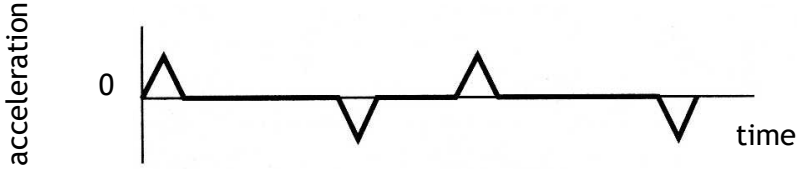


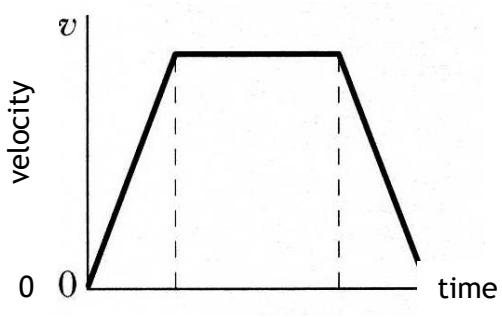
D



E

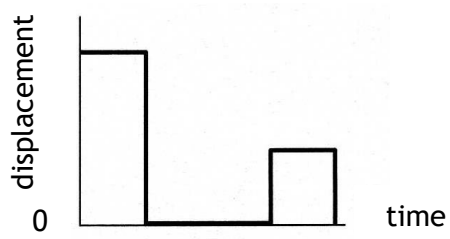


10. The diagram below is the velocity-time graph for a model train moving along a straight piece of track.

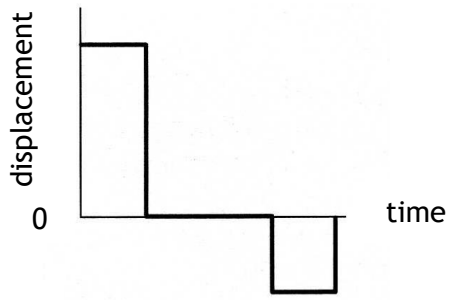


Identify which of the following displacement-time graphs represents the same motion.

A



B



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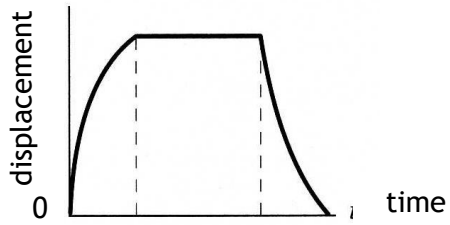

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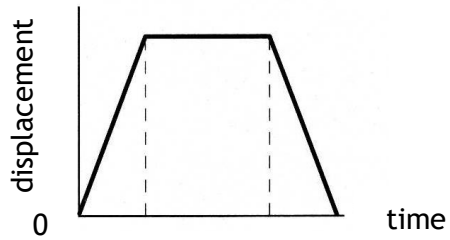

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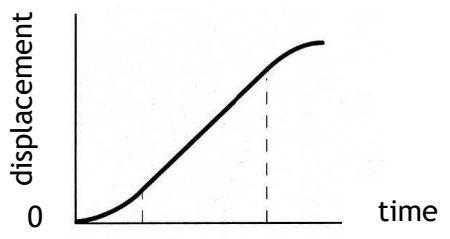
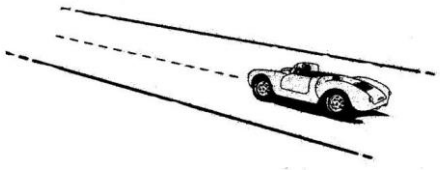


Full Response Questions 11 → 14

11. An aircraft of mass 333000 kg has a speed of 81 ms^{-1} before it takes off from a runway. The engine of the aircraft provides a constant acceleration of 1.68 ms^{-2}. The aircraft starts from rest.
    Calculate the minimum length of runway required for the aircraft to take off.

12. A sports car is being tested along a straight track.

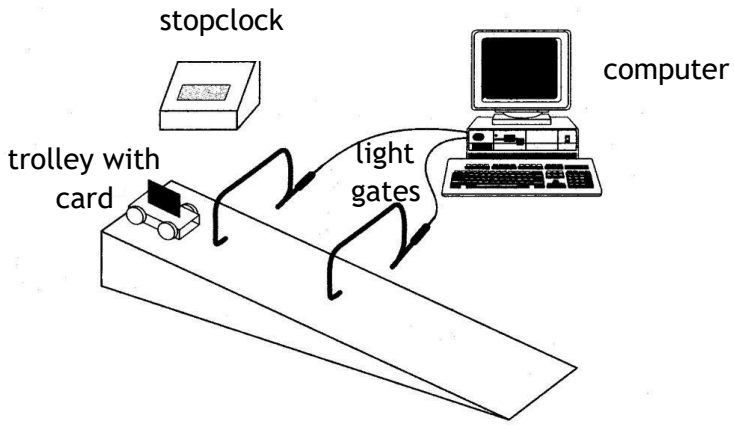


    (a) In the first test, the car starts from rest and has a constant acceleration of 4·0 ms^{-2} in a straight line for 7·0 s.
    Calculate the distance the car travels in the 7·0 s.

    (b) In a second test, the car again starts from rest and accelerates at 4·0 ms^{-2} over twice the distance covered in the first test.
    Calculate the **increase** in the final speed of the car at the end of the second test compared with the final speed at the end of the first test.

    (c) A third test was completed, with the same car. The car reached a speed of 40 ms^{-1}.
    The car then decelerated at 2·5 ms^{-2} until it came to rest.
    Calculate the distance travelled by the car whilst it decelerated to rest.

13. A student measures the acceleration of a trolley as it moves freely down a sloping track.



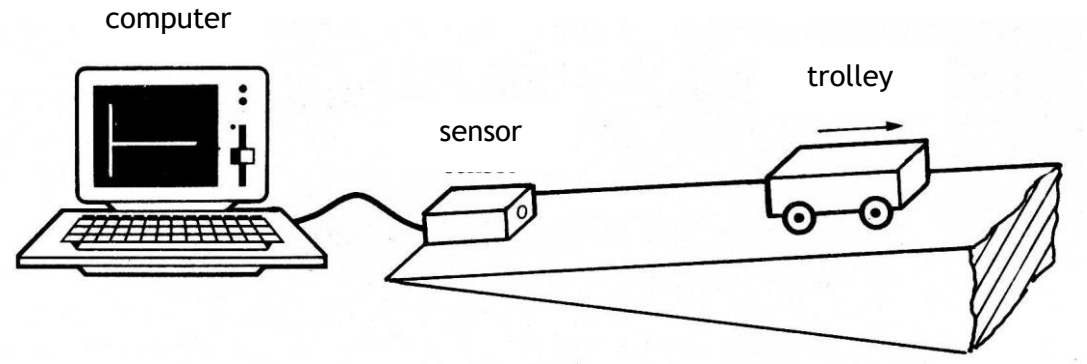
    The trolley has a card mounted on it. As it moves down the track the card cuts off the light at each of the light gates in turn. The light gates are connected to a computer, which is used for timing.

    The student uses a stopclock to measure the time it takes the trolley to move from the first light gate to the second light gate.

    a) State all of the **measurements** that are made by the student and the computer to allow the acceleration of the trolley to be calculated.

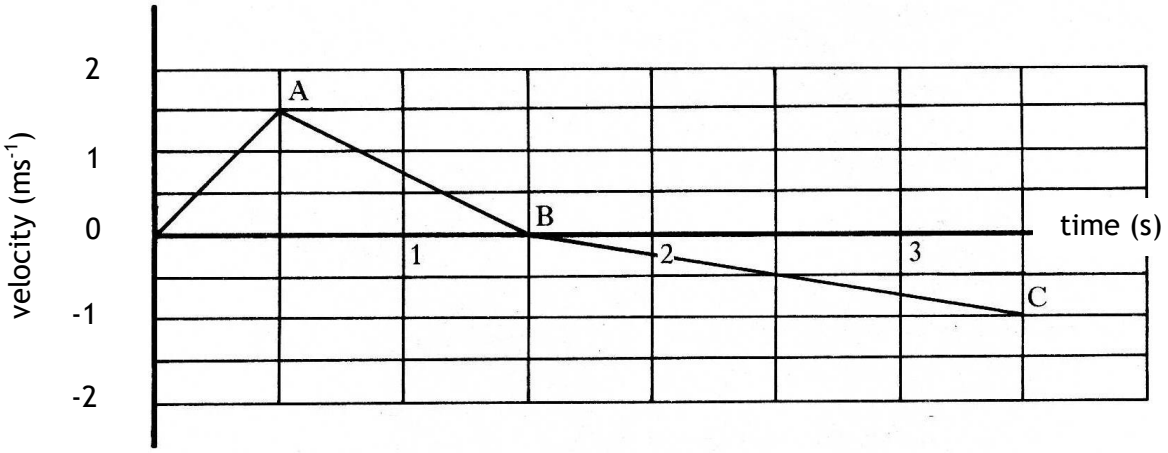
    b) Describe fully how these measurements are used to **calculate** the acceleration of the trolley, as it moves down the slope.

14. The velocity of a trolley on an inclined plane (slope) can be investigated using a computer and a sensor as shown below.



The sensor emits ultrasound pulses, which are reflected from the trolley. The computer measures the time between the transmitted and reflected pulses and uses this information to calculate the velocity at regular intervals of time.

In an investigation, the trolley is given a sharp push **up** the slope before being allowed to continue unaided. The graph below shows the resulting velocity-time graph as displayed on the computer screen.



Point A, on the graph, corresponds to the instant that the trolley is released, after the push.

(a) State the time at which the trolley is at its maximum displacement from the sensor.
You must justify your answer.

(b) Sketch the corresponding acceleration-time graph for the first 3 seconds of the motion.
Numerical values are required on both the time and acceleration axes. The points A, B and C must be indicated.