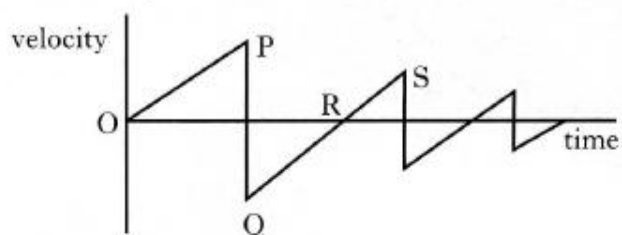


## Exercise 2 - Equations of Motion

### Past paper Homework Questions

1. The following velocity-time graph describes the motion of a ball, dropped from rest and bouncing several times.



Which of the following statements is/are true?

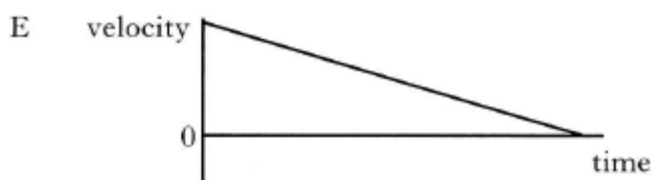
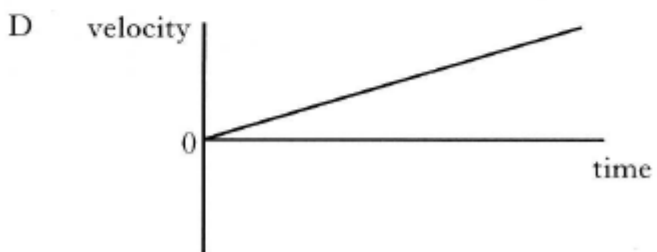
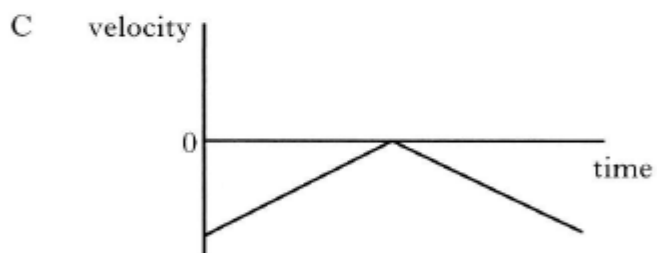
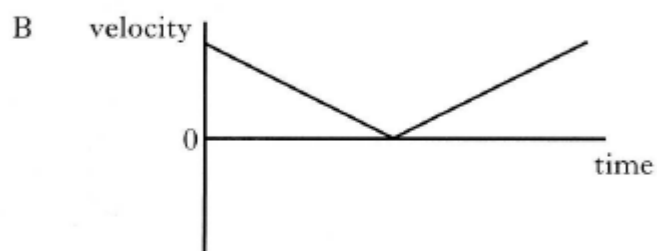
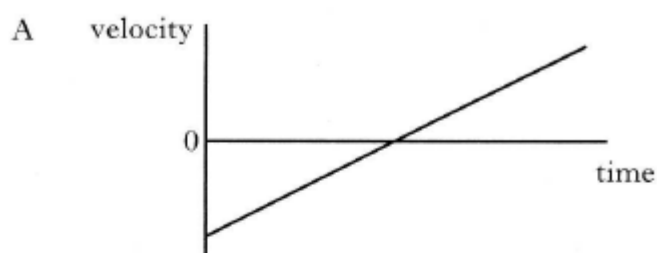
- I The ball hits the ground at P.
  - II The ball is moving upwards between Q and R.
  - III The ball is moving upwards between R and S.
- A I only  
 B II only  
 C III only  
 D I and II only  
 E I and III only

2. A helicopter is **descending** vertically at a constant speed of  $3.0 \text{ ms}^{-1}$ . A sandbag is released from the helicopter. The sandbag hits the ground  $5.0 \text{ s}$  later.

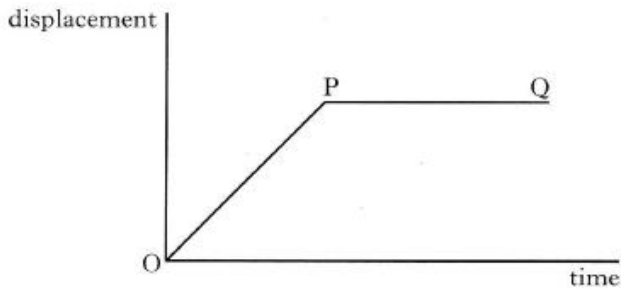
What was the height of the helicopter above the ground at the time the sandbag was released?

- A  $15.0 \text{ m}$   
 B  $49.0 \text{ m}$   
 C  $107.5 \text{ m}$   
 D  $122.5 \text{ m}$   
 E  $137.5 \text{ m}$

3. Which of the following velocity-time graphs best describes a ball being thrown vertically into the air and returning to the thrower's hand?



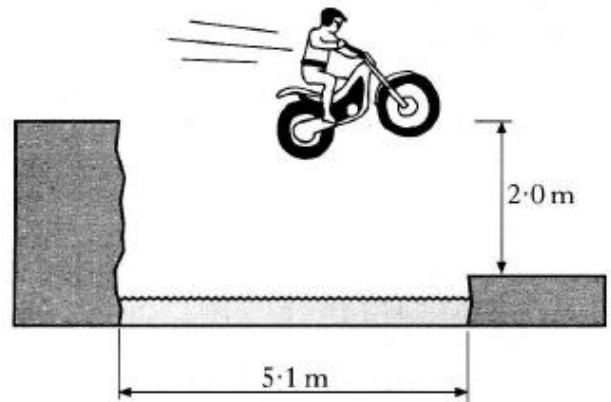
4. The following graph shows how the displacement of an object varies with time.



Which row of the table below best describes the motion of this object?

	<i>From O to P</i>	<i>From P to Q</i>
A	constant acceleration	constant velocity
B	zero velocity	constant deceleration
C	constant velocity	zero velocity
D	zero velocity	constant velocity
E	constant velocity	constant deceleration

6. A stuntman on a motorcycle jumps a river which is 5.1 m wide. He lands on the edge of the far bank, which is 2.0 m lower than the bank from which he takes off.

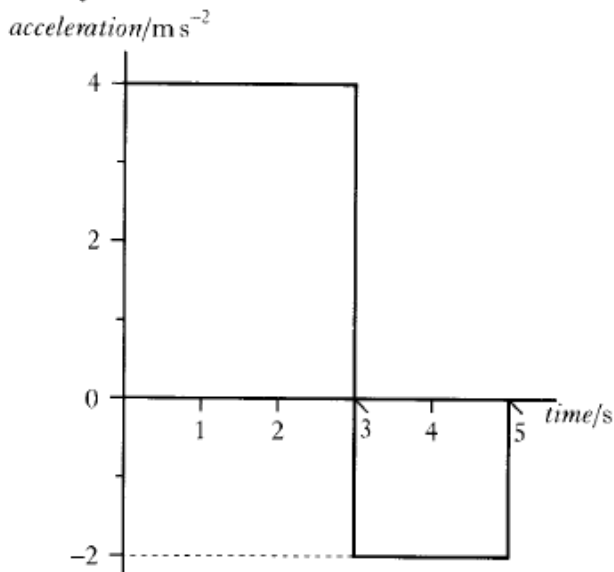


His minimum horizontal speed at take off is

- A  $2.0 \text{ m s}^{-1}$   
 B  $3.2 \text{ m s}^{-1}$   
 C  $5.5 \text{ m s}^{-1}$   
 D  $8.0 \text{ m s}^{-1}$   
 E  $9.8 \text{ m s}^{-1}$ .

5. An object starts from rest and accelerates in a straight line.

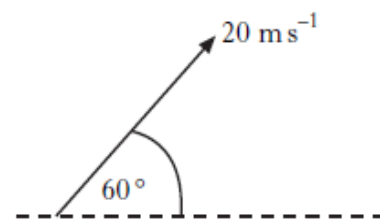
The graph shows how the acceleration of the object varies with time.



The object's speed at 5 seconds is

- A  $2 \text{ m s}^{-1}$   
 B  $8 \text{ m s}^{-1}$   
 C  $12 \text{ m s}^{-1}$   
 D  $16 \text{ m s}^{-1}$   
 E  $20 \text{ m s}^{-1}$ .

7. A javelin is thrown at  $60^\circ$  to the horizontal with a speed of  $20 \text{ m s}^{-1}$ .



The javelin is in flight for 3.5 s.

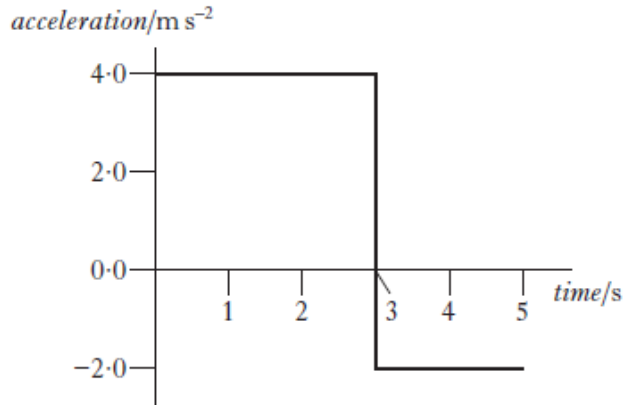
Air resistance is negligible.

The horizontal distance the javelin travels is

- A 35.0 m  
 B 60.6 m  
 C 70.0 m  
 D 121 m  
 E 140 m.

8. An object starts from rest and accelerates in a straight line.

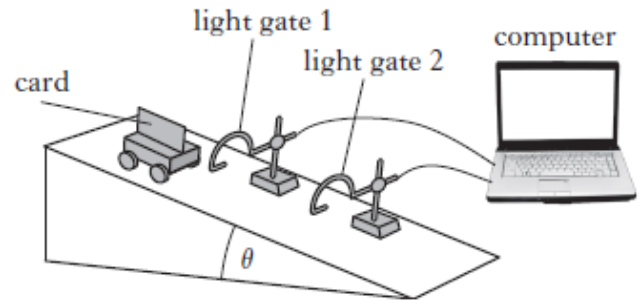
The graph shows how the acceleration of the object varies with time.



The speed of the object at 5 seconds is

- A  $2 \text{ m s}^{-1}$
- B  $8 \text{ m s}^{-1}$
- C  $12 \text{ m s}^{-1}$
- D  $16 \text{ m s}^{-1}$
- E  $20 \text{ m s}^{-1}$ .

10. A vehicle runs down a slope as shown.



The following results are obtained.

angle of slope,

$$\theta = 15.0 \pm 0.5^\circ$$

length of card on top of vehicle,

$$d = 0.020 \pm 0.001 \text{ m}$$

time for card to pass light gate 1,

$$t_1 = 0.40 \pm 0.01 \text{ s}$$

time for card to pass light gate 2,

$$t_2 = 0.25 \pm 0.01 \text{ s}$$

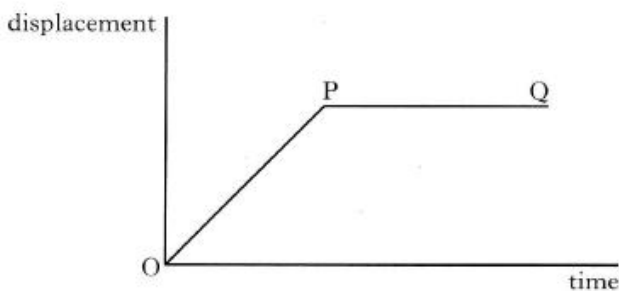
time for vehicle to travel between the light gates,

$$t_3 = 0.50 \pm 0.01 \text{ s}$$

Which quantity has the largest percentage uncertainty?

- A  $\theta$
- B  $d$
- C  $t_1$
- D  $t_2$
- E  $t_3$

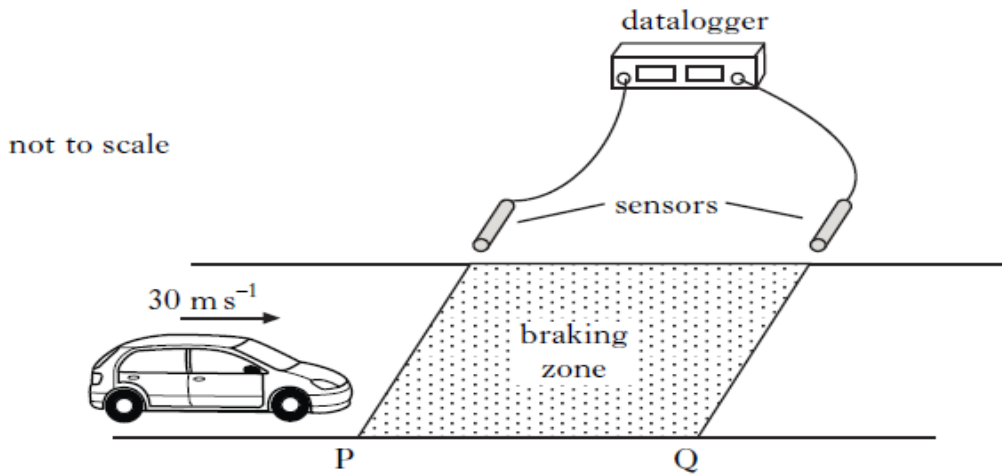
9. The following graph shows how the displacement of an object varies with time.



Which row of the table below best describes the motion of this object?

	<i>From O to P</i>	<i>From P to Q</i>
A	constant acceleration	constant velocity
B	zero velocity	constant deceleration
C	constant velocity	zero velocity
D	zero velocity	constant velocity
E	constant velocity	constant deceleration

11. To test the braking system of cars, a test track is set up as shown.



The sensors are connected to a datalogger which records the speed of a car at both P and Q.

A car is driven at a constant speed of  $30 \text{ m s}^{-1}$  until it reaches the start of the braking zone at P. The brakes are then applied.

- (a) In one test, the datalogger records the speed at P as  $30 \text{ m s}^{-1}$  and the speed at Q as  $12 \text{ m s}^{-1}$ . The car slows down at a constant rate of  $9.0 \text{ m s}^{-2}$  between P and Q.

Calculate the length of the braking zone.

2

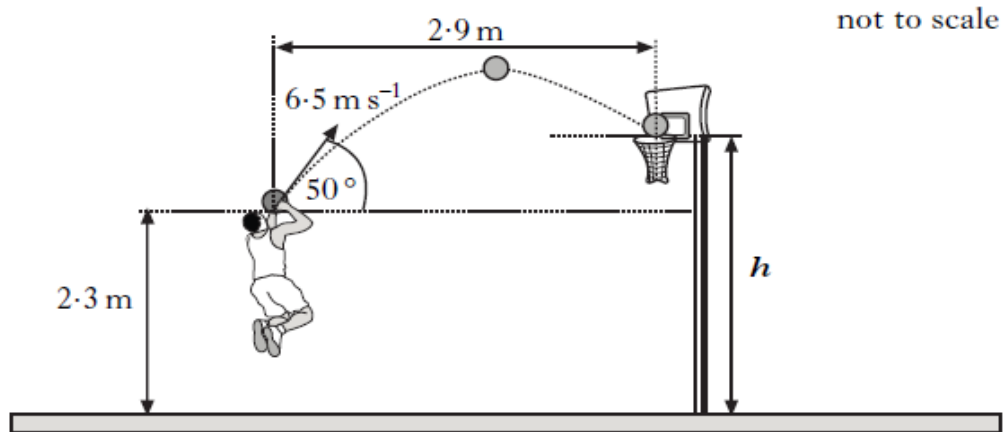
- (b) The test is repeated. The same car is used but now with passengers in the car. The speed at P is again recorded as  $30 \text{ m s}^{-1}$ .

The same braking force is applied to the car as in part (a).

How does the speed of the car at Q compare with its speed at Q in part (a)? Justify your answer.

2

12. A basketball player throws a ball with an initial velocity of  $6.5 \text{ m s}^{-1}$  at an angle of  $50^\circ$  to the horizontal. The ball is  $2.3 \text{ m}$  above the ground when released.

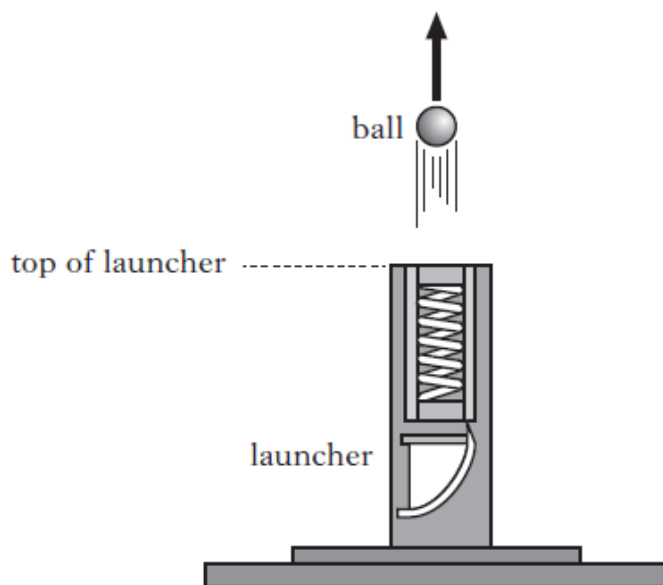


The ball travels a horizontal distance of  $2.9 \text{ m}$  to reach the top of the basket. The effects of air resistance can be ignored.

- (a) Calculate:
- (i) the horizontal component of the initial velocity of the ball; 1
  - (ii) the vertical component of the initial velocity of the ball. 1
- (b) Show that the time taken for the ball to reach the basket is  $0.69 \text{ s}$ . 1
- (c) Calculate the height  $h$  of the top of the basket. 2
- (d) A student observing the player makes the following statement.
- “The player should throw the ball with a higher speed at the same angle. The ball would then land in the basket as before but it would take a shorter time to travel the  $2.9 \text{ metres}$ .”*
- Explain** why the student’s statement is incorrect. 2

(7)

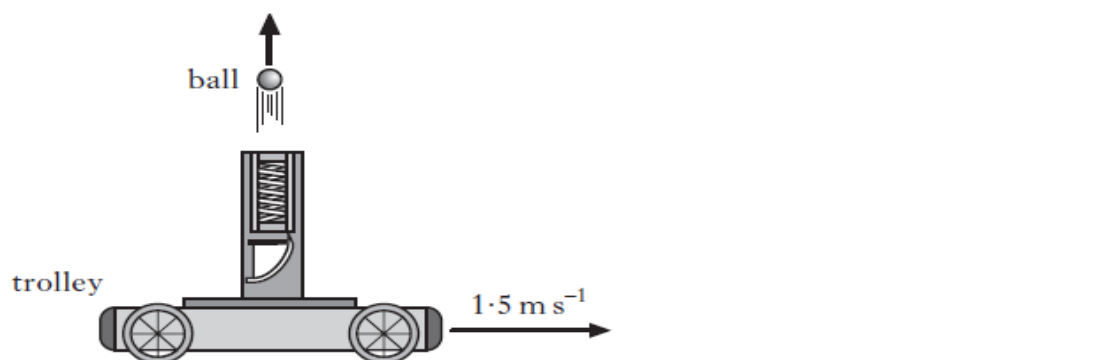
13. A student investigates the motion of a ball projected from a launcher. The launcher is placed on the ground and a ball is fired vertically upwards. The vertical speed of the ball as it leaves the top of the launcher is  $7.0 \text{ m s}^{-1}$ . The effects of air resistance can be ignored.



- (a) (i) Calculate the maximum height above the top of the launcher reached by the ball. 2
- (ii) Show that the time taken for the ball to reach its maximum height is  $0.71 \text{ s}$ . 1

- (b) The student now fixes the launcher to a trolley. The trolley travels horizontally at a constant speed of  $1.5 \text{ m s}^{-1}$  to the right.

The launcher again fires the ball vertically upwards with a speed of  $7.0 \text{ m s}^{-1}$ .



- (i) Determine the velocity of the ball after  $0.71 \text{ s}$ . 1
- (ii) The student asks some friends to predict where the ball will land relative to the moving launcher. They make the following statements.

*Statement X: The ball will land behind the launcher.*

*Statement Y: The ball will land in front of the launcher.*

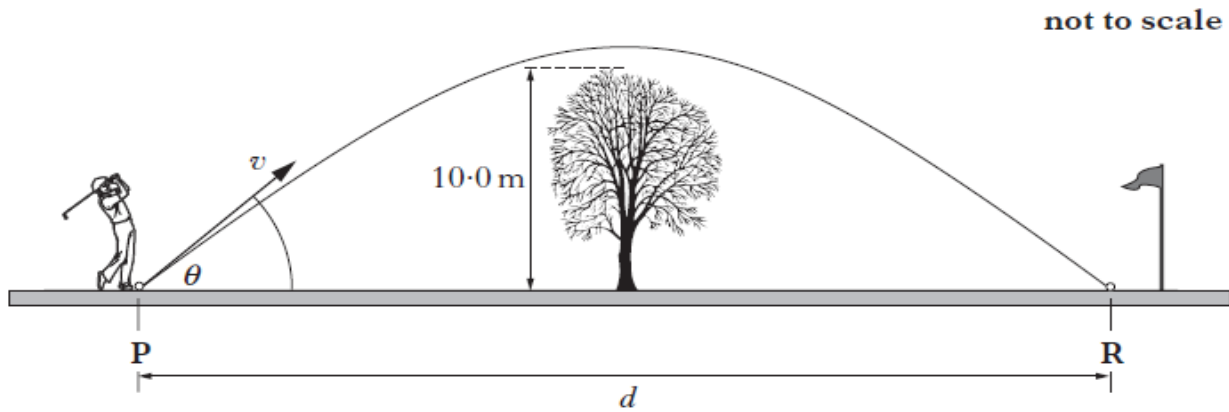
*Statement Z: The ball will land on top of the launcher.*

Which of the statements is correct?

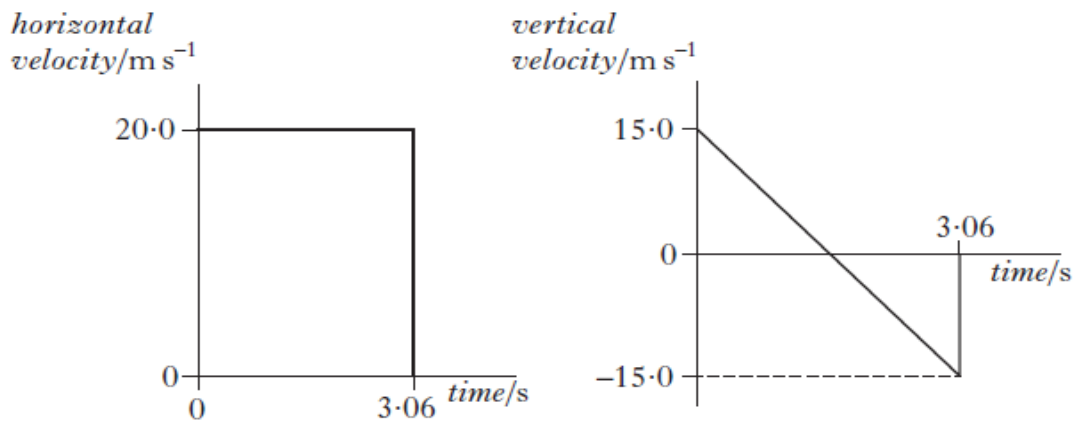
You must justify your answer.

2  
(6)

14. A golfer hits a ball from point **P**. The ball leaves the club with a velocity  $v$  at an angle of  $\theta$  to the horizontal.  
 The ball travels through the air and lands at point **R**.  
 Midway between **P** and **R** there is a tree of height 10.0 m.



- (a) The horizontal and vertical components of the ball's velocity during its flight are shown.



The effects of air resistance can be ignored.

Calculate:

- (i) the horizontal distance  $d$ ; **1**  
 (ii) the maximum height of the ball above the ground. **2**
- (3)**

**(30 marks)**