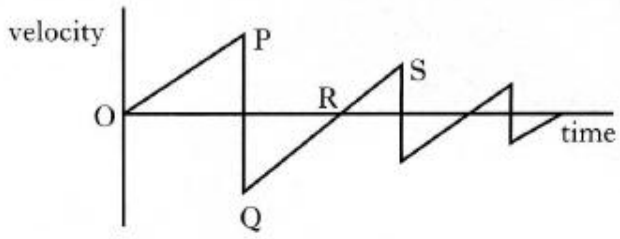
## Exercise 2 - Equations of Motion

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 $3{\cdot}0\,\text{m}\,\text{s}^{-1}$. A sandbag is released from the helicopter. The sandbag hits the ground 5·0 s later.

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

A 15·0 m

B 49·0 m

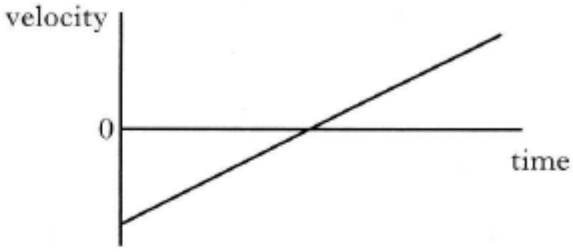
C 107·5 m

D 122·5 m

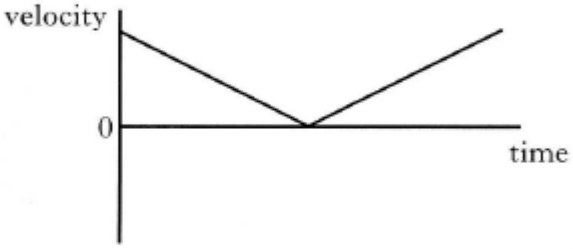
E 137·5 m

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?

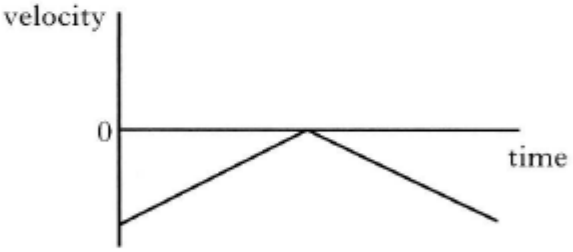
A



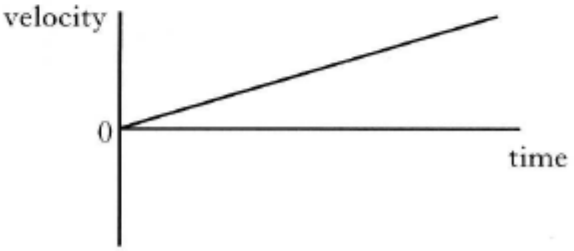

B



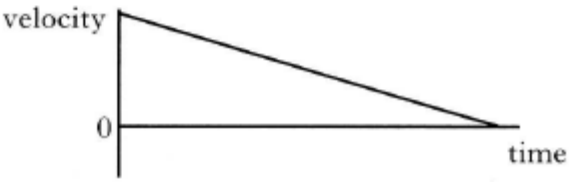

C



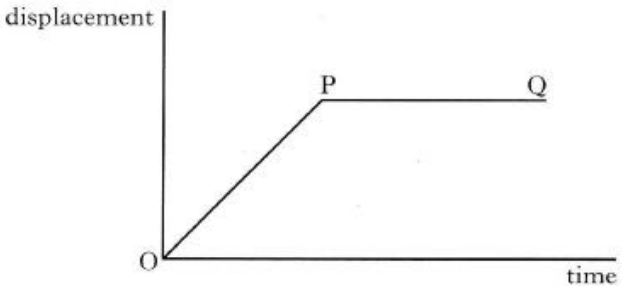

D




E



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

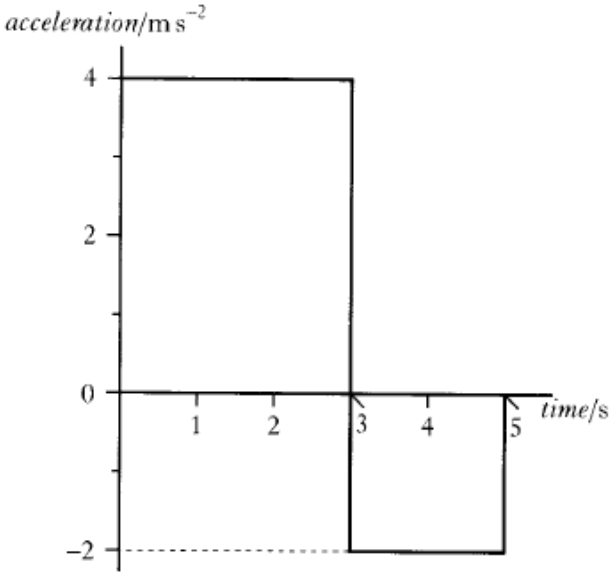



Which row of the table below best describes the motion of this object?

| | *From O to P* | *From P to Q* |
|---|---|---|
| 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 |

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 m s$^{-1}$

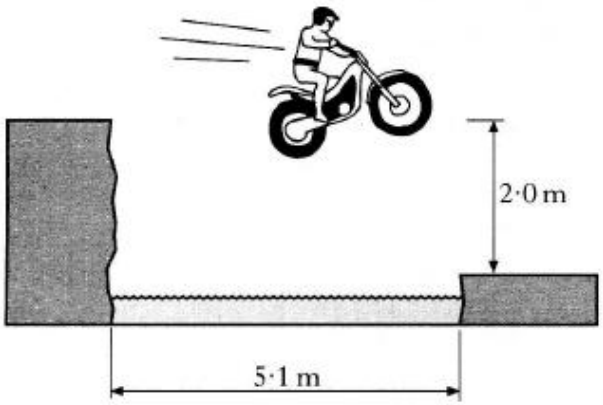
B 8 m s$^{-1}$

C 12 m s$^{-1}$

D 16 m s$^{-1}$

E 20 m s$^{-1}$.

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 m s$^{-1}$

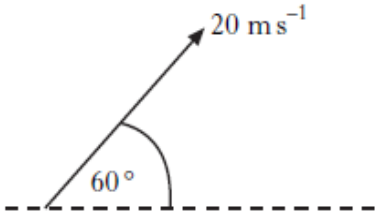
B 3·2 m s$^{-1}$

C 5·5 m s$^{-1}$

D 8·0 m s$^{-1}$

E 9·8 m s$^{-1}$.

7. A javelin is thrown at 60° to the horizontal with a speed of 20 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

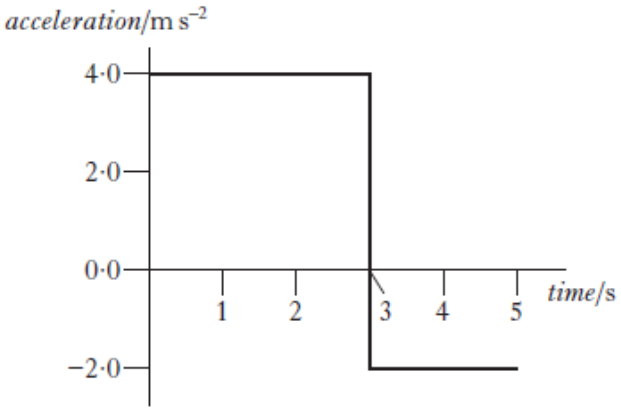
C 70·0 m

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 m s$^{-1}$

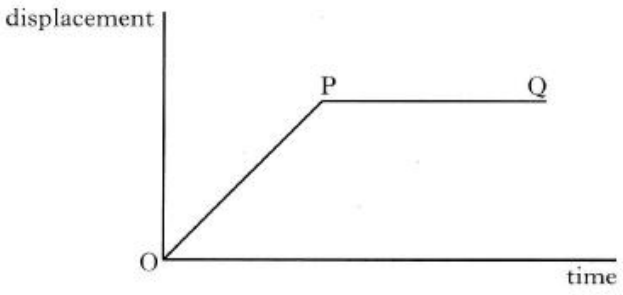
B 8 m s$^{-1}$

C 12 m s$^{-1}$

D 16 m s$^{-1}$

E 20 m s$^{-1}$.

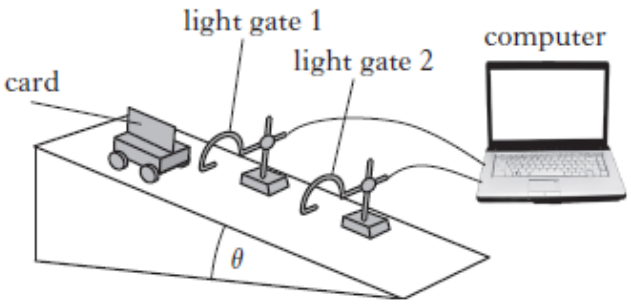
9. The following graph shows how the displacement of an object varies with time.




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

| | *From O to P* | *From P to Q* |
|---|---|---|
| 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 |

10. A vehicle runs down a slope as shown.




The following results are obtained.

angle of slope,
$\theta = 15{\cdot}0 \pm 0{\cdot}5°$

length of card on top of vehicle,
$d = 0{\cdot}020 \pm 0{\cdot}001$ m

time for card to pass light gate 1,
$t_1 = 0{\cdot}40 \pm 0{\cdot}01$ s

time for card to pass light gate 2,
$t_2 = 0{\cdot}25 \pm 0{\cdot}01$ s

time for vehicle to travel between the light gates,
$t_3 = 0{\cdot}50 \pm 0{\cdot}01$ s

Which quantity has the largest percentage uncertainty?

A $\theta$

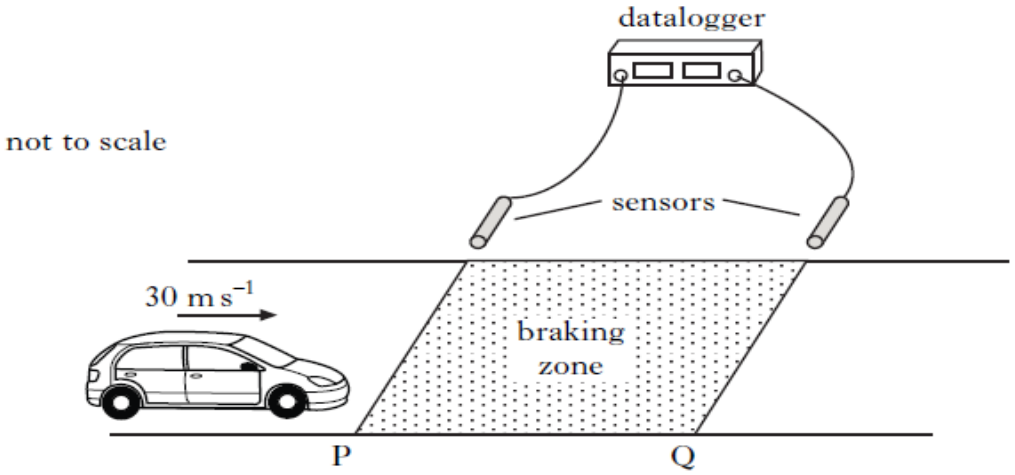
B $d$

C $t_1$

D $t_2$

E $t_3$

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 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 m s$^{-1}$ and the speed at Q as 12 m s$^{-1}$. The car slows down at a constant rate of 9·0 m s$^{-2}$ between P and Q.

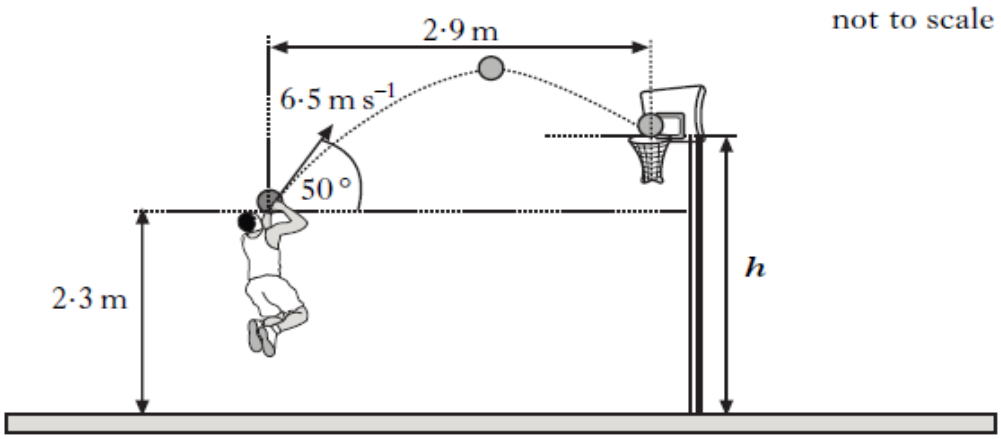
Calculate the length of the braking zone. **2**

(*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 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 $6{\cdot}5\ \text{m s}^{-1}$ at an angle of $50\,°$ to the horizontal. The ball is 2·3 m above the ground when released.




The ball travels a horizontal distance of 2·9 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 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 metres."*

**Explain** why the student's statement is incorrect. **2**

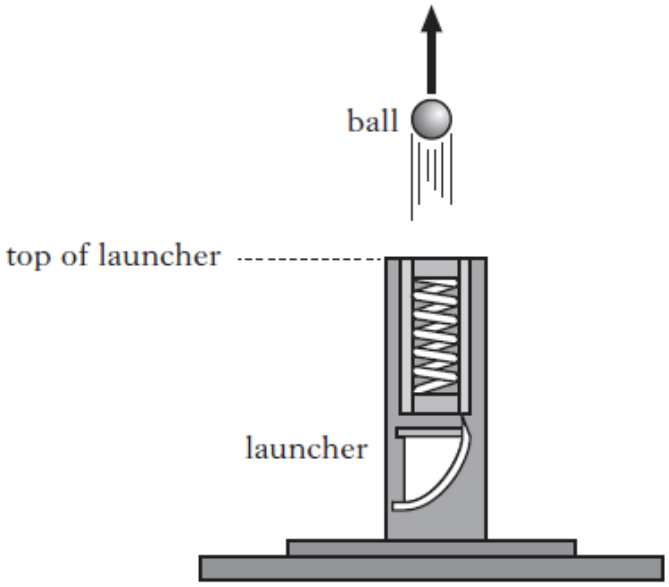
**(7)**

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 $7{\cdot}0\,\text{m s}^{-1}$.

The effects of air resistance can be ignored.

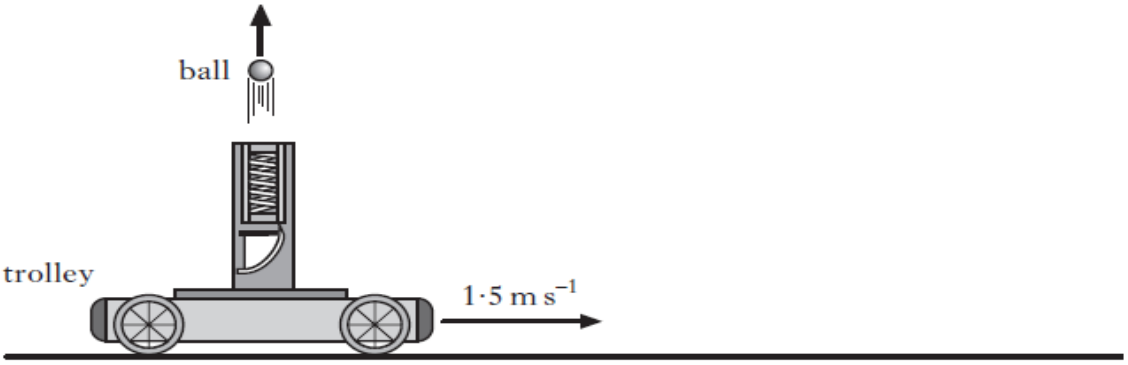



(*a*) (i) Calculate the maximum height above the top of the launcher reached by the ball. **2**

(ii) Show that the time taken for the ball to reach its maximum height is 0·71s. **1**

(*b*) The student now fixes the launcher to a trolley. The trolley travels horizontally at a constant speed of $1{\cdot}5\ \text{m s}^{-1}$ to the right.

The launcher again fires the ball vertically upwards with a speed of $7{\cdot}0\ \text{m s}^{-1}$.




(i) Determine the velocity of the ball after 0·71 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**

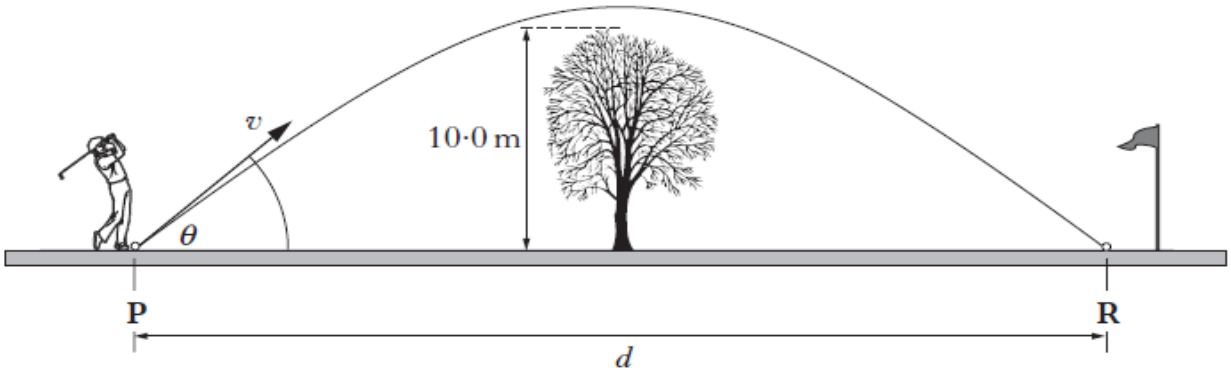
**(6)**

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.

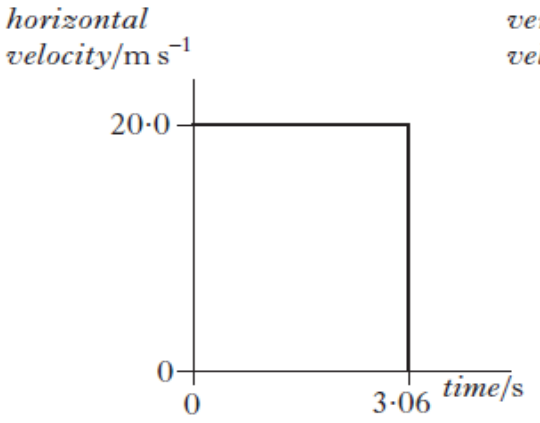
The ball travels through the air and lands at point **R**.

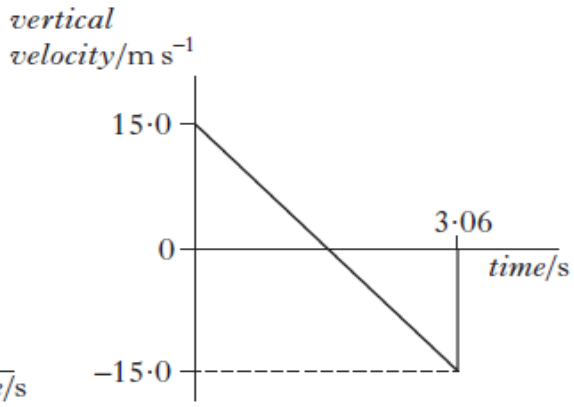
Midway between **P** and **R** there is a tree of height 10·0 m.

**not to scale**




(*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)**