LONDON SCIENCE COLLEGE

Name:

Date:

PROJECTILE MOTION
TEST 2

AS-Level

Mark

Grade

PHYSICS

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

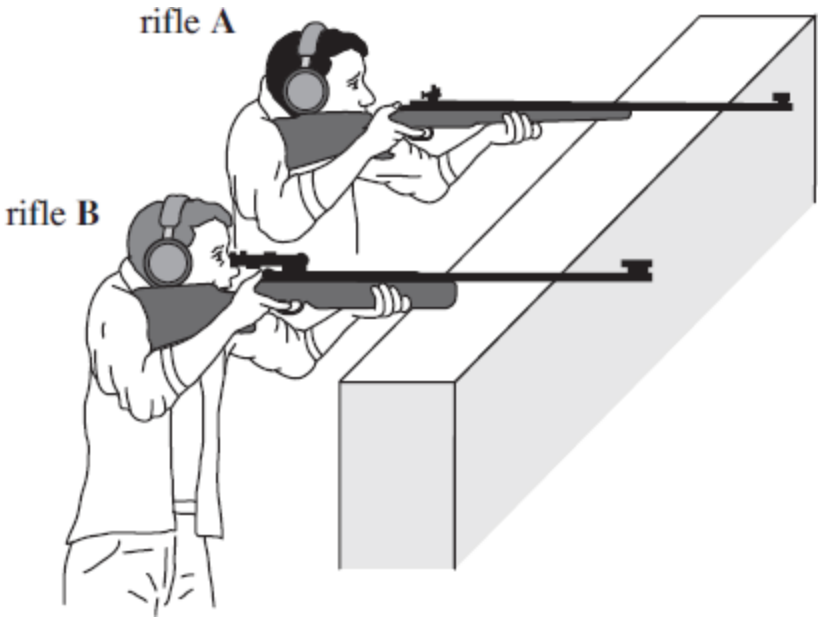
Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

1 The diagram below shows two different rifles being fired horizontally from a height of 1.5 m above ground level.
Assume the air resistance experienced by the bullets is negligible.



(a) When rifle **A** is fired, the bullet has a horizontal velocity of 430 m s^{-1} as it leaves the rifle.
Assume the ground is level.

(i) Calculate the time that the bullet is in the air before it hits the ground.

time _____ s

(2)

(ii) Calculate the horizontal distance travelled by the bullet before it hits the ground.

horizontal distance _____ m

(1)

(b) Rifle **B** is fired and the bullet emerges with a smaller horizontal velocity than the bullet from rifle **A**.

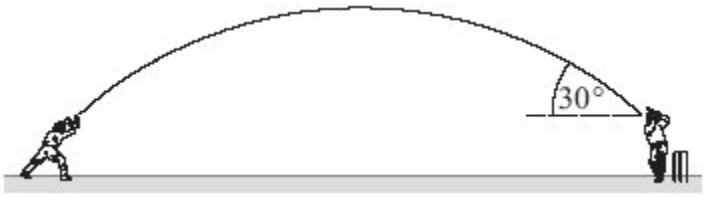
Explain why the horizontal distance travelled by bullet **B** will be less than bullet **A**.

(3)

(Total 6 marks)

2 **Figure 1** shows the flight of a cricket ball hit by a batsman at 30° to the horizontal at a speed of 22 m s^{-1}. The ball reached a fielder without bouncing and was caught at the same height as it was hit. The effect of air resistance on the cricket ball is negligible.

Figure 1



(a) (i) Calculate the vertical speed of the ball at the instant it left the bat.

vertical speed _____ m s^{-1}

(1)

(ii) Show that the ball was in the air for about 2.2 s.

(3)

(iii) How far did the ball travel horizontally before it was caught?

distance _____ m

(1)

(b) (i) A tennis ball is about the same size as a cricket ball but has a lower mass.
By considering the energy changes that take place, explain why a tennis ball hit at the same speed and angle as the cricket ball would be unlikely to reach the fielder without bouncing.

_____

_____

_____

_____

_____

_____

_____

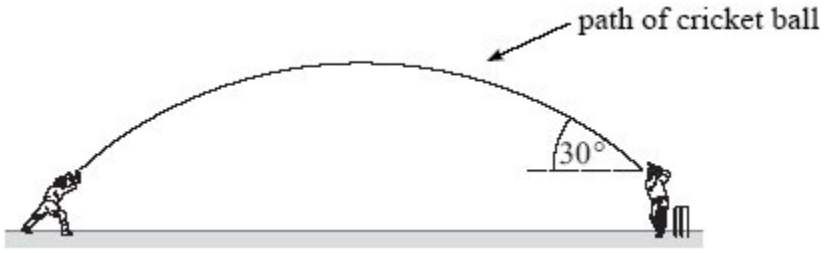
_____

_____

(3)

(ii) Draw on **Figure 2** the path you would expect a tennis ball to follow when hit at the same speed and angle as the cricket ball.

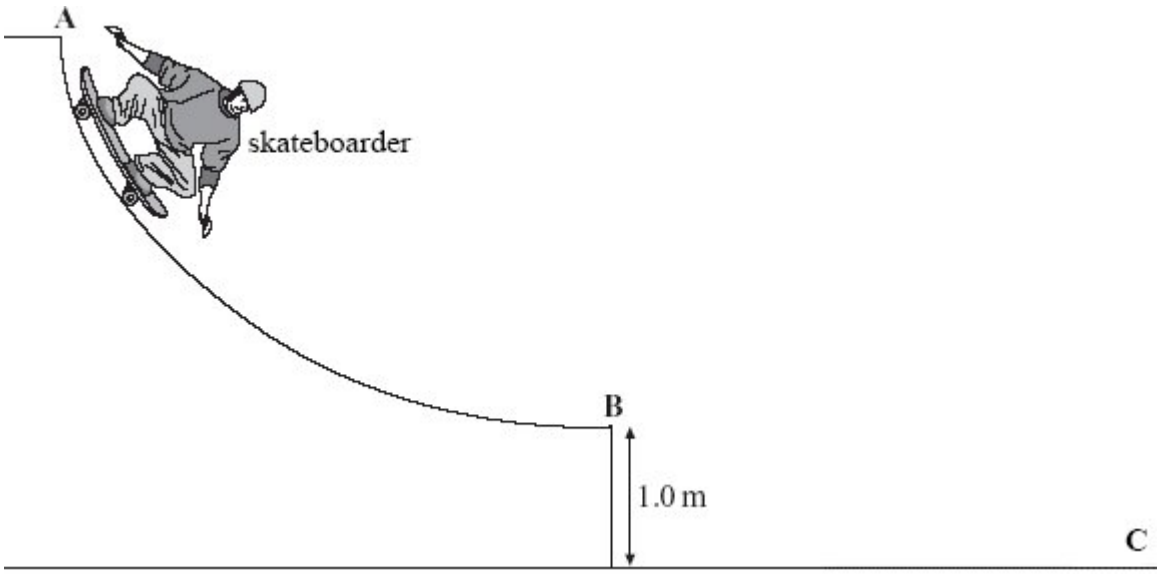
Figure 2



(2)

(Total 10 marks)

3 The figure below shows a skateboarder descending a ramp.



The skateboarder starts from rest at the top of the ramp at **A** and leaves the ramp at **B** horizontally with a velocity *v*.

(a) State the energy changes that take place as the skateboarder moves from **A** to **B**.

(2)

(b) In going from **A** to **B** the skateboarder's centre of gravity descends a vertical height of 1.5 m. Calculate the horizontal velocity, *v*, stating an assumption that you make.

(3)

(c) Explain why the acceleration decreases as the skateboarder moves from **A** to **B**.

(2)

(d) After leaving the ramp at **B** the skateboarder lands on the ground at **C** 0.42 s later.

Calculate for the skateboarder

(i) the horizontal distance travelled between **B** and **C**,

_____

_____

(ii) the vertical component of the velocity immediately before impact at **C**,

_____

_____

_____

(iii) the magnitude of the resultant velocity immediately before impact at **C**.

_____

_____

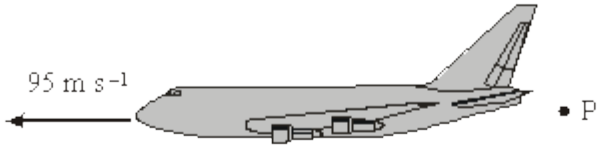
_____

_____

(5)

(Total 12 marks)

4 The aeroplane shown in the diagram below is travelling horizontally at 95 m s^{-1}.
It has to drop a crate of emergency supplies.
The air resistance acting on the crate may be neglected.



(a) (i) The crate is released from the aircraft at point **P** and lands at point **Q**. Sketch the path followed by the crate between **P** and **Q** as seen from the ground.

(ii) Explain why the horizontal component of the crate's velocity remains constant while it is moving through the air.

_____

_____

_____

(3)

(b) (i) To avoid damage to the crate, the maximum vertical component of the crate's velocity on landing should be 32 m s^{-1}. Show that the maximum height from which the crate can be dropped is approximately 52 m.

_____

_____

_____

(ii) Calculate the time taken for the crate to reach the ground if the crate is dropped from a height of 52 m.

_____

_____

(iii) If **R** is a point on the ground directly below **P**, calculate the horizontal distance **QR**.

_____

_____

(6)

(c) In practice air resistance is **not** negligible. State and explain the effect this has on the maximum height from which the crate can be dropped.

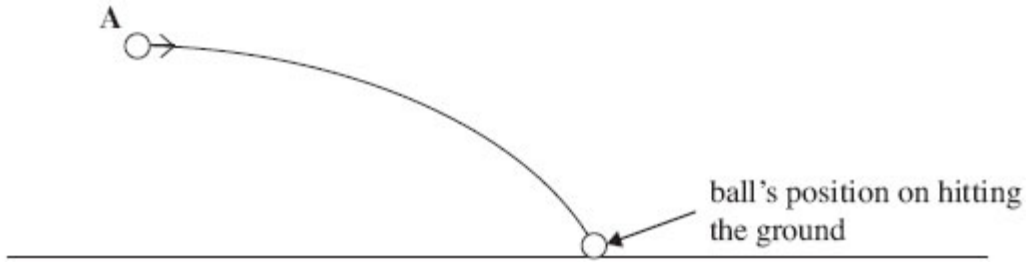
_____

_____

(2)

(Total 11 marks)

5 The figure below shows the path that a tennis ball would follow in the absence of air resistance, after being hit horizontally at **A**.



(a) Explain why the path of the ball is curved in this way.

_____

_____

_____

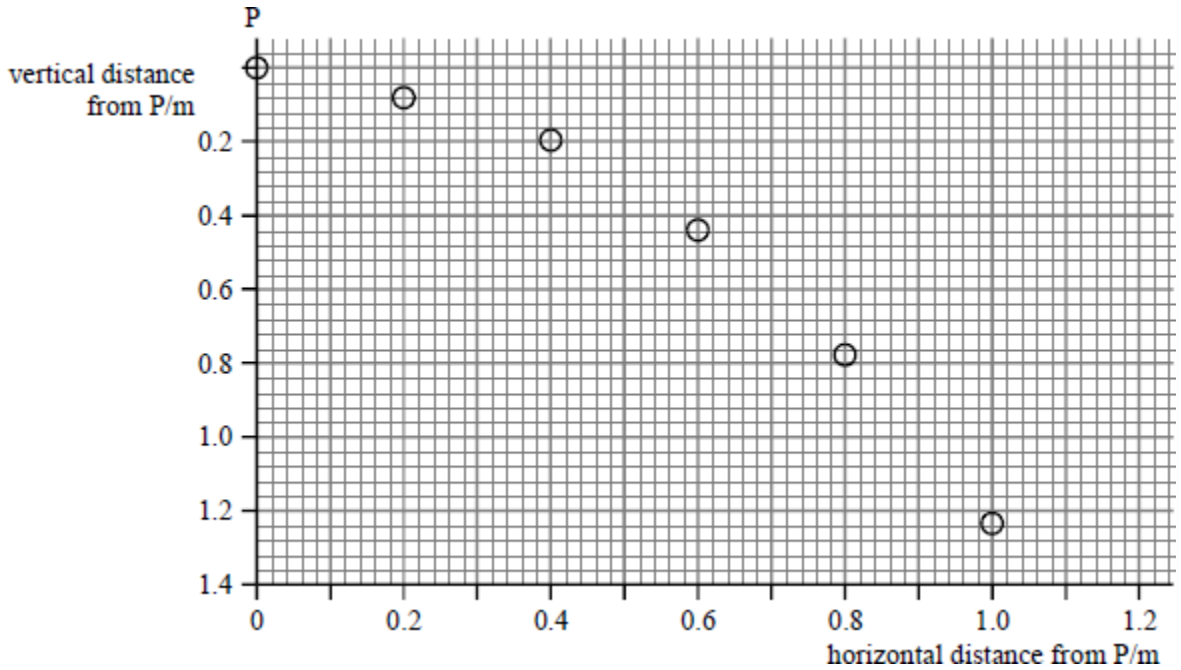
(2)

(b) Draw onto the figure the path of a ball, hit in the same way at **A**, that is affected by air resistance.

(1)

(Total 3 marks)

6 The graph shows how the position of a steel ball which has been projected horizontally from P changes with time. The position of the ball is shown at constant time intervals.



(a) Explain how the horizontal motion of the ball shows that air resistance is negligible.

_____

_____

_____

_____

(2)

(b) Explain the vertical motion of the ball.

_____

_____

_____

(2)

(c) If air resistance were not negligible, describe how this would affect

(i) the horizontal motion of the ball,

_____

_____

(ii) the vertical motion of the ball.

(3)

(Total 7 marks)

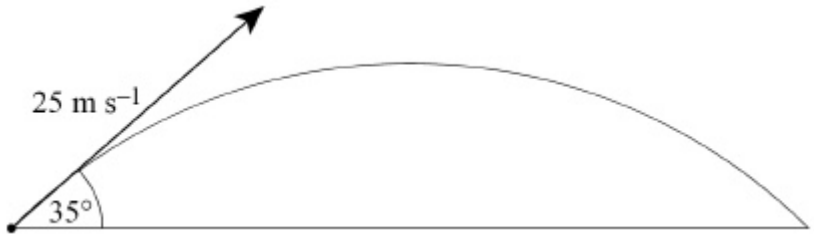
7 Two spheres, **P** and **Q**, have the same volume but **P** has a greater mass. The spheres fall in air at their terminal velocities v_P and v_Q respectively.

Which row states the relationship between v_P and v_Q and the reason?

	Relationship between v_P and v_Q	**Reason**	
A	$v_P = v_Q$	Terminal velocity is unaffected by mass	⬭
B	$v_Q > v_P$	The mass of **Q** is less and it accelerates more	⬭
C	$v_Q > v_P$	**P** reaches equilibrium at a lower terminal velocity	⬭
D	$v_P > v_Q$	**Q** reaches equilibrium at a lower terminal velocity	⬭

(Total 1 mark)

8 A projectile is launched with a speed of 25 m s^{-1} at an angle of 35° to the horizontal, as shown in the diagram.



Air resistance is negligible.

What is the time taken for the projectile to return to the ground?

A 1.5 s ⬭

B 2.1 s ⬭

C 2.9 s ⬭

D 4.2 s ⬭

(Total 1 mark)

9 Two identical balls, **X** and **Y**, are at the same height and a horizontal distance of 25 cm apart.

X is projected horizontally with a velocity of 0.10 m s^{-1} towards **Y** at the same time that **Y** is released from rest. Both **X** and **Y** move freely in the absence of air resistance.

What is the distance between the balls 1.0 s later?

A 0.15 m ⬭

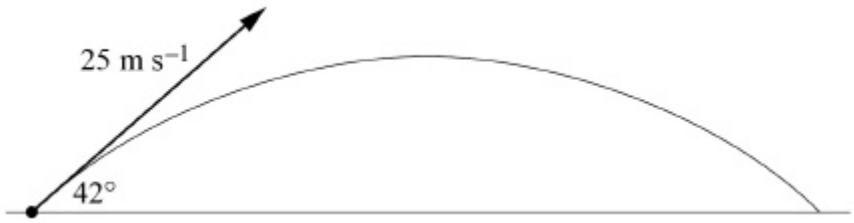
B 0.25 m ⬭

C 2.4 m ⬭

D 4.9 m ⬭

(Total 1 mark)

10 The diagram shows the path of a projectile launched from ground level with a speed of 25 m s^{-1} at an angle of 42° to the horizontal.



What is the horizontal distance from the starting point of the projectile when it hits the ground?

A 23 m ⬭

B 32 m ⬭

C 47 m ⬭

D 63 m ⬭

(Total 1 mark)

11 A stone of mass 0.4 kg is projected horizontally at a speed of 6.0 m s^{-1} from the top of a wall, 5.0 m above the surrounding ground. When it arrives at the ground its speed is 10 m s^{-1}.

How much energy is lost by the stone in falling through the air?

A 2.4 J ⬭

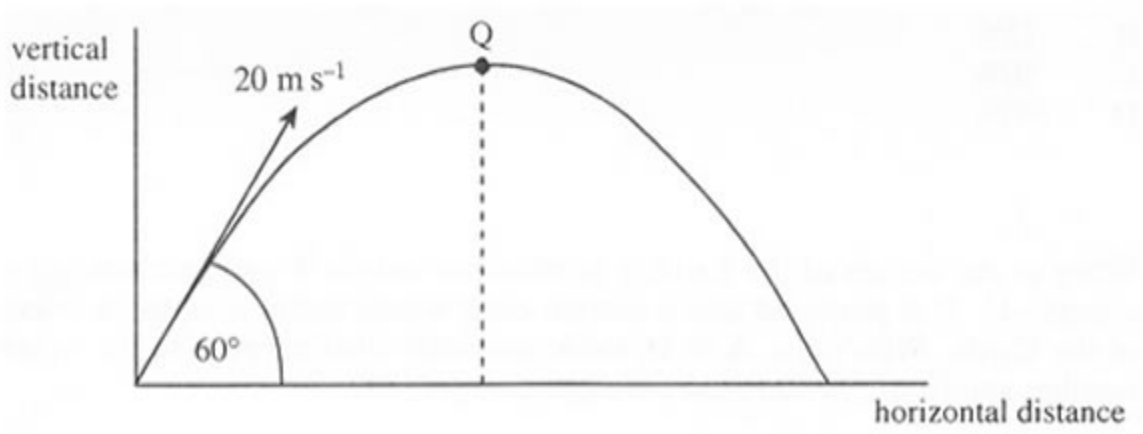
B 6.8 J ⬭

C 12.8 J ⬭

D 14.4 J ⬭

(Total 1 mark)

12 A ball of mass 0.20 kg is thrown and moves in a curved path, as shown below. At Q it is travelling horizontally.



Assume air resistance is negligible.

What is the momentum of the ball at Q?

A zero ⬭

B 2.0 N s ⬭

C 3.5 N s ⬭

D 4.0 N s ⬭

(Total 1 mark)