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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

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CAMBRIDGE INTERNATIONAL MATHEMATICS **0607/62**

Paper 6 Investigation and Modelling (Extended) **May/June 2025**

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a graphic display calculator where appropriate.
- You may use tracing paper.
- You must show all necessary working clearly, including sketches, to gain full marks for correct methods.
- In this paper you will be awarded marks for providing full reasons, examples and steps in your working to communicate your mathematics clearly and precisely.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

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Section A

INVESTIGATION THE CORE AND SHELL OF LINEAR SEQUENCES

You are advised to spend no more than 45 minutes on this section.

In this investigation you will look at the difference between the values of the shell and the core in linear sequences.
The linear sequences have a constant positive difference between consecutive terms.

Each sequence in this investigation has an odd number of terms.
Each term is a positive integer.

The *core integer* is the integer in the middle of the sequence.
The *shell integers* are the integer at the beginning and the integer at the end of the sequence.

<u>Example</u>

core integer ↓

For the sequence 6 9 12 15 18 21 24 the core integer is 15 and the shell integers are 6 and 24.

shell integers

You calculate the *value of the core* by multiplying the core integer by itself. $15 \times 15 = 225$

You calculate the *value of the shell* by multiplying the shell integers together. $6 \times 24 = 144$

F is the positive difference between the value of the core and the value of the shell. $F = 225 - 144 = 81$

1 **(a)** Write down the core integer and the shell integers for the sequence

5 7 9 11 13 15 17 19 21.

Core integer ....

Shell integers .... and ....
[1]

(b) Calculate F for the sequence in **part (a)**.

.... [2]

2 **(a)** Write down a linear sequence with 5 terms.

.... , ... , ... , ... , ... [1]

(b) For your sequence in **part (a)** find the value of F.
Write F as the square of a number.

.... [3]

3 The general linear sequence has 1st term a and common difference d.
So the first 3 terms of this sequence are $a,\ a+d,\ a+2d$.

(a) Write the 7th term of the general linear sequence in terms of a and d.

.... [1]

(b) A general linear sequence has 7 terms.

Find an expression for F.
Write your answer in the form $(kd)^2$ where k is a positive integer.

.... [3]

4 **(a)** Complete the table.

Linear sequence with common difference d			Number of terms n	F
1st term	Middle term	Last term		
a	$a+d$	$a+2d$		$(\quad)^2$
a	$a+2d$		5	$(\quad)^2$
a			7	$(\quad)^2$
a	$a+4d$	$a+8d$		$(\quad)^2$
a		$a+10d$		$(5d)^2$

[4]

(b) The 1st term of a linear sequence of positive integers is 1.
The value of F is 36.

Use the pattern in the F column in **part (a)** to help you find all the possible sequences.

[5]

5 **(a)** A linear sequence has n terms.
The common difference is d.

$F = 100d^2$

Find the number of terms in the sequence.

.... [2]

(b) Another linear sequence has n terms.
The common difference is d.

$F = d^4$.

(i) Find n in terms of d.

.... [2]

(ii) Give an example of a linear sequence with 11 terms where $F = d^4$.

.... [1]

Section B

MODELLING HAMMER THROWING

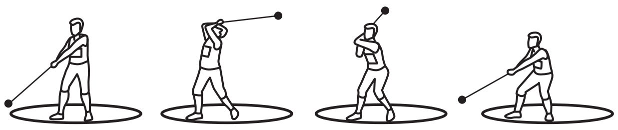
You are advised to spend no more than 45 minutes on this section.

In this task you will look at the sport of hammer throwing.

The task uses models to find the horizontal distance that an athlete can throw the hammer.
The hammer is a metal ball.
The metal ball is fixed to a wire with a handle.

A hammer throw has two stages.

Stage 1



The athlete rotates the hammer holding it by the handle.

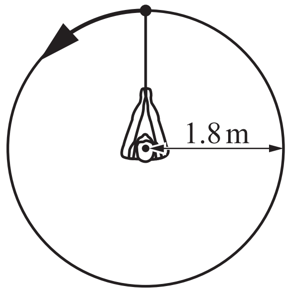
Stage 2

The athlete releases the hammer, which travels in a parabola before hitting the ground.

Athletes want to maximise the horizontal distance that the hammer travels after release.

6 **Stage 1**

The athlete rotates the hammer holding it by the handle.
The hammer travels along a circle of radius 1.8 m as shown in this diagram.



(a) The circumference, C, of a circle of radius r is $C = 2\pi r$.

Calculate how far the hammer travels in one complete turn.

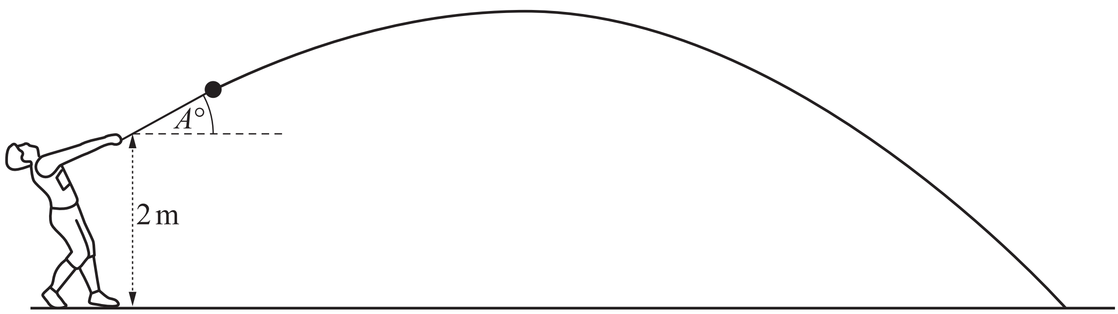
.... [2]

(b) The hammer makes N complete turns in one second.
The speed of the hammer is V m/s.

Write down a model for V in terms of N.

.... [1]

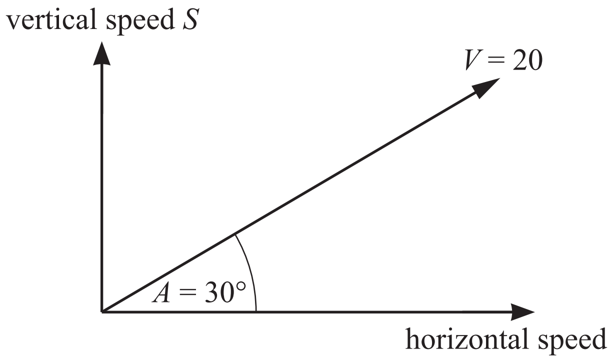
7 Stage 2



The diagram shows an athlete releasing the hammer at a speed of V m/s at an angle A to the horizontal. A is the *release angle*.

The athlete releases the hammer at a speed of 20 m/s with release angle 30°.

As the hammer travels it moves both vertically and horizontally as shown.



This is a model for the vertical speed S m/s.

$$S = V \sin A$$

(a) Calculate the vertical speed of the hammer.

.... [2]

(b) In this part assume that gravity has no effect.

The hammer travels vertically for x seconds at the speed that you calculated in **part (a)**.

(i) Write down an expression in terms of x for the number of metres that the hammer travels vertically.

.... [1]

(ii) The athlete releases the hammer when it is 2 metres above the ground.

Change your expression in **part (b)(i)** to give the number of metres that the hammer is above the ground after x seconds.

.... [1]

(c) Gravity reduces the height in **part (b)(ii)** by $4.9x^2$ metres.

(i) Write down a model for the height in metres, H, of the hammer above the ground after x seconds.

.... [1]

(ii) When the hammer hits the ground, $H = 0$.
The hammer hits the ground after x seconds.

Find the value of x.

.... [3]

8 The best release angle A is approximately 45°.
This angle gives the greatest horizontal distance that the hammer travels after release.

An Olympic athlete uses the best release angle.
The athlete releases the hammer at a speed of V m/s when the hammer is 2 metres above the ground.
The hammer hits the ground after x seconds.

(a) $S = V\sin A$ and $\sin 45° = 0.7$.

Use **Question 7(c)(i)** to show that $4.9x^2 - (0.7V)x - 2 = 0$.

[1]

(b) The formula for the solution of $ax^2 + bx + c = 0$ is $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$.

(i) Use this formula to solve $4.9x^2 - (0.7V)x - 2 = 0$ and show that a model for x is

$$x = \frac{V + \sqrt{V^2 + 80}}{14}.$$

[3]

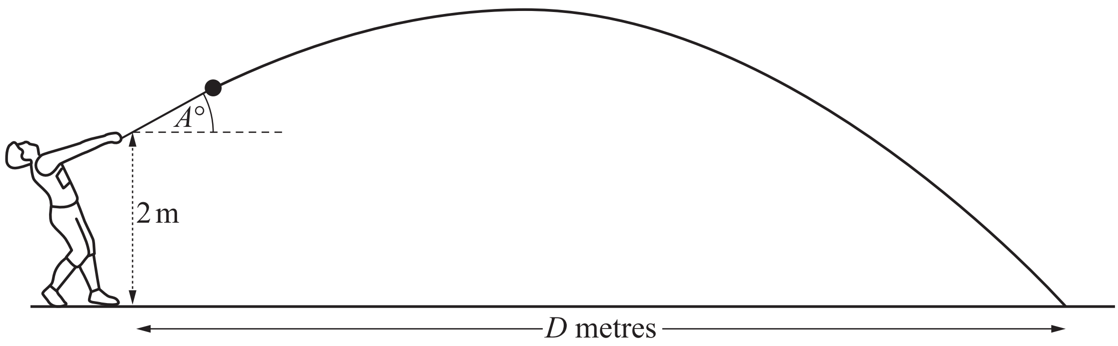
(ii) The solution $x = \dfrac{V - \sqrt{V^2 + 80}}{14}$ has been rejected because x cannot be negative.

Give a reason why $\dfrac{V - \sqrt{V^2 + 80}}{14}$ always gives a negative result.

.... [1]

9 An athlete uses the best release angle.
The hammer has a constant horizontal speed which is equal to the hammer's vertical speed at the moment of release.

(a) An athlete uses the best release angle A to throw a hammer at a speed of 20 m/s.
The horizontal distance that the hammer travels is D metres.



(i) Use $\sin A = 0.7$ and the model $S = V \sin A$ to find the horizontal speed.

.... [1]

(ii) Use the model in **Question 8(b)(i)** to find the value of D.

.... [3]

(b) An athlete throws a hammer at V m/s using the best release angle.

Use the model in **Question 8(b)(i)** to show that a model for D is

$$D = \frac{V^2 + V\sqrt{V^2 + 80}}{20}.$$

[1]

(c) In 2016 Anita Włodarczyk from Poland set the Women's World Record for hammer throwing.

Using the best release angle, she threw the hammer 82.98 metres.

(i) Use the model in **part (b)** to find the speed V m/s at which she released the hammer.
This was at the end of Stage 1 of her throw.

.... [2]

(ii) In **Question 6(b)**, at the end of Stage 1, the rate of turning is N turns per second.

Find the value of N for Anita Włodarczyk's record throw.

.... [2]

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