



## RUGBY SCHOOL

# Mathematics: 16+ Specimen Paper

Time allowed: 60 Minutes  
[Group 1: 70 marks or Group 2: 82marks]

### Instructions to Candidates:

- **Group 1:** Sections A and B should be completed by candidates not intending to study Maths in the Sixth Form, or who intend to study IB Standard Level Maths.
- **Group 2:** Sections B and C should be completed by candidates intending to study Maths or Further Maths at A level, or IB Maths at Higher Level

*A Group 1 candidate can choose to sit the Group 2 sections if they consider themselves a strong mathematician (anticipating a grade 9 at GCSE).*

- Write your solutions in the spaces provided.
- Show all your workings clearly. Poorly set out work may be penalised.
- Answer as many questions as you can.
- Do not worry if you do not finish your two sections in the time limit.
- Lined paper is available if needed.
- Calculators are allowed.

## Formulae Sheet

### Arithmetic Sequences and Series

General term,  $U_n = a + (n - 1)d$

Sum to  $n$  terms,  $S_n = \frac{n}{2}[2a + (n - 1)d]$

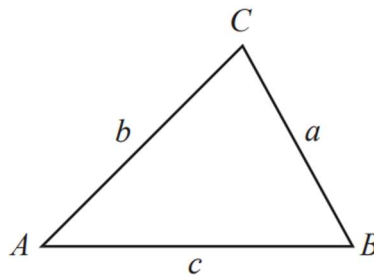
### Trigonometry

In any triangle, ABC,

$$\frac{a}{\sin(A)} = \frac{b}{\sin(B)} = \frac{c}{\sin(C)}$$

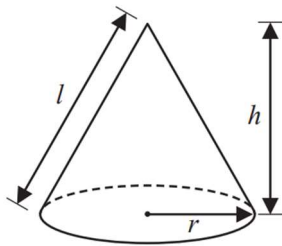
$$a^2 = b^2 + c^2 - 2bccos(A)$$

$$Area = \frac{1}{2}absin(C)$$

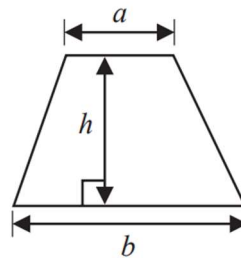


**Volume of cone** =  $\frac{1}{3}\pi r^2 h$

**Curved surface area of cone** =  $\pi r l$



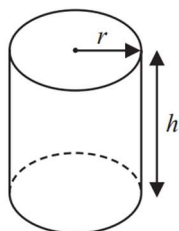
**Area of trapezium** =  $\frac{1}{2}(a + b)h$



**Volume of cylinder** =  $\pi r^2 h$

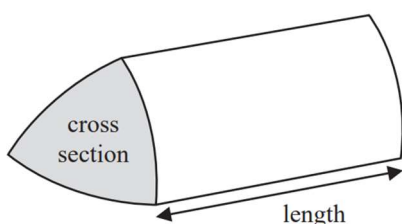
**Curved surface area**

**of cylinder** =  $2\pi r h$



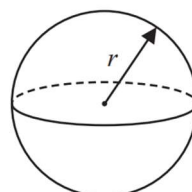
### Volume of prism

= area of cross section  $\times$  length



**Volume of sphere** =  $\frac{4}{3}\pi r^3$

**Surface area of sphere** =  $4\pi r^2$



# Section A

Group 1 Candidates only

Group 2 candidates (applying for Maths, Further Maths, or IB HL Maths) should not answer this section and instead skip to Section B.

**Q1.**

*(2 marks)*

Solve  $4x - 5 = 5$

**Q2.**

*(2 marks)*

Find the lowest common multiple (LCM) of 18 and 56. You must show your working.

**Q3.**

*(3 marks)*

Find which is larger

42% of 350

or

$\frac{3}{5}$  of 275

You must show all of your working.

**Q4.**

*(3 marks)*

Show that  $2\frac{7}{12} \times \frac{8}{21} = \frac{62}{63}$

**Q5.**

*(3 marks)*

In 2022, the population of a town was 12,500

In 2023, the population of the town was 13,900

Work out the percentage increase in the population of the town from 2022 to 2023

**Q6.**

*(6 marks)*

(a) Simplify  $a^9 \times a^4$

(b)  $Y = d^2 - 5d$

Find the value of  $Y$  when  $d = -5$

(c) Solve  $\frac{5x-3}{4} = 2x + 3$

Show clear algebraic working.

**Q7.**

(5 marks)

Alex makes 80 cakes to sell.

He makes only chocolate cakes, lemon cakes and fruit cakes where

Number of chocolate cakes : number of lemon cakes : number of fruit cakes = 3:2:5

Alex sells

All of the chocolate cakes

$\frac{3}{4}$  of the lemon cakes

$\frac{7}{8}$  of the fruit cakes

The profit he makes on each cake he sells is shown in the table.

Type of cake	Profit per cake he sells
Chocolate	£2.00
Lemon	£1.70
Fruit	£2.40

Work out the total profit that Alex makes from the cakes he sells.

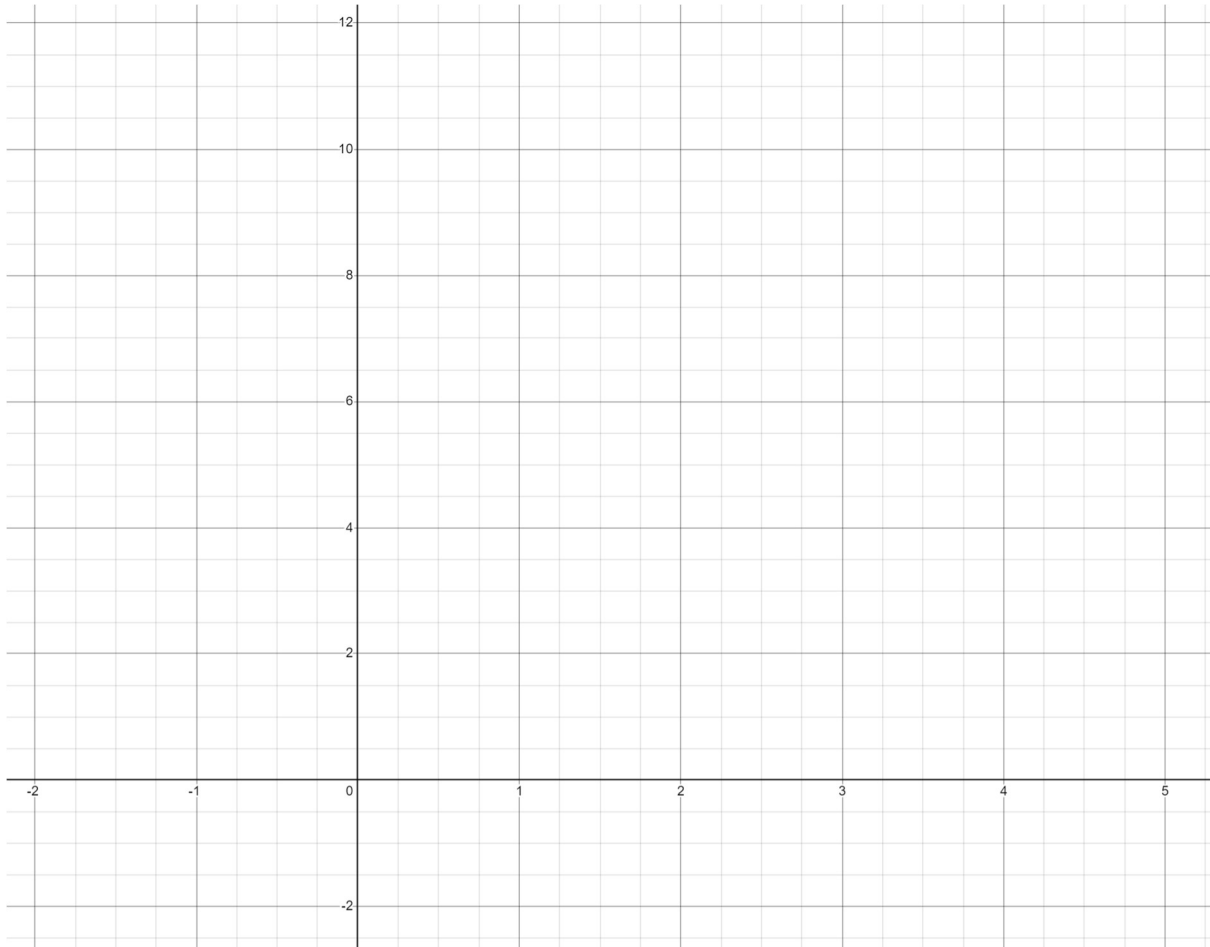
**Q8.**

(4 marks)

(a) Complete the table of values for  $y = x^2 - 2x + 2$

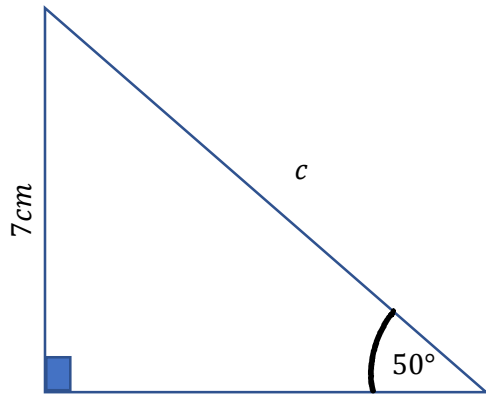
$x$	-2	-1	0	1	2	3	4
$y$							

(b) On the grid, draw the graph of  $y = x^2 - 2x + 2$  for values of  $x$  from -2 to 4

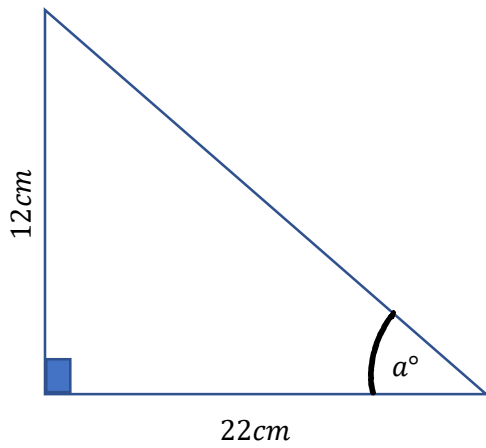


**Q9.**

*(6 marks)*



(a) In the triangle above, find the length of the side labelled  $c$ .



(b) In the triangle above, find the size (in degrees) of the angle labelled  $a$ .

*Group 1 candidates should continue with Section B*



# Section B

*All candidates should complete Section B.*

**Q1.**

*(6 marks)*

Solve the following equations

(a)  $\frac{2x+1}{3} - \frac{x-3}{4} = 10$

(b)  $\frac{3(4x-3)}{7} + 1 = x$

**Q2.**

*(3 marks)*

Harold bought an antique clock for £1200. The clock increased in value by 8% per year. Find the value of the clock exactly 3 years after Harold bought the clock. Give your answer correct to the nearest £.

**Q3.**

*(4 marks)*

Solve the simultaneous equations

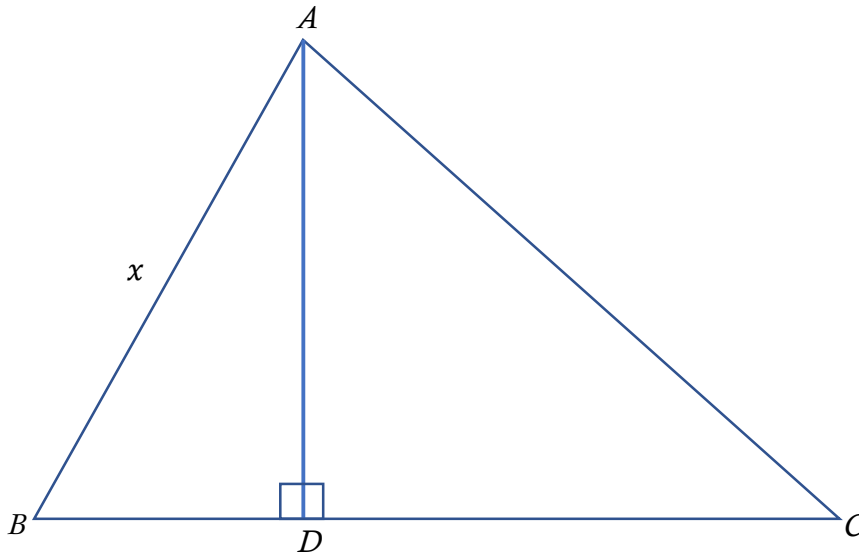
$$7x + 2y = 5.5$$

$$3x - 5y = 17$$

Show clear algebraic working.

**Q4.**

*(7 marks)*



In the triangle  $ABC$ ,  $AD$  is perpendicular to  $BC$ ,  $AD$  is  $1\text{ cm}$  less than  $AB$  and  $BD$  is  $8\text{ cm}$  less than  $AB$ , as shown.

- a) If  $AB = x$  as labelled, show that  $x^2 - 18x + 65 = 0$
- b) Solve the equation  $x^2 - 18x + 65 = 0$
- c) Using your answer to (b), or otherwise, find the length  $AB$ . Give a brief explanation of your answer

**Q5.**

*(3 marks)*

Expand and simplify  $(4x + 1)(3 - x)(5x + 6)$

**Q6.**

*(4 marks)*

In an arithmetic series, the 6<sup>th</sup> term is 39. In the same arithmetic series, the 19<sup>th</sup> term is 7.8

Work out the sum of the first 25 terms of the arithmetic series

*[In an arithmetic series, the terms of the series increase or decrease by a common amount. For example,  $2 + 5 + 8 + 11 + \dots$  is an arithmetic series.]*

**Q7.**

(3 marks)

The diagram shows a prism  $ABCDEFGH$  with an horizontal base.

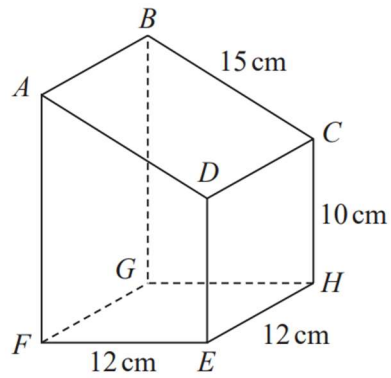


Diagram **NOT**  
accurately drawn

The base of the prism,  $EFGH$ , is a square of side 12 cm.

Trapezium  $ADEF$  is a cross section of the prism where  $AF$  and  $DE$  are vertical edges.

$$DE = CH = 10 \text{ cm}$$

$$AD = BC = 15 \text{ cm}$$

Work out the size of the angle between  $CF$  and the base  $EFGH$ .

Give your answer correct to one decimal place.

**Q8.**

(3 marks)

The diagram shows rectangle  $ABCD$  with rectangle  $EFGH$  cut out to form the shaded region.

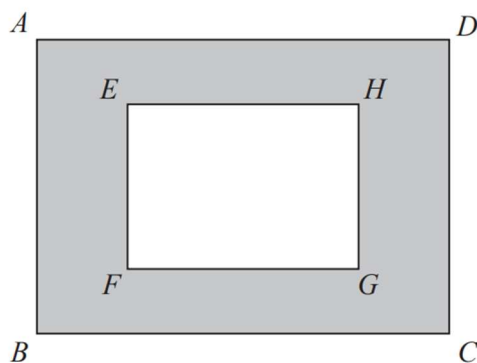


Diagram **NOT** accurately drawn

$AD = 8.3$  cm correct to one decimal place

$DC = 7$  cm correct to the nearest cm

$EH = 6.5$  cm correct to the nearest 5mm

$HG = 5.3$  cm correct to one decimal place

By considering the range of possible values taken by each length, work out the largest possible area of the shaded region. Show your working clearly.

**Q9.**

(3 marks)

My journey home from work usually takes me the same time each day. By what percentage would I need to increase my average speed in order for my journey to take 20% less time than usual?

*For Group 1 candidates (who have completed Section A), this is the end of the exam.  
Group 2 candidates (who will not have completed Section A), please continue with Section C.*

# Section C

*Group 2 candidates (A Level Maths, Further Maths, and IB HL) should complete this section.*

*Candidates in Group 1 can choose to answer Section C (instead of Section A) if they consider themselves a strong mathematician (anticipating a grade 9 at GCSE).*

**Q1.**

*(3 marks)*

Given that  $(2 + \sqrt{3})(5 + \sqrt{3}) \equiv a + b\sqrt{3}$ , find  $a$  and  $b$

**Q2.**

*(7 marks)*

(a) Given that  $\frac{2^{4x}}{4^x} = 16^{3y}$ , find an expression for  $y$  in terms of  $x$

(b) Solve  $\frac{2^{2x-1}}{4} = \frac{1}{16}$

**Q3.**

(4 marks)

(a) Find  $a$ ,  $b$ , and  $c$  if  $3x^2 + 12x + 7 \equiv b(x + c)^2 + a$  where  $a$ ,  $b$ , and  $c$  are integers.

Let  $y = 3x^2 + 12x + 7$ .

(b) Using your answer to part (a), write down the minimum value of  $y$ .

**Q4.**

(6 marks)

The curve with equation  $x^2 - x + y^2 = 10$  and the straight line with equation  $x - y = -4$  intersect at the points  $A$  and  $B$ .

Work out the exact length of  $AB$ .

Show your working clearly and give your answer in the form  $\frac{\sqrt{a}}{2}$  where  $a$  is an integer.



**Q5.**

*(5 marks)*

Express

$$\frac{1}{3x-2} \times \frac{9x^2-4}{3x^2-13x-10} - \frac{7}{x-1}$$

As a single fraction in its simplest form

**Q6.**

*(5 marks)*

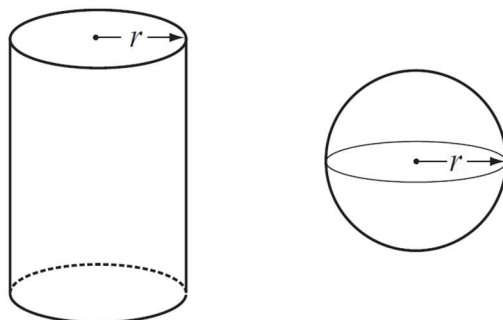


Diagram **NOT**  
accurately drawn

The diagram shows a solid cylinder and a solid sphere.  
The cylinder has radius  $r$ .  
The sphere has radius  $r$ .

Given that  $\frac{\text{Total surface area of cylinder}}{\text{Surface area of sphere}} = 2$

find the value of  $\frac{\text{Volume of cylinder}}{\text{Volume of sphere}}$

**Q7.**

*(4 marks)*

In a bag, there are only

3 blue beads  
4 white beads  
and  $x$  orange beads.

Jean is going to take at random two beads from the bag. The probability that Jean will take two beads of the same colour is  $\frac{3}{8}$ . Find the total number of beads in the bag. Show clear algebraic working.

**Q8.**

*(3 marks)*

Fully factorise

$$ax + ay + 2bx + 2by$$

**Q9.**

(6 marks)

The *digit sum* of a number is defined to be the total of its digits when added together.

For example, the *digit sum* of 3376 is  $3+3+7+6 = 19$

- (a) A number, N, has a digit sum of 6. None of the digits is a 0, and no digit occurs more than once. What is the largest number that N can be?
- (b) A number, M, has a digit sum of 6. None of the digits is a 0 but some digits may be repeated. What is the largest number that N can be?
- (c) A number, P, has a digit sum of 6 with no other conditions. Is it possible to identify the largest number that M can be? Explain your answer.

**Q10.**

(3 marks)

For each positive two-digit number, Jack subtracts the units digit from the tens digit; for example, the number 34 gives  $3 - 4 = -1$ .

What is the sum of all of his results?

*This is the end of the exam. If you have finished early, use the spare time to check your answers.*