OUNDLE
School

EXAMINATION PAPER
Academic Scholarship 2026

Mathematics Paper 2

Time allowed: 1 hour

Name: _____

Instructions

- Calculators are **NOT** allowed
- This paper consists of **7** questions
  - You are **not** expected to have time to answer all of the questions
  - You can attempt the questions in **any order**
  - Focus on completing some questions in full rather than rushed or incomplete answers to every question
- Full working is required, not just answers
  - Your working should clearly demonstrate how you have arrived at your answer, and should be presented in a clear, mathematical way
  - There may be more space provided than required

Question 1

When the diagram below is complete, the number in the middle of each group of three adjoining cells is the mean of its two neighbours.

	10.5		17	

a) Fill in the blank cells

The same rules apply to the diagram below.

8			21.2	

b) Work out the number that goes in the right-hand cell
[hint: let the middle cell equal n]

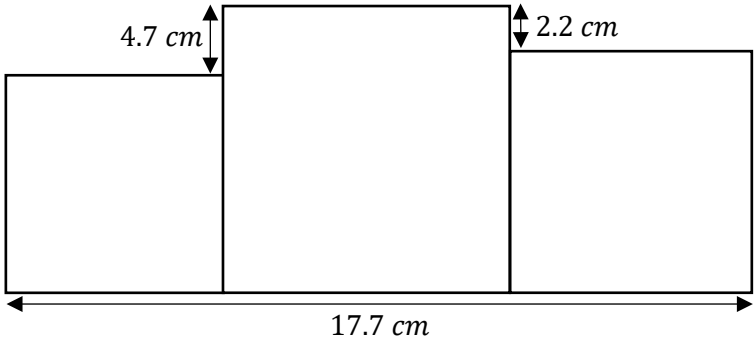
This time, the cells contain algebraic terms.

x			y	

c) Find an expression in terms of x and y for the right-hand cell

Question 2

The diagram below (not drawn to scale) shows three squares. Using the measurements provided, calculate the total area of all three squares.



Question 3

It is possible to approximate the square root of a number, x, that isn't a perfect square, using the nearest square number, n^2.

If the nearest square number, n^2, is less than x:

$$\sqrt{x} \approx n + \frac{x - n^2}{2n}$$

ie.

$$\sqrt{27} \approx 5 + \frac{27 - 25}{2 \times 5}$$
$$\sqrt{27} \approx 5 + \frac{2}{10}$$
$$\sqrt{27} \approx 5\frac{1}{5}$$

If the nearest square number, n^2, is greater than x:

$$\sqrt{x} \approx n - \frac{n^2 - x}{2n}$$

ie.

$$\sqrt{33} \approx 6 - \frac{36 - 33}{2 \times 6}$$
$$\sqrt{33} \approx 6 - \frac{3}{12}$$
$$\sqrt{33} \approx 5\frac{9}{12} = 5\frac{3}{4}$$

[≈ means approximately equal to]

Use this method to approximate the following, leaving your answers as mixed numbers:

a) $\sqrt{53}$

b) $\sqrt{75}$

c)

(i) Use the method to approximate both $\sqrt{20}$ and $\sqrt{5}$
Leave your answers as mixed numbers.

(ii) Using your answers to part (i), estimate the value of $\sqrt{20} \times \sqrt{5}$

(iii) $\sqrt{20} \times \sqrt{5}$ is actually equal to exactly 10. What is the percentage error in your answer to part (ii)?

Question 4

The town of Oundle has invented its own currency, using three different coins called Beans, Piglets, and Lemons. No coins can be split into smaller or fractional denominations.

10 Beans and 3 Piglets are worth the same amount as 7 Piglets and 3 Beans, which is worth the same as 9 Lemons, and 1 Piglet.

a) Complete the following sentences; each number should be an integer (whole number)

(i) ___ Bean(s) = ___ Piglet(s)

(ii) ___ Piglet(s) = ___ Lemon(s)

(iii) ___ Bean(s) = ___ Lemon(s)

(iv) ___ Bean(s) = ___ Piglet(s) = ___ Lemon(s)

b) Put the coins in order of value, from least to most valuable

The coins in use are the only form of money used in Oundle, which can make transactions a bit tricky…payments sometimes have to be much higher than the price so that exact change can be given – there are no part coins (ie. you can't have 0.5 beans).

c) If you wanted to buy something that cost 1 Bean,

   (i) how much change would you get if you paid with 2 Lemons?

   (ii) how much change would you get if you paid with 2 Piglets?

d) If you wanted to buy something that cost 12 piglets, but only had Beans and Lemons, how many different ways could you pay without needing any change?

Question 5

Using each of the digits 0, 1, and 2 once only, it is possible to write a 3-digit number so that the first digit is divisible by 1, the number formed by the first two digits is divisible by 2, and the number formed by all three digits is divisible by 3.

ie. 120 works because

- 1 is divisible by 1
- 12 is divisible by 2
- 120 is divisible by 3

210 does not work because

- 2 is divisible by 1
- 21 is **not** divisible by 2
- 210 is divisible by 3

In this question, numbers with a leading zero (ie. 012) do not count.

a) Find another 3-digit number which satisfies the conditions above.

This problem can be extended to longer numbers, with the numbers formed by the first k digits being divisible by k, ie. the number formed by the first 4 digits is divisible by 4, etc.

b) The 4-digit version of this problem (using the digits 0 – 3) has no solutions – explain logically why this is the case.

c) The 10-digit version of this problem, using all of the digits from 0 to 9, has one unique solution.

(i) Determine where the digits 5 and 0 must go, explaining your reasoning

(ii) Given that the solution starts with the digits 3 and 8, determine the positions of the remaining digits.

Question 6

A unit fraction is a fraction with a numerator of 1.

A unit fraction with an even denominator can be written as the sum of *two* distinct (different) unit fractions by splitting it into two thirds and one third of its original value.

ie.

$$\frac{1}{2} = \frac{2}{3} \times \frac{1}{2} + \frac{1}{3} \times \frac{1}{2}$$

$$\frac{1}{2} = \frac{1}{3} + \frac{1}{6}$$

a) Write one quarter as the sum of two distinct unit fractions using the method given.

A unit fraction with an odd denominator can be written as the sum of *three* distinct unit fractions, first by splitting into halves, and then applying the method above to *one* of the two equal unit fractions.

ie.

$$\frac{1}{3} = \frac{1}{2} \times \frac{1}{3} + \frac{1}{2} \times \frac{1}{3}$$

$$\frac{1}{3} = \frac{1}{6} + \mathbf{\frac{1}{6}}$$

$$\frac{1}{3} = \frac{1}{6} + \mathbf{\frac{2}{3}} \times \mathbf{\frac{1}{6}} + \mathbf{\frac{1}{3}} \times \mathbf{\frac{1}{6}}$$

$$\frac{1}{3} = \frac{1}{6} + \mathbf{\frac{1}{9}} + \mathbf{\frac{1}{18}}$$

b) Write one fifth as the sum of three distinct unit fractions using the method given.

One fifth can also be written as the sum of five distinct unit fractions by using a combination of the methods given above:

$$\frac{1}{5} = \frac{1}{10} + \frac{1}{10}$$

$$\frac{1}{5} = \frac{1}{10} + \frac{1}{20} + \frac{1}{20}$$

$$\frac{1}{5} = \frac{1}{10} + \frac{1}{20} + \frac{1}{40} + \mathbf{\frac{1}{40}}$$

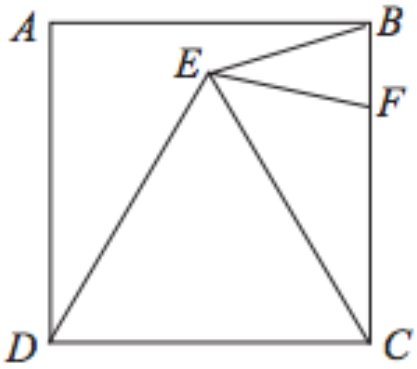
$$\frac{1}{5} = \frac{1}{10} + \frac{1}{20} + \frac{1}{40} + \mathbf{\frac{2}{3} \times \frac{1}{40}} + \mathbf{\frac{1}{3} \times \frac{1}{40}}$$

$$\frac{1}{5} = \frac{1}{10} + \frac{1}{20} + \frac{1}{40} + \mathbf{\frac{1}{60}} + \mathbf{\frac{1}{120}}$$

c) Write one sixth as the sum of six distinct unit fractions, showing all the stages of your working.

Question 7

In the diagram shown, $ABCD$ is a square and the point F lies on BC. Triangle DEC is equilateral and $EB = EF$.



What is the size of angle CEF?

Full solutions, with angle reasons and correct use of notation will receive higher marks.