WINCHESTER
COLLEGE

ELECTION

Mathematics 2

Wednesday 8 May 2019

Time allowed: 1 hour 30 minutes

Total marks: 100

Calculators are not allowed.

Write your answers in this booklet. If you need additional space, please write on sheets of A4 paper and attach them to this booklet. You may use a pencil for diagrams.

Work carefully, and *do not be discouraged if you do not finish*.

You should show your working so that credit may be given for partly correct answers.

1.

a) Evaluate $28 \div \dfrac{7}{3}$.

b) Evaluate $(3\sqrt{11})^2 + 1$. [1]
[1]

c) Evaluate $\sqrt{1.96}$.

d) Evaluate $\dfrac{0.09 \times 0.028}{0.00006}$. [1]
[1]

e) What fraction is halfway between $\dfrac{1}{4}$ and $\dfrac{1}{5}$?

f) Find 20% of 40% of 80% of 5000. [2]
[2]

2. Solve:

a) $4(7-x)-5(2x-1)=12$

b) $\left(\dfrac{x-1}{11}\right)^3 = 8$ [2]
[2]

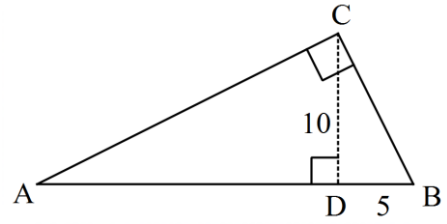c) $\dfrac{2}{x-5} = \dfrac{3}{x+1}$

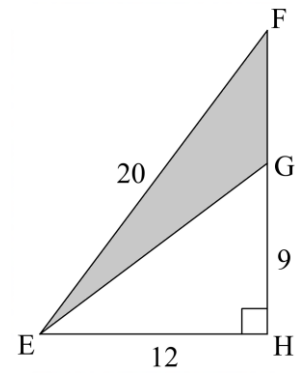d) $\dfrac{77}{15 - \dfrac{8}{7-x}} = 7$ [2]
[2]

3.

a) In the diagram below, $CD = 10$ and $BD = 5$. Find the area of triangle ABC. [3]
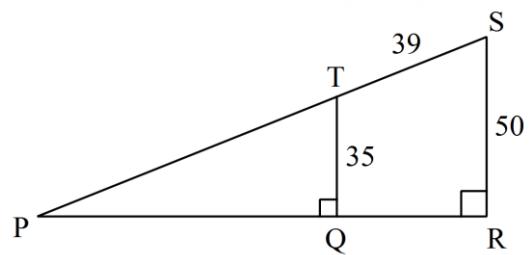

b) In the diagram below, $EH = 12$, $GH = 9$ and $EF = 20$. Find the area of triangle EFG. [4]

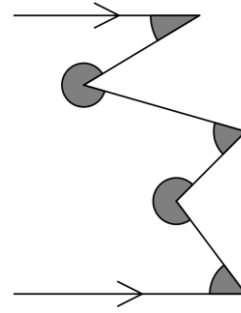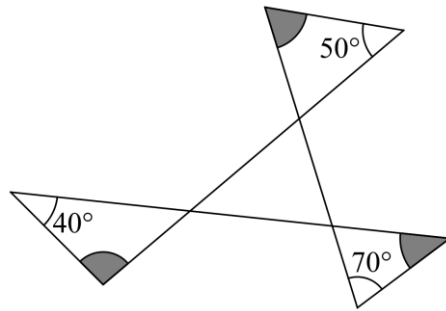c) In the diagram below, $TQ = 35$, $SR = 50$ and $TS = 39$. Find the area of triangle PRS. [5]

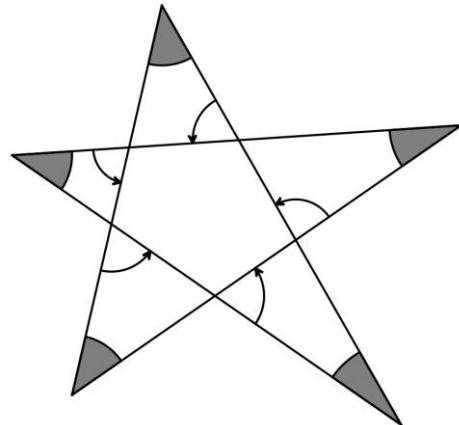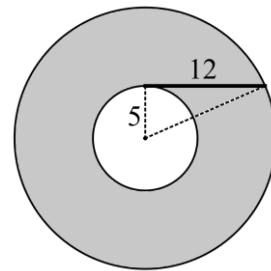| 4.	a) In the diagram below, two of the six lines are parallel. Find the sum of the shaded angles.	[2]
	b) In the diagram below, there are six straight lines. Find the sum of the shaded angles.	[3]
	c) In the diagram below, there are five straight lines. Find the sum of the shaded angles. (*Hint*: you might consider the sum of the arrowed angles.)	[3]

5.

a) Multiply out $(a-b)(a+b)$. [1]

b) Find all the solutions of the equation $a^2 - b^2 = 99$, where a and b are (positive) whole numbers. [6]
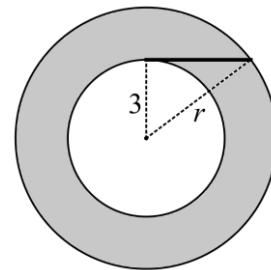
5. [1]

6. In all the diagrams below, the circles are concentric, radii are dotted and tangents are bold.
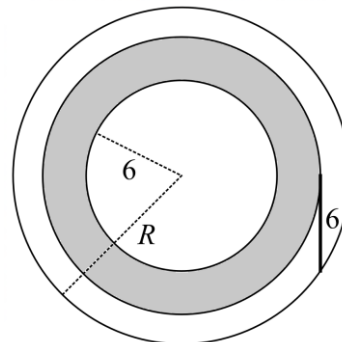
a) Find the shaded area in the diagram below. [2]

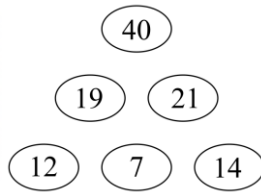b) The shaded area in the diagram below is 16π. Find r, the radius of the larger circle. [2]

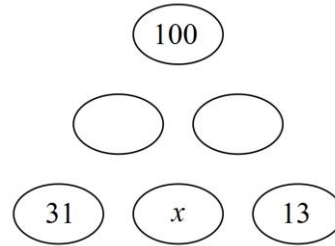c) In the diagram below, the shaded area is 49π. Find R, the radius of the largest circle. [4]

7. In a *plus-pyramid*, every number is a whole number greater than zero and is the sum of the two numbers below it. The diagram below gives an example.
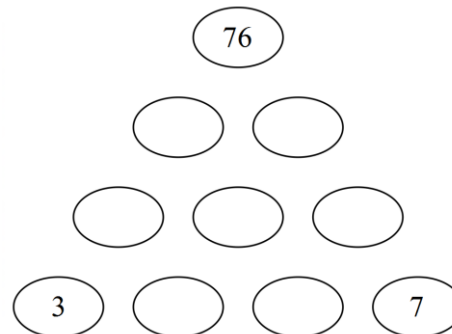
$$40$$
$$19 \quad 21$$
$$12 \quad 7 \quad 14$$

a) The diagram below shows another plus-pyramid. Find x. [2]

$$100$$
$$\bigcirc \quad \bigcirc$$
$$31 \quad x \quad 13$$

b) How many different ways of completing the plus-pyramid below are there? [4]

$$76$$
$$\bigcirc \quad \bigcirc$$
$$\bigcirc \quad \bigcirc \quad \bigcirc$$
$$3 \quad \bigcirc \quad \bigcirc \quad 7$$

In a *times-pyramid*, every number is a whole number greater than zero and is the product of the two numbers below it. The diagram below gives an example.
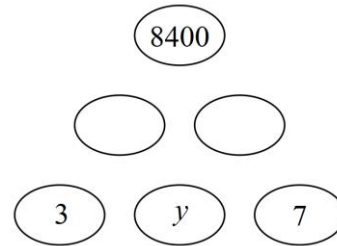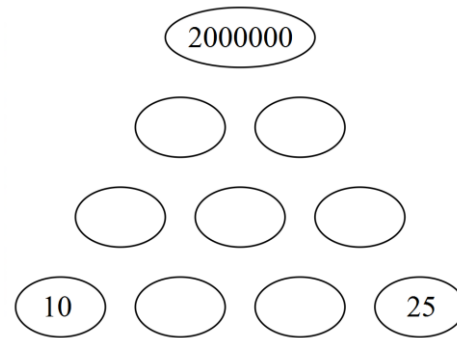
$$300$$
$$10 \quad 30$$
$$1 \quad 10 \quad 3$$
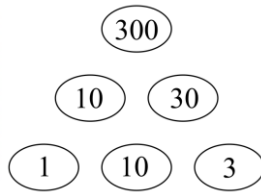
c) The diagram below shows another times-pyramid. Find y. [2]

$$8400$$
$$\bigcirc \quad \bigcirc$$
$$3 \quad y \quad 7$$

d) How many different ways of completing the times-pyramid below are there? [5]

$$2000000$$
$$\bigcirc \quad \bigcirc$$
$$\bigcirc \quad \bigcirc \quad \bigcirc$$
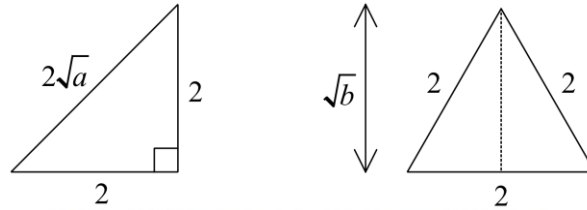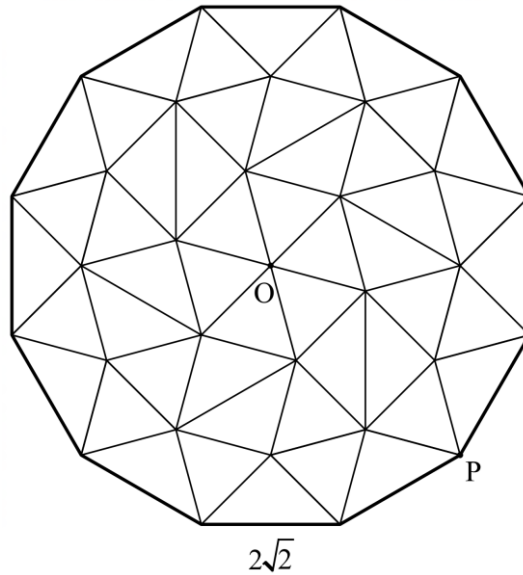$$10 \quad \bigcirc \quad \bigcirc \quad 25$$

8.

a) Find a and b. [2]

b) The diagram below shows a bold regular dodecagon (12 sides) divided into equilateral triangles (all the same size) and right-angled isosceles triangles (also all the same size). The length of a side of the dodecagon is $2\sqrt{2}$. Find the area of the dodecagon. Give your answer in the form $c + d\sqrt{3}$. [3]
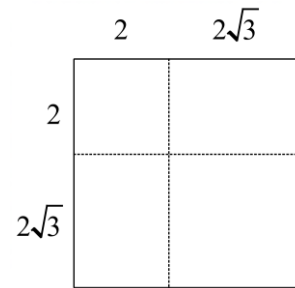

$2\sqrt{2}$

c) Find the distance OP. [1]

d) Find $(2 + 2\sqrt{3})^2$, in the form $p + q\sqrt{3}$. You might find the diagram below useful. [2]

e) Using the fact that the area of the circle through the vertices of the dodecagon has area $\pi(OP)^2$, find an approximation to π. Show your working clearly. [2]

f) All the shaded triangles in the diagram below are equilateral. The area of the bold outer regular dodecagon is 40. Find the area of the bold innermost regular dodecagon. [4]
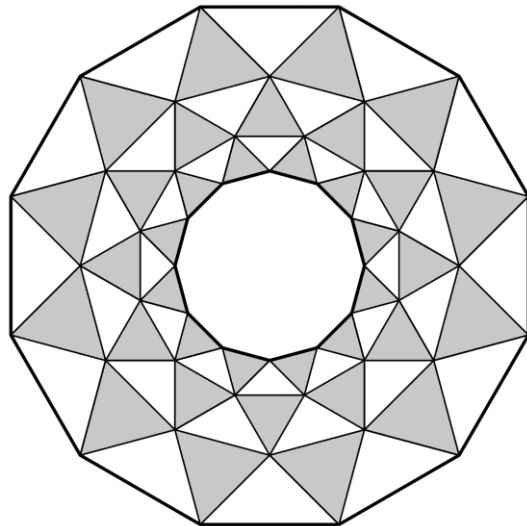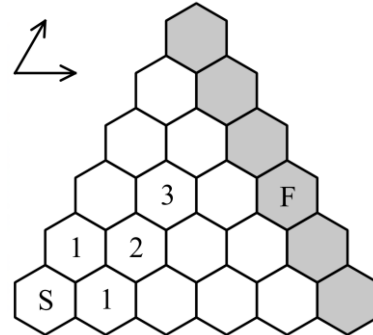
9.	A bee starts in cell S and moves from cell to cell, always moving in the direction of one of the arrows (to the right, or up and to the right).

a) How many routes to cell F can the bee take?   [3]

(*Hint*: one cell has a three in it because there are three routes to that cell.)
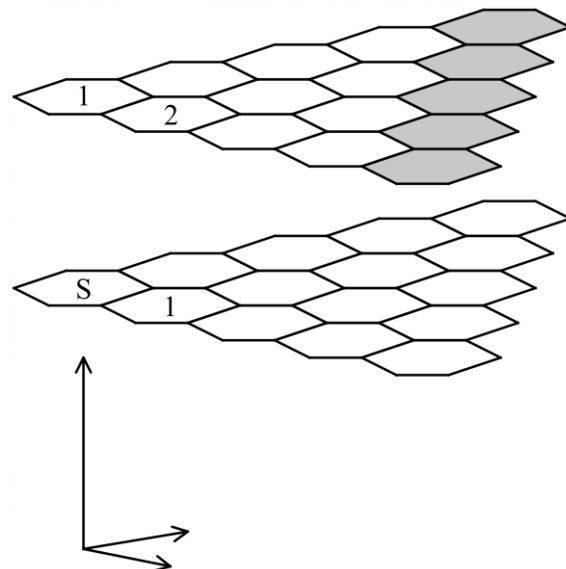

b) How many routes to the shaded row can he take?   [3]

c) The bee now navigates two layers of cells in the 3-D diagram below, always moving in the direction of one of the arrows. How many routes to shaded row can he take?   [4]
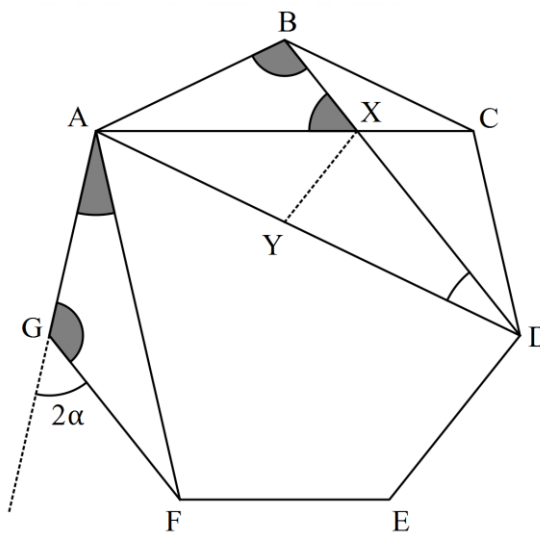
(One cell has a two in it because there are two routes to that cell.)

10. The diagram shows a regular heptagon with external angle 2α. X lies on AC and BD.

a) Find the value of 7α. [1]

b) Write the value of each of the shaded angles, in terms of α, on the diagram. Also prove that $\angle XDY = \alpha$. [6]

c) Triangle XDY is isosceles. Prove that $AB + AX = AD$. [5]

(END OF PAPER)