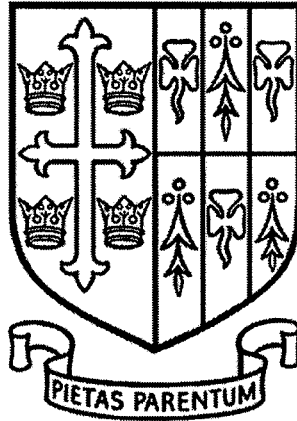


ST EDWARD'S OXFORD



13+ SCHOLARSHIP EXAMINATION 2010

MATHEMATICS PAPER II

1 hour

Answer all questions, showing **full** working.
Calculators are allowed.

Name: _____

1. **Compactness**

The compactness value, C, of a shape can be calculated using the formula

$$C = \frac{4A}{\pi K^2}$$

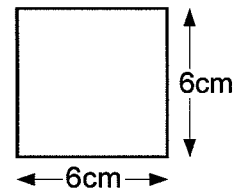
The **area** of the shape is **A**.

The **distance** between two points in the shape that are **furthest apart** is **K**.

(a) **Calculate** the compactness value for this square.

(The distance K is the length of a diagonal.)

Show your working.

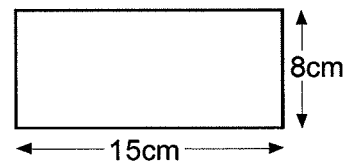


Compactness value

3 marks

(b) **Calculate** the compactness value for this rectangle.

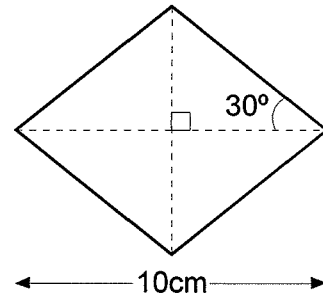
Show your working.



Compactness value

2 marks

- (c) **Calculate** the compactness value for this rhombus.
 (An angle is given for you to use in your calculation.)
 Show your working.



Compactness value

3 marks

- (d) Calculate the compactness value of a circle with radius 3cm.
 (The distance K is the length of a diameter).
 Show your working.



Compactness value

2 marks

- (e) What is the compactness value of a circle with radius R?

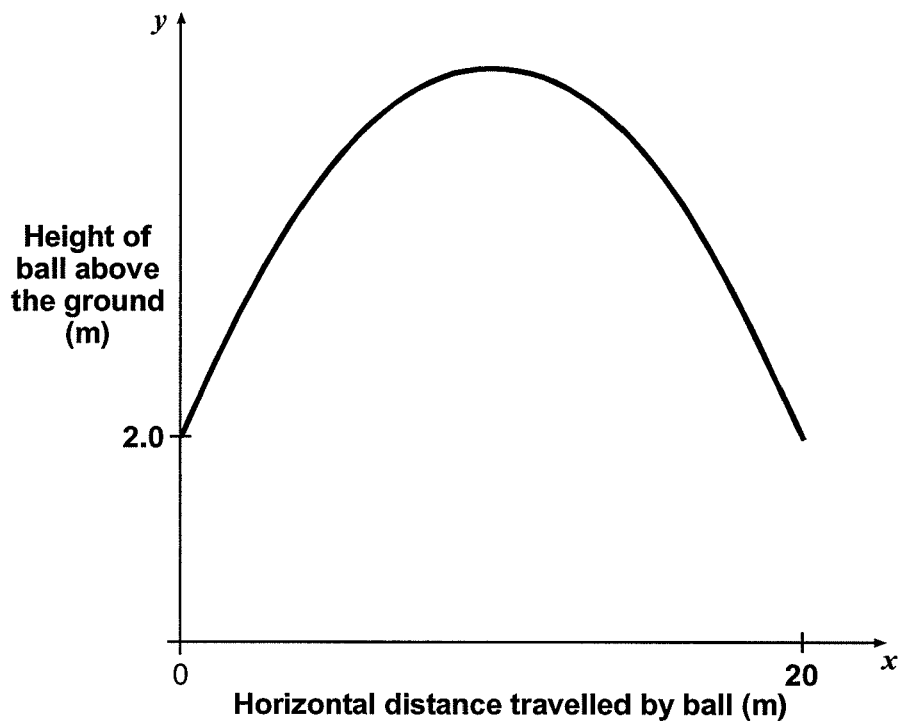


Compactness value

1 mark

2. Throw

Alan throws a ball to Katie who is standing 20m away.
The ball is thrown and caught at a height of 2.0m above the ground.



The ball follows the curve with equation

$$y = 6 + c(10 - x)^2 \quad \text{where } c \text{ is a constant.}$$

- (a) Calculate the value of c by substituting $x = 0$, $y = 2$ into the equation.

Show your working.

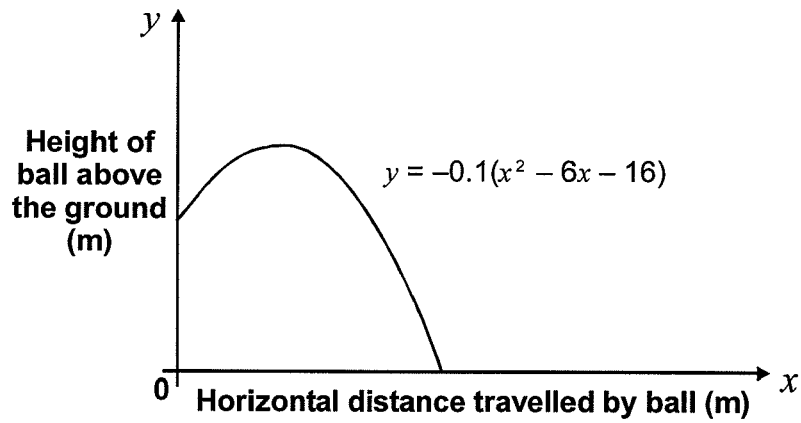


$$c = \dots\dots\dots$$

3 marks

Alan throws the ball to Katie again, but this time the ball hits the ground before it reaches her.

The ball follows the curve with equation $y = -0.1(x^2 - 6x - 16)$



- (b) Calculate the height above the ground at which the ball left Alan's hand.

Show your working.



..... m

3 marks

3. Tanks

On a farm many years ago the water tanks were filled using a bucket from a well.

- (a) The table shows the numbers of buckets, of different capacities, needed to fill a tank of capacity 2400 pints.

Complete the table:



| | | | | | | | |
|----------------------------|---|----|-----|----|-----|-----|----|
| Capacity of bucket (pints) | 8 | 10 | 12 | 15 | 16 | | |
| Number of buckets | | | 200 | | 150 | 100 | 80 |

- (b) Write an equation using symbols to connect **T**, the capacity of the tank, **B**, the capacity of a bucket, and **N**, the number of buckets.



1 mark

- (c) Now tanks are filled through a hosepipe connected to a tap.
The rate of flow through the hosepipe can be varied.

The tank of capacity **4000** litres fills at a rate of **12.5** litres per minute.
How long in hours and minutes does it take to fill the tank?

Show your working.



..... hours minutes

2 marks

- (d) Another tank took **5 hours** to fill at a **different rate** of flow.
How long would it have taken to fill this tank if this rate of flow had been increased by **100%**?



..... hours minutes

1 mark

- (e) How long would it have taken to fill this tank if the rate of flow had been increased by only **50%**?

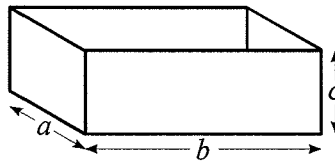
Show your working.



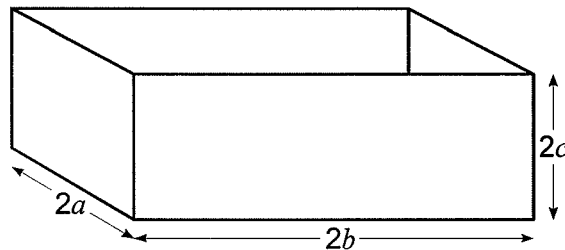
..... hours minutes

2 marks

- (f) This tank, measuring a by b by c , takes 1 hour 15 minutes to fill.



How long does it take to fill $2a$ by $2b$ by $2c$, at the same rate of flow?



Show your working.

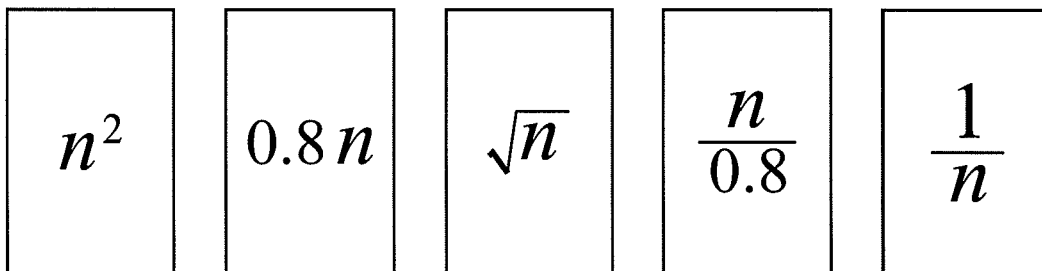


2 marks

4. Operations

For each of these cards n can be any positive number.

The **answers** given by the cards are all positive numbers.



- (a) Which card will **always** give an answer **less than n** ?



1 mark

- (b) When n is **1**, which cards will give the answer 1?



2 marks

- (c) When n is **4**, which cards will give an answer **less than 4**?



2 marks

- (d) When n is **less than 1**, which cards will give an answer **less than n** ?

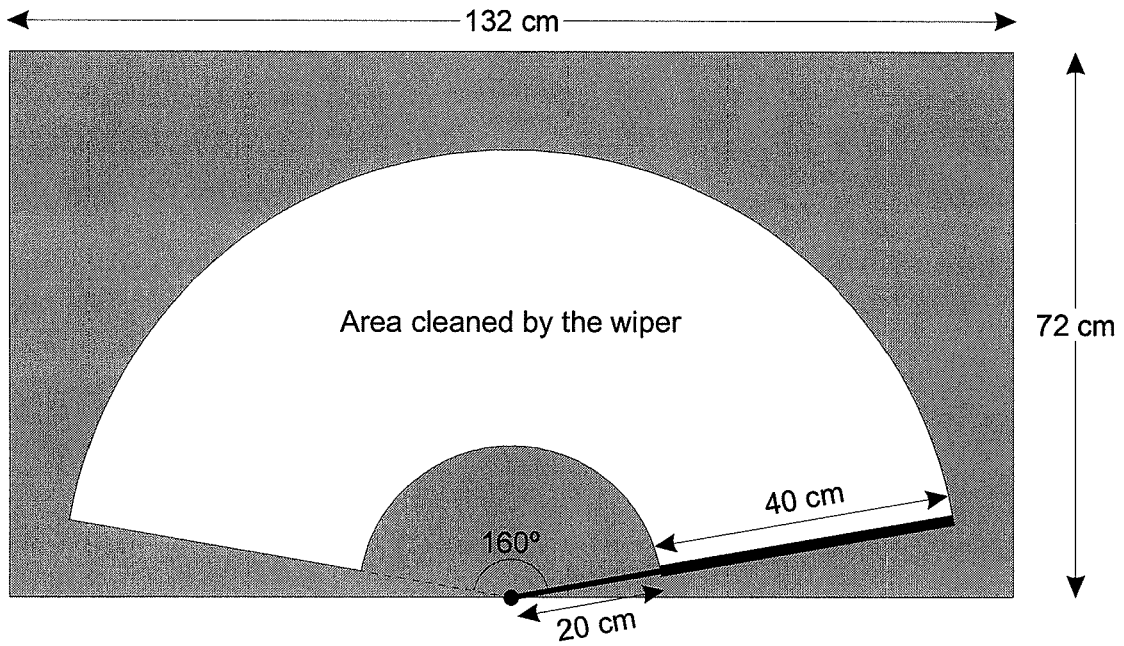


2 marks

5. **Windscreen wiper**

The diagram models a rectangular rear windscreen of a car.

The windscreen wiper can rotate through 160°



What percentage of the rear windscreen is cleaned by the wiper?

Show your working.



..... %

5 marks

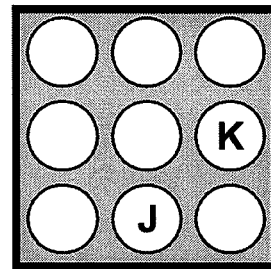
6. **Game**

A computer game has nine circles arranged in a square.

The computer chooses circles at random and shades them black.

- (a) At the start of the game, two circles are to be shaded black.

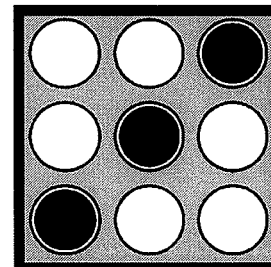
Show that the probability that both circles
J and K will be shaded black is $\frac{1}{36}$



1 mark

- (b) Halfway through the game, three circles are to be shaded black.

Here is **one example** of the three circles
shaded black in a straight line.



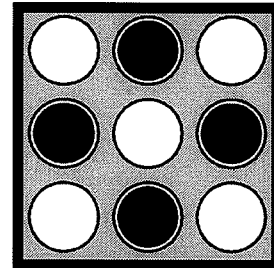
Show that the probability that the three circles shaded black will be
in a straight line is $\frac{8}{84}$



3 marks

(c) At the end of the game, four circles are to be shaded black.

Here is **one example** of the four circles shaded black forming a square.



What is the probability that the four circles shaded black form a square?

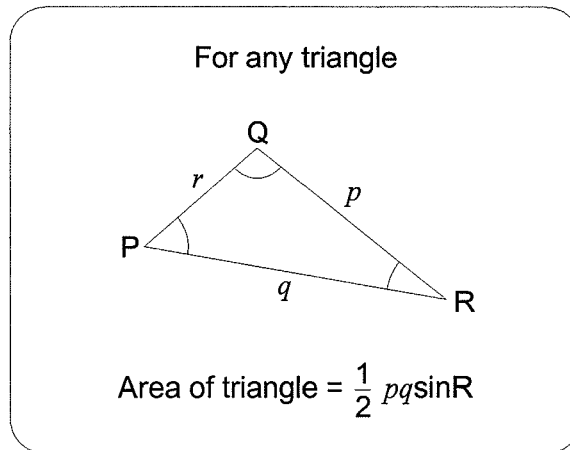
Show your working.



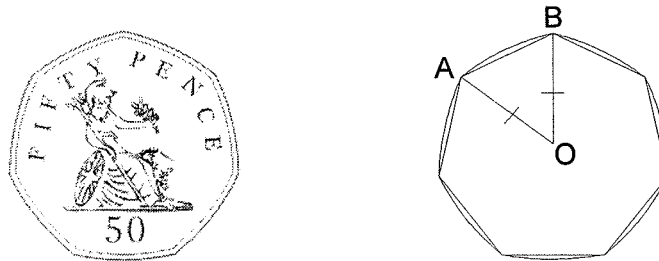
3 marks

7. **Fifty pence**

Note: For some of the calculations in this question, you may wish to use the formula in the box.



This question is about calculating the area of a fifty pence coin.



- (a) The centre, O, of the fifty pence coin is the same distance, 1.39 cm, from all seven vertices.

Show that the area of triangle AOB is approximately 0.76 cm²

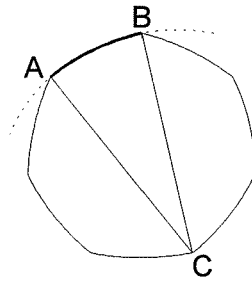


2 marks

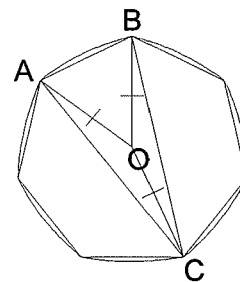
The edges of the fifty pence coin are not straight.

Each edge is an arc of a circle.

The centre of the circle is the opposite vertex of the fifty pence coin.



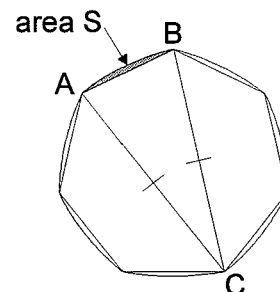
(b) Show that length AC is approximately 2.71 cm.



3 marks

(c) Using values from parts (a) and (b), find the area of sector ABC, and the area of triangle ABC.

Then show that the shaded area S is approximately 0.055 cm^2



5 marks

(d) Calculate the area of a fifty pence coin.

Show your working.



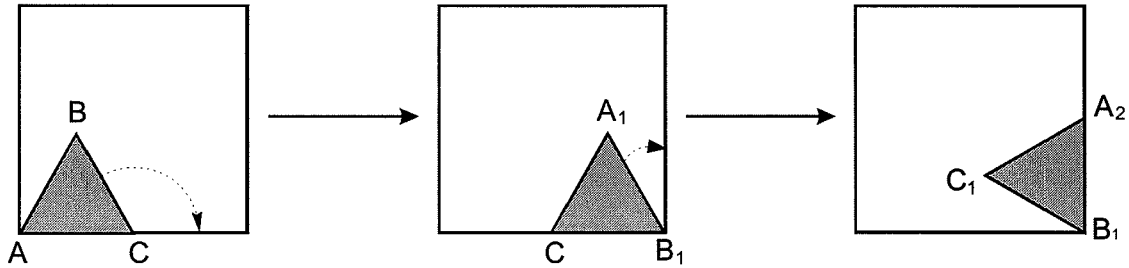
..... cm²

2 marks

8. Turning


An equilateral triangle ABC has side length 10cm.

It rotates around the inside of a square of side length 20cm.



(a) Triangle ABC rotates about C to the position shown as CA_1B_1

What is the angle of rotation?



1 mark

(b) Calculate the distance along the path travelled by point A in **turning** from A to A_1

Show your working.



..... cm

2 marks

(c) Calculate the distance along the path travelled by point A in **turning** from A_1 to A_2

Show your working.



..... cm

2 marks

The triangle continues rotating around the inside of the square in the same way until it is back at the original position.

- (d) Which of the original points A, B or C will point A land on when it has completed its rotations around the inside of the square?



.....

1 mark

- (e) Calculate the **total** distance along the path travelled by point A

Show your working.



..... cm

3 marks

End of Paper