Surname ..... **Candidate number** .....

First name .....

Current school .....

mgs Founded 1515 | The Manchester Grammar School

Entrance Examination 2019
Arithmetic Section B

1 Hour

Do not open this booklet until told to do so

Calculators may not be used

Write your names, school and candidate number in the spaces provided at the top of this page.

For each question, show all your working in full, as this will be marked, and then write your answer clearly in the space provided. If you run out of space for an answer use the space provided at the end of this booklet, numbering your answers carefully.

You have 1 hour for this paper which is worth 80 marks.

Marker	Short Problems Q1 - 6	Longer Problems Q7 - 11	**TOTAL**
Score			
out of	**30**	**50**	**80**

1. The table below shows the highest and lowest temperatures in °C recorded in six cities around the world on one particular day last year

City	Highest temperature (°C)	Lowest temperature (°C)
Boston	30	8
Munich	19	- 6
Los Angeles	23	11
Cairo	32	19
St Petersburg	9	- 8
Budapest	10	- 9

(a) What is the difference between the highest and lowest temperatures in Boston? 1a ____ °

(b) What is the difference between the highest and lowest temperatures in St Petersburg? 1b ____ °

(c) Which city has the lowest recorded temperature of all? 1c ____

(d) Which city has the largest difference between its highest and lowest temperature? 1d ____

[4 marks]

2. The gas meter reading on Andrew's smart meter in October was 5475 units. Exactly **three** months later, in January, the reading was 6045 units. M-power charge a fixed amount of £16.20 **each month** plus 40p for **each unit** used during the three months between the two readings.

(a) How many units of gas has Andrew used in the three month period from October to January?

2a	

(b) Calculate the **total** amount Andrew has to pay for that three month period.

2b	£

(c) In fact, M-power also have to add 5% to Andrew's bill which is the tax known as VAT. What will be the **final** bill that Andrew has to pay for his gas?

2c	£

[5 marks]

3. The “Blast” of a two digit number is obtained as follows:

The Blast of 63 is 216 because 6 x 6 x 6 = 216

and the Blast of 27 is 128 because 2 x 2 x 2 x 2 x 2 x 2 x 2 = 128

(a) Write down the Blast of the two digit number 34

3a

(b) Which two digit number has a Blast of 125

3b

(c) Work out another two digit number which has the **same** Blast as 24

3c

(d) A particular two digit number is Blasted and then that answer is also Blasted. If the final answer is 9, what was the **original** number?

3d

[5 marks]

4. A plant grows during the first month after it is planted. During the second month it grows by half the height it had already reached. During the third month it grows by one third of the height it had reached at the end of the second month. It then grows by one quarter and one fifth of the height reached in the same way in the next two months.

(a) If a plant is 1 metre tall at the end of the first month, how tall will it be after five months?

4a ____ m

(b) If a plant **grows** 90 cm in the third month, how tall was it after one month?

4b ____ cm

(c) If a plant is 2 metres tall at the end of the first month, **how much will it have grown,** in total, by the end of the fifth month?

4c ____ m

[5 marks]

5. The table below shows four different makes of car each with four different engine sizes, in litres, and the Insurance Group for each. **For example a Hissan 1.5 car is in Insurance Group B.**

	Car type	Skoyota	Hissan	Foxhall	Jagley
Engine size					
1.1		A	A	A	-
1.2		A	A	B	-
1.5		B	B	B	C
1.9		-	C	B	D

The second table shows the monthly insurance payment paid by drivers of different age bands for each of the insurance groups, **so a person aged 37 would be in the age band 21 - 45 and so would pay £105 each month for a car in Insurance group C.**

	Age band	Under 21	21 - 45	Over 45
Insurance Group				
A		£90	£80	£70
B		£110	£95	£85
C		£122	£105	£98
D		£190	£160	£170

(a) How much will a 19 year old pay for a Foxhall 1.5 car each month?

5a £

(b) A 30 year old pays £95 for a Hissan car. What is the engine size of their car, in litres?

5b ltrs

(c) How much would a 50 year old person **save** each month by using a 1.1 Hissan car rather than a 1.9 Hissan car?

5c £

(d) If a 32 year old pays £95 for a Skoyota car, what would a 20 year old pay for a Jagley car with the **same** size engine?

5d £

[5 marks]

6. If the weight of straight bones in the human body depends on the length, radius and density of the bone using the following formula

Weight = Length x Radius x Radius x Density

or W = L x R x R x D

then a shin bone of length 40cm, radius 3cm and density 5 would have a weight of 1800g because

W = 40 x 3 x 3 x 5 = 1800

Using this formula,

(a) Work out the weight of a finger bone of length 3cm, with a radius of 0.5cm and density 2

6a ____ g

(b) Work out the density of a forearm of length 30cm, with a radius of 2cm which weighs 480g

6b ____

(c) Work out the radius of a thigh bone of length 50cm which has a density of 8 and weighs 3600g

6c ____ cm

[6 marks]

FOR MARKER USE ONLY

Short problems	**/30**

7. A top international bowler playing in a cricket match bowls a cricket ball at 90 miles per hour.

(a) How many miles would the ball travel in one minute?

7a	miles

(b) If a mile is 1760 yards, how many yards would the ball travel in one minute?

7b	yards

(c) How many yards does the ball travel in one second?

7c	yards

(d) If the distance the ball travels through the air from the point where the bowler bowls the ball to the point where it is hit by the batsman is 22 yards, how long is the ball travelling for?

7d	secs

[8 marks]

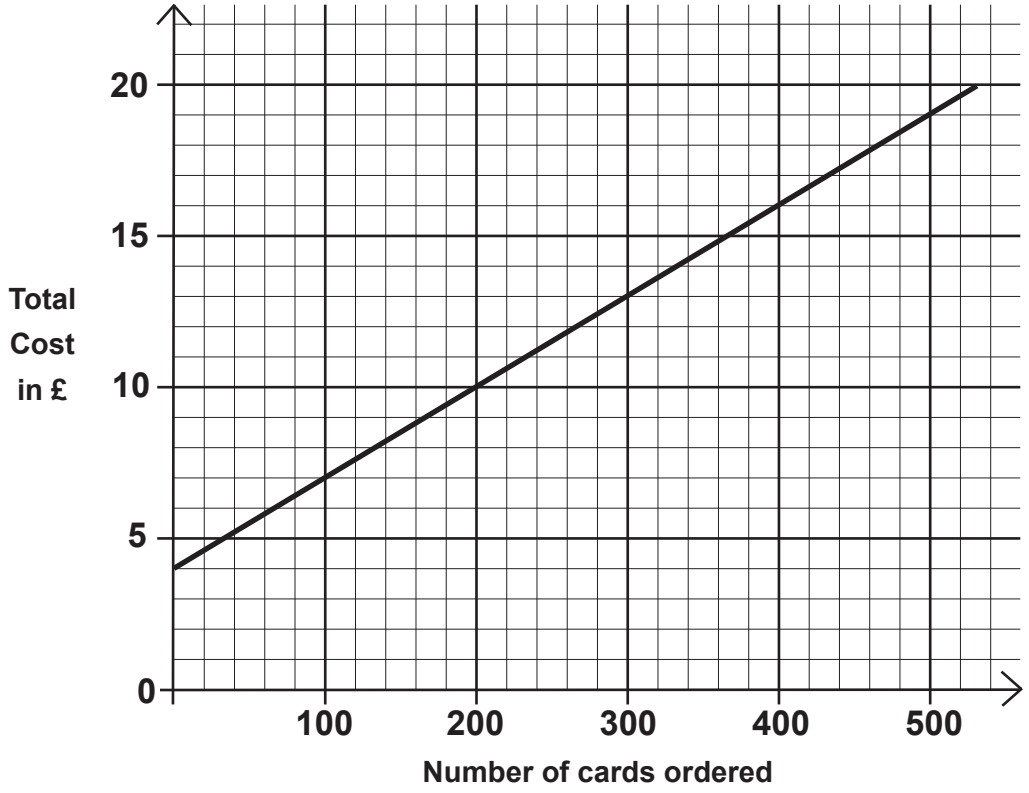
8. Complete **all** the entries in the table below showing the sum, difference, product and quotient for pairs of numbers from the first two columns. **The first row is completed as an example to help you.**

1st number	2nd number	SUM	DIFFERENCE	PRODUCT	QUOTIENT
6	2	8	4	12	3
12	3	.....	.....	.....	.....
.....	.....	15	5	.....	.....
.....	.....	.....	2	8	.....
.....	.....	.....	.....	18	2
.....	.....	21	.....	.....	6

[10 marks]

9. Megaprint make small business cards with names and contact details on, that people can give to clients as part of their work. The total cost of buying the cards they sell is made up of two amounts.

There is a fixed cost that people must pay no matter how many cards they order and this amount is <u>always</u> the same. Then there is a second amount which depends on the number of cards ordered. These two amounts are added together to give the total cost of the order and the graph below shows what the <u>total</u> cost would be for the number of cards ordered.



Using the graph

(a) Write down the total cost of having 100 cards printed.

9a	£

(b) Andy's order costs him £16.00. Write down the number of cards he ordered.

9b	

(c) If 200 cards are ordered, **using the total cost** what is the cost of one card?

9c	p

(d) Write down the fixed cost that Megaprint charge for each order, regardless of the number of cards ordered.

9d	£

(e) If you **exclude** the fixed cost, how much is charged for one card to be printed?

9e	p

Maxicard also make business cards but they charge a fixed cost of £6.00 for an order and the <u>total</u> cost of 500 cards is £16.00.

(f) Mark **two** points on the graph and join them with a straight line to show this information.

9f	on graph

(g) Using the graph, or otherwise, work out the number of cards for which the total cost would be the same from both companies.

9g	

[10 marks]

10. A two digit number is called a multisum if it is a multiple of the sum of its digits.

So 84 is a multisum since 8 + 4 = 12

and 84 <u>is a multiple</u> of 12

(a) Work out and write down the smallest number, greater than 50, which is a multisum

10a

(b) Work out and write down the smallest multiple of 7 which is a multisum

10b

(c) Work out and write down the only multiple of 9 which is **NOT** a multisum

10c

(d) Work out and write down **all** the numbers between 20 and 30 which are **NOT** multisums

10d

[10 marks]

11. A pair of numbers written as a column like this $\begin{pmatrix} 5 \\ 2 \end{pmatrix}$ is known as a **VEC.**

VECs can be combined together in two different ways, as follows

i. $\begin{pmatrix} 5 \\ 2 \end{pmatrix} . \begin{pmatrix} 6 \\ 7 \end{pmatrix} = 5 \times 6 + 2 \times 7 = 30 + 14 = 44$

ii. $\begin{pmatrix} 5 \\ 2 \end{pmatrix} \wedge \begin{pmatrix} 6 \\ 7 \end{pmatrix} = 5 \times 7 - 2 \times 6 = 35 - 12 = 23$

(a) Work out the value of $\begin{pmatrix} 7 \\ 5 \end{pmatrix} . \begin{pmatrix} 8 \\ 9 \end{pmatrix}$

11a	

(b) Work out the value of $\begin{pmatrix} 7 \\ 5 \end{pmatrix} \wedge \begin{pmatrix} 8 \\ 9 \end{pmatrix}$

11b	

(c) Find the value of p if $\begin{pmatrix} 3 \\ 11 \end{pmatrix} . \begin{pmatrix} 5 \\ p \end{pmatrix} = 37$

11c	p =

(d) Find the value of q if $\begin{pmatrix} 3 \\ 9 \end{pmatrix} \wedge \begin{pmatrix} 2 \\ q \end{pmatrix} = 6$

11d	q =

(e) Find the value of r if $\binom{6}{r} \cdot \binom{r}{4} = 40$

11e	r =

(f) Find the value of s if $\binom{8}{s} \wedge \binom{2}{s} = 30$

11f	s =

(g) Find the value of t if $\binom{12}{t} \wedge \binom{t}{8} = 47$

11g	t =

[12 marks]

This is the end of the Examination

Use any remaining time to check your work or try any questions you have not answered.

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Long problems	/50