OCR
Oxford Cambridge and RSA

H

Tuesday 11 June 2019 – Morning

GCSE (9–1) Mathematics

J560/06 Paper 6 (Higher Tier)

Time allowed: 1 hour 30 minutes

You may use:
- a scientific or graphical calculator
- geometrical instruments
- tracing paper

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Read each question carefully before you start to write your answer.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).

INFORMATION
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- Use the π button on your calculator or take π to be 3.142 unless the question says otherwise.
- This document consists of **24** pages.

Answer **all** the questions.

1 A grain of salt weighs 6.48×10^{-5} kg on average.
A packet contains 0.35 kg of salt.

(a) Use this information to calculate the number of grains of salt in the packet.

(a) ..... **[2]**

(b) Explain why your answer to part **(a)** is unlikely to be the actual number of grains of salt in the packet.

.....

.....

..... **[1]**

2 Tom researches the weights of plant seeds.

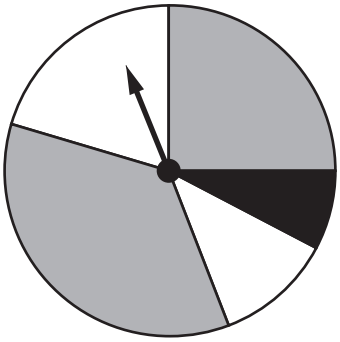
- One poppy seed weighs 3×10^{-4} grams.
- 250 pumpkin seeds weigh 21 grams.
- One sesame seed weighs 3.64×10^{-6} kilograms.

Write the three types of seed in order according to the weight of one seed.
Write the lightest type of seed first.
You must show how you decide.

..... , ... , ...**[4]**

lightest

3 **(a)** This spinner has two grey sections, two white sections and one black section.



Vlad says

The probability of the spinner landing on black is $\frac{1}{5}$.

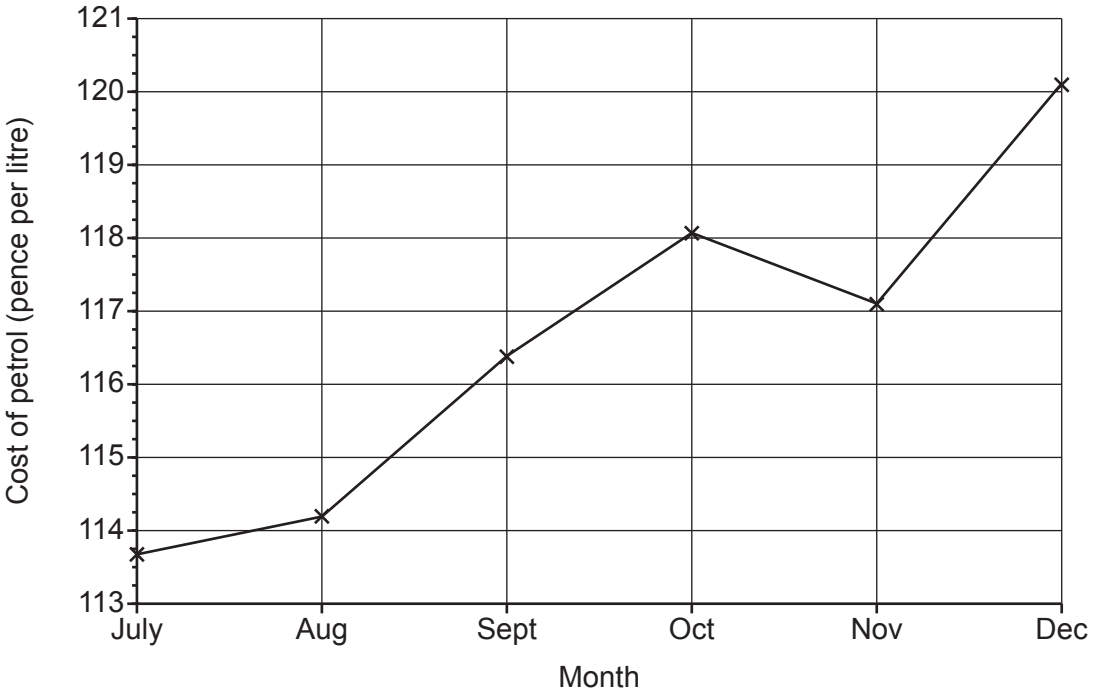
Explain why Vlad is not correct.

.....

.....

..... **[1]**

(b) The graph shows the cost of a litre of petrol for the last six months of 2017.



Explain why this graph is misleading.

.....

.....

..... **[1]**

4 Sophie is organising a raffle.

- Each raffle ticket costs 50p.
- She sells 400 tickets.
- The probability that a ticket, chosen at random, wins a prize is 0.1.
- Each winning ticket receives a prize worth £3.

Sophie says

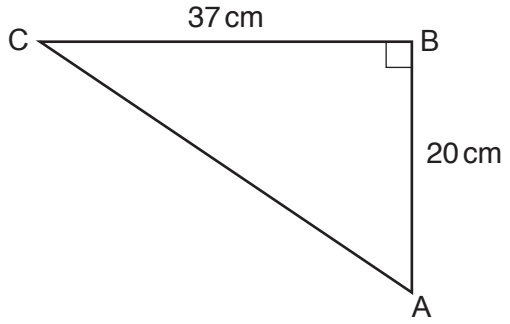
I expect the raffle to make over £100 profit.

Show that Sophie is wrong.

.....

..... **[4]**

5 ABC is a right-angled triangle.
AB = 20 cm and BC = 37 cm.



Not to scale

Calculate angle BAC.

..... ° **[3]**

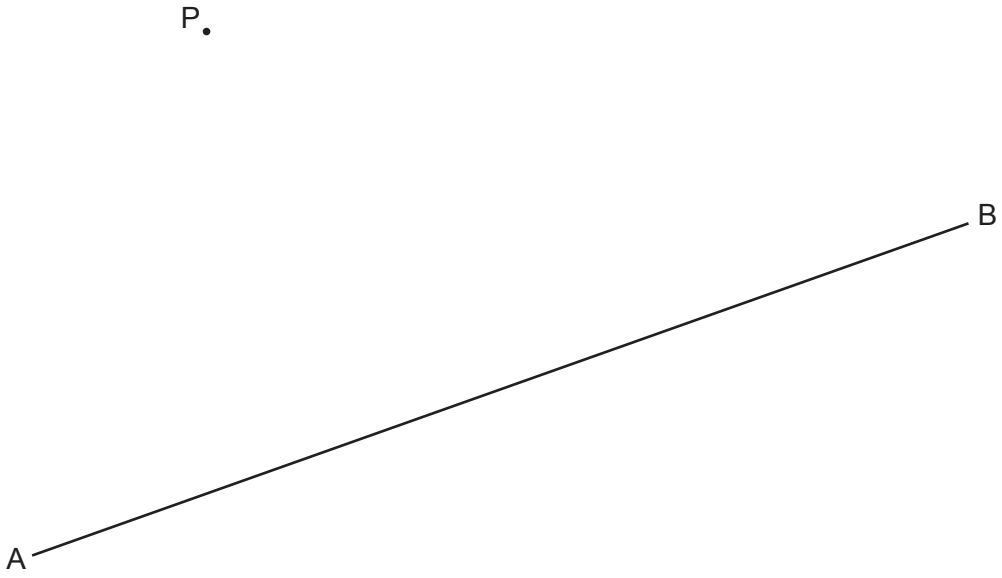
6 A bag contains some counters.

- There are 300 counters in the bag.
- There are only red, white and blue counters in the bag.
- The probability of picking a blue counter is $\frac{23}{50}$.
- The ratio of red counters to white counters is 2 : 1.

Calculate the number of red counters in the bag.

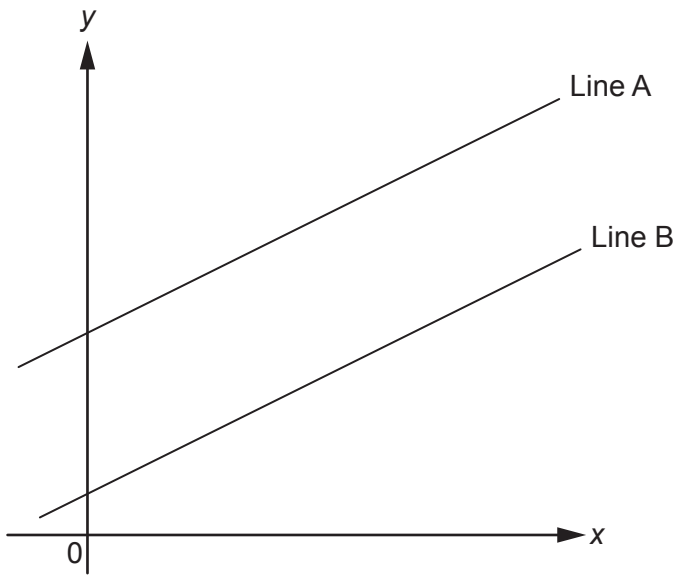
..... **[4]**

7 Construct the perpendicular from the point P to the line AB.
Show all of your construction lines.



[2]

8 The graph shows two parallel lines, Line A and Line B.



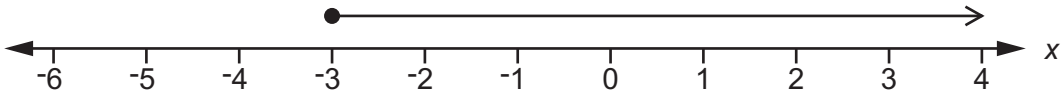
Not to scale

Line A has equation $y = 6x + 7$.
Line B passes through the point (4, 26).

Find the equation of Line B.

..... **[4]**

9 Martha's solution to the inequality $8x + 5 \leqslant 3x - 10$ is shown on the number line.



Is her solution correct?
Explain your reasoning.

.....

..... **[4]**

10 In 2017, the value of a house increased by 4%.
In 2018, the value of the house then decreased by 3%.

Teresa says

Over the two years the value of the house increased by exactly 1% because 4 – 3 = 1.

Show that Teresa is wrong.

.....

..... **[6]**

11 You are given that

$$270 = 3^3 \times 2 \times 5 \quad \text{and} \quad 177\,147 = 3^{11}$$

(a) (i) Find the lowest common multiple (LCM) of 270 and 177 147.
Give your answer using power notation and as an ordinary number.

(a)(i) using power notation .....

as an ordinary number ..... **[2]**

(ii) Write 177 147 000 000 as a product of its prime factors.

(ii) ..... **[3]**

(b) $3^n = 177\,147 \times 9^5$.

Find the value of n.

(b) $n =$ ..... **[3]**

12 Antonio rolls two fair six-sided dice and calculates the **difference** between the scores.
For example, if the two scores are 2 and 5 or 5 and 2 then the difference is 3.

(a) Complete the sample space diagram to show the possible outcomes from Antonio's dice.

		Dice 2					
	difference	1	2	3	4	5	6
Dice 1	1	0					
	2					3	
	3		1				
	4						
	5		3				
	6						

[2]

(b) Antonio rolls the two dice three times.

Calculate the probability that he gets a difference of 1 on all three rolls.
Give your answer as a fraction in its lowest terms.

(b) ..... **[4]**

13 Prove that the mean of any four **consecutive** even integers is an integer. **[4]**

14 The length of the longest diagonal of a cube is 25 cm.

Calculate the total surface area of the cube.

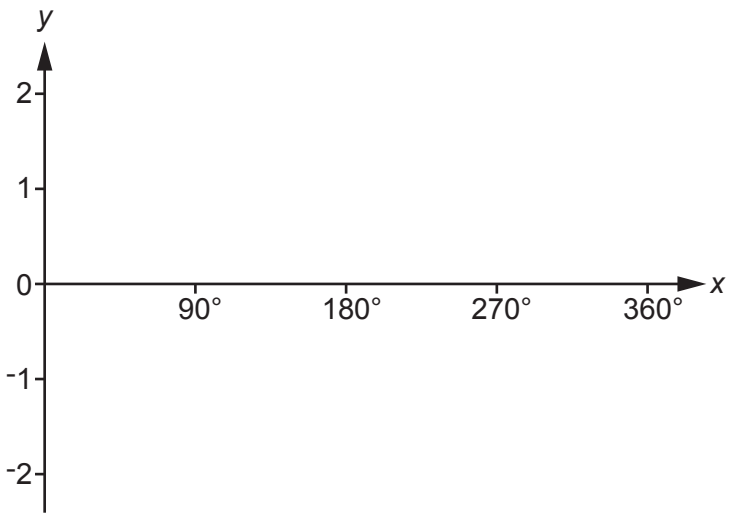
..... cm^2 **[5]**

15 Solve by factorisation.

$$5x^2 + 7x + 2 = 0$$

$x =$ ..... or $x =$ ..... **[3]**

16 Sketch the graph of $y = -\sin x$ for $0° \leqslant x \leqslant 360°$.

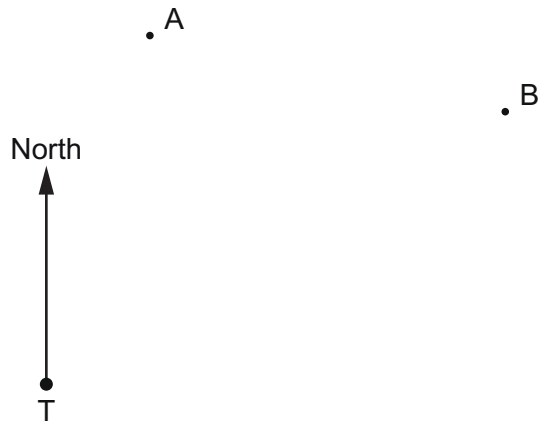


[3]

17 T is a radar tower.
A and B are two aircraft.

At 3pm
- aircraft A is 3250 km from T on a bearing of 015°
- aircraft B is 4960 km from T on a bearing of 057°.

Not to scale



(a) Aircraft A flies directly towards radar tower T at a speed of 890 km/h.

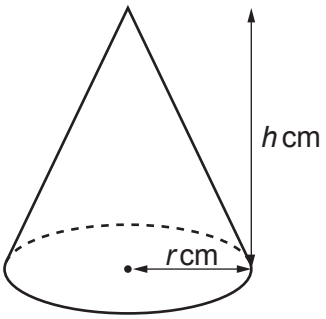
At what time will the aircraft pass over radar tower T?
Give your answer to the nearest minute.

(a) ..... **[4]**

(b) Calculate the distance that was between aircraft A and aircraft B at 3pm.

(b) ..... km **[4]**

18 A cone has radius r cm and height h cm.



The height is three times the radius.
The volume of the cone is $2100\,\text{cm}^3$.

Calculate the radius of the cone.

[The volume V of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

..... cm **[4]**

19 The point $(-5, 2)$ lies on the circumference of a circle, centre (0, 0).

(a) Find the equation of the circle.

(a) ..... **[4]**

(b) Work out the gradient of the tangent to the circle at $(-5, 2)$.

(b) ..... **[2]**

20 **(a)** Show that the equation $x^4 - x^2 - 9 = 0$ has a solution between $x = 1$ and $x = 2$. **[3]**

(b) Find this solution correct to 1 decimal place.
Show your working.

(b) $x =$ ..... **[4]**

21 Toy building bricks are available in two sizes, small and large.
The small and large bricks are mathematically similar.

A small brick has volume $8\,cm^3$ and width 2.1 cm.
A large brick has volume $15.625\,cm^3$.

Calculate the width of a large brick.

..... cm **[4]**

Turn over for question 22

22 At the start of 2018, the population of a town was 17 150.
At the start of 2019, the population of the town was 16 807.

It is assumed that the population of the town is given by the formula

$$P = ar^t$$

where P is the population of the town t years after the start of 2018.

(a) Write down the value of a.

(a) ..... **[1]**

(b) Show that $r = 0.98$. **[1]**

(c) Show that the population is predicted to be less than 16 000 at the start of 2022. **[2]**

(d) Use the formula to work out what the population might have been at the start of 2017.

(d) ..... **[2]**

END OF QUESTION PAPER

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GCSE (9–1)

Mathematics

J560/06: Paper 6 (Higher tier)

General Certificate of Secondary Education

Mark Scheme for June 2019

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

Annotations used in the detailed Mark Scheme.

Annotation	Meaning
✓	Correct
×	Incorrect
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working (after correct answer obtained), provided method has been completed
M0	Method mark awarded 0
M1	Method mark awarded 1
M2	Method mark awarded 2
A1	Accuracy mark awarded 1
B1	Independent mark awarded 1
B2	Independent mark awarded 2
MR	Misread
SC	Special case
^	Omission sign

These should be used whenever appropriate during your marking.

The **M**, **A, B**, etc annotations must be used on your scripts for responses that are not awarded either 0 or full marks.

It is vital that you annotate these scripts to show how the marks have been awarded.

Subject-Specific Marking Instructions

1. **M** marks are for using a correct method and are not lost for purely numerical errors.
   A marks are for an accurate answer and depend on preceding **M** (method) marks. Therefore **M0 A1** cannot be awarded.
   B marks are independent of **M** (method) marks and are for a correct final answer, a partially correct answer, or a correct intermediate stage.
   SC marks are for special cases that are worthy of some credit.

2. Unless the answer and marks columns of the mark scheme specify **M** and **A** marks etc, or the mark scheme is 'banded', then if the correct answer is clearly given and is not from wrong working **full marks** should be awarded.

   Do not award the marks if the answer was obtained from an incorrect method, ie incorrect working is seen and the correct answer clearly follows from it.

3. Where follow through (**FT**) is indicated in the mark scheme, marks can be awarded where the candidate's work follows correctly from a previous answer whether or not it was correct.

   Figures or expressions that are being followed through are sometimes encompassed by single quotation marks after the word *their* for clarity, eg FT 180 × (*their* '37' + 16), or FT 300 – $\sqrt{}$(*their* '$5^2 + 7^2$'). Answers to part questions which are being followed through are indicated by eg FT 3 × *their* (a).

   For questions with FT available you must ensure that you refer back to the relevant previous answer. You may find it easier to mark these questions candidate by candidate rather than question by question.

4. Where dependent (**dep**) marks are indicated in the mark scheme, you must check that the candidate has met all the criteria specified for the mark to be awarded.

5. The following abbreviations are commonly found in GCSE Mathematics mark schemes.

   - **cao** means **correct answer only**.
   - **figs 237**, for example, means any answer with only these digits. You should ignore leading or trailing zeros and any decimal point eg

     237000, 2.37, 2.370, 0.00237 would be acceptable but 23070 or 2374 would not.
   - **isw** means **ignore subsequent working** (after correct answer obtained).
   - **nfww** means **not from wrong working**.
   - **oe** means **or equivalent**.

- **rot** means **rounded or truncated**.
- **seen** means that you should award the mark if that number/expression is seen anywhere in the answer space, including the answer line, even if it is not in the method leading to the final answer.
- **soi** means **seen or implied**.

6. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise, indicated for example by the instruction 'mark final answer'.

7. As a general principle, if two or more methods are offered, mark only the method that leads to the answer on the answer line. If two (or more) answers are offered, mark the poorer (poorest).

8. When the data of a question is consistently misread in such a way as not to alter the nature or difficulty of the question, please follow the candidate's work and allow follow through for **A** and **B** marks. Deduct 1 mark from any **A** or **B** marks earned and record this by using the MR annotation. **M** marks are not deducted for misreads.

9. Unless the question asks for an answer to a specific degree of accuracy, always mark at the greatest number of significant figures even if this is rounded or truncated on the answer line. For example, an answer in the mark scheme is 15.75, which is seen in the working. The candidate then rounds or truncates this to 15.8, 15 or 16 on the answer line. Allow full marks for the 15.75.

10. If the correct answer is seen in the body and the answer given in the answer space is a clear transcription error allow full marks unless the mark scheme says 'mark final answer' or 'cao'. Place the annotation ✓ next to the correct answer.

    If the answer space is blank but the correct answer is seen in the body allow full marks. Place the annotation ✓ next to the correct answer.

    If the correct answer is seen in the working but a completely different answer is seen in the answer space, then accuracy marks for the answer are lost. Method marks would still be awarded. Use the M0, M1, M2 annotations as appropriate and place the annotation × next to the wrong answer.

11. Ranges of answers given in the mark scheme are always inclusive.

12. For methods not provided for in the mark scheme give as far as possible equivalent marks for equivalent work. If in doubt, consult your Team Leader.

13. Anything in the mark scheme which is in square brackets […] is not required for the mark to be earned, but if present it must be correct.

MARK SCHEME

Question			Answer	Marks	Part marks and guidance	
1	a		5400 or 5401 or 5402 final answer	2	**M1** for figs 35 ÷ figs 648, soi by figs 540[1…] or for 0.000 064 8 seen	
	b		Any reference to average/inexact weight oe [in packet weight or weight of a grain] or recognising that the number of grains of salt must be integer oe	1		Condone any mention of • average for variation and/or • size for weight Mark the best part if no contradiction or wrong statement See appendix

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Part marks and guidance</th></tr>
<tr><td>2</td><td></td><td></td><td>Poppy, Sesame, Pumpkin with correct comparable values shown</td><td>4</td><td>
B3 for all 3 quantities seen <u>correct in comparable form</u>

or
B2 for 8.4×10^{-5} or 8.4×10^{-2} seen
or
seen <u>correct in comparable form</u>:
• pumpkin with poppy
eg implied by [250 poppy =] 0.075
or
• pumpkin with sesame
eg implied by [250 sesame =] 0.91
or
B1 poppy and sesame seen <u>correct in comparable form</u>
or [pumpkin =] 0.084 or 0.000 084 seen

or [250 poppy =] 0.000 075 oe seen
or [250 sesame =] 0.000 91 oe seen
</td><td>
Condone weights as answer

Quantities given in the question (bold in table) need not be rewritten

Comparable forms include:
<table>
<tr><td colspan="3">In kilograms:</td></tr>
<tr><td>Pop</td><td>0.000 000 3</td><td>3×10^{-7}</td></tr>
<tr><td>Pum</td><td>0.000 084</td><td>8.4×10^{-5}</td></tr>
<tr><td>Ses</td><td>0.000 003 64</td><td>3.64×10^{-6}</td></tr>
</table>
<table>
<tr><td colspan="3">In grams:</td></tr>
<tr><td>Pop</td><td>0.000 3</td><td>3×10^{-4}</td></tr>
<tr><td>Pum</td><td>0.084</td><td>8.4×10^{-2}</td></tr>
<tr><td>Ses</td><td>0.003 64</td><td>3.64×10^{-3}</td></tr>
</table>
Must not be a mix of standard and ordinary form

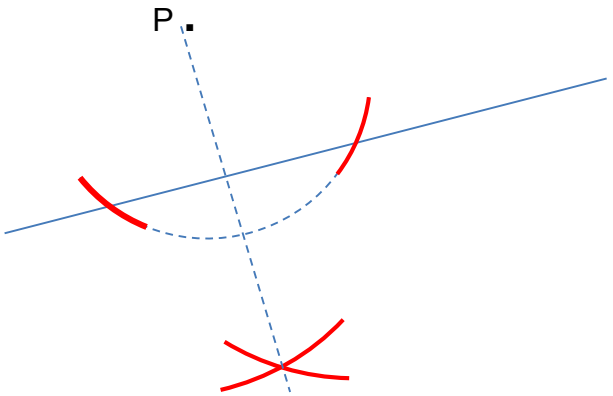
Accept consistent multiples for full marks. eg.
250 poppy = 0.075 and
250 sesame seeds = 0.91

May be all fractions with common denominator
</td></tr>
</table>

Question			Answer	Marks	Part marks and guidance	
3	a		Correct answer based on angle or area/arc length	1	The angle [for black] • is too small oe or • is less than a fifth oe or • should be 72 oe The area/arc length [for black] • is too small oe or • is less than a fifth oe	Accept 26 to 30 for "the angle" Accept "not equal to" for "too small" or "less than" See appendix
	b		Any comment recognising limitations in range of the vertical scale	1		EG It does not start at zero or It starts at 113 See appendix
4			[expected profit is £] 80 with 200 and 120 seen	4	**B1** for [£] 200 or 20 000[p] AND **M2** for 0.1 × 400 × 3 soi 120 or **M1** for 0.1 × 400 soi 40 <u>Alternative method</u> **B1** for [£] 200 or 20 000[p] **M1** for $\frac{their200-100}{3}$ [prizes] soi 33[.3…] **M1** for 0.1 × 400 soi 40 **A1** for she is giving away too many prizes oe <u>Alternative method</u> **B1** for [£] 200 or 20 000[p] **M1** for $\frac{their200-100}{3}$ [prizes] soi 33[.3…] **M1** for $\frac{their\ 33[.3...]}{400}$ soi 0.08[3…] **A1** for the probability of winning the game is too great oe	Apply scheme to consistent working in pence rather than £.

Question			Answer	Marks	Part marks and guidance	
5			Answer which rounds to 61.6 nfww	3	**M2** for $\tan^{-1}(\frac{37}{20})$ oe or **M1** for $\tan[x =] \frac{37}{20}$ oe If **M0** scored then **SC1** for answers 28.4, 28 or angles that round to 28.4 if correct working seen.	Condone answer of 62 only if correct working seen Answers of 68.5 or 68.4(5..) [grads] or 1.08 or 1.07(5..) [rads] imply **M2** **Alternative method** After correct method for Pythagoras soi by 42.0 to 42.1 **M2** for $\sin^{-1}(\frac{37}{their\ \sqrt{20^2+37^2}})$ or $\cos^{-1}(\frac{20}{their\ \sqrt{20^2+37^2}})$ or **M1** for $\sin[x =] \frac{37}{their\ \sqrt{20^2+37^2}}$ or $\cos[x =] \frac{20}{their\ \sqrt{20^2+37^2}}$ or **M0** for just Pythagoras reaching AC = 42.0 to 42.1 Do not condone answer of 62 following an interim answer seen that does not round to 61.6 **0** for scale drawing

Question	Answer	Marks	Part marks and guidance	
6	108 nfww	4	**B3** for $\frac{108}{300}$ OR **M3** for $(300 - \frac{23}{50} \times 300) \div 3 \times 2$ oe or **M2** for $300 - \frac{23}{50} \times 300$ soi 162 or **M1** for $\frac{23}{50} \times 300$ oe soi 138 <u>Alternative method</u> **M1** for [p(white or red) =] $1 - \frac{23}{50}$ soi $\frac{27}{50}$ **M1** for *their* $\frac{27}{[50]} \div 3 \times 2$ soi $\frac{18}{[50]}$ **M1** for *their* 18×6 or *their* $\frac{18}{50} \times 300$	May use percentages or decimals for M marks May use 23 : 18 : 9 for M2

Question			Answer	Marks	Part marks and guidance	
7			Ruled perpendicular constructed with correct arcs (one pair intersecting AB)	2	Condone dashed line **B1** for correct arcs (one pair intersecting AB) only but no line or correct ruled line but no, or incomplete construction arcs  	Set protractor to 90° and check 88° to 92° at AB Correct construction arcs as shown (may be two pairs of arcs used to draw line through P) Ignore other arcs if correct arcs clearly used to construct line Condone perpendicular extending beyond AB but must pass through P and reach AB (no daylight) **Alternative arcs**. One centred on A length AP and one centred on B length BP meeting below AB (may also pass through P). Use overlay as check Candidates may use points on AB other than A and B for this construction. In such cases check radii of arcs using on-line ruler to judge.

Question			Answer	Marks	Part marks and guidance	
8			$y = 6x + 2$ oe final answer	4	**B3** for $6x + 2$ as final answer or for $y = 6x + 2$ oe seen and then spoiled as final answer OR **B2** for $y = 6x + k$ oe $0 < k < 7$ or for $y = mx + 2$, $m > 0$ and $m \neq 6$ or **B1** for gradient or $m = 6$ stated or for $y = 6x$ or for $[y =] 6x + k$ $k \neq 0$ or 7 oe or for $mx + 2$, $m > 0$ and $m \neq 6$ **B0** for $y = 6x + 7$ (as given)	Accept $y - 26 = 6(x - 4)$ as equivalent Do not allow other letters for x <u>Alternative methods</u> **M1** for $6 \times 4 + 7$ soi 31 **M1** for *their* $31 - 26$ soi 5 **M1** for 7 - *their* 5 OR **M1** for $[\pm]6 \times 4$ soi 24 or -24 **M1** for $26 -$ *their* 24 soi 2 **M1** for $6x +$ *their* 2

Question	Answer	Marks	Part marks and guidance
9	Correct solution is $x \leq -3$ from algebraic working	M3	**M2** for $8x - 3x \leq -10 - 5$ or better, or for $5 + 10 \leq 3x - 8x$ or better or **M1** for $8x - 3x$, or $3x - 8x$, or $[\pm]5x$, or $-10 - 5$, or $5+10$, or $[\pm]15$ seen
	No and number line shows $x \geq -3$ oe or No and draws the correct inequality on number line or No and "the arrow points the wrong way" oe	A1dep	**A1** dep on **M3** After **0** scored, allow **SC1** for number line shows $x \geq -3$ or "the arrow points the wrong way" oe but only if no incorrect working shown or correct substitution of a value $\neq -3$ and conclusion that inequality is false oe

For **M2** and **M1** condone incorrect inequality sign or "equals".

Alternative method
3 trials for values of x where
$x < -3$, $x = -3$ and $x > -3$
and correct conclusion
can score full marks.
Without the correct conclusion, maximum for this approach is **SC1** for only the 3 correct trials (as described above)

x	$8x + 5$		$3x - 10$
-6	-43	<	-28
-5	-35	<	-25
-4	-27	<	-22
-3	-19	=	-19
-2	-11	>	-16
-1	-3	>	-13
0	5	>	-10
1	13	>	-7
2	21	>	-4
3	29	>	-1
4	37	>	2

Question			Answer	Marks	Part marks and guidance	
10			[0].88% [increase] Alternative method The two answers are different oe dep on **B5**	6	**B5** for 1.0088 or [0].0088 seen or **B4** for 1.0088*x* where *x* is any letter or **M4** for *k* × 1.04 × [0].97 ÷ *k* oe or (k × 1.04 × [0].97 – k) ÷ *k* oe or **M3** for *k* × 1.04 × [0].97 oe or **M2** for *k* × 1.04 oe or *k* × [0].97 oe or **M1** for 1.04 or [0].97 or 4% of *k* found or 3% of *k* found If **0** scored then **SC3** for figs 10088 or 88 seen Alternative method **B5** for correct answers to both *k* × 1.04 × [0].97 and *k* × 1.01 OR **M3** for *k* × 1.04 × [0].97 oe or **M2** for *k* × 1.04 oe or *k* × [0].97 oe or **M1** for 1.04 or [0].97 or 4% of *k* found or 3% of *k* found and **M1** for *k* × 1.01 oe	accept [0].9% increase after 1.0088 found For M marks, *k* is any seen starting value or a letter. eg **M4** for 1.04 × [0].97 as *k* assumed to be 1. eg **M3** for 104 × [0].97 as *k* assumed to be 100. **M2 or M1** may be embedded in an incorrect calculation, or in stages eg **M2** for *k* × 1.4 × [0].97 eg **M1** for *k* × 1.4 × [0].03 Alternative method Answers to these calculations must be checked

Question			Answer	Marks	Part marks and guidance	
11	a	i	$2 \times 3^{11} \times 5$ 1 771 470	1 1		Condone answers switched
		ii	$2^6 \times 3^{11} \times 5^6$	3	**B1** for 3^{11} in answer and **M1** for 2 and 5 identified as factors	Accept written in full without indices eg in factor tree
	b		21	3	**M1** for 3^2 or $(3^2)^5$ or 3^{10} seen and **M1** for 11 + *their* 10 soi after attempt at converting 9^5 to power of 3 Alternative method by trials: **3** marks for answer 21 but **M0** for just converting to ordinary number and a wrong trial	**M1M1** for answer 3^{21} eg **M1M1** for $(3^2)^5 = 3^7$ and $3^{11} \times 3^7 = 3^{18}$

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Part marks and guidance</th><th></th></tr>
<tr><td>12</td><td>a</td><td></td><td>
<table>
<tr><td>(0)</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>2</td><td>(3)</td><td>4</td></tr>
<tr><td>2</td><td>(1)</td><td>0</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>0</td><td>1</td><td>2</td></tr>
<tr><td>4</td><td>(3)</td><td>2</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>
</td><td>2</td><td>B1 for at least 10 correct entries</td><td></td></tr>
<tr><td></td><td>b</td><td></td><td>$\frac{125}{5832}$</td><td>4</td><td>B3 for $\frac{1000}{46656}$ oe isw wrong cancelling
or for 0.0214(33…) oe as final answer

OR

B1FT for $\frac{10}{36}$ oe

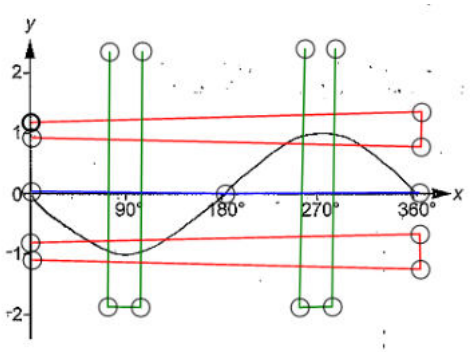
and
M1 for their$\frac{10}{36}$ × their$\frac{10}{36}$ × their$\frac{10}{36}$</td><td>FT from their completed table in part (a)

$\frac{10}{36} = \frac{5}{18}$ = 0.2777… to 0.278

Common mistake:
B1 M0 for 3 × $\frac{10}{36}$</td></tr>
</table>

Question			Answer	Marks	Part marks and guidance	
13			$\frac{(2x)+(2x+2)+(2x+4)+(2x+6)}{4}$ $= \frac{8x+12}{4}$ $= 2x + 3$ which is an integer OR $(2x) + (2x + 2) + (2x + 4) + (2x + 6)$ $= 8x + 12$ $= 4(2x + 3)$ which is divisible by 4 oe	4	**M1** for $2x$, $2x + 2$, $2x + 4$ and $2x + 6$ seen and **M1** for adding their four terms in x, eg. $(2x) + (2x + 2) + (2x + 4) + (2x + 6)$ and **M1** for *their* $(8x + 12) \div 4$ or better, condoning lack of brackets, or for $4(2x + 3)$ and **A1dep** (dep on **M0M1M1** or **M1M1M1**) for correct algebraic mean for *their* four terms and conclusion eg. $2x + 3$ is an integer or $4(2x + 3)$ which is divisible by 4 If **0** scored, allow **SC1** for a numerical example with any 4 consecutive even integers with mean correctly calculated	Or equivalent algebraic representations of 4 consecutive even numbers. In this case, x does not need to be defined as being an integer. Using x, $x + 2$, $x + 4$, $x + 6$ oe does not score the first M mark unless x stated as even integer, but can score up to 3 marks for $(x) + (x + 2) + (x + 4) + (x + 6)$ *their* $(4x + 12) \div 4$ or better, or for $4(x + 3)$ and the relevant conclusion Using $x + 1$, $x + 3$, $x + 5$, $x + 7$ oe does not score the first M mark unless x stated as odd integer but can score up to 3 marks similar to above.

Question	Answer	Marks	Part marks and guidance	
14	1250 nfww	**5**	**M4** for [$6x^2$ =] 2 × 625 or **B4** for final answer 1244 to 1250.05 OR **M1** for $3x^2$ oe or 625 and **M1** for $3x^2 = 625$ oe and **A1** for [x =] $\sqrt{\frac{625}{3}}$ or $\frac{25\sqrt{3}}{3}$ oe or 14.4 to 14.434 soi (14.4 to 14.434 seen implies **M1M1A1**) and **M1** for 6 × *their* x^2 If **0** scored, **SC1** for starting from $x^2 = 25$ **and** final answer 150 or starting from $2x^2 = 25$ **and** final answer 75	<u>Special cases:</u> Starting from $3x^2 = 25$ oe soi **M1M0** for $3x^2 = 25$ **A1** for [x =] $\sqrt{\frac{25}{3}}$ or $\frac{5\sqrt{3}}{3}$ oe or 2.88 to 2.89 soi (2.88 to 2.89 seen implies **M1M0A1**) **M1** for 6 × *their* x^2 soi by 50 Starting from $2x^2 = 625$ oe soi **M1M0** for $2x^2 = 625$ **A1** for [x =] $\sqrt{\frac{625}{2}}$ or $\frac{25\sqrt{2}}{2}$ or 17.6 to 17.7 soi (17.6 to 17.7 seen implies **M1M0A1**) **M1** for 6 × *their* x^2 (1875 as final answer implies **M1M0A1M1A0**) Starting from $x^2 = 625$ oe soi **M1M0** for $x^2 = 625$ **A0** (equation has been simplified and it is a more substantial error) **M1** for 6 × *their* x^2 (3750 as final answer implies **M1M0A0M1A0**)

Question			Answer	Marks	Part marks and guidance	
15			(5x + 2)(x + 1) oe using two pairs of brackets	**2**	**M1** for any two factors that give two correct terms when expanded or partial factorisation such as $5x(x+1) + 2(x+1)$ or $x(5x + 2) + [1](5x + 2)$	Condone missing final bracket for up to full marks Up to full marks can be awarded for solving using non-integer factorisations such as $5(x + 0.4)(x + 1)$ oe NB Working backwards from the answers scores only the final mark eg. $(x + 0.4)(x + 1) = 0$ without seeing a factor of 5 or division by 5 leading to -0.4 and -1 Any other method, award **B1** for both answers correct
			-0.4 oe and -1	**1**	Correct or **FT** *their* two factors	
16			Correct sketch of $y = -\sin x$  	**3**	There must be at least one cycle to gain any marks. **B1** for a positive or negative sine curve shape starting at (0, 0) and **B1** for maximums at (…, 1) and minimum at (…, -1) and **B1** for maximum only at (270, …) and minimum only at (90, …)	eg **B1B1B0** for $y = \sin x$ drawn **B0B1B0** for $y = \pm\cos x$ drawn **B1B1B0** for $y = \sin 2x$ drawn Before using overlay, check blue line is the *x*-axis All maximums and minimums within red on overlay Maximum and minimum within green on overlay

Question			Answer	Marks	Part marks and guidance	
17	a		6.39 [pm] or 1839	4	**B3** for 39 or answer rounding to 39.1 or 3˚39 to 3˚39'6.07" or 6˚39 to 6˚39'6.07" or 219 or answer rounding to 219.1 OR **M1** for [*t* =] $\frac{3250}{890}$ oe soi by 3.65(…) and **M1FT** for 60 × (*their* time) soi or evidence from *their* answer by using calculator key <u>Alternative method (converting speed to km/min)</u> **M1** for 890 ÷ 60 soi by $\frac{89}{6}$ or $14\frac{5}{6}$ oe or 14.8[3…] and **M1FT** for [*t* =] 3250 ÷ *their* 14.8[3…]	Condone 1839pm for full marks eg $3\frac{58}{89}$ *their* time could be fraction or decimal and could be just the non-integer part (check using calculator)

Question			Answer	Marks	Part marks and guidance	
	b		3345 to 3350 nfww	**4**	**B1** for 42 seen AND **M2** for [x^2 =] $3250^2 + 4960^2 - 2 \times 3250 \times 4960 \cos\theta$ oe soi by [x^2 =] 11205110 to 11205111 or **M1** for correct cosine rule with x^2 not as subject <u>Alternative method (using horizontal/vertical components and Pythagoras)</u> **M3** for $\sqrt{(4960\sin 57 - 3250\sin 15)^2 + (3250\cos 15 - 4960\cos 57)^2}$ or **M2** for 4960sin57 – 3250sin15 or 3250cos15 – 4960cos57 or **M1** for two of 4960sin57, 3250sin15, 3250cos15 or 4960cos57	May be seen on sketch diagram For **M2** or **M1**, θ is a number in the range $15 \le \theta \le 57$ eg $\cos\theta = \frac{3250^2+4960^2-x^2}{2\times 3250\times 4960}$ Allow numerical values to imply relevant trig functions as below for **M** marks: • 4960sin57 = 4159 to 4160 • 3250sin15 = 841 to 842 • 3250cos15 = 3139 to 3140 • 4960cos57 = 2701 to 2702 • 4960sin57 – 3250sin15 = 3317 to 3319 • 3250cos15 – 4960cos57 = 437 to 439 • $(4960\sin 57 - 3250\sin 15)^2$ = 11 002 489 to 11 015 761 • $(3250\cos 15 - 4960\cos 57)^2$ = 190 969 to 192 721

Question			Answer	Marks	Part marks and guidance	
18			8.74[…] nfww	4	**M3** for [r =] $\sqrt[3]{\frac{2100}{\pi}}$ or **M2** for $\pi r^3 = 2100$ oe **M1** for $\frac{1}{3}\pi r^2(3r)$ oe Alternative method using *h* **M3** for [*h* =] $\sqrt[3]{\frac{56700}{\pi}}$ soi by 26.2[3…] or **M2** for $\pi h^3 = 56700$ oe **M1** for $\frac{1}{3}\pi\left(\frac{h}{3}\right)^2 h$ oe	Accept answer of 8.7 after **M3** May be done in stages eg **M3** for $\sqrt[3]{668.(\ldots)}$ eg. **M2** for $3\pi r^3 = 6300$ or $\frac{1}{3}\pi r^2(3r) = 2100$ etc eg. **M1** for πr^3 eg. **M1** for $\frac{1}{27}\pi h^3$
19	a		$x^2 + y^2 = 29$ oe	4	**B2** for 29 or $\sqrt{29}$ or 5.38(5…) to 5.39 or **M1** for $2^2 + 5^2$ or $\sqrt{2^2 + 5^2}$ or $2^2 + (-5)^2$ or $\sqrt{2^2 + (-5)^2}$ **AND** **B1** for $x^2 + y^2 = k$ where *k* is a number > 0 or $x^2 + y^2 = r^2$	Condone poor use of or missing brackets for **M1** eg $-5^2 + 2^2$ or $2^2 + -5^2$ earns **M1**, but $2^2 - 5^2$ does NOT earn **M1** Condone other letters instead of *r*, except *x* and *y*.
	b		2.5 or $\frac{5}{2}$ oe	2	**M1** for $-\frac{2}{5}$ oe or -0.4 seen or use of $m_1m_2 = -1$ with *their* radius gradient	**M1** for [*y* =] $\frac{5}{2}x$ [+ *c*] oe Condone $-\frac{2}{5}x$ seen for **M1**

Question			Answer	Marks	Part marks and guidance	
20	a		$1^4 - 1^2 - 9 = -9$ $2^4 - 2^2 - 9 = 3$ Sign change, solution between $x = 1$ and $x = 2$	3	**M2** for $1^4 - 1^2 - 9 = -9$ and $2^4 - 2^2 - 9 = 3$ or **M1** for $1^4 - 1^2 - 9$ or $2^4 - 2^2 - 9$ soi by -9 or 3 <u>Alternative method</u> After $x^4 - x^2 = 9$ seen **M2** for $2^4 - 2^2 = 12$ and $1^4 - 1^2 = 0$ **A1** for $12 > 9$ and $0 < 9$ so solution between $x = 1$ and $x = 2$ OR **M1** for $2^4 - 2^2$ or $1^4 - 1^2$ soi by 12 or 0 <u>Alternative method</u> **SC3** for using an iterative equation that converges to a value in the range 1.85 to 1.95 **and** concluding statement that $1 < 1.85$ to $1.95 < 2$ oe or **SC2** for using an iterative equation that converges to a value in the range 1.85 to 1.95 <u>Alternative method</u> **SC3** for using quadratic formula (see (b)) leading to a value in the range 1.88 to 1.89 **and** concluding statement that $1 < 1.88$ to $1.89 < 2$ oe or **SC2** for using quadratic formula (see (b)) leading to a value in the range 1.88 to 1.89	Accept other values of x used between 1 and 2 (see table in part (b)). For full marks, the two values need to produce a sign change. Examples just sufficient for third mark include: sign change $-9 < 0 < 3$ $x = 1$ gives an answer < 0 and $x = 2$ gives an > 0 Examples insufficient for third mark: so x lies between 1 and 2 If candidates **<u>refer to</u> their working** in part **(b)** within part **(a)**, award marks for any of the final 2 alternative methods.

Question			Answer	Marks	Part marks and guidance	
	b		Two correct evaluations in the range 1.85 to 1.95, one which gives a positive value and the other giving a negative value and 1.9	**M3** **A1dep**	**M2** for two correct evaluations between 1 and 2, one which gives a positive value and the other giving a negative value or **M1** for one correct evaluation between 1 and 2 Dependent on achieving at least **M2** OR **SC1** for 1.9 with no worthwhile working <u>Alternative method by iteration</u> **M1** rearranges to a correct iterative formula (converging or diverging) **M1** <u>attempts</u> first iteration (either substitution of $1 \le x \le 2$ seen or found to at least 2dp rot) **M1** continues further iteration(s) to reach *x* in the range 1.85 to 1.95 **A1** for 1.9 <u>Alternative method by quadratic formula</u> **M2** for $[x^2 =] \frac{-(-1) \pm \sqrt{(-1)^2 - 4(1)(-9)}}{2(1)}$ soi by 3.54[1..] or **M1** for this formula with at most two errors AND **M1** for $x = \sqrt{their\ 3.54[1..]}$ soi by 1.88 to 1.89 **A1** for 1.9	Likely values: accept rot to 1 or more dp | x | $x^4 - x^2 - 9$ | |---|---| | 1.1 | -8.7459 | | 1.2 | -8.3664 | | 1.25 | -8.12109… | | 1.3 | -7.8339 | | 1.4 | -7.1184 | | 1.5* | -6.1875 | | 1.6 | -5.0064 | | 1.7 | -3.5379 | | 1.75* | -2.68359… | | 1.8 | -1.7424 | | 1.85 | -0.70899… | | 1.875* | -0.1560… | | 1.9 | 0.4221 | | 1.9375* | 1.3379…. | | 1.95 | 1.656506 | | 2 | 3 | <u>Alternative iteration method notes</u> condone missing subscripts eg **M1** for $x = \sqrt{\sqrt{9 + x^2}}$ and **M1** for $\sqrt{\sqrt{9 + 1^2}}$ or 1.77[8..] or 1.78 If candidates **<u>refer to or use</u> their working** in part **(a)** within part **(b)**, award up to full marks for part **(b)**.

Question	Answer	Marks	Part marks and guidance	
21	2.625 nfww	**4**	**M3** for $2.1 \times \sqrt[3]{\frac{15.625}{8}}$ oe or $2.1 \div \sqrt[3]{\frac{8}{15.625}}$	Accept 2.6, 2.62 or 2.63 as final answer after **M3**
			or	May be done in stages, including rounding to at least 3 sig figs of intermediate steps
			M2 for $\sqrt[3]{\frac{15.625}{8}}$ soi by $\frac{5}{4}$ or 1.25 oe	May see as length ratio, eg. **M2** for $\sqrt[3]{8} : \sqrt[3]{15.625}$ soi by 2 : 2.5 oe
			or $\sqrt[3]{\frac{8}{15.625}}$ soi by $\frac{4}{5}$ or 0.8 oe	
			or	
			M1 for $\frac{15.625}{8}$ soi by $\frac{125}{64}$ oe or 1.95(31…)	May see as volume ratio, eg. **M1** for 8 : 15.625 oe May also be seen as part of wrong approach eg. $\frac{15.625}{8 \div 2.1}$ seen or done in stages scores **M1**
			or $\frac{8}{15.625}$ soi by $\frac{64}{125}$ oe or 0.512	
			If **0** scored then **SC1** for 4.1 to 4.11 as final answer	

Question			Answer	Marks	Part marks and guidance	
22	a		17 150	1		
	b		16 807 ÷ 17 150 = 0.98	1	Condone: 17150 × [0].98 = 16807 16807 ÷ [0].98 = 17150	
	c		15 818 to 15 819	2	**M1** for 17150×0.98^4 or *their* (a) $\times 0.98^4$ or for 16807×0.98^3 and **A1FT** from *their* (a) $\times 0.98^4$ correctly evaluated <u>Alternative methods using division</u> **M1** for $16000 \div 0.98^4$ **A1** for 17300 to 17350 is greater than 17150 **OR** **M1** for $16000 \div 0.98^3$ **A1** for 16900 to 17000 is greater than 16807	**FT** from *their* (a), and only if method shown Accept "[population in] 2018" for 17150 Accept "[population in] 2019" for 16807
	d		17 500 nfww	2	**M1** for 17150×0.98^{-1} oe or *their* (a) $\times 0.98^{-1}$ oe or 16807×0.98^{-2} oe	NB: **M1** for $0.98^{-1} = 1.02[04\ldots]$ **and** 17150 x 1.02[04…] but **M0** for 17150 × 1.02 = 17493

APPENDIX

Question 1b

A	Because it is a decimal and you can't have a decimal of a grain of salt.	**1** Reference to requiring integer value
B	They might have rounded the 0.35kg up.	**1** Equivalent to "figures not exact"
C	Some grains can be lighter or heavier than this.	**1** "this" is "the average"?
D	The weight of each grain is an average.	**1** True; mention of average
E	The weight given is an average weight.	**1** True; mention of average
F	As it is an average amount of salt.	**1** True; mention of average. Read amount for weight
G	Some grains of salt may be heavier.	**1** Implies variation
H	It's an average	**1** Minimum case
I	It's not exact	**1** Minimum case
J	It's a decimal	**1** Minimum case
K	Because it is hard to exactly measure that finite amount consistently.	**0** It may be "hard to measure" but doesn't say they are not exact.
L	It's an estimate because in some packets there will be slightly more or less grains as they are too small to count.	**0** Refers to the number of grains and does not reference the weight of a grain.
M	There could be a fraction of a grain of salt.	**0** Implies number of grains can be non-integer.
N	They all weigh the same but could be different sizes	**0** Choice One incorrect statement and one correct

Question 3a

A	The black section does not cover 1/5 of the spinner	**1** "covering" implies area
B	The angle is 28˚. It should be 72˚.	**1**
C	1/5 is 72 ˚ and the black section is less than this	**1**
D	The angle is **only** 28.	**1** Implied comparison with correct angle BOD Minimum case
E	Because 30/360 is 1/12	**1** comparing angle as fraction with common numerator with 1/5 (which is given) (3/36 is not enough to compare)
F	Because 28/360 = 0.07[…] not 0.2	**1** Correct comparison (but (26 to 30)/360 needed for evidence of working with angle)
G	The angle is 28˚.	**0** Does not say that it should be 72 or is too small
H	The sections are not of equal area	**0**
I	The sections are not of equal width	**0**
J	The black section is the smallest section	**0**
K	The spinner is unequal and some spaces are the same colour but different size	**0**
L	It's more like a tenth	**0** No angle used to justify

Question 3b

A	The graph starts at 113	**1** Recognises limitation in scale
B	The y-axis is only from 113 to 121	**1** Recognises limitation in scale
C	Because you don't see anything below 113	**1** Recognises limitation in scale
D	You can't read between the numbers on the scale	**0** Does not recognise limitations in the **range** of the scale
E	It doesn't start from the bottom of the graph and the units go up in an unusual pattern.	**0** Too vague.
F	It looks as though there has been a drastic increase in price when there hasn't.	**0** Not explained why the scale causes this
G	There are lines joining the points.	**0** Irrelevant
H	Because the cost varies throughout the month.	**0** True but describing patterns
I	Because it would have fluctuated.	**0** True but describing patterns
J	You don't see the bottom of the graph	**0** Too vague

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