AQA

GCSE
MATHEMATICS

H

Higher Tier   Paper 3 Calculator
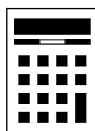
Tuesday 11 June 2019   Morning   Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- a calculator
- mathematical instruments.

Instructions

- Use black ink or black ball-point pen. Draw diagrams in pencil.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You may ask for more answer paper, graph paper and tracing paper. These must be tagged securely to this answer book.

Advice

In all calculations, show clearly how you work out your answer.

For Examiner's Use	
Pages	Mark
2–3	
4–5	
6–7	
8–9	
10–11	
12–13	
14–15	
16–17	
18–19	
20–21	
22–23	
24–25	
26–27	
TOTAL	

Answer **all** questions in the spaces provided

1 Work out £1.50 as a fraction of 60p

Circle your answer.

[1 mark]

$$\frac{2}{5} \qquad \frac{1}{4} \qquad \frac{4}{1} \qquad \frac{5}{2}$$

2 For a biased dice, $P(6) = \dfrac{3}{5}$

Circle the probability of two sixes when the dice is rolled twice.

[1 mark]

$$\frac{6}{25} \qquad \frac{6}{10} \qquad \frac{9}{25} \qquad \frac{9}{5}$$

3 Circle the lowest common multiple (LCM) of 5, 15 and 25

[1 mark]

$$5 \qquad 45 \qquad 75 \qquad 150$$

4   Circle the **two** roots of $(x - 5)(x + 3) = 0$

[1 mark]

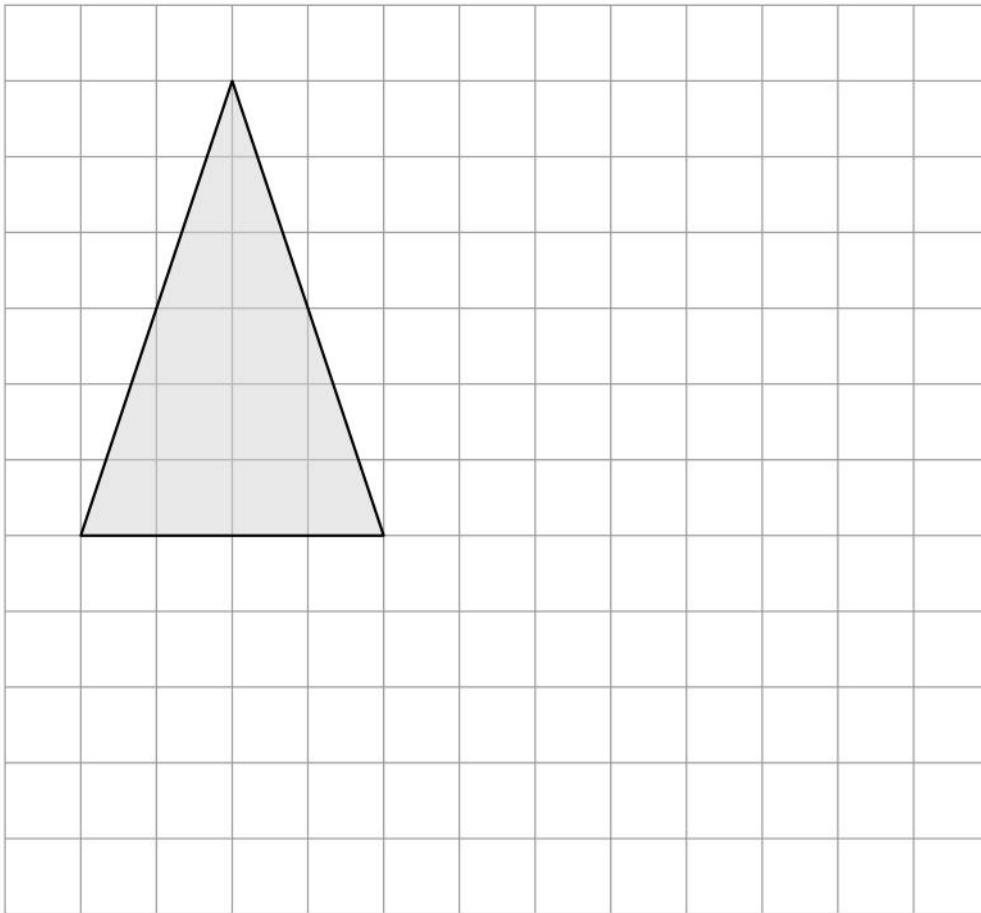−5   −3   3   5

5   On the grid, draw an enlargement of the triangle with scale factor $\frac{1}{2}$

[2 marks]

6

Turn over ▶

6 To the nearest pound, Jon has £9

To the nearest 50p, Ellie has £6.50

Work out the maximum possible total amount of money.

[3 marks]

Answer £_____

7 Two solids, J and K, have the same density.

Complete the table.

Include units in your answers.

[3 marks]

	J	**K**
Mass	48 g	78 g
Volume	8 cm^3	
Density		

8 Rearrange $y = 3x - 2$ to make x the subject.

Circle your answer.

[1 mark]

$$x = \frac{y}{3} - 2 \qquad x = \frac{y+2}{3} \qquad x = \frac{y-2}{3} \qquad x = \frac{y}{3} + 2$$
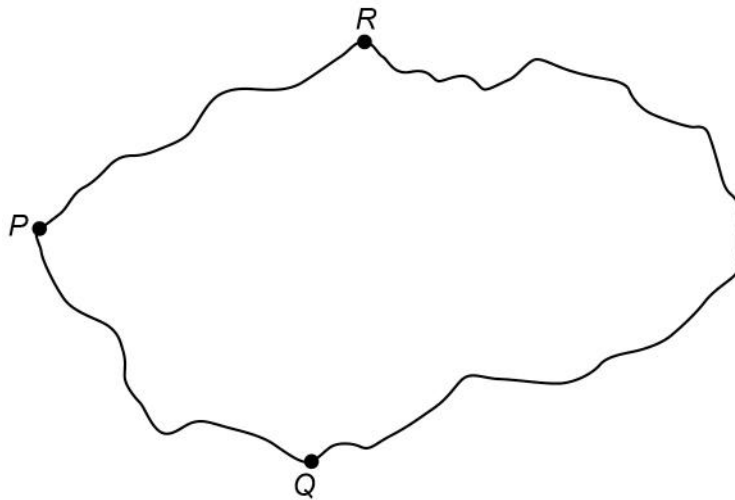
7

Turn over ▶

9 Towns *P*, *Q* and *R* are connected by roads *PQ*, *PR* and *QR*.

PR is 10 km longer than *PQ*.

QR is twice as long as *PR*.

The total length of the three roads is 170 km

Not drawn accurately

Work out the length of *PQ*.

[4 marks]

Answer _____ km

10 Mia wants to borrow £6000 and repay it, with interest, after two years.

She sees two offers for loans.

<table>
<tr><td>

Offer 1

Compound interest

3% per year

</td><td>

Offer 2

Compound interest

First year 1%

Second year 5%

</td></tr>
</table>

Mia says,

"I will pay back the same amount because the average of 1% and 5% is 3%"

Is she correct?

You **must** show your working.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

Turn over for the next question

7

Turn over ▶

11 Here are two sets of numbers, A and B.

Set A

200	160
104	100

Set B

270	400	483
	300	x

mean of Set A : mean of Set B = 3 : 8

Work out the value of x.

[4 marks]

Answer _____

12 A straight line

has gradient 4

and

passes through the point (5, 23)

Work out the equation of the line.

Give your answer in the form $y = mx + c$

[3 marks]

_____

_____

_____

_____

_____

_____

_____

_____

Answer _____

Turn over for the next question

Turn over ▶

7

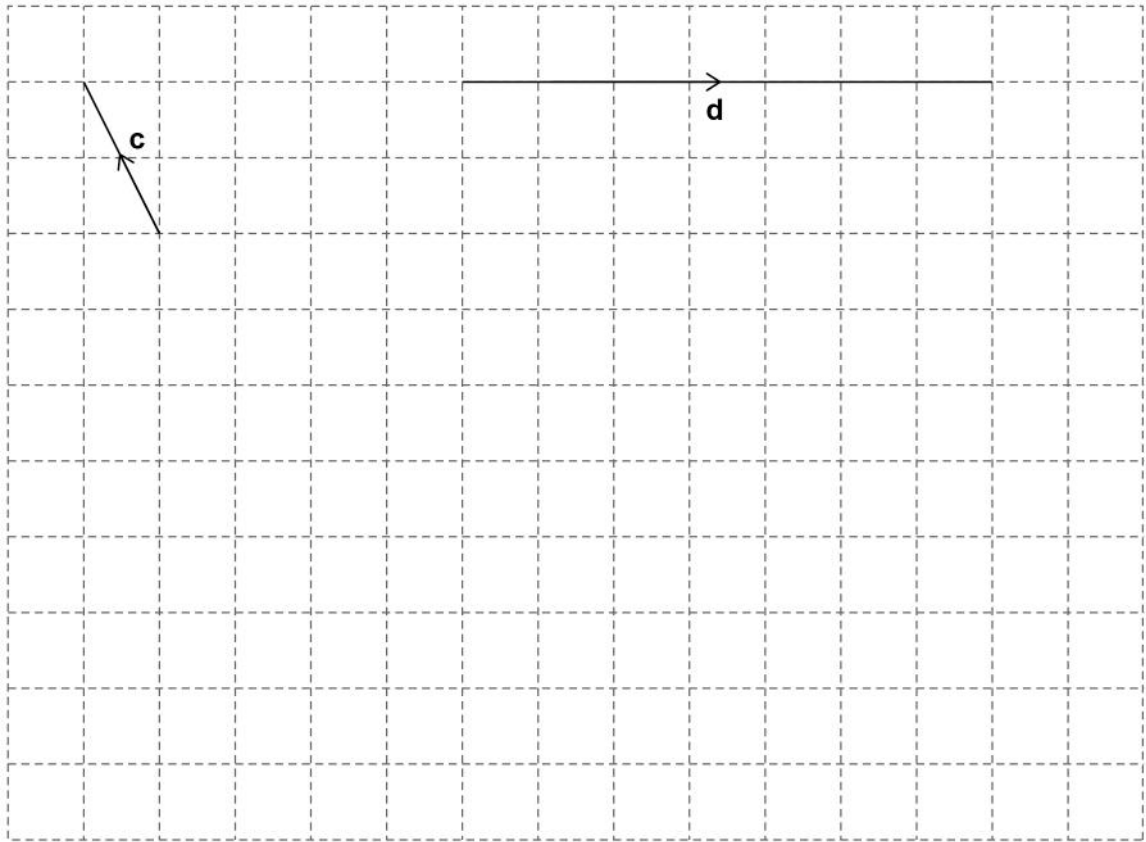**13 (a)**   Vectors **a** and **b** are drawn on a grid.
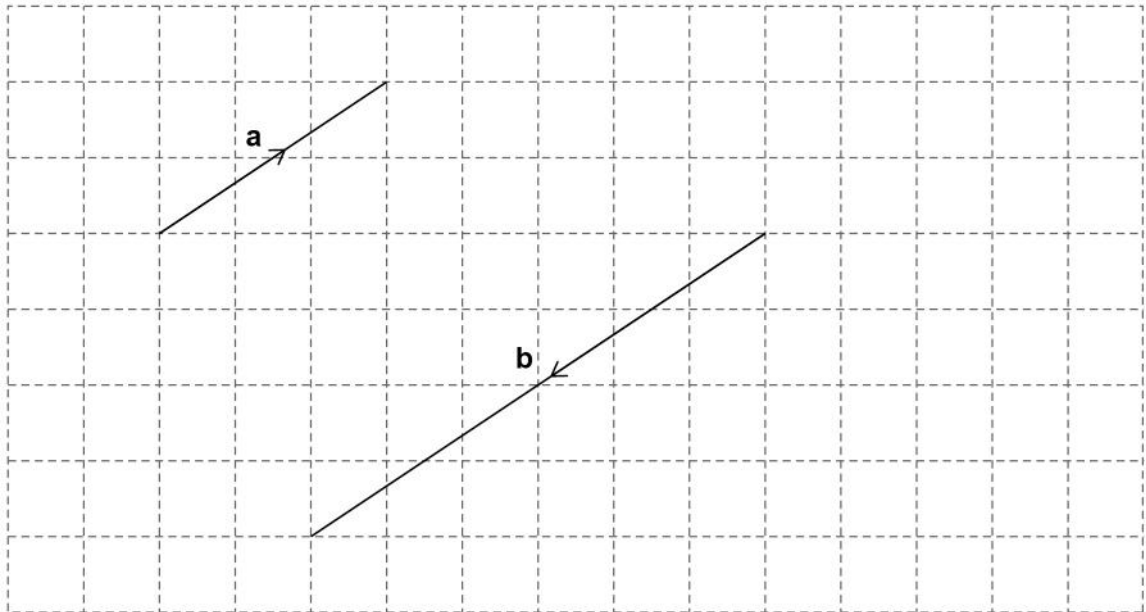
Write **b** in terms of **a**.

[1 mark]

b = _____

13 (b)   Vectors **c** and **d** are drawn on a grid.

On the grid above, draw a vector representing   **c** – **d**

[2 marks]

Turn over for the next question

3

14 For Class X, number of boys : number of girls = 7 : 8

For Class Y, number of boys : number of girls = 3 : 4

Which statement **must** be true?

Tick **one** box.

[1 mark]

☐ Class X has more boys than class Y

☐ Class X has twice as many girls as class Y

☐ Class X has a greater proportion of boys than class Y

☐ Class X has the same proportion of boys as class Y

15 Simplify fully $\dfrac{a^3b^2}{cd} \times \dfrac{c}{ab^5}$

[3 marks]

Answer _____

16 Here are two sectors from different circles.

Sector A
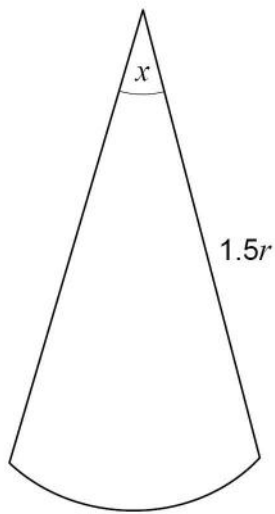
Sector B

Not drawn accurately

x

$1.5r$

$2x$

r
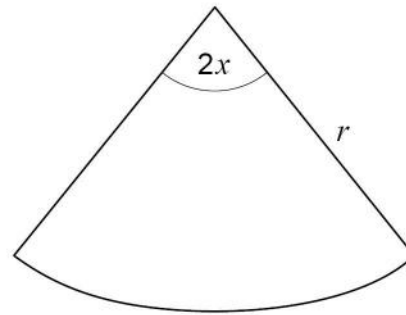
Which sector has the bigger area?

Tick a box.

☐ Sector A   ☐ Sector B

Show working to support your answer.

[2 marks]

6

17 A factory makes kettles.

Four samples of kettles are tested for faults.

Each sample has size 200

Here are the relative frequencies of faulty kettles in the samples.

Sample	P	Q	R	S
Relative frequency	0.03	0.035	0.015	0.01

Work out the range of the number of faulty kettles in the four samples.

[3 marks]

Answer _____

18 (a) Write $x(3x - 9) = 4$ in the form $ax^2 + bx + c = 0$ where a, b and c are integers.

[1 mark]

Answer _____

18 (b) Solve $x(3x - 9) = 4$

Give your answers to 2 decimal places.

[2 marks]

Answer _____

Turn over for the next question

6

Turn over ▶

19 Here is some information about the times people took to complete a survey.

Fastest time	3 minutes
Slowest time	18 minutes
Median	11 minutes
Lower quartile	7 minutes
Interquartile range	8 minutes

Ben draws this box plot to show the information.

Time to complete a survey

Time (minutes)
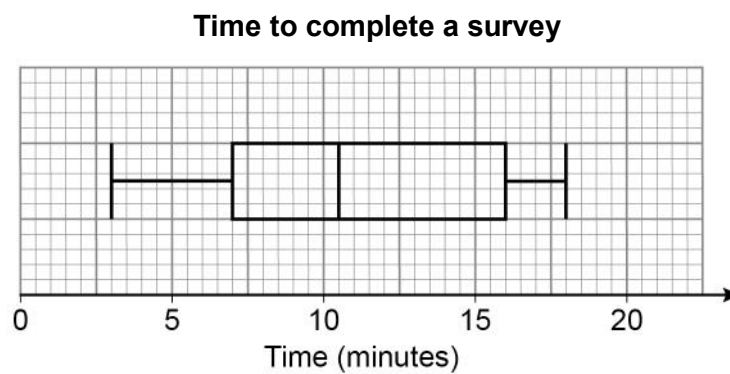
Make **two** criticisms of his box plot.

[2 marks]

Criticism 1 _____

_____

_____

Criticism 2 _____

_____

_____

20 d is directly proportional to the square of v.

$d = 6$ when $v = 20$

20 (a)   Work out an equation connecting d and v.

[3 marks]

Answer _____

20 (b)   Work out the value of d when $v = 30$

[2 marks]

Answer _____

Turn over for the next question

7

Turn over ▶

21 Hanif makes green paint by mixing blue paint and yellow paint in the ratio

blue : yellow = 7 : 3

He buys blue paint in 50-litre containers, each costing £225

He buys yellow paint in 20-litre containers, each costing £80

He wants to

sell the green paint in 5-litre tins

make 40% profit on each tin.

How much should he sell each tin for?

[5 marks]

Answer £ _____

22   ξ = 29 students in a class

C = students who own a cat

D = students who own a dog
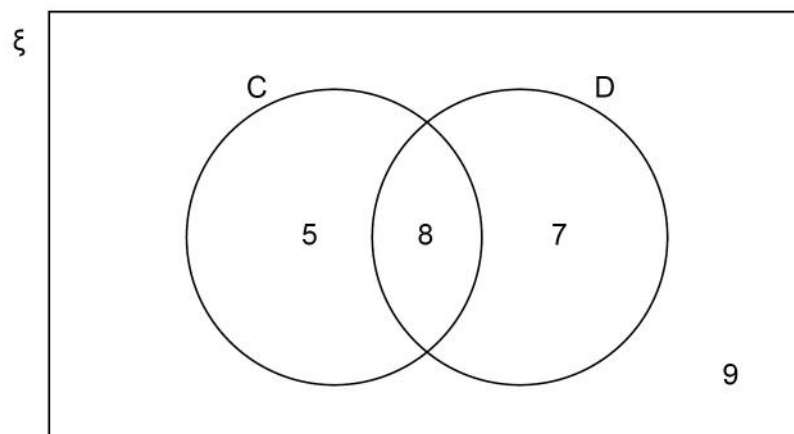
22 (a)   A student is chosen at random.

Circle the probability that the student owns a cat or a dog but not both.

[1 mark]

$$\frac{12}{29} \qquad \frac{13}{29} \qquad \frac{15}{29} \qquad \frac{20}{29}$$

22 (b)   A student who owns a dog is chosen at random.

Circle the probability that the student also owns a cat.

[1 mark]

$$\frac{7}{15} \qquad \frac{8}{15} \qquad \frac{7}{29} \qquad \frac{8}{29}$$

7

Turn over ▶

23   Here is a sketch of the curve $y = 2^x$
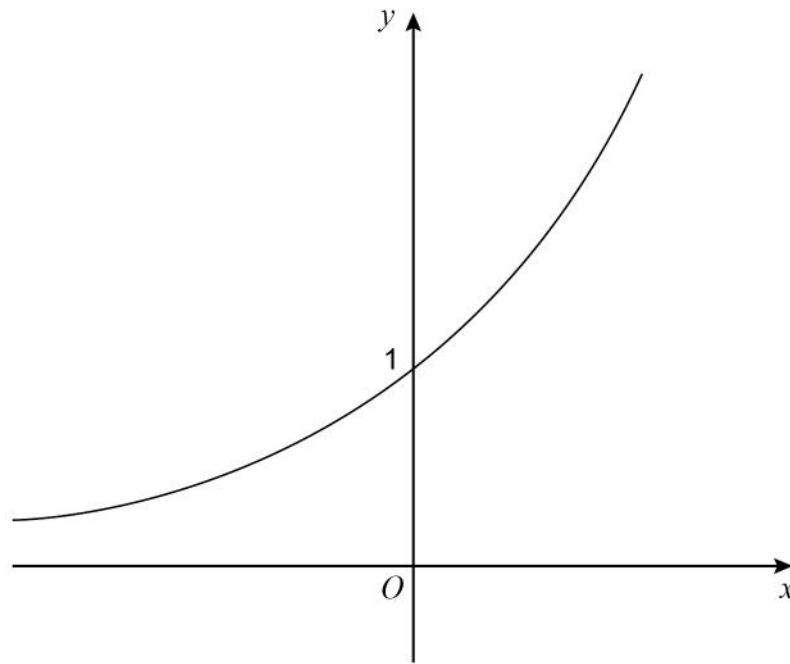
On the axes above, sketch the curve $y = 3^x$

[2 marks]

24 The length of a diagonal of a cuboid is 20 cm

The diagonal makes an angle of 24° with the base.

The area of the base is 150 cm^2
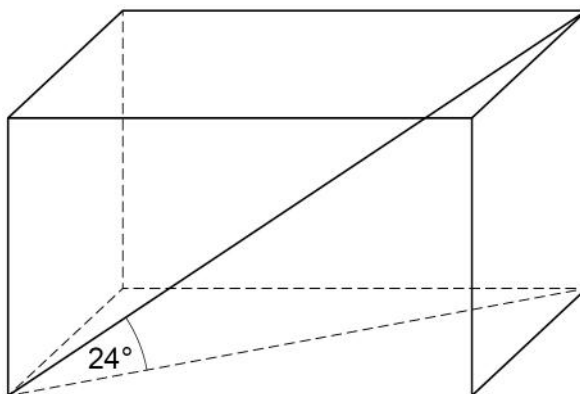
Work out the volume of the cuboid.

[3 marks]

Answer _____ cm^3

5

Turn over ▶

25   *ABCD* is a square.

A is (–2, 1)   *B* is (0, –1)   *C* is (2, 1)   *D* is (0, 3)
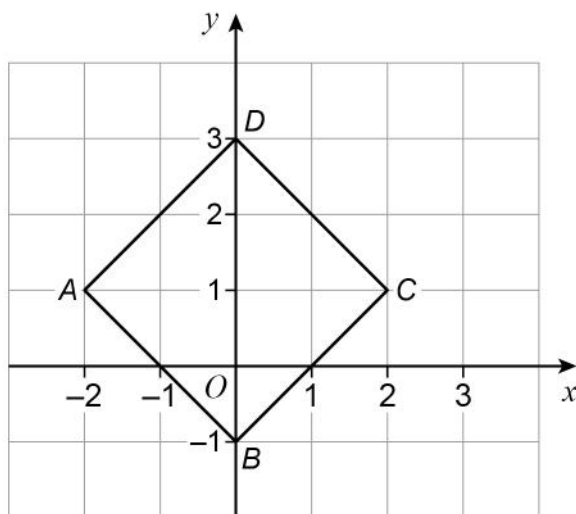
25 (a)   A **single** transformation of *ABCD* is such that

B is mapped to *D*

D is mapped to *B*

A and *C* are invariant points.

Describe fully the transformation.

[2 marks]

25 (b) A different **single** transformation of *ABCD* is such that

B is mapped to *D*

D is mapped to *B*

the only invariant point is (0, 1)

Describe fully the transformation.

[3 marks]

_____

_____

_____

26 g(x) = 16 − x h(x) = x^3

Solve   gh(x) = 24

[3 marks]

_____

_____

_____

_____

_____

$x =$ _____

Turn over for the next question

8

Turn over ▶

27 In this question, all lengths are in centimetres.

A is a point on a circle, centre *O*.

B is a point on a different circle, centre *O*.

AB = 20

Not drawn accurately
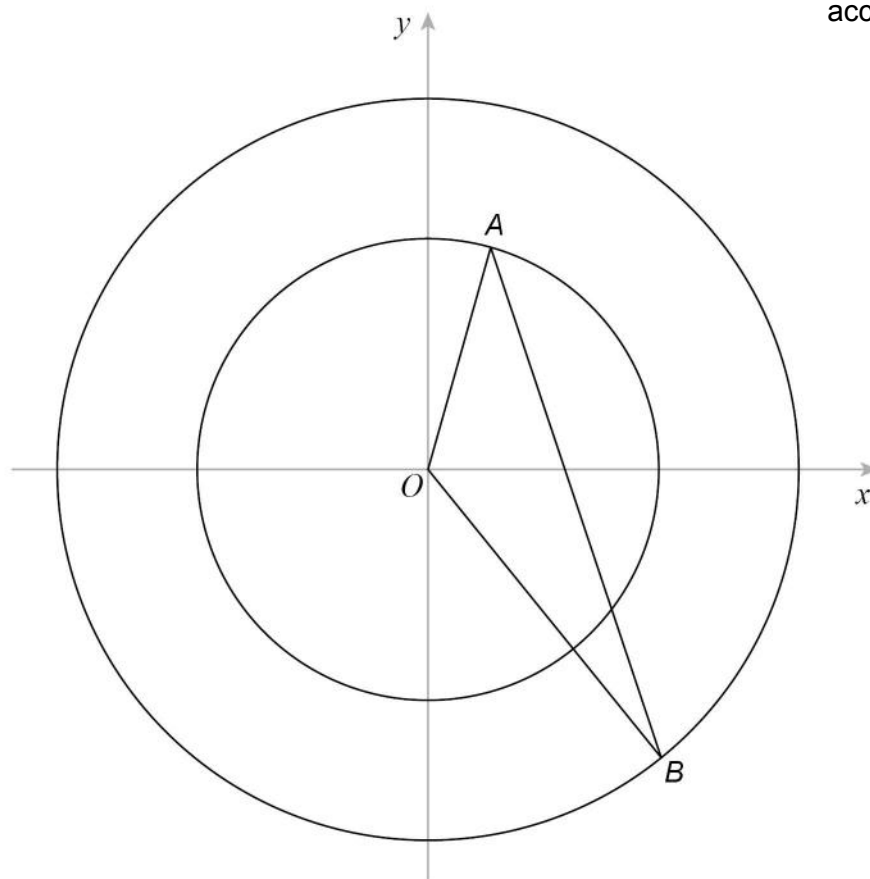
The equation of the larger circle is $x^2 + y^2 = 144$

radius of smaller circle : radius of larger circle = 4 : 5

Work out the size of angle *AOB*.

[5 marks]

Answer _____ degrees

Turn over for the next question

Turn over ▶

28   Leo runs for 12 seconds.

The graph shows his speed.
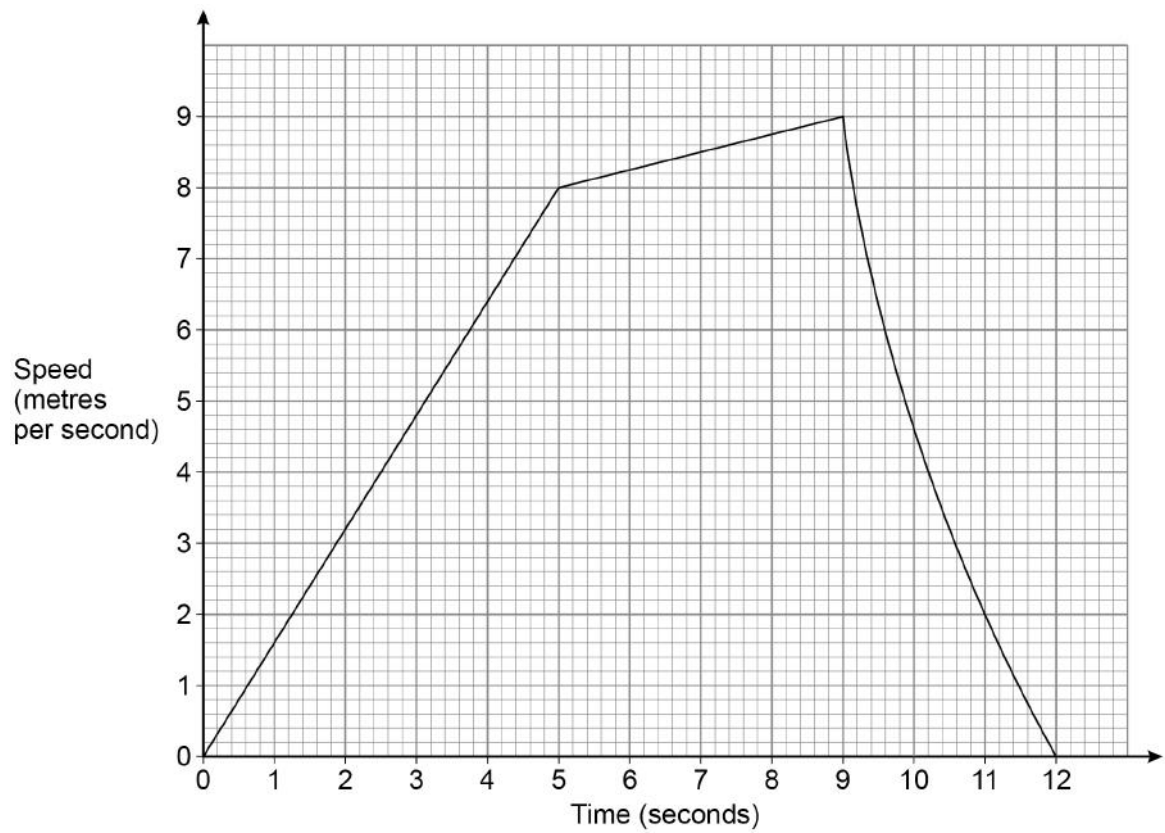
28 (a)   Show that the distance he runs is less than 67.5 metres.

[4 marks]

28 (b) Work out his average acceleration for the first 9 seconds.

State the units of your answer.

[2 marks]

Answer _____

END OF QUESTIONS

6

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

GCSE
MATHEMATICS
8300/3H

Higher Tier Paper 3 Calculator

Mark scheme

June 2019

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Glossary for Mark Schemes

GCSE examinations are marked in such a way as to award positive achievement wherever possible. Thus, for GCSE Mathematics papers, marks are awarded under various categories.

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

M	Method marks are awarded for a correct method which could lead to a correct answer.
A	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
B	Marks awarded independent of method.
ft	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
SC	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
M dep	A method mark dependent on a previous method mark being awarded.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
oe	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
[a, b]	Accept values between a and b inclusive.
[a, b)	Accept values a ≤ value < b
3.14 …	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
Use of brackets	It is not necessary to see the bracketed work to award the marks.

Examiners should consistently apply the following principles

Diagrams

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

Responses which appear to come from incorrect methods

Whenever there is doubt as to whether a student has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the student. In cases where there is no doubt that the answer has come from incorrect working then the student should be penalised.

Questions which ask students to show working

Instructions on marking will be given but usually marks are not awarded to students who show no working.

Questions which do not ask students to show working

As a general principle, a correct response is awarded full marks.

Misread or miscopy

Students often copy values from a question incorrectly. If the examiner thinks that the student has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

Further work

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

Choice

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

Work not replaced

Erased or crossed out work that is still legible should be marked.

Work replaced

Erased or crossed out work that has been replaced is not awarded marks.

Premature approximation

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

Continental notation

Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the student intended it to be a decimal point.

Question	Answer	Mark	Comments
1	$\dfrac{5}{2}$	B1	

Question	Answer	Mark	Comments
2	$\dfrac{9}{25}$	B1	

Question	Answer	Mark	Comments
3	75	B1	

Question	Answer	Mark	Comments
4	–3 and 5	B1	

Question	Answer	Mark	Comments
5	Isosceles triangle with base 2 cm and height 3 cm in any orientation	B2	± ¼ square on base or height B1 isosceles triangle with base 2 cm or height 3 cm in any orientation or acute angled triangle with base 2 cm and height 3 cm in any orientation

Additional Guidance

Mark intention for isosceles triangle within tolerance, lines do not need to be ruled	
Enlargement can be drawn wholly or partially inside the original	
Correct vertices not connected	B1
Right angled isosceles triangle	B0

Question	Answer	Mark	Comments
6	8.5(0) or 9.49 or 9.5(0) or 6.25 or 6.74 or 6.75	B1	
	9.49 + 6.74 or (9, 9.5] + (6.5, 6.75]	M1	
	16.23	A1	accept (£)16.23p SC2 16.25 or 16.24

Additional Guidance	
9.5(0) and 6.55 with answer 16.05	B1M1A0
9.4(0) and 6.25 with answer 15.65	B1M0A0
9.4(0) and 6.55 with answer 15.95	B0M1A0

Question	Answer	Mark	Comments
7	6 as density for J or K	B1	
	13 as volume for K or 78 ÷ their 6 as volume for K	B1ft	ft their 6
	g/cm^3 as units for densities of J and K and cm^3 as unit for volume of K	B1	allow g cm^{-3}

Additional Guidance	
Mark table first	
Full marks are only awarded for a fully correct table with no errors or omissions	
13 cm^3 as a volume for K, 0.006 kg/cm^3 for both densities	B1B1B1
Condone g per cm^3, gpcm^3 or g per cubic centimetre as units for density	

Question	Answer	Mark	Comments
8	$x = \dfrac{y+2}{3}$	B1	

Question	Answer	Mark	Comments
	Alternative method 1 – PQ as the unknown		
	$x + 10$ or $2(x + 10)$	M1	any unknown
	$x + x + 10 + 2(x + 10) = 170$	M1dep	oe any consistent unknown x + their two expressions (with at least one correct) = 170
	$4x + 30 = 170$	M1dep	oe $4x = 140$ must be correct
	35	A1	
	Alternative method 2 – PR as the unknown		
	$x - 10$ or $2x$	M1	any unknown
	$x + x - 10 + 2x = 170$	M1dep	oe any consistent unknown x + their two expressions (with at least one correct) = 170
9	$4x - 10 = 170$ or $x = 45$	M1dep	oe $4x = 180$ must be correct
	35	A1	
	Alternative method 3 – QR as the unknown		
	$\dfrac{x}{2}$ or $\dfrac{x}{2} - 10$	M1	any unknown
	$x + \dfrac{x}{2} + \dfrac{x}{2} - 10 = 170$	M1dep	oe any consistent unknown x + their two expressions (with at least one correct) = 170
	$2x - 10 = 170$ or $x = 90$	M1dep	oe $2x = 180$ must be correct
	35	A1	

Mark scheme for Question 9 continues on next page

Question	Answer	Mark	Comments
	Alternative method 4 – trial and improvement with addition of three lengths		
	A correctly evaluated trial with a difference of 10 (km) between the two shorter lengths and the longest length twice the length of the middle length	M1	may be seen as a subtraction of three numbers from 170
	A different correctly evaluated trial with a difference of 10 (km) between the two shorter lengths and the longest length twice the length of the middle length	M1dep	may be seen as a subtraction of three numbers from 170
	35, 45 and 90	A1	
	35	A1	
9 cont	**Alternative method 5 – trial and improvement with subtraction from 170**		
	A correctly evaluated trial of two lengths subtracted from 170 with a difference of 10 (km) between the two lengths or one length twice the length of the other	M1	
	A different correctly evaluated trial of two lengths subtracted from 170 with a difference of 10 (km) between the two lengths or one length twice the length of the other	M1dep	
	35, 45 and 90	A1	
	35	A1	

Additional Guidance is on the next page

		Additional Guidance	
9 cont		If the student attempts more than one method, mark each method and award the highest mark	
		Alt 1 $PQ + PQ + 10 + 2(PQ + 10) = 170$	M1M1
		Alt 1 $PQ + PQ + 10 + 2PR = 170$	M1
		Alt 2 $x, \; x + 10$ and $2x$ seen on diagram, $4x + 10 = 170$	M1M1M0A0
		Alt 4 $35 + 45 + 90$ with no choice made	M1M1A1A0
		Alt 4 $170 – 30 – 40 – 80 = 20$	M1
		Alt 4 $170 – 30 – 40 – 60 = 40$ incorrect number is doubled	M0
		Alt 5 $170 – 30 – 60 = 80$	M1

Question	Answer	Mark	Comments
	Alternative method 1		
	6000 × 1.03 or 6180 or 6000 × 0.03 or 180 or 6000 × 1.01 or 6060 or 6000 × 0.01 or 60	M1	6000 × 1.05 or 6300 6000 × 0.05 or 300
	their 6180 × 1.03 or 6365.4(0) or their 6180 × 0.03 or 185.4(0) or 365.4(0) or their 6060 × 1.05 or 6363 or their 6060 × 0.05 or 303 or 363	M1dep	$6000 × 1.03^2$ or 6000 × 1.0609 or 6000 × 1.01 × 1.05 or 6000 × 1.0605 or 6300 × 1.01 or 6300 × 0.01 or 63
10	6365.4(0) and 6363 and No or 365.4(0) and 363 and No	A1	accept 2.4(0) difference to imply 'No'
	Alternative method 2		
	1.03 or 1.01 or 1.05	M1	
	1.03^2 or 1.03 × 1.03 or 1.0609 or 0.0609 or 6.09(%) or 1.01 × 1.05 or 1.0605 or 0.0605 or 6.05(%)	M1dep	
	1.0609 and 1.0605 and No or 0.0609 and 0.0605 and No or 6.09(%) and 6.05(%) and No	A1	accept 0.0004 difference to imply 'No' accept 0.04(%) difference to imply 'No'

Additional Guidance is on the next page

		Additional Guidance	
10 cont		Accept any clear indication that the Offer 1 amount is different to the Offer 2 amount for 'No'	
		If build up methods are used they must be complete	
		6000×0.03^2 implies 6000×0.03	M1
		1.03^3 implies 1.03	M1
		360 without 180 seen (simple interest)	M0
		If a different starting value is used, apply Alt 2 with correctly evaluated answers eg $600 \times 1.03^2 = 636.54$ $600 \times 1.01 \times 1.05 = 636.30$ No, pay less with Offer 1 (condone incorrect choice of Offer 1) $500 \times 1.03 = 515$ $515 \times 1.03 = 530.45$ $500 \times 1.01 = 505$ $505 \times 1.05 = 530.25$ No, they are different	M1M1A1 M1M1A1

11	$(200 + 160 + 104 + 100) \div 4$ or $564 \div 4$ or 141	M1		
	their $141 \div 3 \times 8$ or 47×8 or $1128 \div 3$ or 376	M1dep	oe accept $141 \times 2.66(\ldots)$ or 141×2.67	
	their 376×5 or 1880	M1dep		
	427	A1		
	Additional Guidance			
	$(270 + 400 + 483 + 300 + 427) \div 5$ embedded answer		M1M1M1A0	
	$(1453 + x) \div 5 = 376$ and $1453 + x = 1880$		M1M1M1	
	$(1453 + x) \div 5 = 376$		M1M1M0	
	$200 + 160 + 104 + 100 \div 4$ scores M0 unless recovered			

Question	Answer	Mark	Comments
	Alternative method 1		
	$4 \times 5 + c = 23$	M1	oe $20 + c = 23$
	$c = 3$	A1	implied by (0, 3) or 3 shown as y-axis intercept
	$y = 4x + 3$	A1	SC1 $y = 4x + c$ $c \neq 3$
	Alternative method 2		
	$y - 23 = 4(x - 5)$	M1	oe
	$y - 23 = 4x - 20$	M1dep	
	$y = 4x + 3$	A1	SC1 $y = 4x + c$ $c \neq 3$
12	**Additional Guidance**		
	If 3 is clearly linked to c in $y = mx + c$ condone M1A1		
	$4x + 3$ on answer line, $y = 4x + 3$ seen in working		M1A1A1
	$4x + 3$ on answer line, $y = 4x + 3$ not seen in working		M1A1A0
	$m = 4$, $c = 3$ on answer line, $y = 4x + 3$ seen in working		M1A1A1
	$m = 4$, $c = 3$		M1A1A0
	$y = mx + 3$		M1A1A0
	$23 = 4 \times 5 + 3$ embedded value for c		M1A0A0
	$4x + c$ on answer line with $c \neq 3$		M0A0A0

Question	Answer	Mark	Comments
13(a)	–2**a**	B1	oe eg –**a** –**a** or 2(–**a**)

	Additional Guidance	
	Do not accept in column vector form unless correct answer is also seen	
	Do not accept –**a**2 for –2**a**	

Question	Answer	Mark	Comments
13(b)	$\begin{pmatrix} -8 \\ 2 \end{pmatrix}$ drawn on the grid with direction shown	B2	± ¼ centimetre square B1 $\begin{pmatrix} -8 \\ 2 \end{pmatrix}$ seen in working or correct line drawn with incorrect direction or no direction shown or correctly joined vectors for **c** and –**d** with correct directions shown

	Additional Guidance	
	Mark intention, line does not need to be ruled and ignore all labelling for **c**, **d** and **c** – **d**	

Question	Answer	Mark	Comments
14	Class X has a greater proportion of boys than class Y	B1	

Question	Answer	Mark	Comments
	Alternative method 1 – answer written as a fraction		
	a^2 on numerator	B1	a correctly simplified
	b^3 on denominator or b^{-3} on numerator	B1	b correctly simplified
	c cancelled and d on denominator or d^{-1} on numerator	B1	d correctly simplified
	Alternative method 2 – answer written only as a product		
	a^2	B1	a correctly simplified
	b^{-3}	B1	b correctly simplified
	d^{-1} and c cancelled	B1	d correctly simplified
	Additional Guidance		
15	If answer line is blank, marks can be awarded in the working		
	Do not award any marks if addition or subtraction is seen in their best attempt		
	Condone use of capital letters		
	Penalise use of ✕ sign by one mark only if full marks would have been awarded eg $a^2 \times b^{-3} \times d^{-1}$		B1B1
	$\dfrac{a^2}{db^3}$ or $\dfrac{a^2 d^{-1}}{b^3}$ or $\dfrac{a^2 b^{-3}}{d}$ or $a^2 b^{-3} d^{-1}$		B1B1B1
	$\dfrac{a^2 b^2}{db^5}$ or $\dfrac{a^2 b^2 d^{-1}}{b^5}$ or $a^2 b^2 d^{-1} b^{-5}$		B1B0B1
	$\dfrac{a^3}{dab^3}$		B0B1B1
	$\dfrac{a^2 c}{cdb^3}$		B1B1B0
	$\dfrac{a}{d} \times b^3$ use of ✕ sign not penalised as full marks would not be awarded		B0B0B1
	$a^2 + b^{-3} - d^{-1}$		B0B0B0

Question	Answer	Mark	Comments
16	$\dfrac{x}{360} \times \pi \times (1.5r)^2$ or $\dfrac{1}{160}\pi xr^2$ or $0.019...xr^2$ or $\dfrac{2x}{360} \times \pi \times r^2$ or $\dfrac{1}{180}\pi xr^2$ or $0.017...xr^2$	M1	oe eg (working in radians) $\dfrac{1}{2} \times (1.5r)^2 \times x$ or $\dfrac{1}{2} \times r^2 \times 2x$
	$\dfrac{1}{160}\pi xr^2$ and $\dfrac{1}{180}\pi xr^2$ and A or $0.019...xr^2$ and $0.017...xr^2$ and A	A1	oe eg (working in radians) $\dfrac{9}{8}r^2x$ and r^2x and A

Additional Guidance	
Methods must be algebraic, containing x, π and r	
If a box is not ticked, must say 'A' without contradiction in working to award M1A1	
To award A1 their areas must be in a comparable form eg $\dfrac{2.25}{360}\pi xr^2$ and $\dfrac{2}{360}\pi xr^2$ and A ticked	
Ignore further incorrect working after A1 scored	

Question	Answer	Mark	Comments
	Alternative method 1		
	0.03 × 200 or 6 or 0.035 × 200 or 7 or 0.015 × 200 or 3 or 0.01 × 200 or 2	M1	
	0.035 × 200 or 7 and 0.01 × 200 or 2	M1dep	
17	5	A1	
	Alternative method 2		
	0.035 – 0.01 or 0.025	M1	
	their 0.025 × 200	M1dep	
	5	A1	

	Additional Guidance	
	Condone errors in calculating 6 or 3 as only the values 7 and 2 are required to correctly answer the question eg 5, 7, 3, 2 the range is 7 – 2 = 5	M1M1A1
	5 on answer line does not imply full marks, method must be checked eg 0.03 × 200 = 8 8 – 3 = 5	M1M0A0

	$3x^2 - 9x - 4 = 0$ or $-3x^2 + 9x + 4 = 0$	B1	must see = 0 on answer line
18(a)	**Additional Guidance**		
	Do not accept $x9$ or $9 \times x$ for $9x$		
	$3x^2 + -9x + -4 = 0$		B1
	$3x^2 - +9x - +4 = 0$		B0

Question	Answer	Mark	Comments
18(b)	$$\frac{--9 \pm \sqrt{(-9)^2 - 4 \times 3 \times -4}}{2 \times 3}$$ or $\dfrac{9 \pm \sqrt{129}}{6}$ or $\left(x - \dfrac{3}{2}\right)^2 - \dfrac{9}{4} = \dfrac{4}{3}$ or $\dfrac{3}{2} \pm \sqrt{\dfrac{43}{12}}$ or 3.392… or 3.393 or –0.392… or –0.393	M1	oe correct or ft their 3-term quadratic seen
	3.39 and –0.39	A1ft	correct or ft their 3-term quadratic seen ft answers must be rounded to 2 dp

	Additional Guidance	
	The word 'and' does not need to be seen to award A mark	
	Full fraction line, correct full square root, ± and $(-9)^2$ or 9^2 must be seen to award M1 but can be recovered by sight of correct solution(s)	
	$3x^2 - 9x + 4 = 0$ in 18(a) $\dfrac{9 \pm \sqrt{33}}{6}$ or $\dfrac{3}{2} \pm \sqrt{\dfrac{11}{12}}$ or 2.457… or 0.542… 2.46 and 0.54	M1 A1ft
	3.39 and –0.39 on answer line with no incorrect working	M1A1
	2.46 and 0.54 on answer line with no incorrect working	M1A1ft
	One correct answer with no incorrect working	M1A0

Question	Answer	Mark	Comments
19	Median is at 10.5	B1	oe eg median should be one square to the right
	Upper quartile should be at 15	B1	oe eg IQR is 9 eg UQ should be two squares to the left
	Additional Guidance		
	Ignore irrelevant and non-contradictory statements alongside a B1 response		
	To score either mark, answers must correctly refer to a number of minutes or exact position on the box plot		
	The median should be at 11	B1	
	The median is half a minute too low	B1	
	The interquartile range should be 8	B1	
	The interquartile range is one minute too big	B1	
	Upper quartile = 16 minutes	B1	
	The median is in the wrong place	B0	
	The median is 11	B0	
	The median is wrong	B0	
	The median is inaccurate by 1 square	B0	
	The interquartile range is too small	B0	
	The upper quartile should be at 16	B0	
	The upper quartile is wrong by 1	B0	

Question	Answer	Mark	Comments
20(a)	$d\ \alpha\ v^2$ or $d = k \times v^2$ or $6 = k \times 20^2$ or $c \times d = v^2$ or $c \times 6 = 20^2$	M1	oe eg $v = kd^{½}$
	$(k =) 6 \div 20^2$ or 0.015 or $(c =) 20^2 \div 6$ or $66.66\dots$ or 66.67	M1dep	oe eg $\dfrac{6}{400}$ or $\dfrac{3}{200}$ $\dfrac{400}{6}$ or $\dfrac{200}{3}$
	$d = 0.015 \times v^2$ or $\dfrac{200}{3} \times d = v^2$	A1	oe equation

Additional Guidance

Working for second M mark must follow from their initial equation	
$d\ \alpha\ 0.015 \times v^2$	M1M1A0
$(k =) 0.015$ or $(c =) \dfrac{200}{3}$ with no incorrect working	M1M1A0
$0.015v^2$ or $\dfrac{200}{3}d$	M1M1A0

Question	Answer	Mark	Comments
	their 0.015×30^2 their 0.015×900 or $6 \times \left(\dfrac{30}{20}\right)^2$ or $30^2 \div$ their $\dfrac{200}{3}$ or $900 \div \dfrac{200}{3}$ or $6 \div \left(\dfrac{20}{30}\right)^2$	M1	oe
	13.5	A1ft	oe ft their 0.015 provided using $d =$ their $0.015 \times v^2$

20(b)	**Additional Guidance**		
	Must use $\times 30^2$ or $\times 900$ or $\times \left(\dfrac{30}{20}\right)^2$ for M1	
	d α 13.5	M1A0
	If in part (a) $d = k \times v$ $6 = k \times 20$ $d = \dfrac{6}{20}v$ and in part (b) $d = \dfrac{6}{20} \times 30$, $m = 9$	M0 part (a) M0 part (b)
	If in part (a) $d = k \times v$ $6 = k \times 20$ $d = \dfrac{6}{20}v$ and in part (b) $d = \dfrac{6}{20} \times 30^2$, $d = 270$	M0 part (a) M1A1ft part (b)

Question	Answer	Mark	Comments
	Alternative method 1 – making 10 litres of paint		
	225 ÷ 50 (= 4.5(0)) or 80 ÷ 20 (= 4(.00))	M1	cost of 1 litre for one colour
	225 ÷ 50 (= 4.5(0)) and 80 ÷ 20 (= 4(.00))	M1	cost of 1 litre for both colours
	their 4.5(0) × 7 + their 4(.00) × 3 or 43.5(0)	M1dep	31.5(0) + 12(.00) dep on M2
	their 43.5(0) × 1.4 or 60.9(0) or their 43.5(0) ÷ 2 × 1.4	M1dep	oe dep on M3
	30.45	A1	
21	**Alternative method 2 – making 5 litres of paint**		
	5 ÷ (7 + 3) or 0.5	M1	
	their 0.5 × 7 or 3.5 and their 0.5 × 3 or 1.5	M1dep	3.5 : 1.5
	$\dfrac{\text{their } 3.5}{50} \times 225$ or 15.75 and $\dfrac{\text{their } 1.5}{20} \times 80$ or 6	M1dep	dep on M2
	(their 15.75 + their 6) × 1.4	M1dep	oe 21.75 × 1.4 or 21.75 + 8.7(0) dep on M3
	30.45	A1	

Mark scheme for Question 21 continues on next page

	Alternative method 3 – making 10 litres of paint when profit is added at the start		
	225 × 1.4 (= 315) and 80 × 1.4 (= 112)	M1	40% added to the cost of both colours
	their 315 ÷ 50 (= 6.3(0)) or their 112 ÷ 20 (= 5.6(0))	M1dep	selling price of 1 litre of either colour
	their 315 ÷ 50 (= 6.3(0)) and their 112 ÷ 20 (= 5.6(0))	M1dep	selling price of 1 litre of both colours
	their 6.3(0) × 7 + their 5.6(0) × 3 or 60.9(0)	M1dep	oe 44.1(0) + 16.8(0) dep on M3
	30.45	A1	
	Alternative method 4 – making n litres of paint		
21 cont	225 ÷ 50 × 0.7n or 3.15n or 80 ÷ 20 × 0.3n or 1.2n	M1	cost of blue or yellow paint in n litres of green paint
	225 ÷ 50 × 0.7n or 3.15n and 80 ÷ 20 × 0.3n or 1.2n	M1	cost of blue and yellow paint in n litres of green paint
	their 3.15n + their 1.2n or 4.35n	M1dep	total cost of n litres of green paint dep on M2
	their 4.35n × 1.4 or 6.09n	M1dep	oe dep on M3
	30.45	A1	
	Additional Guidance		
	If the student attempts more than one method, mark each method and award the highest mark		
	Alt 4 value of n must be clear eg 100 litres total or 700:300 (1000 litres implied)		
	Alt 4 their 4.35n ÷ k × 1.4 implies their 4.35n × 1.4 where ÷ k is their attempt to scale to the cost of a 5-litre tin		M1M1M1M1

Question	Answer	Mark	Comments
22(a)	$\dfrac{12}{29}$	B1	

Question	Answer	Mark	Comments
22(b)	$\dfrac{8}{15}$	B1	

Question	Answer	Mark	Comments
23	Correct curve	B2	B2 correct curve must be correct shape and pass through (0, 1) and be in correct position relative to $y = 2^x$ B1 correct shape and pass through (0, 1)

Additional Guidance

Correct curve must be an exponential graph

Correct position must be

    above $y = 2^x$ for $x > 0$

    below $y = 2^x$ for $x < 0$

Question	Answer	Mark	Comments
24	$\sin 24 = \dfrac{h}{20}$	M1	oe $\cos 66 = \dfrac{h}{20}$ $\dfrac{20}{\sin 90} = \dfrac{h}{\sin 24}$
	$20 \times \sin 24$ or 8.1…	M1dep	$20 \times \cos 66$ $\dfrac{20}{\sin 90} \times \sin 24$
	[1215, 1221]	A1	with no incorrect working seen

Additional Guidance

$150 \times 20 \times \sin 24$	M1M1

Question	Answer	Mark	Comments
25(a)	Reflection	B1	
	$y = 1$ or AC	B1	
	Additional Guidance		
	Mirror line		B0
	Contradiction for line of reflection		B0
	More than one transformation given		B0

Question	Answer	Mark	Comments
25(b)	**Alternative method 1**		
	Rotation	B1	
	Centre (0, 1)	B1	
	180°	B1	degrees symbol does not have to be seen
	Alternative method 2		
	Enlargement	B1	
	Centre (0, 1)	B1	
	Scale factor –1	B1	
	Additional Guidance		
	For centre (0, 1) allow about (0, 1) or (0, 1)		B1
	For centre (0, 1) do not allow 0, 1		B0
	More than one transformation given eg rotation then translation		B0
	Do not allow half turn for 180°		
	Ignore clockwise or anticlockwise		
	For scale factor allow sf or scale or (✗) –1		

Question	Answer	Mark	Comments
26	$16 - x^3$	M1	
	$x^3 = 16 - 24$ or $x^3 = -8$ or $x = \sqrt[3]{-8}$ or $-x^3 = 24 - 16$ or $-x^3 = 8$ or $-x = -\sqrt[3]{-8}$	M1dep	
	-2	A1	
	Additional Guidance		
	$16 - x^3 = 24$ $x^3 = 24 - 16$		M1M0A0

Question	Answer	Mark	Comments
	$\sqrt{144}$ or 12	B1	radius of larger circle may be seen on diagram
	$\dfrac{4}{5}$ × their 12 or 9.6	M1	their 12 must be a value may be seen on diagram
	(cos AOB =) $\dfrac{\text{their } 12^2 + \text{their } 9.6^2 - 20^2}{2 \times \text{their } 12 \times \text{their } 9.6}$ or $\dfrac{144 + 92.16 - 400}{230.4}$ or $-\dfrac{32}{45}$ or $-0.71\dots$	M1dep	oe
27	$\cos^{-1}$ their $-\dfrac{32}{45}$	M1dep	dep on M2
	135.(…)	A1	
	Additional Guidance		
	144		B0
	$\dfrac{4}{5}$ × 144 = 115.2		M1
	(cos AOB =) $\dfrac{144^2 + 115.2^2 - 20^2}{2 \times 144 \times 115.2}$		M1M0A0
	12 seen, but a different value used for the radius of the larger circle cannot score B1M1		
	$x + y$ = 12 seen, but x = 6 used to find radius OA = 4.8		B0M1

Question	Answer	Mark	Comments
28(a)	$\dfrac{1}{2}$ × 5 × 8 or 20 or $\dfrac{1}{2}$ × (8 + 9) × (9 – 5) or 34	M1	oe eg $\dfrac{1}{2}$ × 4 (× 1) and 4 × 8 or 2 and 32
	$\dfrac{1}{2}$ × 5 × 8 or 20 and $\dfrac{1}{2}$ × (8 + 9) × (9 – 5) or 34	M1dep	$\dfrac{1}{2}$ × 4 (× 1) and 4 × 8 or 2 and 32
	$\dfrac{1}{2}$ × (9 + 4.6) × 1 + $\dfrac{1}{2}$ × (4.6 + 2) × 1 + $\dfrac{1}{2}$ × 1 × 2 or 6.8 + 3.3 + 1 or 11.1 or $\dfrac{1}{2}$ × (9 + 4.6) × 1 + $\dfrac{1}{2}$ × 2 × 4.6 or 6.8 + 4.6 or 11.4 or $\dfrac{1}{2}$ × (9 + 2) × 2 + $\dfrac{1}{2}$ × 1 × 2 or 11 + 1 or 12 or $\dfrac{1}{2}$ × 3 × 9 or 13.5	M1	correct attempt to estimate the full area below curve using trapezia, a trapezium and a triangle or a triangle
	Correctly evaluates 20 + 34 + their correct estimate for the full area below curve, which must sum to an answer which is less than or equal to 67.5	A1	M3 must be awarded

Additional Guidance is on the next page

	Additional Guidance	
28(a) cont	If first two marks are awarded, the third area must not come from 67.5 minus their two areas	
	If a concluding statement is made do not award A mark if it contains an error	

	1	B1	
28(b)	m/s^2 or ms^{-2} or metres per second per second	B1	oe allow mps^2 or m/s/s
	Additional Guidance		
	Do not accept fractions		
	m/s^{-2}		B0