Guidance on the use of codes for this mark scheme	
M	Method mark
A	Accuracy mark
B	Working mark
C	Communication mark
P	Proof, process or justification mark
cao	Correct answer only
oe	Or equivalent
ft	Follow through

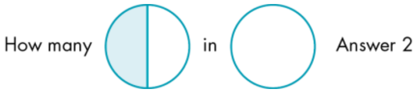
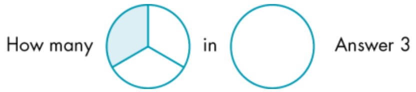
Question	Working	Answer	Mark	AO	Notes	Grade
1 a	1 : 6 ≠ 6 : 1 because 1 : 6 = 6 : 36 (×6) Or 6:1 = 1: $\frac{1}{6}$ (÷6)	No	P1	2	P1 for demonstrating an understanding of each ratio in its unitary form as a method of comparison, oe	B
b	19 : 95 = 1 × 19 : 5 × 19 = 1 : 5	19 : 95 (÷19) 1 : 5	B1		B1 for calculation showing cancelling	
c		No, because the units must be the same in order to compare	C1		C1 for an understanding of scale and equivalence of units	
d	B: G 2 : 5 4 : 10 6 : 15 (21 students) 7 : 17.5 (not possible) 8 : 20 (28 students)	No, to retain this ratio requires 2 boys and 5 girls each time, so 7 students. This means that there can only be multiples of 7 students in the club. 24 is not a multiple of 7.	C1		C1 for reference to multiples of 7	
			4			
2 a	Packs of 3: 90 ÷ 3 = 30 30 packs cost 30 × £1.50 = £45 Packs of 15: 90 ÷ 15 = 6 6 packs cost 6 × £5= £30 Packs of 25: Not possible, because 90 is not divisible by 25.	6 packs of 15. 6 packs of 15 for £30.	B1 A1	2	B1 for correct combination to 90 A1 for correct cost	B
b	Buy 2 get one free on packs of 15. Buy two packs of 15 for £10 Get a pack of 15 free. 45 will cost £20. So new cost = £20 Or (3 × 15) + (3 × 15) = 90 £10 + £10 = £20	No, still buy 6 packs of 15 but now for the lower price of £20.	B1 C1		B1 for a method for calculating $\frac{2}{3}$ of the cost C1 for correct justification of choice	
			4			

3 a **b**	Appropriate workings related to their question.	For example: Easy: a shop increased its prices by 10%. If an item costs £100, how much more does it costs after the price increase? £10 Easy to find because original amount is £100. Difficult: A worker's hourly rate increased by 25%. If the hourly rate was £8 before the increase, how much does the worker get paid per hour after the increase? **£10** Difficult to find because the percentage is not a multiple of 10 and context is more complex.	C1 C1 C1 C1 **4**	2 3	C1 for clarity of question C1 for explanation that links complexity of mathematics to context of question C1 for clarity of question C1 for explanation that links complexity of mathematics to context of question	B
4		The formula for density is: density = mass ÷ volume If the objects have the same volume but different masses, this formula indicates that the densities will be different and so suggests the objects are made from different metals.	C1 **1**	3	C1 for insight into the effect of changing a variable in a formula	M

5 a	1 g/cm^3 = 1000 kg/m^3 So 2.3 g/cm^3 = 2300 kg/m^3 Use the formula: density = $\frac{\text{mass}}{\text{volume}}$ Rearrange the formula: volume = mass ÷ density 1 tonne = 1000 kg so volume = $\frac{30\ 000}{2300}$ kg	= 13 m^3 to nearest m^3	P1 B1 A1	2 3	P1 for conversion from g/cm^3 to kg/m^3 B1 for correct rearrangement of formula A1 oe	M
b	2.7 g/cm^3 = 2700 kg/m^3 They both have the same volume. Again, use the formula: mass = density × volume 13 × 2700 = 35 100 The granite has a mass of 35.1 tonnes and the sandstone has a mass of 30 tonnes OR $\frac{35\ 100}{30\ 000}$ =1.17	5.1 tonnes heavier or 17% heavier.	B1 M1 C1		B1 for calculating correct tonnage for granite M1 for correct method for comparison of mass C1 for stating correct comparison	
			6			

6	$p_0 = 630$ kg/m^3 $p_m = 550$ kg/m^3 $m_0 = 315$ g $= 0.315$ kg Start with the formula: $p = \frac{m}{v}$ Rearrange to: $v = \frac{m}{p}$ The carvings are identical so the volume is the same. $\frac{0.315}{630} = \frac{m_m}{550}$ Rearranging: $m_m = 550 \times \frac{0.315}{630}$ $= 0.275$ kg		M1 B1 A1 **3**	3	M1 for dividing mass by volume and making correct comparison B1 for rearranging A1 oe	M
7 a	The ratio men : women is 5 : 2. There are 24 women so the total membership is: $5 \times 12 : 2 \times 12$ The ratio becomes 60 : 24 Then the total membership = 60 + 24 = 84	84	M1 A1	3	M1 for multiplying by 12 oe A1 for 84 members in total	M
b	The ratio R : S : J is 2 : 3 : 5. There are 10 shares. £85 ÷ 10 = £8.50 Shaun pays 3 × £8.50 = £25.50	£25.50	M1 A1		M1 for division of 85 by 10 A1 for correct multiplication $3 \times$ £8.50 oe	
c		Own question like the one in part a. For example: In a tennis club, 30 members are men. The ratio of women to men is 6 : 5. How many of the members are female? **36**	C1 **5**		C1 for correct type of question	

8 a	$b_2 = \frac{5}{4} \times b_1$ $b_2 = \frac{5}{4} \times 8$ $= \frac{40}{4}$ = 10 hours	10 hours	P1 A1	3	P1 for process of setting up equation A1 cao	M
b	b_2 costs £198 b_1 costs £118 $\frac{198}{118}$ = 1.68 to 2dp $\frac{5}{4}$ = 1.25	The increase in cost is proportionally more than the increase in battery life.	B1 C1		B1 for division of higher cost by lower cost C1 for use of comparison to justify the answer	
c	$\frac{b_2}{118} = \frac{5}{4}$ $b_2 = \frac{5 \times 118}{4}$ $= \frac{590}{4}$ = £147.50 Reduction is: £198 – £147.50 = £50.50	She would need a reduction of £50.50.	M1 A1 **6**		M1 for multiplying lower cost by 5 and dividing by 4 A1 cao	
9 a	For the first 5-pack: 5 × 90 minutes = 450 minutes £6.60 = 660p 650p ÷ 450 = 1.44p per minute For the 10-pack: 10 × 80 = 800 minutes for £6.50 ÷ 800 = 0.8125p per minute cheapest For the second 5-pack: 5 × 80 = 400 minutes £4.00 = 400p 400p ÷ 400 = 1p per minute Or 450 ÷ 6.50 = 69 minutes per £1 800 ÷ 6.50 = 123 minutes per £1 best value	The best buy is the 10-pack of 80 minutes each @ £6.50.	P1 B2	3	P1 for process of multiplying up for total minutes and then division to identify either cost per minute or time per £ B2 for correct workings in each of the three cases	M

b	400 ÷ 4.00 = 100 minutes per £1	There are more CDs than are needed. A recording time of 80 minutes is not long enough. £6.50 is too expensive at time of purchase (prefer just to spend £4).	C1 **4**		C1 for explanation of possible reasons not to choose the best buy	
10	£800 × 1.19 gives €952 £800 × 1.22 gives €976 €976 – €952 = €24	They will get €24 more.	M1 B1 A1 **3**	2	M1 for multiplications B1 for subtraction ft A1 cao	M
11 a i	By expressing this as: ‘How many….. in ….’ 		C2	2	C1 for correct justification C1 for showing diagram oe	M
ii			C1		C1 for correct justification showing diagram oe	
iii			C1		1 for correct justification showing diagram oe	
b	Use chosen method from part a to explain correctly how to divide, using fractions.		C1 P1 **6**		C1 for correct explanation P1 for process showing that dividing by $\frac{1}{2}$ doubles the number of pieces, so is the same as multiplying by 2	

12 a	8 kg = 8000 g 8000 ÷ 250 = 32 3 kg = 3000 g 3000 ÷ 85 = 35 (to nearest whole number) 2 kg = 2000 g 2000 ÷ 20 = 100 7 kg = 7000 g 7000 ÷ 250 = 28 So the limiting value is the amount of icing sugar. Therefore she can make 24 × 28 = 672 biscuits. 672 ÷ 15 = 44.8	She can make 44 complete packs of 15 biscuits.	P1 B1 P1	2 3	P1 for process of division to see how many batches of 15 biscuits can be made with each ingredient B1 for 32, 35, 100 and 28 P1 for correct identification of limiting value	M
b	$44 \times \frac{3}{4} = 33$ 33 × £2.99 = £98.67 44 – 33 = 11 discounted £2.99 × 0.85 = £2.54 to 2 dp 11 × 2.54 = £27.94 Total sales = £98.67 + £27.94 = £126.61 Total costs = £59 + £26 = £85 To calculate percentage profit: profit = $\frac{(£126.81 - £85)}{£85}$ = 0.489 529 412 and percentage profit = 0.489 529 412 × 100% = 48.95%	49% profit to the nearest integer.	B1 M1 A1 M1 A1 **8**		B1 for correct cost of $\frac{3}{4}$ of biscuits M1 for use of 0.85 multiplier A1 for cao M1 for division of total sales by total cost (ft) A1 for correct percentage with rounding	
13	Price including VAT = £595 × 1.20 = £714 With a 20% discount: £714 × 0.8 = £571.20 £571.20 – £595 = £23.80 OR £595 × 0.8 = £476 £476 × 1.2 = £571.20	He is overpaying by £23.80 Disagree. He would pay the shop more than he needs to.	P1 M1 B1 C1 **4**	2	P1 for process of multiplying by 1.2 to find cost with VAT M1 for multiplying by 0.8 to find 20% reduced price (ft) B1 for subtracting to find overpayment C1 for demonstrating overpayment with explanation	M

14 a **b** **c** **d**		With a reduction of 15%, the sale price (B) is $A \times 0.85$. $A = \frac{B}{0.85}$ Yes, the new value will always be the original value multiplied by a percentage, calculated from the percentage change. For a reduction, the multiplier is (100 – the percentage reduction)%, for an increase it is (100 + the percentage increase)%. Percentage change problem, for example: The cost of a new car was £A. In the new financial year, it increased by 5% to £B. Write a formula to describe the proportional change. $B = A \times 1.05$ and $A = \frac{B}{1.05}$.	M1 P1 C1 C1 **4**	2	M1 for correct formula P1 for correct rearrangement of ÷ by 0.85 C1 for clear explanation C1 for clarity of communication of question	M
15 a **b** **c**	$A \times 1.5 \times 1.5 = A \times 1.5^2$ $= A \times 2.25$ 80% discount gives a price of $A \times 0.20$. 60% followed by 20% gives a price of $A \times 0.4 \times 0.8 = A \times 0.32$. $A \times 0.75 \times 1.20 = 0.9A$ $A \times 1.20 \times 0.75 = 0.9A$	No, an increase to A of 50% followed by another increase of 50% gives $2.25A$. Doubling would give $2A$ and $2A \neq 2.25A$. An 80% discount off the price of A gives a new price of $0.2A$. A 60% discount off the price of A, followed by a further 20% discount, gives a new price of $0.32A$ so the 80% discount is better value. If the original cost is A, the cost after a discount of 25% is $0.75A$ and paying VAT at 20% gives a new price of $0.9A$. If VAT is added first, the price is $1.2A$. A 25% reduction gives a new price of $0.9A$. Because multiplication is commutative, the final prices are the same. It makes no difference.	C1 P1 C1 **3**	2	C1 for clear explanation with calculated justification oe P1 for clear explanation with calculated justification oe C1 for clear explanation with calculated justification oe	M

16 a	$A \times \frac{6}{7} = £996$ $A = £996 \times \frac{7}{6} = £1162$	£1162	M1 A1	2 3	M1 for multiplication A1 cao	M
b	$A \times 1.04 = £6.50$ $A = \frac{£6.50}{1.04} = £6.25$	£6.25	M1 A1		M1 for multiplication by 1.04 and rearrangement A1 cao	
c	$A \times 1.07 = £957.65$ $A = £\frac{957.65}{1.07} = £895$	£895	M1 A1		M1 for multiplication by 1.07 and rearrangement A1 cao	
d	If the original amount is A, the multiplier is b for a percentage increase or decrease, and the new value is C: $A \times b = C$	$A = C \times \frac{1}{b}$	C1		C1 for correct explanation either in words or by a general formula, provided the variables are defined	
e		If the multiplier is x: $x > 1$ means an increase $0 < x < 1$ means a decrease.	C1		C1 for clarity that a decrease has a multiplier between 0 and 1 and increase has a multiplier greater than 1 (a multiplier of 1 will not change the value)	
			8			
17 a	Comparing salary in May and April: £1568 – £1544 = £24 Comparing sales in May and April: £24 is earned on £4000 sales. 24 000 ÷ 4000 = 6 6 × £24 = £144 £1544 – £144 = £1400 So the basic salary is £1400. £1553 – £1400 = £153 $\frac{153}{24} = \frac{51}{8} = 6.375$ 6.375 × 4000 = £25 500	£25 500	B1 C1 B1 B1	3	B1 for subtraction of April salary from May salary C1 for clearly comparing the salary difference with the sales difference B1 for division and multiplication to establish basic salary (ft) B1 for correct calculations to find sales figure (ft)	M
b	Own question	Own question	C1		C1 for clear question with reasoning and solution	
			5			

<table>
<tr>
<td>18</td>
<td>Number on Saturday = 2 × number on Friday
$S \times 1.5 = (2F) \times 1.5$
$S = \frac{3F}{1.50} = 2F$</td>
<td>There are still twice as many visitors on Saturday as on Friday. There are 100% more visitors on Saturday compared to Friday.</td>
<td>C1
1</td>
<td>3</td>
<td>C1 for an explanation that includes an appreciation that the two sets of visitors increase proportionally and that the original proportion therefore does not change oe</td>
<td>M</td>
</tr>
<tr>
<td>19 a

b</td>
<td>Number of workers = W
Number of days = t
K = constant
$W = \frac{K}{t}$
$2 = \frac{K}{20}$ so $k = 40$
$W = \frac{40}{t}$
With 3 workers:
$3= \frac{40}{t}$
$t = \frac{40}{3} = 13\frac{1}{3}$ days
This is Thursday of week 3.</td>
<td>They would finish after $13\frac{1}{3}$ days.

They would probably get in each other’s way and would not be able to complete the job in a very short time.
Some jobs have to wait until others are finished, for example, they can’t paint until the walls have been plastered.</td>
<td>M1
B1

C1
3</td>
<td>3</td>
<td>M1 for finding constant of proportionality
B1 for division of 40 by 3 and relating this to number of days worked

C1 for an appropriate reason oe</td>
<td>M</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>Current costs are £1.50 per mile and 20p per minute.
Competitive pricing structure: answers will vary.
<table>
<tr><td>Time taken</td><td>2 min</td><td>5 min</td><td>10 min</td><td>12 min</td><td>15 min</td></tr>
<tr><td>Distance</td><td>1 mile</td><td>2 miles</td><td>3 miles</td><td>5 miles</td><td>6 miles</td></tr>
<tr><td>Total charge (A)</td><td>£2.50</td><td>£4.00</td><td>£6.50</td><td>£9.90</td><td>£12.00</td></tr>
<tr><td>Total charge (B)</td><td>£1.90</td><td>£4.00</td><td>£6.50</td><td>£9.90</td><td>£21</td></tr>
</table></td>
<td>P1
B1

B1
3</td>
<td>2
3</td>
<td>P1 for process of finding charges
B1 for working out current price structure

B1 for correct calculation of a pricing structure that has an element of competition
The suggestion (B) competes for short distances, matches for mid distances and is not competitive for longer journeys.</td>
<td>M</td>
</tr>
</table>

21 a		Travel 30 miles in 45 minutes. 45 minutes = $\frac{3}{4}$ hour $\frac{30}{\frac{3}{4}} = \frac{3 \times 4}{3} = \frac{120}{3}$ = 40 mph as required	C1 C1	2	C1 for correct explanation with calculation that indicates 10 miles every 15 minutes implies 40 miles every 60 minutes oe C1 for clear explanation	M
b		Not changing minutes into hours.	C1		C1 for stating a common misconception	
c		Units of speed = $\frac{\text{units of distance}}{\text{units of time}}$	C1		C1 for correctly stating the relationship between speed, distance and time	
d		Own easy and difficult examples	B2 **6**		B1 for one easy and one difficult example with justification B1 for multiple different examples	
22	A rectangle 1 m × 2 m Area = 2 m^2 A rectangle 4 m × 8 m Area = 32 m^2 Length scale factor = 4 Area scale factor = 16 (4^2)	32 m^2	P1 A1 **1**	2 3	P1 for process of trial and improvement A1 cao	M
23	75 ÷ 30 = 2.5 Length scale factor is 2.5 Volume scale factor is $(2.5)^3$ = 15.625 5000 × 15.625= 78,125 cm^3 = 78.125 litres	78.125 litres	B1 M1 A1 **3**	2 3	B1 for calculation of length scale factor M1 for calculation of volume scale factor A1 cao	M
24	Length scale factor = 450 ÷ 15 = 30 Volume scale factor = 30^3 = 27 000 450 × 27 000 = 12 150 000 cm^3 (÷ 100^3 for m^3) = 12.15 m^3	12.15 m^3	B1 M1 M1 A1 **4**	3	B1 for calculation of length scale factor M1 for calculation of volume scale factor M1 for correct conversion to cubic metres A1 cao	M
25	Length scale factor = 18 ÷ 12 = 1.5 Volume scale factor = $(1.5)^3$ Volume of paint in big tin = 800 ml × $(1.5)^3$ = 2700 ml 2700 ÷ 800 = 3.375 So he can fill 3 tins.	3 small tins can be filled from one large tin.	B1 M1 A1 **3**	2	B1 for calculation of length scale factor M1 for calculation of volume scale factor A1 cao	M

<table>
<tr><td>26 a</td><td>New area is $(a \times 1.15)^2$
$= a^2 \times 1.15^2$
$= 1.3225a^2$
Percentage increase =
(1.3225 – 1) × 100%</td><td>Area increases by 32.25%.</td><td>M1
A1</td><td>2</td><td>M1 for use of correct multiplier showing 15% increase
A1 cao</td><td>M</td></tr>
<tr><td>b</td><td>

Area = $a \times 1.15 \times b \times 0.95$
$= ab \times 1.15 \times 0.95 = 1.0925ab$
Percentage increase (1.0925 – 1) × 100%</td><td>Area increases by 9.25%.</td><td>M1
A1
4</td><td></td><td>M1 for use of correct multiplier showing 15% length increase and 5% width decrease
A1 cao</td><td></td></tr>
<tr><td>27 a</td><td><table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>5</td><td>4</td><td>17</td></tr><tr><td>4</td><td>3.2</td><td>13.6</td></tr><tr><td>2</td><td>1.6</td><td>6.8</td></tr><tr><td>8</td><td>6.4</td><td>27.2</td></tr><tr><td>12</td><td>9.6</td><td>40.8</td></tr><tr><td>6.8</td><td>5.44</td><td>23.12</td></tr><tr><td>2.8</td><td>2.24</td><td>9.52</td></tr></table>$\frac{B}{A} = \frac{1.6}{2} = 0.8$
$\frac{C}{A} = \frac{17}{5} = 3.4$
This also means that
$\frac{C}{B} = \frac{17}{4} = 4.25$
So yes there is enough information.</td><td>Yes, there is sufficient information.</td><td>C1</td><td>2</td><td>C1 if all three ratios are shown as part of the explanation and justification of answer</td><td>M</td></tr>
<tr><td>b</td><td>13 items
e.g.<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>●</td><td></td><td></td></tr><tr><td></td><td>●</td><td>●</td></tr><tr><td></td><td>●</td><td>●</td></tr><tr><td></td><td>●</td><td>●</td></tr><tr><td></td><td>●</td><td>●</td></tr><tr><td></td><td>●</td><td>●</td></tr><tr><td></td><td>●</td><td>●</td></tr></table></td><td></td><td>C1</td><td></td><td>C1 for clear explanation of as many values entered as possible such that one variable remains isolated from the other two oe</td><td></td></tr>
</table>

<table>
<tr><td>c

d</td><td>One variable is isolated from the other two.
9 items e.g.
<table><tr><th>A</th><th>B</th><th>C</th></tr><tr><td>●</td><td></td><td>●</td></tr><tr><td></td><td>●</td><td>●</td></tr><tr><td></td><td></td><td>●</td></tr><tr><td></td><td></td><td>●</td></tr><tr><td></td><td></td><td>●</td></tr><tr><td></td><td></td><td>●</td></tr><tr><td></td><td></td><td>●</td></tr></table>
There should be at least one value in each row and two rows should have at least two pairs linking a different pair.
Always start in a row where at least 2 quantities are given, to work out the third quantity, so that relationships between all three are known. Then use these to work out other quantities.
In this example there are 2 possible starting points.</td><td></td><td>C1

C1
C1

5</td><td></td><td>C1 for clear explanation that there should be at least one value in each row and two rows should have at least two values linking a different pair of A, B, C oe

C1 for clear explanation

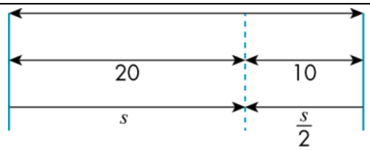
C1 for explanation of the best starting point and stating how many different starting points there are</td><td></td></tr>
<tr><td>28</td><td>In year 1:
£8000 × 0.027 = £216
Interest = £216
Less 20% tax:
£216 × 0.8 = £172.80
So the total at end of year 1
= £8000 + £172.80
=£8172.80
In year 2:
£8172.80 × 0.027 = £220.67
Interest = £220.67
Less 20% tax:
£220.67 × 0.8= £176.54
At end of year 2 :
Amount = £8172.80 + £176.54
= £8349.34</td><td>No, Sam is incorrect.
She will have £8349.34
See workings as explanation.</td><td>P1
B1

B1
C1

4</td><td>2</td><td>P1 for use of correct multipliers
B1 for multistep calculation for year 1

B1 for multistep calculation for Year 2 (ft)
C1 for clarity of explanation through setting out of calculations</td><td>M</td></tr>
</table>

29	$B \times 0.8^n < \frac{B}{2}$ Divide both sides by B. $0.8^n < \frac{1}{2}$ $0.8^3 = 0.512$ $0.8^4 = 0.4096$ OR £100 × 0.8 =£80 £80 × 0.8 = £64 £64 × 0.8 = £51.20 £51.20 × 0.8 = £40.96	4 weeks	P1 M1 P1 A1 **4**	2	P1 for choosing a starting a position, either a variable such as B or a specific amount such as £100 M1 for working through the weeks in some way P1 for the process of finding amounts for weeks 3 and 4 to show the point at which the bank account first dips below 50% of the original balance cao	H
30		i graph d ii graph e iii graph b iv graph c v graph f vi graph a	B6 **6**	2	B1 for each correctly identified graph with reference to why, for example: $f(x) \propto x^2$ is graph d as points are (–2, 4), (–1, 1), (0, 0), (1, 1), (2, 4) and it is a parabola $f(x) = 2x$, $x > 0$ $f(x) = -2x$, $x < 0$ is graph e as it is linear and has no negative $f(x)$ values; the gradient is 2 and –2	H
31 a		Inverse proportion describes the relationship between two variables such that as one increases the other decreases.	C1	2	C1 for clear explanation of inverse proportion	H
b	$y = \frac{k}{x}$ $xy = k$ where k is the constant of proportionality	$xy = k$ or $y = \frac{k}{x}$	M1		M1 for correct equation	
c		Own problem, for example: It takes 5 men 10 days to dig a hole. The number of men, y, is inversely proportional to the number of days, x. How long would it take for ten men to dig the same hole? (5 days)	C1 **3**		C1 for clear question	

32 a		$F_g = \frac{Gm_1m_2}{d^2}$	M1	2	M1 for correct function	H
b	$r = 6 \times 10^3$ m $F_1 \propto \frac{1}{(6\times10^3)^2}$ $= \frac{1}{3.6\times10^7}$ $F_2 \propto \frac{1}{(6\times10^3+12)^2}$ $= \frac{1}{3.6144 \times 10^7}$		B1		B1 for calculation of F_1 and F_2	
	$\frac{F_1}{F_2} = 0.996$	0.996 to 3 dp	A1		A1 cao	
c		The difference is too small (reference part b).	C1		C1 for correct interpretation of a scale factor close to 1	
			4			
33		 The speed of the faster car is 40 mph. $T = \frac{20}{40} = \frac{1}{2}$ So they meet after 30 minutes. Speeds are in the ratio 1 : 2 = 20 : 40 = 10 : 20 So the cars meet when the slower car has travelled 10 miles and the faster car has travelled 20 miles. It will take half an hour for a car travelling at 20 mph to go a distance of 10 miles.	M1 C1 A1	2	M1 for recognising and using the ratio of the speeds C1 for clarity of reasoning and explanation, diagram oe A1 cao	H
			3			

34	$4y = 2x^2$ $y = \frac{x^2}{2}$ gradient = $\frac{f(x_2) - f(x_1)}{2}$ $= \frac{\frac{4^2}{2} - \frac{2^2}{2}}{2}$ $= \frac{8-2}{2}$ $= 3$	3	M1 A1 **2**	2	M1 for rearranging and substituting given values of x A1 cao	H
35		$\frac{f(x+h) - f(x)}{h} = \frac{\frac{(2+2)^2}{2} - \frac{2^2}{2}}{2}$ $= \frac{\frac{4^2}{2} - \frac{2^2}{2}}{2}$ As above.	M1 C1 **2**	2	M1 for appropriate substitution to enable comparison with Q35 C1 for showing that the two functions give the same answer	H
36 a	$f(x) = mx + c$ The gradient = $\frac{m\left(x+h\right)+c-\left(mx+c\right)}{h}$ $= \frac{mx + mh + c - mx - c}{h}$ $= m$	As working	A1 P1	2	A1 for clarity of proof P1 for accuracy with manipulation of function	H
b	$f(x) = \frac{x^2}{2}$ at $x = 2$ The gradient = $\frac{\frac{(x+h)^2}{2} - \frac{x^2}{2}}{h}$ $= \frac{1}{2}(2x + h)\ \ h \to 0$	As working	A1 P1		A1 for clear reasoning P1 for accuracy with manipulation of function to show a gradient of 2	

	$= \frac{1}{2}(2x) = x$ At $x = 2$, gradient = 2. From the graph, points on the tangent are (1, 0) and (2, 2). The gradient = $\frac{2-0}{2-1} = 2$		M1 **5**		M1 for gradient from points on the straight line	
37 a **b**	£28 000 × 1.05^3 = £32 413.50 £14 500 × 1.05^n > £ 20 000 $\frac{20000}{15400} = 1.4$ Try n = 7 years. £14 500 × 1.05^7 = £20 402.96	£32 413.50 7 years	B1 M1 A1 **3**	2	B1 for identification and use of multiplier M1 for trial and improvement or reasoning to try 7 years A1 cao	H
38	Sycamore: 4 × 1.08^{11} = 9.327 4 × 1.08^{12} = 10.073 Conifer: 2 × 1.15^{11} = 9.305 2 × 1.15^{12} = 10.7	12 years After 11 years, the sycamore is 9.326 m tall and the conifer is 9.305 m tall. After 12 years, the sycamore is 10.073 m tall and the conifer is 10.7 m tall.	M1 B1 P1 **3**	2	M1 for correct calculation method to find heights of trees B1 for clarity of final reasoning P1 for finding all four heights after 11 and 12 years	H

39 a	$A \times 1.04^n = 2A$ Divide both sides by A. $1.04^n \geq 2$ $1.04^{10} = 1.48$ (2 dp) $1.04^{15} = 1.80$ (2 dp) $1.04^{20} = 2.19$ (2 dp) $1.04^{17} = 1.95$ (2 dp) $1.04^{18} = 2.03$ (2 dp)	18 years	M1 A1	2	M1 for appropriate iterations to find $2A$ A1 cao	H
b	$10 \times \left(\frac{3}{5}\right)^n = 1$ $\left(\frac{3}{5}\right)^n = 0.1$ $0.6^n = 0.1$ $0.6^2 = 0.36$ $0.6^5 = 0.077\ 76$ $0.6^4 = 0.1296$	4 bounces	M1 A1		M1 for appropriate iterations to find number of bounces A1 cao	
c		Own problem	C1		C1 for clarity, relevance and accuracy of own question	
			5			
40 a	$f(x) = a(b)^x$ Day Number of bacteria 0 1 1 2 2 4 3 8 4 16 5 32 6 64 $= 2^6$	$2^6 = 64$ The population doubles each day.	M1 A1	2	M1 for correct iterations A1 cao	H
b		a and b are constants. a is the starting size of the population and so doesn't change. b is the multiplier (by how much the population grows each day) and the value of this doesn't change. x is a variable as it represents the changing number of days.	C3		C3: one mark for each explanation of a, b and x	
			5			

41 **i** **ii** **iii**		$F(x) = a(b)^x$ $b < 1$ the population decreases. $b = 1$ the population stays the same. $b > 1$ the population increases.	C3 **3**	2	C1 for each correct explanation of the impact on the population as b varies	H
42 a **b**	Epidemic started by a single carrier so $x_0 = 1$. Considering infection after 10 days so $t = 10$.	$x_{n+1} = R^t x_0$ $x_{10} = R^{10}$ Newspaper headline to engage readers with the story of this epidemic e.g. how long before x people are infected.	M1 A1 C1 **3**	2	M1 for correct interpretation of , and use of, the iterative formula A1 for cao C1 for relevant , informative headline	H
43	$p = e^{-\frac{h}{7}}$ $= (2.72)^{-\frac{5.895}{7}}$ $= 2.72^{-0.842\ldots}$ $= 0.430\,555\,245\ldots$	0.43 bar	M1 A1 **2**	2	M1 for correct use of formula A1 cao	H
44 a **b**	$x = 1 + \frac{11}{x-3}$ $x(x-3) = x - 3 + 11$ $x^2 - 3x = x + 8$ $x^2 - 4x - 8 = 0$ if $x_1 = 5$ $x_2 = 1 + \frac{11}{(5-3)} = 1 + \frac{11}{2} = 6.5$ $x_3 = 1 + \left(\frac{11}{6.5-3}\right) = 4.14286$ …	Show that… as workings. $x = -1.46$ to 2 dp	M1 C1 M1 B1 A1 **5**	3	M1 for algebraic manipulation C1 for clarity of justification M1 for correct use of iteration B1 for substitutions A1 for one root found (no credit if both roots are found) Using $x = 5$ as the first iteration, after 19 iterations you arrive at $x = -1.46$ to 2 dp Likewise, if the first trial is –1, 11 iterations lead to the solution $x = -1.46$ to 2 dp.	H