Guidance on the use of codes for this mark scheme	
M	Method mark
A	Accuracy mark
B	Working mark
cao	Correct answer only
oe	Or equivalent
ft	Follow through

Question	Working	Answer	Mark	AO	Notes	Grade
1	79 298 – 78 987 = 311 kWh used.		M1	2	M1 for subtracting the given readings to find the amount of electricity used	B
	80 kWh × 20.95 pence = 1676 pence = £16.76		B1		B1 for multiplying 80 by 20.95 or for writing down £16.76	
	311 – 80 = 231 231 × 10.80 pence = 2494.80 pence = £24.948		B1		B1 for subtracting 80 from 311 and then finding the cost of the remainder used by multiplying by 10.80 or for writing down £24.948	
	Total bill = £16.76 + £24.948 = £41.708	£41.71	B1		B1 for adding the two amounts found together or writing down £41.708	
			A1		A1 for converting to pounds correctly	
	Assumption that if you average consumption over the year, April will be representative.	Yes	B1		B1 for assumption made such as that given or showing that the standing order is higher than the cost of electricity used in April oe assumptions stated	
			6			

2	Assuming dates are inclusive and not a leap year: 27 August to 30 December = 4 + 30 + 31 + 30 + 30 = 125 days 31 December to 9 April = 1 + 31 + 28 + 31 + 9 = 100 Total number of days = 125 + 100 = 225 Total amount of electricity used = 55 916 – 53 480 = 2436 kWh Current supplier: 225 × 13.99 pence = 3147.75 pence = £31.4775 2436 × 15.09 pence = 36759.24 pence = £367.5924 Total = £31.4775 + £367.5924 = £399.07 New supplier: 225 × 23.818 pence = 5359.05 = pence = £53.5905 2436 × 14.37 pence = 35005.38 pence = £350.0538 Total = £53.5905 + £350.0538 = £403.64	He should stay with his current supplier, assuming that electricity use continues at the same level. The summary does not include the summer months when use is likely to be less. The difference is likely to be greater for the summer months.	M1 A1 B1 B2 B1 B2 A1 B2 **11**	2	M1 for showing how many days from each month are used and added together A1 for stating the assumptions about inclusive days, that this is not a leap year and for calculating number of days correctly B1 for showing how to find the difference of the readings B2 for showing how to calculate each part of the total cost B1 if the conversion to pounds and correct rounding has not been done B1 for showing how the cost is derived for the new supplier with the same data as before B1 for finding the total cost and correctly rounding into money units B1 if the correct amount has been calculated but not rounded or changed to correct monetary units A1 for correctly stating he should stay with current supplier B2 for clarity of answer, including any assumptions given	B

3 a		175 ÷ 8 = 21.875 Round up to the nearest integer, 22, as tables are needed for everybody and you can't have part of a table.	M1 A1 B1	2 3	M1 for dividing guests by number at a table A1 for the rounded, correct integer B1 for explaining the need to round up to the nearest integer	B
b		175 ÷ 8 = £21.875 If all the guests pay the same amount of £21.88 or more there is enough to cover the bill.	M1 A1 B1		M1 for dividing bill by the number at the table A1 for a correct monetary amount higher than £21.875 and less than £22 unless a tip is mentioned B1 for stating the need to round up in order to create a total higher than the bill if they all pay the same	
c		175 ÷ 8 = 21.875 Cannot have a fraction of a box, so only 21 boxes can be filled. 21 × 8 = 168 rolls hence 7 rolls left over	M1 M1 A1 M1 A1		M1 for correctly dividing number of bread rolls by number in each box or the number 21.875 M1 for stating the need to truncate the amount A1 for the correct truncation M1 for calculating the number of boxes multiplied by 8 or the total 168 A1	
d		Average speed = distance ÷ time 165 ÷ 8 = 21.875 km/h	M1 A1		M1 for stating formula for calculating speed A1 for the correct answer with correct units	
e		You do not need to round this figure as the speed can be given with this accuracy.	B1 B2		B1 for stating no need to round the answer B1 for describing what is the same and what is different about each context B1 for quality of questions and explanations in mark scheme	
			16			

4 a i	4.6 × 40 = 4.6 × 10 × 4 = 46 × 4 = 184	184	M1 A1	3	M1 for knowing and using the links A1 for correctly using the links to get to 184	B
ii		50 × 40 = 200	B1		B1 for correctly showing rounded figures to show the answer is reasonable	
iii		Two correct calculations, e.g. 1156 ÷ 34 = 34 Multiplying both by ten 11.56 ÷ 0.34 = 34 Dividing both by ten	B2		B1 for each correct statement B1 for each correct explanation of the relationships between the calculations	
iv	24 × 72 = 1728 1728 ÷100 = 17.28	Two correct calculations, e.g. 2.4 × 7.2 = 17.28 Divide both by 10 24 × 0.72 = 17.28 Divide one of the numbers by 100	B2		B1 for each correct statement B1 for each correct explanation of the relationships between the calculations	
b		Suitable question, using concepts introduced in part a.	B2		B1 for each set of questions, but the second must be harder than the first B1 Explanation marks for correct explanation of the relationships between the calculations and identification of progression in difficulty	
			9			
5		2484 and 3426 are both even and so are divisible by 2.	B2	2	oe B1 for each reason why the numbers cannot be prime	B
		17 625 ends in a 5 so is divisible by 5. Therefore none are prime numbers as they have factors other than one and themselves.	B2	3	B2 for quality of explanation and communication	
			4			
6	17 × a = 629 $a = \frac{629}{17}$ Therefore: a = 37	37	M1 A1 B2	3	M1 for dividing 629 by 17 A1 for 37 B1 for clarity of communication B1 for use of mathematical connectives	B
			4			

7	4.75 ≤ space < 4.85 4.25 ≤ car < 4.75		B1 B1	3	B1 for stating upper and lower bounds of space B1 for stating upper and lower bounds of car	B
i		A – Yes, the car is always smaller than the smallest possible space.	B1		B1 for correct explanation of why this is definitely true oe	
ii		B – No, the smallest space is the same size as the largest car length.	B1		B1 for correct explanation of why this is definitely not true oe	
iii		C – No, because the car is always smaller than the minimum size of the space, you can always say it will fit.	B1		B1 for correct explanation of why this is definitely not true oe	
			5			
8	14.5 cm ≤ brick < 15.5 cm	The maximum length for 20 identical bricks is: 20 × 15.5 = 310 cm	M1 A1	3	M1 for identifying the upper bound of the length of one brick and multiplying this by 20 A1 for correct answer only	B
			2			
9 a		How long will it take Barry to recover the money it cost him to convert the car?	B1	3	B1 for suitable question oe	M
b		Cost of 1 litre of LPG (CPLG) Cost of 1 litre petrol (CP) The distance he can travel per litre of each fuel (DPLG and DP) How far does he travel in one month (D)	B4		B1 for each piece of information oe	
c		Cost of using LPG per month is: A = CPLG × (D ÷ DPLG) Cost of using Petrol per month is: B = CP × (D ÷ DP) The saving is B – A	M1 M1 M1 M1 A1 B1		M1 for trying to find first cost M1 for correct method of finding this cost M1 for trying to find second cost M1 for correct method of finding this cost A1 for finding this difference correctly B1 for clarity of explanation throughout part **c**	
d		Can now ask: 'Is B – A more than £66.99?'	B1		B1 for clarity of explanation in linking part **c** with the new information	
			12			

10	Assume the dolphin starts from the bottom. A complete cycle from top to bottom, back to top, takes 7 minutes. Therefore in 90 minutes it completed the following cycles: 90 ÷ 7 = 12 .857 142 8 cycles. It has therefore completed 12 cycles but is not back at the back at the bottom. To work out which of the other options is correct calculate: 0.857 142 8 × 7 = 6 minutes. Therefore if we assume that the time started by observing the dolphin at the surface, the 6 minutes of the cycle will be towards the end of the cycle, it is on its way up.	On its way up.	M2 B1 M1 B1 A1 **6**	2	M1 for adding the times to create a 7-minute cycle M1 for dividing 90 by the time of one cycle B1 for stating that the dolphin has completed 12 cycles M1 for multiplying the fraction part of 12.8… by 7 B1 for finding this time and relating it to a part of the cycle A1 for correct answer only	M
11 a **b**	26 letters × 25 numbers So 26 × 25 = 650 5 flavours, 4 sizes, cone or tub 5 × 4 × 2 = 40	650 40	B1 M1 A1 B1 M1 A1 **6**	2 3	B1 for knowing to use 26 and 25 M1 for 26 × 25 A1 correct answer only B1 for identifying the need to use 5, 4 and 2 M1 for 5 × 4 × 2 A1 for correct answer only	M

<table>
<tr>
<td>12 a

b

c</td>
<td colspan="2">
<table>
<tr><th>Planet</th><th>Distance from the Sun (million km)</th><th>Diameter (km)</th></tr>
<tr><td>Mercury</td><td>5.8×10^{1}</td><td>4.878×10^{3}</td></tr>
<tr><td>Venus</td><td>1.08×10^{2}</td><td>1.2104×10^{4}</td></tr>
<tr><td>Earth</td><td>1.5×10^{2}</td><td>1.2756×10^{4}</td></tr>
<tr><td>Mars</td><td>2.28×10^{2}</td><td>6.787×10^{3}</td></tr>
<tr><td>Jupiter</td><td>7.78×10^{2}</td><td>$1.427\ 96 \times 10^{5}$</td></tr>
<tr><td>Saturn</td><td>1.427×10^{3}</td><td>1.20660×10^{5}</td></tr>
<tr><td>Uranus</td><td>2.871×10^{3}</td><td>5.1118×10^{4}</td></tr>
<tr><td>Neptune</td><td>4.497×10^{3}</td><td>4.8600×10^{4}</td></tr>
<tr><td>Pluto</td><td>5.913×10^{3}</td><td>2.274×10^{3}</td></tr>
</table>

i Jupiter
ii Pluto
iii Pluto
iv Jupiter
v Uranus
vi Earth and Venus

Diameter and mass increase with distance from the Sun until you reach Jupiter.
Diameter and mass then decrease with distance from the Sun.</td>
<td>B2

B6

B3

11</td>
<td>2</td>
<td>B1 for correct distance column
B1 for correct diameter column

B1 cao
B1 cao
B1 cao
B1 cao
B1 cao
B1 cao

B3 for clarity of explanation and of finding some trend within the data</td>
<td>M</td>
</tr>
<tr>
<td>13 a

b

c

d</td>
<td></td>
<td>Sometimes true – not true for fractions or negative numbers.

Always true (positive × positive = positive, negative × negative = positive).

False – you can’t find the square root of a negative number using real numbers.

Always true – the cube root of a positive number is positive and the cube root of a negative number is negative.</td>
<td>B1
B1

B1
B1

B1
B1

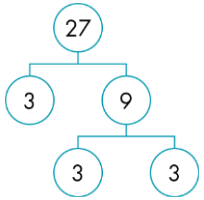
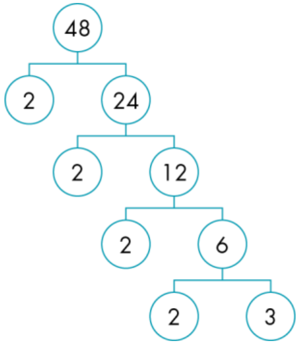
B1
B1

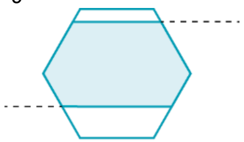
8</td>
<td>2</td>
<td>B1 for sometimes
B1 for correct explanation

B1 for always true
B1 for correct explanation

B1 for false
B1 for correct explanation

B1 for always true
B1 for correct explanation</td>
<td>M</td>
</tr>
</table>

14 i	$5^6 \div 5^{-3} = 5^{(6--3)} = 5$ or $\dfrac{\frac{5\times5\times5\times5\times5\times5}{1}}{5\times5\times5} = \dfrac{5\times5\times5\times5\times5\times5\times5\times5\times5}{1}$ $=5^9$		M2	2	M1 for showing subtraction of indices M1 for recognising 6 – –3 = 6 + 3 or M1 for showing each number as a product of factors M1 for combining them to give all the 5s as numerators	M
ii	$5^6 \times 5^{-3} = 5^{(6+-3)} = 5^3$ or $\dfrac{5\times5\times5\times5\times5\times5}{5\times5\times5} = 5\times5\times5 = 5^3$		M2		M1 for showing the indices are added M1 for recognising 6 + –3 = 6 – 3 or M1 for showing each number as a product of factors M1 for combining them to give all the 5s as numerators	
	$27 \times 48 = n^4 \times 2^c$	The power $\frac{1}{2}$ represents the reciprocal of squaring so take the square root.	B2		B1 for showing square root B1 for clear explanation	
	Using prime factors:  $27 = 3^3$  $48 = 2^4 \times 3$ So $27 \times 48 = 3^4 \times 2^4$	So $n = 3$ and $c = 4$	M2 B2 A2 B1		M1 for finding the prime factors of each number M1 for stating each number as the product of the prime factors B1 for 27 expressed as product of prime factors in index form B1 for 48 expressed as product of prime factors in index form A1 for $n = 3$ cao A1 for $c = 4$ cao B1 for clear communication of solution	
			11			

15 a	$\frac{8.848 \times 10^3}{8.298 \times 10^2} = 10.66$	10.66	M1 A1	2	M1 for dividing mountain height by skyscraper height A1 accept 10.66…… or 10.7	M
b	$8.298 \times 10^2 \div 10^3 = 0.8298$ km	0.8298 km	M1 A1		M1 for dividing skyscraper height by 1000 A1 cao	
c	$20 \div 1\,000\,000\,000 = 2 \times 10^{-8}$	2×10^{-8} m	M1 A1		M1 for dividing 2 by 1 000 000 000 A1 cao	
d	Area of eye = $9\pi \times 10^{-6}$ Radius of eye = $\sqrt{9p´\frac{10^{-6}}{p}}$ $= 3 \times 10^{-3}$ m Diameter of eye = $2 \times 3 \times 10^{-3}$ m $= 6 \times 10^{-3}$ m Fraction = $\frac{2 \times 10^{-8}}{6 \times 10^{-3}}$ $= 3.333\,333 \times 10^{-6}$	3.33×10^{-6}	M1 A1 M1 A1 B1		M1 for connection between area of eye and πr^2 A1 cao M1 for setting up fraction with correct numbers A1 cao B1 for clear communication shown of methods	
			11			
16	$\frac{1}{9}$  B $\frac{2}{7}$ $\frac{1}{9}+\frac{2}{7}=\frac{7}{63}+\frac{18}{63}=\frac{25}{63}$		M1 B1 A1	2	M1 for adding given fractions B1 for use of common denominator 63 A1 cao	M
	$1-\frac{25}{63}=\frac{38}{63}$	$\frac{38}{63}$	M1 A1		M1 for subtracting fraction sum from 1 A1 ft from their first $\frac{25}{63}$	
			5			

17	So $\frac{3}{8}$ of the residential land is used for services. $\frac{3}{8} \times 5\frac{1}{2} = \frac{33}{16}$ m^2 $\left(\frac{33}{16} \div 15\right) \times 100$ = 13.75%	13.75% of the total area is used for services.	B1 M1 A1 M1 A1 **5**	2 3	B1 for recognising and stating $\frac{3}{8}$ of residential development is used for the services M1 for multiplying $\frac{3}{8}$ by $5\frac{1}{2}$ A1 oe M1 for finding above fraction of 15 and multiplying by 100 A1 accept 14 or 13.8	M

18 a		The volume of the 2 cm cube is 2 × 2 × 2 = 8 cm^3. The volume of the 4 cm cube will be 4 × 4 × 4 = 64 cm^3. This is 8 times as much plastic as the 2 cm cube. The 4 cm dice will use 64 – 8 = 56 cm^3 more plastic. (Or could say 8 times as much.)	B2 B1	3	B1 for clear explanation showing how to find volumes of each cube B1 for clear indication that the volume of the 4 cm dice is not twice as much as the 2 cm Or B2 for stating that doubling the length will increase the volume by a factor of 2^3 B1 for stating 56 cm^3 more plastic or for stating 8 times as much	M
b i		The volume of the 3 cm cube is 3 × 3 × 3 = 27 cm^3. The volume of the 2 cm cube is 8 cm^3 so will use 27 – 8 = 19 cm^3 more plastic or 27 ÷ 8 = 3.375 times as much.	B1 B1		B1 for finding the volumes of both cubes B1 for finding 19 cm^3 more plastic or for stating 3.375 times as much	
ii		The volume of the 3 cm dice = 27 cm^3. The volume of the 4 cm dice = 4^3 = 64 cm^3. So it needs 64 – 27 = 37 cm^3 less plastic.	B1 B1		B1 for finding the volumes of both cubes B1 for finding 37 cm^3 less plastic	
c		A dice that has twice the volume will have volume ratio of 1 : 2. Hence the length ratio will be $1 : \sqrt[3]{2}$ = 1 : 1.26. Hence the length of the dice will be 2 × 1.26 = 2.52 cm. The advice to give Siobhan is to make the cube with a side length just larger than 2.5 cm.	M2 B1 B1		M1 for setting up ratio as 1:2 M1 for finding and stating the cube root of ratio B1 for calculation of 2 × cube root of 2 B1 for communicating the idea of making a cube just larger than 2.5 cm	
			11			

19 a		0.8 is less than 1 so 68 ÷ 0.8 will be greater than 68, because dividing by a number less than 1 gives an answer greater than the number you started with.	B1	3	B1 For 'greater' with a correct explanation	M
bi		75 × 20 = 1500 oe The approximation will be smaller because each term has been rounded down.	M1 A1 M1		M1 for a suitable rounding of each number A1 for correctly multiplying the rounded numbers M1 for a correct justification	
ii		$\frac{25}{5}$ = 5 oe The approximation will be smaller because the numerator has been rounded up and the denominator rounded down. Dividing a smaller number by a larger number will result in a smaller answer.	M1 A1 A1		M1 for suitable rounding of each number A1 for correctly dividing the rounded numbers A1 for a correct justification	
iii		2^2 × 7.5 = 30 oe The approximation will be bigger because both numbers have been rounded up and so the estimation is larger than the real answer.	M1 A1 A1 **10**		M1 for suitable rounding of each number A1 for correctly multiplying the rounded numbers A1 for a correct justification In each case award answer marks only if the estimation is one that could be done in your head. Award explanation marks only for a valid explanation but allow ft for a given approximation	
20 a		Three calculations that approximate to 75, e.g. 1.1 × 75.1 based on 1 × 75 24.7 × 3.2 based on 25 × 3 147 ÷ 1.9 based on 150 ÷ 2	B3 B2	2 3	B1 for each example that approximates to 75 B1 for use of multiplication and division B1 for evidence of progression of complexity in the questions	M
b		9 ÷ 3 is a better approximation than 10 ÷ 3 because 9 ÷ 3 is easily worked out in your head with an integer answer whereas 10 ÷ 3 gives a decimal answer.	B2 **7**		oe B2 for use of mathematical language and possibly connectives in the answer	

21	The minimum area would be: 14.5 × 18.5 = 268.25 The maximum area would be less than: 15.5 × 19.5 = 302.25 where area = 15 × 19 = 285 The sensible answer for the area is 290 m^2	 268.25 302.25 268.25 ≤ floor area < 302.25 Given lengths are to 2 sf, so it would be sensible to give area to 2 sf also. 290 m^2	 M1 A1 M1 A1 A1 M1 A1 **7**	2	 M1 for multiplying the lower bounds A1 cao M1 for multiplying the upper bounds A1 cao A1 cao M1 for explanation of why 2 sf should be used A1 cao	M
22	Assume maximum mass of pallet is 525 kg. A 6-axle lorry can carry up to 44 ÷ 0.525 = 83.8 So a maximum of 83 pallets per trip. A 5-axle lorry can carry up to 40 ÷ 0.525 = 76.2 So a maximum of 76 pallets per trip.	 6 axle maximum of 83 pallets 5 axle maximum of 76 pallets	B1 M1 A1 A1	2 3	B1 for stating maximum possible mass of pallet M1 for dividing both load limits by maximum pallet mass A1 cao A1 cao	M
a	80 is less than 83 but more than 76, so choose the 6-axle lorry, as this can do it in one trip.		B2		B2 for clear explanation of correct choice	
b	150 pallets can be split into two loads of 75, this is less than 76, so choose 5-axle lorry to make two trips, as this works out cheaper per trip.		B2		B2 for clear explanation of correct choice	
c	159 can be split into two loads, 76 + 83. So choose the 5-axle lorry to make one trip, as this is cheaper per trip, and 6-axle lorry to make one trip as this avoids the need for a third trip.		B2 **10**		B2 for clear explanation of correct choice.	

23 a		0.4 m is written to 1 dp so could have a value between 0.35 m and 0.449 999 m. 0.400 m is written to 3 dp so could have a value between 0.3995 m and 0.400 499 9 m.	B2	2 3	B2 for clear explanation showing the range of possible values each could have	M
b		If the answer is required to 3 dp, to provide all the information required, you need to include three places of decimals even if the last digits are 0.	B1		B1 for clear explanation	
c		425 cm ≤ length < 435 cm	B1		B1 for communicating clearly this information	
d		Tenth of a metre or 10 cm.	B1		B1 for communicating clearly this information	
e	13.25 ≤ runner 1 < 13.35 13.295 ≤ runner 2 < 13.305	Therefore runner 1's fastest time could be less than that of runner 2. But it is also true that the slowest time for runner 1 is more than the slowest time of runner 2.	B1 B1 B2		B1 for runner 1 limits B1 for runner 2 limits B2 for clear explanation showing both possibilities	
		If each person is measured to the nearest kg. They could all, for example, weigh 100.4 kg and 7 × 100.4 > 700 kg.	B1 B2		B1 for a given example B2 for clear explanation	
			12			
24	Maximum number of people turning up will be 104 (as 105 will round to 110).		B1	3	B1 for stating maximum number of people that could turn up	M
	Assume 5% of the 280 do not turn up. 0.05 × 280 = 14		B1		B1 for finding the assumed number not turning up	
	Hence assume 266 seats already taken.		B1		B1 for finding assumed seats taken	
	365 – 266 = 99 free seats	If the estimate of how many will fail to turn up is correct, 266 seats will be taken with advance sales. This leaves 99 seats free. If up to 99 extra people turn up, they all get seats. If 100–104 turn up, some will not get a seat. So it is possible they will all get seats.	B1 B2		B1 for finding assumed number of free seats B2 for clear explanation using all the calculated data	
			6			

25	12.25 seconds ≤ time < 12.35 seconds 99.995 m ≤ distance < 100.005 m Speed = distance ÷ time Greatest speed is longest distance divided by shortest time = 100.005 ÷ 12.25 = 8.163 67 m/s	8.164 m/s	B1 B1 M1 B1 M1 A1 **6**	2	B1 for time range B1 for distance range M1 for correct formula used for speed B1 for explanation of longest distance used with shortest time M1 for division A1 for suitably rounded speed (4 or 5 sf)	M
26	124.5 ≤ volume < 125.5 Take cube root for lengths of sides, giving: 4.993 324 4 ≤ length < 5.006 657 8 Area of side will be square of lengths, giving 24.933 289 ≤ area < 25.066 622	24.93 cm^2 ≤ area < 25.07 cm^2	B1 M1 A1 M1 A1 **5**	2	B1 for stating limits of accuracy for volume M1 for finding cube root to find length A1 for un rounded limits to length M1 for squaring unrounded length limits A1 for rounded limits to 3 or 4 sf	M
27 a i		True. When $n = k$, each box contains 1 ball. So when $n > k$ at least one box contains at least two balls.	B1 B1	2	B1 for explaining how it is true: can use example or diagram to show this B1 for clear communication	M
ii		False, for example if $n = 5$ and $k = 2$, $\frac{n}{k} = \frac{25}{5} = 2.5$ As you cannot have half a ball, the statement is false.	B1 B1		B1 for explaining how it is false B1 for clear communication	
iii		False, as a normal year has 365 days there are 366 people, there must be at least two people who share a birthday. OR this could be possible in a leap year, but then not necessarily so.	B1 B1		B1 for explaining how it is false C for clear communication	
b	The maximum for which no grade is achieved by 5 students occurs when each grade is achieved by 4 students, which means 6 × 4 = 24 students. Hence, having one more student will guarantee that at least one grade is achieved by 5 students.	At least 25 students.	M1 M1 A1 **9**		M1 for least number with no grade with 5 students M1 for adding one more student A1 cao	

28 a	Length of A4 paper = 297 mm $= 2.97 \times 10^{2}$ mm 1 mm = 1×10^{-6} km Area A4 paper = $2.97 \times 10^{2} \times 1 \times 10^{-6}$ km $= 2.97 \times 10^{(2-6)} = 2.97 \times 10^{-4}$ km or 297 ÷ 1 000 000 = 0.000 297 0.000 297 km = 2.97×10^{-4} km	False	M1 A1 B1	2	M1 for changing units into mm then converting to m A1 for finding correct length of A4 B1 for effective use of SI in calculation Can also use an approximation of the length of A4 paper	H
b	$3^{-3} = \frac{1}{3}^{3} = \frac{1}{9}$ $\frac{1}{3} - 9 = -8\frac{2}{3}$ The two numbers are not equal.	False	B2		B2 for clear explanation and stating false	
c	$16^{2} = (2 \times 8)^{2} = (2^{1} \times 2^{3})^{2} = (2^{(1+3)})^{2} = (2^{4})^{2}$ $= 2^{(4 \times 2)} = 2^{8}$	True	B2		B2 for clear explanation and stating true	
d	$4\sqrt{3} \times 3\sqrt{3} = 4 \times \sqrt{3} \times 3 \times \sqrt{3}$ $= 4 \times 3 \times \sqrt{3} \times \sqrt{3}$ $= 12 \times 3 = 36$ $7\sqrt{7} = \sqrt{49} \times \sqrt{7}$ $= \sqrt{49 \times 7} = \sqrt{343}$ Is $\sqrt{343} = 36$? We know that $\sqrt{400} = 20$ so $\sqrt{343}$ will be less than 20 and therefore not 36. Or $4\sqrt{3} \times 3 \times \sqrt{3}$ $= \sqrt{16 \times 3} \times \sqrt{9 \times 3}$ $= \sqrt{1296} = 36$ $7\sqrt{7} = \sqrt{49 \times 7}$ $= \sqrt{343}$ But 1296 ≠ 343 So: $4\sqrt{3} \times 3 \times \sqrt{3} \neq 7\sqrt{7}$	False	B2		B2 for clear explanation and stating false	
			9			

29 a	$\sqrt{25} = 5$ So $\sqrt{19} < 5$	False	M1 A1	2	M1 for finding a suitable comparison A1 for showing it is false and stating such	H
b	$4^2 = 16$ $5^2 = 25$ So $\sqrt{23}$ is between 4 and 5.	True	M1 A1		M1 for showing the square of the limits A1 for showing it is true and stating such	
c	$2\sqrt{2} = \sqrt{4 \times 2} = \sqrt{8}$ So $2\sqrt{2}$ is not less than $\sqrt{8}$ but is equal to it.	False	M1 A1 B1		M1 for showing $\sqrt{4 ´ \ 2}$ A1 for showing it is false and stating such B1 for explaining they are in fact equal	
iv	$\sqrt{0.38} = \sqrt{\frac{38}{100}}$ $= \sqrt{38} \, ¸ \sqrt{\frac{1}{100}}$ Consider 0.6 $= \sqrt{36} \, ¸ \sqrt{\frac{1}{100}}$ Hence $\sqrt{0.38} > 0.6$	True	M1 A1 B1 **10**		M1 for showing both in similar comparable terms A1 for showing it is true and stating such B1 for clear concise communication of method	
30	$27^{-\frac{1}{3}} = \frac{1}{\sqrt[3]{27}}$ $= \frac{1}{3}$ $25^{-\frac{1}{2}} = \frac{1}{\sqrt{25}} = \frac{1}{5}$ $3^{-1} = \frac{1}{3}$	Odd one out is $25^{-\frac{1}{2}}$.	M3 A1 **4**	2	M1 for showing $27^{-\frac{1}{3}} = \frac{1}{3}$ M1 for showing $25^{-\frac{1}{2}} = \frac{1}{5}$ M1 for showing $3^{-1} = \frac{1}{3}$ A1 cao	H
31	$x^{-\frac{1}{4}} = y^{-\frac{1}{2}}$ $\frac{1}{\sqrt[4]{x}} = \frac{1}{\sqrt{y}}$ Square both sides: $\frac{1}{\sqrt{x}} = \frac{1}{y}$ Hence $\sqrt{x} = y$ Hence $x^2 = y$	Any example where x is the square of y, e.g. $x = 1, y = 1$ $x = 4, y = 2$ $x = 9, y = 3$	M2 A1 B1 **4**	2	M1 for squaring both sides to make information clearer M1 for considering only the denominator A1 for a correct example B1 for clear progression through the solution	H

32	$2.5 \times 10^3 = 2500$ Too small $2.5 \times 10^4 = 25\,000$ $2.5 \times 10^5 = 250\,000$ Too big	$n = 4$	M1 A1 **2**	2	M1 for using trial and improvement A1 for correct answer	H
33 a **b** **c** **d** **e** **f** **g** **h** **i** **j**		0.6 0.9 1.3 0.3 0.1 1.2 1.5 1.4 2.1 3.5	B1 B1 B1 B1 B1 B1 B1 B1 B1 B1 **10**	2	cao cao cao cao cao cao cao cao cao cao	H
34	Try $a = 3$, $b = 4$ $\sqrt{(a^2 + b^2)} = \sqrt{(9 + 16)} = \sqrt{25} = 5$ $a + b = 7$	Statement is false.	M1 A1 B1 **3**	2	M1 for finding an example that disproves the statement A1 for stating it is false B1 for clear communication of the solution	H
35		For example: $2\sqrt{3} \div \sqrt{3}$ $= \frac{2\sqrt{3}}{\sqrt{3}}$ The $\sqrt{3}$ cancels from numerator and denominator leaving 2, an integer.	B1 M1 A1 **3**	2	B1 for a correct division of two surds M1 for showing how the surds will leave an integer answer A1 for clear communicating of method used	H
36 a **b**		For example: $3 + \sqrt{2}$ and $3 - \sqrt{2}$ For example: $\sqrt{2}$ and $\sqrt{3}$	B1 B1 **2**	2	B1 for a correct possible pair of surds B1 for a correct possible pair of surds	H

37		$\sqrt{3}$ is more than 1 and less than 2, since $\sqrt{1} = 1$ and $\sqrt{4} = 2$. So $1 + \sqrt{3}$ is more than 2 and less than 3.	B1 B1 **2**	2	B1 for explaining the integer range for $\sqrt{3}$ B1 for explaining how this relates to the 2 and 3 metres	H
38 a	Earth diameter = 1.2756×10^4 km So radius = 6.378×10^3 Population = $7.185\ 004 \times 10^9$ Surface area sphere = $4\pi r^2$ Surface area of the Earth $= 4 \times \pi \times (6.378 \times 10^3)^2$ $= 5.111\ 859\ 3 \times 10^8$ km^2 Per person $= \frac{5.1118593 \times 10^8}{7.185004 \times 10^9}$ $= 0.071\ 146\ 22$ km^2	0.07 km^2	M1 A1 M1 M1 A1 M1 A1 B1	2	M1 for halving diameter A1 for correct radius M1 for applying correct formula M1 for using correct formula with correct data Cao not rounded Correct division of surface area by population A1 correct answer rounded to 1 or 2 sf B1 for a clear communication of solution	H
b		It reduces the total surface area by 30% of the total. Multiply the area per person by 0.3. The revised answer is 0.021 km^2.	B2 **10**		B2 for a clear explanation of how the percentage makes a difference	

39 a		True. All terminating decimals can also be written as fractions, for example: $0.456 = \frac{456}{1000}$	B1 B1	2 2	True followed by a clear example B1 clear explanation	H
b		True, for example: $a = 0.4242\ldots\ldots$ $100a = 42.42\ldots\ldots$ $100a - a = 42.42\ldots.. - 0.42\ldots$ Therefore: $99a = 42$ $a = \frac{42}{99}$ For the recurring decimal with n repeating digits, replace the 100 above by 10^n and this will make it possible to follow the same procedure and find the fraction.	B1 B1 B2		B1 for work showing how you change a recurring decimal to fraction B1 for clear explanation B2 for clear explanation showing how all recurring decimals can be treated in this way to change to a fraction	
c		False. Irrational numbers cannot be expressed in the form a/b where a and b are integers; for example, π and $\sqrt{2}$ are irrational numbers.	B2 **8**		B2 Clear explanation showing definition of rational numbers and at least one example	
40 a		If the prime factors of the denominator of a fraction in its simplest form are only 2 and/or 5 its decimal will terminate. So the following are terminating	B2	2	B2 for clarity of explanation	H
b		$\frac{3}{5}, \frac{9}{20}, \frac{7}{16}$	B1		B1 for the 3 correct fractions	
c		$\frac{1}{6}$ is non-terminating because the prime factors of 6 are 2 and 3. Any multiple of $\frac{1}{6}$ where the numerator is not a factor or a multiple of 6 will also be recurring. $\frac{1}{3} = \frac{2}{6} = 2 \times 0.166\ 666\ldots.$ $\frac{1}{60} = \frac{1}{6 \times 10}$ $= \frac{1}{6} \times \frac{1}{10} = 0.1666\ldots. \div 10$	B2 B1 B1		B2 for clear explanation B1 for clear communication of method B1 for clear communication of method	

d		Easy to convert are 0.027 272 7… and 0.272 727….. Since after multiplying by 100 in each case, you can eliminate the infinite recurrence to be left with a simple fraction. The hardest to convert are 2.727 272 and 27.272 727 only because the result will give an improper fraction.	B1 B1 B1		B1 for clear explanation of easy B1 for clear explanation of more difficult B1 for clear explanation for any recurring decimal	
		But any decimal with n recurring digits can be changed to a fraction by multiplying by 10^n and eliminating the infinite part.	M1		M1 for correct method of converting recurring decimal to fraction	
e		$a = 2.727\ 272\ldots$ $100a = 272.7272\ldots$ $100a - a = 270$ $99a = 270$ $a = \frac{270}{99}$ $a = 27.272\ 72\ldots$ $100a = 2727.272\ldots$ $100a - a = 2700$ $99a = 2700$ $a = \frac{2700}{99}$ which is $\frac{270}{99} \times 10$	A1 A1 B1 **11**		cao cao B1 clear communication of full answer.	

41	Using the sine rule: $\frac{42}{\sin 61°} = \frac{35}{\sin B}$ $\sin B = 35 \times \frac{\sin 61°}{42}$ To maximise the angle we need to maximise this calculation by using the upper bound of sin 61° and 35 cm and the lower bound of 42 cm: $\sin B = 35.5 \times \frac{\sin 61.5°}{41.5}$ sin *B* = 0.751 759 2 $B = \sin^{-1} 0.751\ 759\ 2$ *B* = 48.742 997°	B = 48.7° (3 sf)	M2 M1 M1 A1 A1 A1 **7**	2	M2 for showing how the sine rule is applied in this situation M1 for setting the equation with sin *B* as subject M1 for clear explanation of how we maximise the calculation A1 for calculation used with correct bounds A1 for correct value not rounded A1 for correct answer to 2 or 3 sf	H