

Guidance on the use of codes for this mark scheme	
M	Method mark
A	Accuracy mark
B	Working mark
C	Communication mark
P	Process, proof or justification 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.	£41.71	M1	2	M1 for subtracting the given readings to find the amount of electricity used B1 multiplying 80 by 20.95 or for writing down £16.76	B
	80 kWh × 20.95 pence = 1676 pence = £16.76		B1			
	311 – 80 = 231 231 × 10.80 pence = 2494.80 pence = £24.948		B1			
	Total bill = £16.76 + £24.948 = £41. 708		B1 A1			
	Assumption that if you average consumption over the year April will be representative.		C1			
			6			

2	<p>Assuming dates are inclusive and not a leap year:</p> <p>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</p> <p>Current supplier: 225×13.99 pence $= 3147.75$ pence $= \pounds 31.4775$ 2436×15.09 pence $= 36\,759.24$ pence $= \pounds 367.5924$ Total $= \pounds 31.4775 + \pounds 367.5924 = \pounds 399.07$</p> <p>New supplier: 225×23.818 pence $= 5359.05$ pence $= \pounds 53.5905$ 2436×14.37 pence $= 35005.38$ pence $= \pounds 350.0538$ Total $= \pounds 53.5905 + \pounds 350.0538 = \pounds 403.64$</p>	<p>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.</p>	M1	2	M1 for showing how many days from each month are used and added together	B
			C1		C1 For stating the assumptions about inclusive days, that this is not a leap year and for calculating number of days correctly	
			M1		M1 for showing how to find the difference of the readings	
			B2		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	
			M1		M1 for showing how the cost is derived for the new supplier with same data as before	
			B2		B2 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		A1 for correctly stating he should stay with current supplier	
C2	C2 for clarity of answer, including any assumptions given.					
			11			

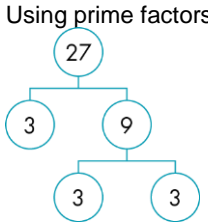
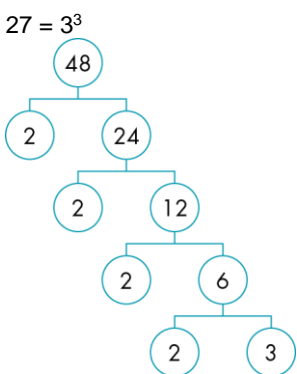
3 a		$175 \div 8 = 21.875$ Round up to the nearest integer, 22, as tables are needed for everybody and you can't have part of a table.	M1 A1 C1	2 3	M1 for dividing guests by number at a table A1 for the rounded, correct integer C1 for explaining the need to round up to the nearest integer	B
b		$175 \div 8 = \pounds 21.875$ If all the guests pay the same amount of $\pounds 21.88$ or more there is enough to cover the bill.	B1 A1 C1		B1 for dividing bill by the number at the table A1 for a correct monetary amount higher than $\pounds 21.875$ and less than $\pounds 22$ unless a tip is mentioned C1 for stating the need to round up in order to create a total higher than the bill if they all pay the same	
c		$175 \div 8 = 21.875$ Cannot have a fraction of a box, so only 21 boxes can be filled. $21 \times 8 = 168$ rolls hence 7 rolls left over	B1 P1 A1 B1		B1 for correctly dividing number of bread rolls by number in each box or the number 21.875 P1 for stating the need to truncate the amount A1 for the correct truncation B1 for calculating the number of boxes multiplied by 8 or the total 168	
d		Average speed = distance \div time	A1 M1		A1 M1 for stating formula for calculating speed	
e		$165 \div 8 = 21.875$ km/h You do not need to round this figure off as the speed can be given with this accuracy.	A1 C1 C2		A1 for the correct answer with correct units C1 for stating no need to round off answer C1 for an answer C1 for describing what is the same and different about each context C2 for quality of questions and explanations in mark scheme	
			16			

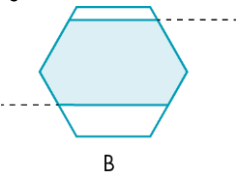
4 a i ii iii iv b	$4.6 \times 40 = 4.6 \times 10 \times 4$ $= 46 \times 4$ $= 184$	184	M1	3	M1 for knowing and using the links	B	
		50 × 40 = 200 Two correct calculations e.g. $1156 \div 34 = 34$	A1 C1				A1 for correctly using the links to get to 184 C1 for correctly showing rounded figures to show the answer is reasonable B1 for each correct statement
		Multiplying both by ten $11.56 \div 0.34 = 34$ Dividing both by ten Two correct calculations, e.g. $2.4 \times 7.2 = 17.28$	B2				
		Divide both by 10 $24 \times 0.72 = 17.28$ Divide one of the numbers by 100	B2 C2				
		Suitable question using concepts introduced in part a.	C2				
	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.	C2				3
			4				
6	$17 \times a = 629$ $a = \frac{629}{17}$ Therefore: $a = 37$	37	M1 A1	3	M1 for dividing 629 by 17 A1 for 37	B	
			C2				C1 for clarity of communication C1 for use of mathematical connectives
			4				

7 i ii iii	4.75 ≤ space < 4.85 4.25 ≤ car < 4.75	A – Yes, the car is always smaller than the smallest possible space. B – No, the smallest space is the same size as the largest car length. C – No, because the car is always smaller than the minimum size of the space, you can always say it will fit.	B1 B1	3	B1 for stating upper and lower bounds of space B1 for stating upper and lower bounds of car C1 for correct explanation of why this is definitely true oe C1 for correct explanation of why this is definitely not true oe C1 for correct explanation of why this is definitely not true oe	B
			C1			
			C1			
			C1			
			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 b c d		How long will it take Barry to recover the money it cost him to convert the car? 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) 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 Can now ask: 'Is B – A more than £66.99?'	C2	3	oe oe M1 for trying to find first cost B1 for correct method of finding this cost M1 for trying to find second cost B1 for correct method of finding this cost B1 for finding this difference correctly C2 for clarity of explanation throughout part c C2 for clarity of explanation in linking part c with the new information	M
			C4			
			M1 B1 M1 B1 B1 C2			
			C2			
			12			

<p>10</p>	<p>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: $90 \div 7 = 12.8571428$ 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: $0.8571428 \times 7 = 6$ minutes.</p> <p>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.</p>	<p>– on its way up.</p>	<p>M3 C2 A1 6</p>	<p>2</p>	<p>M1 for adding the times to create a 7 minute cycle M1 for dividing 90 by the time of one cycle C1 for stating that the dolphin has completed 12 cycles M1 for multiplying the fraction part of 12.8... by 7 C1 for finding this time and relating it to a part of the cycle A1 for correct answer only</p>	<p>M</p>
<p>11 a</p>	<p>26 letters \times 25 numbers So $26 \times 25 = 650$</p>	<p>650</p>	<p>B1 M1 A1</p>	<p>2 3</p>	<p>B1 for knowing to use 26 and 25 M1 for 26×25 A1 correct answer only</p>	<p>M</p>
<p>b</p>	<p>5 flavours, 4 sizes, cone or tub. $5 \times 4 \times 2 = 40$</p>	<p>40</p>	<p>B1 M1 A1 6</p>		<p>B1 for identifying the need to use 5, 4 and 2 M1 for $5 \times 4 \times 2$ A1 for correct answer only</p>	

12 a	Planet	Distance from the Sun (million km)	Diameter (km)	B2	2	B1 for correct distance column B1 for correct diameter column	M
	Mercury	5.8×10^1	4.878×10^3				
	Venus	1.08×10^2	1.2104×10^4				
	Earth	1.5×10^2	1.2756×10^4				
	Mars	2.28×10^2	6.787×10^3				
	Jupiter	7.78×10^2	1.42796×10^5				
	Saturn	1.427×10^3	1.20660×10^5				
	Uranus	2.871×10^3	5.1118×10^4				
	Neptune	4.497×10^3	4.8600×10^4				
	Pluto	5.913×10^3	2.274×10^3				
b	i Jupiter ii Pluto iii Pluto iv Jupiter v Uranus vi Earth and Venus			B6		B1 cao B1 cao B1 cao B1 cao B1 cao B1 cao	
c	Diameter and mass increase with distance from the Sun until you reach Jupiter. Diameter and mass then decrease with distance from the Sun.			C3		C3 for clarity of explanation and of finding some trend within the data	
				11			
13 a		Sometimes true – not true for fractions or negative numbers.		B1 C1	2	B1 for sometimes C1 for correct explanation	M
b		Always true (positive \times positive = positive, Negative \times negative = positive).		B1 C1			
c		False – you can't find the square root of a negative number using real numbers.		B1 C1			
d		Always true – The cube root of a positive number is positive and the cube root of a negative number is negative.		B1 C1			
				8			

<p>14 i</p>	$5^6 \div 5^{-3} = 5^{(6 - -3)} = 5^9$ $\frac{5 \times 5 \times 5 \times 5 \times 5 \times 5}{5 \times 5 \times 5} = \frac{5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5}{1}$		M2	2	<p>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</p>	M
<p>ii</p>	$5^6 \times 5^{-3} = 5^{(6 + -3)} = 5^3$ $\frac{5 \times 5 \times 5 \times 5 \times 5 \times 5}{5 \times 5 \times 5} = 5 \times 5 \times 5 = 5^3$		M2		<p>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</p>	
	<p>$27 \times 48 = n^4 \times 2^c$</p> <p>Using prime factors:</p>  <p>$27 = 3^3$</p> 	<p>The power $\frac{1}{2}$ represents the reciprocal of squaring so take the square root.</p>	C2		<p>C1 for showing square root C1 for clear explanation</p>	
	<p>$48 = 2^4 \times 3$ So $27 \times 48 = 3^4 \times 2^4$</p>	<p>So $n = 3$ and $c = 4$</p>	M2		<p>M1 for finding the prime factors of each number M1 for stating each number as the product of the prime factors</p>	
			B2		<p>B1 for 27 expressed as product of prime factors in index form B1 for 48 expressed as product of prime factors in index form</p>	
			A2		<p>A1 for $n = 23$ cao A1 for $c = 4$ cao C1 for clear communication of solution</p>	
			C1			
			11			

<p>15 a</p> $\frac{8.848 \times 10^3}{8.298 \times 10^2} = 10.66$ <p>b</p> $8.298 \times 10^2 \div 10^3 = 0.8298 \text{ km}$ <p>c</p> $20 \div 1\,000\,000\,000 = 2 \times 10^{-8}$ <p>d</p> <p>Area of eye = $9\pi \times 10^{-6}$</p> $\text{Radius of eye} = \sqrt{9\rho \cdot \frac{10^{-6}}{\rho}}$ $= 3 \times 10^{-3} \text{ m}$ <p>Diameter of eye = $2 \times 3 \times 10^{-3} \text{ m}$</p> $= 6 \times 10^{-3} \text{ m}$ <p>Fraction = $\frac{2 \times 10^{-8}}{6 \times 10^{-3}}$</p> $= 3.333\,333 \times 10^{-6}$	<p>10.66</p> <p>0.8298 km</p> <p>$2 \times 10^{-8} \text{ m}$</p> <p>$3.33 \times 10^{-6}$</p>	<p>M1 A1</p> <p>M1 A1</p> <p>M1 A1</p> <p>M1 A1</p> <p>M1 A1 C1</p> <p style="text-align: center;">11</p>		<p>M1 for dividing mountain height by skyscraper height A1 accept 10.66..... or 10.7</p> <p>M1 for dividing skyscraper height by 1000 A1 cao</p> <p>M1 for dividing 2 by 1 000 000 000 A1 cao</p> <p>M1 for connection between area of eye and πr^2 A1 cao</p> <p>M1 for setting up fraction with correct numbers A1 cao C1 for clear communication shown of methods</p>	<p>M</p>
<p>16</p> <p>$\frac{1}{9}$</p>  <p style="text-align: center;">B</p> <p>$\frac{2}{7}$</p> $\frac{1}{9} + \frac{2}{7} = \frac{7}{63} + \frac{18}{63} = \frac{25}{63}$ $1 - \frac{25}{63} = \frac{38}{63}$	<p>$\frac{38}{63}$</p>	<p>M1 B1 A1</p> <p>M1 A1</p> <p style="text-align: center;">5</p>	<p>2</p>	<p>M1 for adding given fractions B1 for use of common denominator 63 A1 cao</p> <p>M1 for subtracting fraction sum from 1 A1 ft from their first $\frac{25}{63}$</p>	<p>M</p>

17	<p>So $\frac{3}{8}$ of the residential land is used for services.</p> $\frac{3}{8} \times 5\frac{1}{2} = \frac{33}{16} \text{ m}^2$ $\left(\frac{33}{16} \div 15\right) \times 100$ $= 13.75\%$	<p>13.75% of the total area is used for services.</p>	<p>C1 M1 A1 M1 A1 5</p>	<p>2 3</p>	<p>C1 for recognising and stating $\frac{3}{8}$ of residential development is used for the services</p> <p>M1 for multiplying $\frac{3}{8}$ by $5\frac{1}{2}$ A1 oe</p> <p>M1 for finding above fraction of 15 and multiplying by 100</p> <p>A1 accept 14 or 13.8</p>	M
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18 a		<p>The volume of the 2 cm cube is $2 \times 2 \times 2 = 8 \text{ cm}^3$.</p> <p>The volume of the 4 cm cube will be $4 \times 4 \times 4 = 64 \text{ cm}^3$.</p> <p>This is 8 times as much plastic as the 2 cm cube.</p>	C2	3	<p>C1 for clear explanation showing how to find volumes of each cube</p> <p>C1 for clear indication that the volume of the 4cm dice is not twice as much as the 2 cm</p> <p>Or C2 for stating twice as large in dimensions will be 2^3 as large in volume</p>	M				
		<p>The 4 cm dice will use $64 - 8 = 56 \text{ cm}^3$ more plastic.</p> <p>(Or could say 8 times as much.)</p>	B1				<p>B1 for stating 56 cm^3 more plastic</p> <p>Or for stating 8 times as much</p>			
	b i	<p>The volume of the 3 cm cube is $3 \times 3 \times 3 = 27 \text{ cm}^3$.</p> <p>The volume of the 2 cm cube is 8 cm^3 so will use $27 - 8 = 19 \text{ cm}^3$ more plastic or $27 \div 8 = 3.375$ times as much.</p>	B1				B1 for finding the volumes of both cubes			
			<p>The volume of the 2 cm cube is 8 cm^3 so will use $27 - 8 = 19 \text{ cm}^3$ more plastic or $27 \div 8 = 3.375$ times as much.</p>				B1	B1 for finding 19 cm^3 more plastic or for stating 3.375 times as much		
	ii	<p>The volume of the 3 cm dice = 27 cm^3.</p> <p>The volume of the 4 cm dice = $4^3 = 64 \text{ cm}^3$.</p> <p>So it needs $64 - 27 = 37 \text{ cm}^3$ less plastic.</p>	B1				B1 for finding the volumes of both cubes			
							B1	B1 for finding 37 cm^3 less plastic		
	c	<p>A dice that has twice the volume will have volume ratio of 1 : 2.</p> <p>Hence the length ratio will be $1 : \sqrt[3]{2} = 1 : 1.26$.</p> <p>Hence the length of the dice will be $2 \times 1.26 = 2.52 \text{ cm}$.</p> <p>The advice to give Siobhan is to make the cube with a side length just larger than 2.5 cm.</p>	P2				<p>P1 for setting up ration as 1:2</p> <p>P1 for finding and stating the cube root of ratio</p>			
							B1	B1 for calculation of $2 \times$ cube root of 2		
							C1	C1 for communicating the idea of making a cube just larger than 2.5 cm		
							11			

<p>19 a</p> <p>bi</p> <p>ii</p> <p>iii</p>		<p>0.8 is less than 1 so $68 \div 0.8$ will be greater than 68 as dividing by a number less than 1 gives an answer greater than you started with.</p> <p>$75 \times 20 = 1500$ oe The approximation will be smaller because each term has been rounded down</p> <p>$\frac{25}{5} = 5$ 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</p> <p>$2^2 \times 7.5 = 30$ oe The approximation will be bigger because both numbers have been rounded up and so the estimation is larger than the real answer.</p>	<p>C1</p> <p>M1 A1 P1</p> <p>M1 A1</p> <p>P1</p> <p>M1 A1 P1</p>	<p>3</p>	<p>C1 For greater with a correct explanation</p> <p>M1 for a suitable rounding of each number A1 for correctly multiplying the rounded numbers P1 for a correct justification</p> <p>M1 for a suitable rounding of each number A1 for correctly dividing the rounded numbers</p> <p>P1 for a correct justification</p> <p>M1 for a suitable rounding of each number A1 for correctly multiplying the rounded numbers P1 for a correct justification</p> <p>In each case 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</p>	<p>M</p>
		10				
<p>20 a</p> <p>b</p>		<p>Three calculations that approximate to 75, e.g. 1.1×75.1 based on 1×75 24.7×3.2 based on 25×3 $147 \div 1.9$ based on $150 \div 2$</p> <p>$9 \div 3$ is a better approximation than $10 \div 3$ because $9 \div 3$ is easily worked out in your head with an integer answer whereas $10 \div 3$ gives a decimal answer.</p>	<p>B3</p> <p>C2</p> <p>C2</p>	<p>2 3</p>	<p>B1 for each example that approximates to 75</p> <p>C1 for use of multiplication and division C1 for evidence of progression of complexity in the questions</p> <p>oe C2 for use of mathematical language and possibly connectives in answer</p>	<p>M</p>
		7				

21	<p>The minimum area would be: $14.5 \times 18.5 = 268.25$ The maximum area would be less than: $15.5 \times 19.5 = 302.25$</p> <p>Given lengths are 2 sf, so it would be sensible to give area to 2 sf also. Where area = $15 \times 19 = 285$ The sensible answer for the area is 290 m².</p>	<p>268.25</p> <p>302.25 $268.25 \leq \text{floor area} < 302.25$</p> <p>290 m²</p>	<p>M1 A1 M1 A1 A1</p> <p>C1</p> <p>B1</p> <p>7</p>	2	<p>M1 for multiplying the lower bounds A1 cao M1 for multiplying the upper bounds A1 cao A1 cao</p> <p>C1 for explanation of why 2 sf should be used</p> <p>B1 cao</p>	M
22	<p>Assume pallets are at maximum of 525 kg. A 6-axle lorry can carry up to $44 \div 0.525 = 83.8$ So a maximum of 83 pallets per trip. A 5-axle lorry can carry up to $40 \div 0.525 = 76.2$ So a maximum of 76 pallets per trip.</p> <p>a 80 is less than 83 but more than 76, so choose the 6-axle lorry, as this can do it in one trip.</p> <p>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.</p> <p>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.</p>	<p>6 axle max of 83 pallets 5 axle max of 76 pallets</p>	<p>B1</p> <p>M1</p> <p>A1 A1</p> <p>C2</p> <p>C2</p> <p>C2</p> <p>10</p>	2 3	<p>B1 for stating maximum possible mass of pallet</p> <p>M1 for dividing both load limits by maximum pallet mass</p> <p>A1 cao A1 cao</p> <p>C2 for clear explanation of correct choice</p> <p>C2 for clear explanation of correct choice</p> <p>C2 for clear explanation of correct choice.</p>	M

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	C2	2 3	C2 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.	C1				C1 for clear explanation
	c	425 cm ≤ length < 435 cm	C1				C1 for communicating clearly this information
	d	Tenth of a metre or 10 cm.	C1				C1 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. 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 B1 C2 B1 C2
			12				
24		Maximum number of people turning up will be 104 (as 105 will round to 110). Assume 5% of the 280 do not turn up. 0.05 × 280 = 14 Hence assume 266 seats already taken. 365 – 266 = 99 free seats	B1	3	B1 for stating maximum number of people that could turn up B1 for finding the assumed number not turning up B1 for finding assumed seats taken B1 for finding assumed number of free seats C2 for clear explanation using all the calculated data	M	
			B1				
			B1				
			B1				
			C2				
			6				

25	<p>12.25 seconds \leq time $<$ 12.35 seconds 99.995 m \leq distance $<$ 100.005 m</p> <p>Speed = distance \div time Greatest speed is longest distance divided by shortest time = 100.005 \div 12.25 = 8.163 67 m/s</p>	8.164 m/s	B1 B1 M1 C1 M1 A1 6	2	B1 for time range B1 for distance range M1 for correct formula used for speed C1 for explanation of longest distance used with shortest time M1 for division A1 for suitably rounded speed (4 or 5 sf)	M
26	<p>124.5 \leq volume $<$ 125.5 Take cube root for lengths of sides, giving: 4.993 324 4 \leq length $<$ 5.006 657 8 Area of side will be square of lengths, giving: 24.933 289 \leq area $<$ 25.066 622</p>	24.93 cm ² \leq area $<$ 25.07 cm ²	B1 P1 A1 P1 A1 5	2	B1 for stating limits of accuracy for volume P1 for finding cube root to find length A1 for un rounded limits to length P1 for squaring unrounded length limits A1 for rounded limits to 3 or 4 sf	M
27 a i ii iii b	<p>The maximum for which no grade is achieved by 5 students occurs when each grade is achieved by 4 students, which means $6 \times 4 = 24$ students. Hence, having one more student will guarantee that at least one grade is achieved by 5 students.</p>	<p>True. When $n = k$, each box contains 1 ball. So when $n > k$ at least one box contains at least two balls.</p> <p>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.</p> <p>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.</p> <p>At least 25 students</p>	C1 C1 C1 C1 C1 C1 M1 M1 A1 9	2	C1 for explaining how it is true: can use example or diagram to show this C1 for clear communication C1 for explaining how it is true C1 for clear communication C1 for explaining how it is true C for clear communication M1 for least number with no grade with 5 students M1 for adding one more student A1 cao	M

28 a	Length of A4 paper = 297mm $= 2.97 \times 10^2 \text{ mm}$ $1 \text{ mm} = 1 \times 10^{-6} \text{ km}$ Area A4 paper = $2.97 \times 10^2 \times 1 \times 10^{-6} \text{ km}$ $= 2.97 \times 10^{(2-6)} = 2.97 \times 10^{-4} \text{ km}$ or $297 \div 1\,000\,000 = 0.000297$ $= 2.97 \times 10^{-4} \text{ km}$	False	M1 A1 C1	2	M1 for getting units into mm then convert to m A1 for finding correct length of A4 C1 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	C2		C2 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	C2		C2 for clear explanation and stating true		
d	$4\sqrt{3} \times 3\sqrt{3} = 4 \times \sqrt{3} \times 3 \times \sqrt{3}$ $= 4 \times 3 \times \sqrt{3} \times \sqrt{3}$ $= 12 \times 3 = 36$ $7\sqrt{7} = \sqrt{49} \cdot \sqrt{7}$ $= \sqrt{49 \cdot 7} = \sqrt{343}$ 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 $1296 \neq 343$ So: $4\sqrt{3} \cdot 3 \cdot \sqrt{3} \neq 7\sqrt{7}$	False	C2	9		C2 for clear explanation and stating false	

<p>29 a</p> $\sqrt{25} = 5$ <p>So $\sqrt{19} < 5$</p> <p>b</p> $4^2 = 16$ $5^2 = 25$ <p>So $\sqrt{23}$ is between 4 and 5</p> <p>c</p> $2\sqrt{2} = \sqrt{4 \times 2} = \sqrt{8}$ <p>So not less but equal to</p> <p>iv</p> $\sqrt{0.38} = \sqrt{\frac{38}{100}}$ $= \sqrt{38} \cdot \sqrt{\frac{1}{100}}$ <p>Consider 0.6</p> $= \sqrt{36} \cdot \sqrt{\frac{1}{100}}$ <p>Hence $\sqrt{0.38} > 0.6$</p>	<p>False</p> <p>True</p> <p>False</p> <p>True</p>	<p>M1 A1</p> <p>M1 A1</p> <p>M1 A1 C1</p> <p>M1 A1 C1</p>	<p>2</p>	<p>M1 for finding a suitable comparison A1 for showing it is false and stating such</p> <p>M1 for showing the square of the limits A1 for showing it is true and stating such</p> <p>M1 for showing $\sqrt{4 \cdot 2}$ A1 for showing it is false and stating such C1 for explaining they are in fact equal.</p> <p>M1 for showing both in similar comparable terms A1 for showing it is true and stating such C1 for clear concise communication of method</p>	<p>H</p>
10					
<p>30</p> $27^{-\frac{1}{3}} = \frac{1}{\sqrt[3]{27}}$ $= \frac{1}{3}$ $25^{-\frac{1}{2}} = \frac{1}{\sqrt{25}} = \frac{1}{5}$ $3^{-1} = \frac{1}{3}$	<p>Odd one out is $25^{-\frac{1}{2}}$.</p>	<p>M3</p> <p>A1</p>	<p>2</p>	<p>M1 for showing $27^{(-\frac{1}{3})} = \frac{1}{3}$</p> <p>M1 for showing $25^{(-\frac{1}{2})} = \frac{1}{5}$</p> <p>M1 for showing $3^{-1} = \frac{1}{3}$</p> <p>A1 cao</p>	<p>H</p>
4					
<p>31</p> $x^{-\frac{1}{4}} = y^{-\frac{1}{2}}$ $\frac{1}{\sqrt[4]{x}} = \frac{1}{\sqrt{y}}$ <p>Square both sides:</p> $\frac{1}{\sqrt{x}} = \frac{1}{y}$ <p>Hence $\sqrt{x} = y$ Hence $x^2 = y$</p>	<p>Any example where x is the square of y, e.g. $x = 1, y = 1$ $x = 4, y = 2$ $x = 9, y = 3$</p>	<p>M2</p> <p>A1</p> <p>C1</p>	<p>2</p>	<p>M1 for squaring both sides to make information clearer M1 for considering only the denominator</p> <p>A1 for a correct example</p> <p>C1 for clear progression through the solution</p>	<p>H</p>
4					

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	M1 for using trial and improvement A1 for correct answer	H
			2			
33 a b c d e f g h i j		0.6	B1	2	cao	H
			B1			
			B1			
			B1			
			B1			
			B1			
			B1			
			B1			
			B1			
			B1			
			B1			
10						
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 C1	2	M1 for finding an example which disproves the statement A1 for stating it is false C1 for clear communication of the solution	H
			3			
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 P1 C1	2	B1 for a correct division of two surds P1 for showing how the surds will leave an integer answer C1 for clear communicating of method used	H
			3			
36 a b		For example: $3 + \sqrt{2}$ and $3 - \sqrt{2}$ For example: $\sqrt{2}$ and $\sqrt{3}$	B1 B1	2	B1 for a correct possible pair of surds B1 for a correct possible pair of surds	H
			2			

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.	C1 C1 2	2	C1 for explaining the integer range for $\sqrt{3}$ C1 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 = 7.185004×10^9 Surface area sphere = $4\pi r^2$ Surface area of the earth $= 4 \times \pi \times (6.378 \times 10^3)^2$ $= 5.1118593 \times 10^8 \text{ km}^2$ Per person $= \frac{5.1118593 \times 10^8}{7.185004 \times 10^9}$ $= 0.07114622 \text{ km}^2$	 0.07 km ² 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 .	M1 A1 M1 M1 A1 M1 A1 C1 C2 10	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 C1 for a clear communication of solution C2 for a clear explanation of how the percentage makes a difference	H
b						

<p>39 a</p> <p>b</p> <p>c</p>		<p>True. All terminating decimals can also be written as fractions, for example:</p> $0.456 = \frac{456}{1000}$ <p>True. For example: $a = 0.4242\dots\dots$ $100a = 42.42\dots\dots$ $100a - a = 42.42\dots\dots - 0.42\dots$ Therefore $99a = 42$ $a = \frac{42}{99}$</p> <p>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.</p> <p>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.</p>	<p>B1 C1</p> <p>B1 C1</p> <p>C2</p> <p>C2</p> <p>8</p>	<p>2</p> <p>2</p>	<p>True followed by a clear example C1 clear explanation</p> <p>B1 for work showing how you change a recurring decimal to fraction C1 for clear explanation</p> <p>C2 for clear explanation showing how all recurring decimals can be treated in this way to get to a fraction</p> <p>C2 Clear explanation showing definition of rational numbers and at least one example</p>	<p>H</p>
<p>40 a</p> <p>b</p> <p>c</p>		<p>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:</p> $\frac{3}{5}, \frac{9}{20}, \frac{7}{16}$ <p>$\frac{1}{6}$ 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.</p> $\frac{1}{3} = \frac{2}{6} = 2 \times 0.166\ 666\dots$ $\frac{1}{60} = \frac{1}{6 \times 10}$ $= \frac{1}{6} \times \frac{1}{10} = 0.1666\dots \div 10$	<p>C2</p> <p>B1</p> <p>C2</p> <p>C1</p> <p>C1</p>	<p>2</p>	<p>C2 for clarity of explanation</p> <p>B1 for the 3 correct fractions</p> <p>C2 for clear explanation</p> <p>C1 for clear communication of method</p> <p>C1 for clear communication of method</p>	<p>H</p>

d		Easy to convert are 0.027 272 7... and 0.272 727.....	C1		C1 for clear explanation of easy	
		Since after multiplying by 100 in each case, you can eliminate the infinite recurrence to be left with a simple fraction	C1		C1 for clear explanation of more difficult	
e		The hardest to convert are 2.727 272 and 27.272 727 only because the result will give an improper fraction.	C1		C1 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	
		$a = 2.727\ 272\dots$	A1		cao	
		$100a = 272.7272\dots$	A1		cao	
		$100a - a = 270$				
		$99a = 270$				
		$a = \frac{270}{99}$				
		$a = 27.27272\dots$				
		$100a = 2727.272\dots$				
		$100a - a = 2700$				
		$99a = 2700$				
		$a = \frac{2700}{99}$ which is $\frac{270}{99} \times 10$				
			11			

41	<p>Using the sine rule:</p> $\frac{42}{\sin 61^\circ} = \frac{35}{\sin B}$ $\sin B = 35 \times \frac{\sin 61^\circ}{42}$ <p>To maximise the angle we need to maximise this calculation by using the upper bound of $\sin 61^\circ$ and 35 cm and the lower bound of 42 cm:</p> $\sin B = 35.5 \times \frac{\sin 61.5^\circ}{41.5}$ $\sin B = 0.751\ 759\ 2$ $B = \sin^{-1} 0.751\ 759\ 2$ $B = 48.742\ 997^\circ$	<p>$B = 48.7$ (3sf)</p>	<p>M2</p> <p>B1</p> <p>C1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>7</p>	<p>2</p>	<p>M2 showing how the sine rule is applied in this situation</p> <p>B1 for setting the equation with $\sin B$ as subject</p> <p>C1 for clear explanation of how we maximise the calculation</p> <p>B1 for calculation used with correct bounds</p> <p>B1 for correct value not rounded</p> <p>B1 for correct answer to 2 or 3 sf</p>	<p>H</p>
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