GCSE
MATHEMATICS
8300/3H

Higher Tier Paper 3 Calculator

Mark scheme

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23BG8300/3H/MS

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 Examiner.

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.

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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 $\leqslant$ 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.

Q	Answer	Mark	Comments
1	$7n-1$ or $-1+7n$	B1	oe does not need to be simplified
	Additional Guidance		
	$n7-1$		B0

Q	Answer	Mark	Comments
2	$\frac{2}{3}$	B1	oe fraction
	Additional Guidance		
	$\frac{2}{3} = 0.66\ldots$		B0

Q	Answer	Mark	Comment
3	7.5 cm $\leqslant$ length $<$ 8.5 cm	B2	B1 one length correct in correct position SC1 8.5 cm $\leqslant$ length $<$ 7.5 cm
	Additional Guidance		
	Accept $8.4\dot{9}$ for 8.5		

Q	Answer	Mark	Comments
4	(0, –1)	B1	

Q	Answer	Mark	Comment
5	Method to calculate the increase on the salary or the decrease to the bonus or decimal multiplier 1.06 or 0.91	M1	eg 26 000 × 0.06 or 1560 or 4000 × 0.09 or 360 oe fraction
	Method to calculate the value of the increased salary or the decreased bonus or Method to calculate the difference between the increase on the salary and the decrease to the bonus	M1dep	eg 26 000 × 1.06 or 27 560 or 4000 × 0.91 or 3640 eg their 1560 – their 360 or 1200 31 200 implies M2
	Method to calculate the decimal multiplier or percentage of the total annual pay or 1.04 or 104(%) or Method to calculate the decimal multiplier or percentage change in the total annual pay or 0.04 or 4(%)	M1	eg $\frac{31\,200}{30\,000}$ oe eg $\frac{\text{their } 1560 - \text{their } 360}{26\,000 + 4000}$ or $\frac{1200}{30\,000}$ oe
	4(%) increase	A1	
	Additional Guidance		
	For first M mark do not accept a misread of increase for decrease eg 1.09		M0
	$26\,000 \times 1.06 = 27\,560$ and $4000 \times 1.09 = 4360$ $27\,560 + 4360 = 31\,920$ and $\frac{31\,920}{30\,000}$		M1M1M1A0
	$24\,440 + 4360 = 28\,800$ and $\frac{28\,800}{30\,000}$		M0M0M1
	$100 + 6 = 106\%$		M0
	$26\,000 \times 1.06\%$		M1M0

Q	Answer	Mark	Comments
6	$\frac{2}{5} \times 240$ or 96 or $\frac{3}{5} \times 240$ or 144	M1	oe
	$\frac{2}{5} \times 240 \times 172$ or 96×172 or 16 512	M1dep	oe
	$\frac{29\,760 - 16\,512}{144}$ or $\frac{13\,248}{144}$	M1dep	oe dep on M2
	92	A1	
	Additional Guidance		
	Up to M3 may be awarded for correct work, with no answer or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comment
7	27 in the box on the left side of calculation	B1	accept 3^3 for 27 throughout
	Three different prime numbers in the boxes on the right side of calculation	M1	
	$27 = 3 + 5 + 19$ or $27 = 3 + 7 + 17$ or $27 = 3 + 11 + 13$	A1	numbers in the boxes on the right side of calculation can be in any order SC2 $27 = 2 + 2 + 23$ or $27 = 5 + 5 + 17$ or $27 = 7 + 7 + 13$ or $27 = 5 + 11 + 11$
	Additional Guidance		
	SC2 is for using a repeated prime number		
	$27 = 3 + 5 + 17$		B1M1A0
	$27 = 7 + 11 + 9$		B1M0A0
	$27 = 1 + 3 + 23$		B1M0A0
	List of prime numbers with right side boxes empty or incorrect		M0

Q	Answer	Mark	Comments
8	$5.3\dot{4}$	B1	

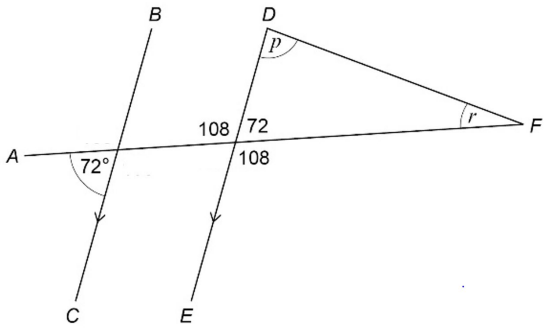
Q	Answer	Mark	Comment
9	**Alternative method 1**		
	cos chosen or used	M1	
	$\cos w = \frac{6.7}{8.3}$ or $\cos^{-1}\frac{6.7}{8.3}$	M1dep	any letter or symbol for w accept 0.807(…) or 0.81 for $\frac{6.7}{8.3}$
	[35.9, 36.2]	A1	
	Alternative method 2		
	$\sin x = \frac{6.7}{8.3}$ or $\sin^{-1}\frac{6.7}{8.3}$ or [53.8, 54.1]	M1	any letter or symbol other than w accept 0.807(…) or 0.81 for $\frac{6.7}{8.3}$
	90 – their [53.8, 54.1]	M1dep	
	[35.9, 36.2]	A1	
	Alternative method 3		
	$\sqrt{8.3^2 - 6.7^2}$ or $\sqrt{68.89 - 44.89}$ or $\sqrt{24}$ or $2\sqrt{6}$ or [4.89, 4.9] **and** $\sin^{-1}\frac{\text{their [4.89, 4.9]}}{8.3}$ or $\tan^{-1}\frac{\text{their [4.89, 4.9]}}{6.7}$	M2	full method to work out the missing length and use it correctly to work out the value of w any letter or symbol for w
	[35.9, 36.2]	A1	
	Additional Guidance		
	Use of sine rule follows Alt method 2		
	$\sin w = \frac{6.7}{8.3}$ without $\sin^{-1}\frac{6.7}{8.3}$ or [53.8, 54.1]		M0
	$\cos w = 0.807$		M1M1
	$\cos^{-1} w = \frac{6.7}{8.3}$ or $\cos = \frac{6.7}{8.3}$ unless recovered		M1M0

Q	Answer	Mark	Comment
10(a)	$\frac{1}{5}$ (Green) and $\frac{4}{5}$ (Yellow) for Bag A	B1	oe fractions, decimals or percentages
	$\frac{3}{10}$ (Green) and $\frac{7}{10}$ (Yellow) on both sections for Bag B	B1	oe fractions, decimals or percentages

Q	Answer	Mark	Comment
10(b)	their $\frac{1}{5}$ × their $\frac{3}{10}$	M1	oe fractions or decimals ft their tree diagram with 0 < both probabilities for Green < 1
	$\frac{3}{50}$ or 0.06 or 6%	A1ft	oe ft their tree diagram with 0 < both probabilities for Green < 1
	Additional Guidance		
	Ignore incorrect simplification or conversion after correct answer seen		
	3 out of 50 or 3 : 50 without working for M1		M0A0

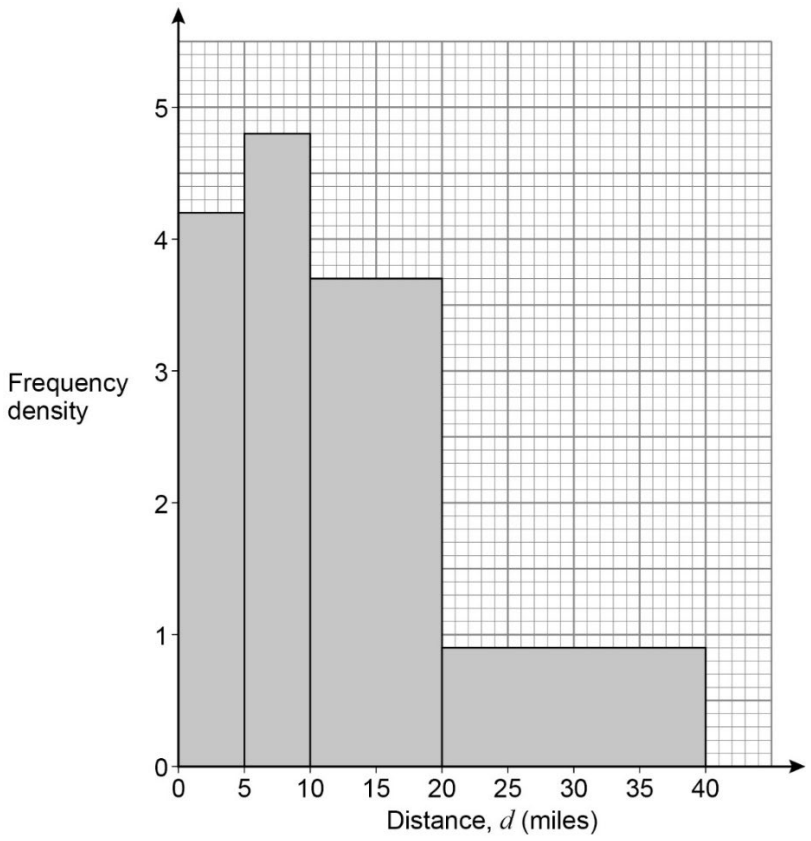
Q	Answer	Mark	Comment
11	Any correct method that would lead to an equation in x or an equation in y	M1	eg $7x - 3x = 100 - 48$ or $100 - 7x = 48 - 3x$ or $7x + 2\left(\frac{48 - 3x}{2}\right) = 100$ or $3x + 2\left(\frac{100 - 7x}{2}\right) = 48$ or $4x = 52$ or $14y - 6y = 336 - 300$ or $7\left(\frac{48 - 2y}{3}\right) + 2y = 100$ or $3\left(\frac{100 - 2y}{7}\right) + 2y = 48$ or $8y = 36$
	$x = 13$ or $y = 4.5$ or $y = 4\frac{1}{2}$ or $y = \frac{9}{2}$	A1	
	$x = 13$ and $y = 4.5$ or $y = 4\frac{1}{2}$ or $y = \frac{9}{2}$	A1	

Additional Guidance	
$(7x + 2y) - (3x + 2y) = 100 - 48$	M1
One correct value with one incorrect value (or no second value)	M1A1A0
Embedded correct values in both equations	M1A1A0
Embedded correct values in one equation only	M1A0A0

Q	Answer	Mark	Comment
12	Angle labelled as 72 for the correct interior angle of the triangle or angle labelled as 108 for a correct exterior angle of the triangle or $3r + r + 72 = 180$ or $4r = 180 - 72$ or $4r = 108$	M1	oe 
	$\frac{180-72}{3+1}$ or $\frac{108}{4}$ or 27 or $108 \times \frac{3}{4}$ or $\frac{4p}{3} = 108$	M1dep	oe
	81	A1	

Q	Answer	Mark	Comments
13(a)	21	B1	

Q	Answer	Mark	Comments
13(b)	$\frac{55}{100}$ or $\frac{11}{20}$ or 0.55 or 55%	B1	oe fraction, decimal or percentage
	Additional Guidance		
	Ignore incorrect simplification or conversion after correct answer seen		

Q	Answer	Mark	Comments
13(c)	21 ÷ 5 or 4.2 or 24 ÷ 5 or 4.8 or 37 ÷ 10 or 3.7 or 18 ÷ 20 or 0.9	M1	implied by a correct bar
	At least three of 4.2 4.8 3.7 0.9	M1dep	implied by at least three correct bars
	Fully correct histogram	A1	$\pm\frac{1}{2}$ small square ignore frequency polygon if included
	Additional Guidance		
	Allow up to M2 even if not subsequently used or incorrectly plotted		
	Allow up to M2 for correct heights seen on a frequency polygon		
	Correct bars must have correct widths		
			M1M1A1

Q	Answer	Mark	Comments
14(a)	$\frac{1}{3} \times 8 \times 8 \times 16$ or $\frac{1024}{3}$ or 341.3… or $\frac{1}{3} \times 5 \times 5 \times 10$ or $\frac{250}{3}$ or 83.3…	M1	oe
	$\frac{1}{3} \times 8 \times 8 \times 16 - \frac{1}{3} \times 5 \times 5 \times 10$ $= 258$ or $\frac{1024}{3} - \frac{250}{3} = 258$ or 341.3… – 83.3… = 258	A1	oe eg $\frac{1024}{3} - 258 = \frac{250}{3}$ must see method or values for both pyramids must use same number of decimal places for both pyramids so their answer is exactly 258

Additional Guidance	
341.3 – 83.3 = 258	M1A1
341.33 – 83.3 = 258.03	M1A0
341 – 83 = 258 with no correct method seen	M0A0

Q	Answer	Mark	Comments
14(b)	$2340 = 7.5 \times V$ or $\frac{2340}{7.5}$ or 312 or 2340 – (7.5 × 258) or 2340 – 1935 or 405	M1	oe
	54	A1	

Q	Answer	Mark	Comments
15	$\begin{pmatrix}8\\5\end{pmatrix}$ or $\begin{pmatrix}2m\\6\end{pmatrix}+\begin{pmatrix}-4\\p\end{pmatrix}$ or $2m-4$ or $6+p$	M1	oe may be seen in a single vector
	$2m-4=$ their 8 or $6+p=$ their 5	M1dep	oe their 8 and their 5 must come from a vector or be shown on the diagram
	$m=6$ or $p=-1$	A1	
	$m=6$ and $p=-1$	A1	SC3 $m=4.5$ and $p=2$ SC2 $m=4.5$ or $p=2$
	Additional Guidance		
	SC are for using $\begin{pmatrix}5\\8\end{pmatrix}$		
	$2m-4=8$ or $6+p=5$ implies M2		

Q	Answer	Mark	Comments
16	**Alternative method 1**		
	$d^2 + d^2 = 10^2$ or $2d^2 = 100$ or $(2r)^2 + (2r)^2 = 10^2$ or $8r^2 = 100$	M1	oe must use same letter for *PQ* and *QR*
	$(d =) \sqrt{\frac{100}{2}}$ or $(d =) 5\sqrt{2}$ or $(d =) 7.07(1\ldots)$ or $(d =) 7.1$ or $(r^2 =) \frac{100}{8}$ or $(r =) \frac{5}{2}\sqrt{2}$	M1dep	oe eg $(d =) \sqrt{50}$
	3.5(3…) or 3.54 or 3.55	A1	
	Alternative method 2		
	$\sin 45 = \frac{d}{10}$ or $\cos 45 = \frac{d}{10}$	M1	oe eg $\sin 45 = \frac{2r}{10}$ or $\sin 45 = \frac{r}{5}$
	$(d =) 10 \times \sin 45$ or $(d =) 10 \times \cos 45$ or $(d =) 5\sqrt{2}$ or $(d =) 7.07(1\ldots)$ or $(d =) 7.1$	M1dep	oe eg $(2r =) 10 \times \sin 45$ or $(r =) 5 \times \sin 45$ or $(r =) \frac{5\sqrt{2}}{2}$
	3.5(3…) or 3.54 or 3.55	A1	
	Additional Guidance		
	Alt method 1 If working with diameter, square root is required for 2nd M1 If working with radius, square root is not required for 2nd M1		
	Alt method 1 $2r^2 + 2r^2 = 10^2$ is M0M0A0 unless recovered		
	Use of sine rule follows Alt method 2		

Q	Answer	Mark	Comments
17	$\frac{a+b}{2}$	B1	oe eg $a + \left(\frac{b-a}{2}\right)$

Q	Answer	Mark	Comments
18	$(x+4)^2$ or $2(x+4)^2$ with no denominator seen	M1	
	$x^2+4x+4x+16$ with three terms correct or x^2+8x+k where k is a non-zero constant	M1	implied by $2x^2+8x+8x+32$ with three terms correct or $2x^2+16x+k$ where k is a non-zero constant ignore any denominator
	$2x^2+16x+32$	A1	
	Additional Guidance		
	Do not award A mark if a correct answer is subsequently divided by 2		
	$(x+4)^2=x^2+16$		M1M0A0

Q	Answer	Mark	Comments
19	$AE = CE$	M1	oe
	angle AEB = angle CED	M1	oe
	$BE = DE$	M1	oe
	$AE = CE$ and radii and angle AEB = angle CED and (vertically) opposite and $BE = DE$ and E is the midpoint and SAS	A1	oe allow $BE = DE$ and given
	Additional Guidance		
	Up to M3 may be awarded for correct, unambiguous working shown on the diagram		
	Angles must be correctly identified, do not accept angle E for angle AEB		
	Do not award A mark if any incorrect statement is seen		

Q	Answer	Mark	Comments
20	$2x^2 + 20x$	M1	
	$2x^2 + 20x - 5x + 18$ (= 0) or $2x^2 + 15x + 18$ (= 0) or $x^2 + 7.5x = -9$	M1dep	oe
	$(2x + 3)(x + 6)$ or $\frac{-15 \pm \sqrt{15^2 - 4 \times 2 \times 18}}{2 \times 2}$ or $-\frac{15}{4} \pm \sqrt{\frac{81}{16}}$	M1	oe eg $\frac{-15 \pm \sqrt{81}}{4}$ correct factorisation or formula or completing the square for their 3-term quadratic
	-6 and -1.5	A1	oe
	Additional Guidance		
	$2x^2 + 10x - 5x - 18$ $2x^2 + 5x - 18$ $(2x + 9)(x - 2)$		M0M0M1A0

Q	Answer	Mark	Comments
21(a)	D	B1	

Q	Answer	Mark	Comments
21(b)	Draws tangent at $t = 10$	M1	
	[0.3, 0.4]	A1	
	Additional Guidance		
	For drawing of tangent mark intention		
	No tangent drawn		M0A0

Q	Answer	Mark	Comments
22	Valid common denominator with at least one correct numerator with all their multiplications correctly processed	M1	eg $\frac{35}{10a^2}$ and $\frac{6a}{10a^2}$ or $\frac{35a}{10a^3}$ and $\frac{6a^2}{10a^3}$
	$\frac{35-6a}{10a^2}$	A1	
	Additional Guidance		
	$\frac{35-6a}{10a^2}$ followed by further work		M1A0
	$\frac{35a-6a^2}{10a^3}$		M1A0

Q	Answer	Mark	Comments
23	$x \times 5x$ or $5x^2$	M1	oe may be implied eg $30x^2$
	$2 \times \frac{3\sqrt{3}}{2}x^2 + 6 \times x \times 5x$ or $3\sqrt{3}\,x^2 + 30x^2$	M1dep	oe eg $35.19(6\ldots)x^2$ or $35.2x^2$
	$650 \div (3\sqrt{3} + 30)$ or [18.4, 18.5] or [4.2, 4.3] **or** $3\sqrt{3} \times 4^2 + 30 \times 4^2$ or 563.(…) and $3\sqrt{3} \times 5^2 + 30 \times 5^2$ or 879.(…) or 880	M1dep	oe dep on M2 calculation or [18.4, 18.5] may be seen in a square root trials $x = 4$ and $x = 5$ ignore substitution of other integer values of x
	4 with at least first two M marks awarded	A1	

Q	Answer	Mark	Comments
24	**Alternative method 1 – finding length *AC***		
	$\frac{b}{\sin 56} = \frac{24}{\sin 73}$	M1	oe any letter
	$\frac{24}{\sin 73} \times \sin 56$ or [20.8, 20.81]	M1dep	oe
	0.5 × 24 × their [20.8, 20.81] × sin 51	M1dep	oe dep on M2 51 must come from 180 – 56 – 73
	[193.9, 194.1]	A1	
	Alternative method 2 – finding length *BC*		
	$\frac{a}{\sin 51} = \frac{24}{\sin 73}$	M1	oe any letter 51 must come from 180 – 56 – 73
	$\frac{24}{\sin 73} \times \sin 51$ or [19.5, 19.504]	M1dep	oe
	0.5 × 24 × their [19.5, 19.504] × sin 56	M1dep	oe dep on M2
	[193.9, 194.1]	A1	

Mark scheme continues on the next page

Q	Answer	Mark	Comments
24 cont	**Alternative method 3 – finding lengths *AC* and *BC***		
	$\frac{b}{\sin 56} = \frac{24}{\sin 73}$ or $\frac{a}{\sin 51} = \frac{24}{\sin 73}$	M1	oe any letter 51 must come from $180 - 56 - 73$
	$\frac{24}{\sin 73} \times \sin 56$ or [20.8, 20.81] or $\frac{24}{\sin 73} \times \sin 51$ or [19.5, 19.504]	M1dep	oe
	0.5 × their [20.8, 20.81] × their [19.5, 19.504] × sin 73	M1dep	oe dep on M2 must have correct method for both *AC* and *BC*
	[193.9, 194.1]	A1	

Q	Answer	Mark	Comments
25	**Alternative method 1**		
	$\frac{3}{4} : \frac{5}{6} : 1$	M1	oe ratio with one value = 1
	$\frac{18}{24} : \frac{20}{24} : \frac{24}{24}$	M1dep	oe ratio with common denominators implied by ratio with integers not in simplest form
	9 : 10 : 12	A1	
	Alternative method 2		
	$a : c = 3 : 4$ and $b : c = 5 : 6$	M1	oe
	$a : c = 9 : 12$ and $b : c = 10 : 12$	M1dep	oe with c values equal
	9 : 10 : 12	A1	
	Alternative method 3		
	Values such that a is three quarters of c and $6b = 5c$	M1	eg $(a =)$ 45 $(b =)$ 50 $(c =)$ 60 or $(a =)$ 3 $(b =) \frac{10}{3}$ $(c =)$ 4
	Correct ratio for their values as integers, decimals or fractions with a common denominator	M1dep	45 : 50 : 60 or $\frac{9}{3} : \frac{10}{3} : \frac{12}{3}$ implies M2
	9 : 10 : 12	A1	
	Additional Guidance		
	Up to M2 may be awarded for correct work, with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	18 : 20 : 24 or 4.5 : 5 : 6		M1M1A0
	0.9 : 1 : 1.2		M1M1A0

Q	Answer	Mark	Comments
26	$\frac{4}{8} \times \frac{3}{7}$ or $\frac{12}{56}$ or $\frac{3}{14}$	M1	oe fractions or decimals probability of first two discs being 5s
	$\frac{4}{8} \times \frac{2}{7} \times \frac{1}{6}$ or $\frac{8}{336}$ or $\frac{1}{42}$	M1	oe fractions or decimals probability of one 5, one 3 and one 2
	6 × their $\frac{1}{42}$ or $\frac{1}{7}$	M1dep	oe fraction or decimal probability of three discs with a total of 10 dep on 2nd M1 accept 3! for 6
	$\frac{5}{14}$ or 0.357(1…) or 35.7(1…)%	A1	oe fraction, decimal or percentage allow 0.36 or 36% with M3 awarded
	Additional Guidance		
	For M marks allow decimals rounded to 2 dp or better		
	Ignore incorrect simplification or conversion after correct answer seen		

Q	Answer	Mark	Comments
27(a)	$\begin{pmatrix}2\\0\end{pmatrix}$	B1	

Q	Answer	Mark	Comments
27(b)	$y = -5x + 4$	B1	oe
	Additional Guidance		
	$-5x + 4$		B0