REVISE
.wales

2.24 — Sampling without replacement (conditional)

Mark schemes for the 2.24 question pack

Spec 3.5.7 — Unit 2

SOLUTIONS · 2025 SPECIFICATION

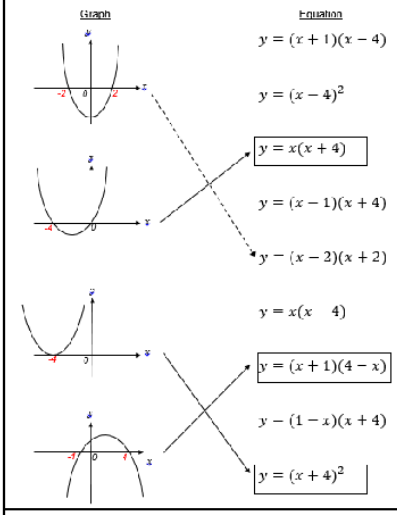
Mark schemes for the 17 questions in the corresponding revise.wales question pack (87 marks total). Sources: legacy WJEC GCSE papers, WJEC SAM, and custom-authored mark schemes. Pack layout © revise.wales.

			subsequently discarding x = –2·5) otherwise B0.
17.(a) $\frac{6}{12}\times\frac{4}{11}\times\frac{2}{10}$ $= \frac{48}{1320}$ or equivalent (2/55) ISW		M1 A1	SC1 for 48/1728 or equivalent (1/36) (With replacement)
17.(b) $\frac{6}{12}\times\frac{5}{11}\times\frac{4}{10} + \frac{4}{12}\times\frac{3}{11}\times\frac{2}{10}$ $= \frac{144}{1320}$ or equivalent (6/55) ISW		M2 A1	F.T. consistent use of incorrect total from part (a). If a product is included for P(YYY), it must be worth zero in order for M2 to be awarded. M1 for either of the two (non-zero) terms or for a sum of 2 correct products and 1 incorrect. C.A.O. SC1 for 288/1728 or equivalent (1/6) (With replacement)
17.(c) $\frac{1176}{1320}$ or equivalent (49/55) ISW		B1	F.T. 1 – 'their 144/1320'.

19. *(a)* 2/6 × 3/5 + 3/6 × 2/5 OR 2 × 2/6 × 3/5 OR 2 × 3/6 × 2/5 12/30 (= 2/5)	M2 A1	P(3, 4 or 4, 3). M1 for sight of 2/6 × 3/5 or sight of 3/6 × 2/5. CAO. Mark final answer If no marks gained, award SC1 for method 'with replacement' leading to 12/36 (= 1/3) *Alternative method* *A list of the 30 possible ordered pairs (permutations) with the correct 12 identified OR a list of the 15 possible pairs (combinations) with the correct 6 identified OR a 6 × 6 two-way table with diagonal deleted to leave 30 spaces with the correct 12 identified* *M2* *(otherwise M1 for a sample space of 30, or M1 for identifying the correct 6 combinations or the correct 12 ordered pairs (permutations))* *12/30 (= 6/15 = 2/5) CAO* *A1*

		Tolerance for accuracy ± ½ a small square.
17. (a) Either 8/12 × 7/11 or 3/12 × 2/11 8/12 × 7/11 + 3/12 × 2/11 with no incorrect additional terms 62/132 (=31/66)	B1 M1 A1	 ISW. If no other marks awarded, SC1 for an answer of 73/144 (from working 'with replacement', without allowing for 2 books)
17. (b) 11/12 × 10/11 × 9/10 or equivalent 990/1320 (= 3/4) or equivalent	M1 A1	Or P(PPP) + 3 × P(PPK) + 3 × P(PKK) + P(KKK) (or an alternative full method) ISW FT consistent use of 'their 12 × 11'. If no other marks awarded, SC1 for an answer of 1331/1728 (from working 'with replacement') OR SC1 for this method and related answer, having omitted up to two (out of eight) products OR SC1 for 11/12 × 10/11 × 9/10 × 1/9 = 990/11880 (= 1/12) (for the 4th prize being the book)

17. (a) sight of 4/10 × 1/9 OR 1/10 × 4/9 4/10 × 1/9 + 1/10 × 4/9 OR 4/10 × 1/9 × 2 = 8/90 (= 4/45)	M1 M1 A1	 Complete correct method. ISW SC1 for method <u>with</u> replacement, leading to an answer of 8/100.
17. (b) 1 – P(both the same colour) = 1 – [5/10 × 4/9 + 4/10 × 3/9] (= 1 – 32/90) = 58/90 (= 29/45)	M1 M2 A1	FT a repeated incorrect total from part (a). <u>Complete</u> correct method. M1 for 1 numerical slip. Accept presence of a correct product of 1/10 × 0/9 for P(GG). ISW. If no marks awarded, SC1 for sight of 32/90 (probability of both the same colour) SC1 for an answer of 70/90 (from 1 – P(R,R)) SC1 for an answer of 78/90 (from 1 – P(Y,Y)) SC2 for method <u>with</u> replacement, leading to an answer of 58/100. SC1 for method <u>with</u> replacement, without a related answer or with 1 numerical slip or without considering P(GG) (59/100).
<u>Alternative method 1</u>: *P(RY or YR or YG or GY or GR or RG)* *= 4/10×5/9 + 5/10×4/9 + 5/10×1/9 + 1/10×5/9 + 1/10×4/9 + 4/10×1/9 or equivalent* *= 58/90 (= 29/45)*	*M1* *M2* *A1*	 *<u>Complete</u> correct method. M1 for 1 numerical slip. FT 'their part (a)' for P(RG) + P(GR).* *ISW* *If no marks awarded,* *SC2 for this method and related answer, having omitted one product (out of 6)* *SC2 for an answer of 29/90 (from P(RY or YG or GR))* *SC1 for this method, having omitted one product, with no related correct answer* *SC1 for this method and related answer, having omitted two products*
<u>Alternative method 2</u>: *P(RR' or YY' or GG')* *= 4/10×6/9 + 5/10×5/9 + 1/10(×9/9)* *= 58/90 (= 29/45)*	*M1* *M2* *A1*	 *<u>Complete</u> correct method. M1 for 1 numerical slip or M1 if 'doubling' is seen (at any stage)* *ISW* *If no marks awarded,* *SC1 for this method and related answer, having omitted one product (out of 3)*

15.  	B2	B1 for any 1 or 2 correct.
16.(a) General sine curve with appropriate orientation and position. -1 and 1 indicated on the y-axis, curve passes through (-180°,0), (0°,0) and (180°,0) and approximately (-90°,-1) and (90°,1).	M1 A1	Ignore curve shown for values x< -180° or x> 180°.
16(b). -30(°) AND -150(°)	B2	Accept embedded answers. Penalise further incorrect answer(s) -1. Ignore further answer(s) outside of the range. Award B1 for sight of an answer -30(°) or -150(°) (but not for sight of -30 as part of working).
17.(a) $\frac{3}{100} \times \frac{1}{99}$ $= \frac{3}{9900}\left(= \frac{1}{3300}\right)$ ISW	M1 A1	Allow $3(.03\ldots)\times10^{-4}$ OR $0.0003(03\ldots)$ or equivalent. A0 for $0.0003(03\ldots)\%$. An unsupported $0.000303(\ldots)$ gains M1A1. An unsupported 3/10000 OR 0.0003 gains no marks.
17(b) $2 \times \frac{3}{100} \times \frac{1}{99}\left(= \frac{6}{9900} = \frac{1}{1650}\right)$ $+ \frac{3}{100} \times \frac{2}{99}\left(= \frac{6}{9900} = \frac{1}{1650}\right)$ OR $\frac{4}{100} \times \frac{3}{99}$ $= \frac{12}{9900}\left(= \frac{1}{825}\right)$ ISW	M2 A1	M1 for sight of $\left(\frac{3}{100} \times \frac{1}{99}\right) + \left(\frac{3}{100} \times \frac{1}{99}\right)$ OR $\left(\frac{3}{100} \times \frac{1}{99}\right) + \left(\frac{1}{100} \times \frac{3}{99}\right)$ OR $2 \times \frac{3}{100} \times \frac{1}{99}$ OR $\left(\frac{3}{100} \times \frac{1}{99}\right) + \left(\frac{3}{100} \times \frac{2}{99}\right)$ Allow $1(.21\ldots)\times10^{-3}$ OR $0.001(21\ldots)$ or equivalent. An unsupported answer of $0.00121(2\ldots)$ gains M2A1. A0 for $0.001(21\ldots)\%$. SC1 for working with replacement leading to an answer of 12/10000 (3/2500) OR 0.001(2) [may be unsupported].

17.(b) *Alternative method* $1-\left[\left(\frac{96}{100}\times\frac{95}{99}\right)+\left(2\times\frac{3}{100}\times\frac{96}{99}\right)+\left(2\times\frac{1}{100}\times\frac{96}{99}\right)\right]$	*M2*	*M1 for sight of:* $\left[\left(\frac{96}{100}\times\frac{95}{99}\right)+\left(2\times\frac{3}{100}\times\frac{96}{99}\right)+\left(2\times\frac{1}{100}\times\frac{96}{99}\right)\right]$ *OR* $1-\left[\left(\frac{96}{100}\times\frac{95}{99}\right)+\left(\frac{3}{100}\times\frac{96}{99}\right)+\left(\frac{1}{100}\times\frac{96}{99}\right)\right]$
$=\frac{12}{9900}\left(=\frac{1}{825}\right)$ *ISW*	*A1*	*Allow 1(.21…)×10^{-3} OR 0.001(21…) or equivalent.* *An unsupported answer of 0.00121(2…) gains M2A1.* *A0 for 0.001(21…)%.* *SC1 for working with replacement leading to an answer of 12/10000 (3/2500) OR 0.001(2) [may be unsupported].*
18. (cos CAB =) $(13^2+17^2-23^2)/(2\times13\times17)$ (=-71/442 OR -0.16(06…)) (CAB =) 99(.2…°)	M2 A1	M1 for $23^2=13^2+17^2-2\times13\times17\times\cos CAB$ SC1 for the correct evaluation of either of the two other angles. ABC = 33(.9...) and ACB = 46(.8...).
19. Sight of $9x^2-6x-6x+4$ Sight of $x^2+x+2x+2$ $8x^2-15x+2=0$	B1 B1 B1	Or equivalent. Or equivalent. FT expansions of equivalent level of difficulty provided B1 previously awarded. '= 0' required, but may be implied by an attempt to use the quadratic formula or if $a=8, b=-15$, $c=2$ used in the quadratic formula.
$x=\frac{-(-15)\pm\sqrt{(-15)^2-4\times8\times2}}{2\times8}$	M1	This substitution into the formula must be seen for M1. FT 'their derived quadratic equation' equated to zero of equivalent difficulty (a, b and c must be non-zero). Allow one slip in substitution **for M1 only**, but must be correct formula.
$x=\frac{15\pm\sqrt{161}}{16}$	A1	Can be implied from at least one correct value of x evaluated.
$x=1.73$ with $x=0.14$ (answers to 2dp)	A1	CAO for their quadratic equation but not if complex roots. M0A0A0 if trial and improvement used or for unsupported answers.
20. Volume scale factor: $\left(\sqrt{199/47}\right)^3$ (=8.712…) OR $\left(\sqrt{47/199}\right)^3$ (=0.114…) or equivalent.	B2	May be seen in parts. Award B1 for a linear scale factor: $\sqrt{(199/47)}$ (= 2.057…) OR $\sqrt{(47/199)}$ (= 0.485…) or equivalent OR Award B1 for (199/47)^3 (= 75.904…) OR (47/199)^3 (= 0.013...).
Volume of larger solid $350\times\left(\sqrt{199/47}\right)^3$ OR $350\div\left(\sqrt{47/199}\right)^3$ or equivalent.	M1	
3049(.305…cm^3)	A1	CAO. Not from premature approximation.

18. *(a)* 4/10 × 3/9 × 6/8 or equivalent 72/720 (= 1/10) or equivalent	M1 A1	Accept e.g. 6/10 × 4/9 × 3/8 or (6 × 4 × 3)/(10 × 9 × 8) ISW
18. *(b)* 1 – P(three red) or 1 – P(no yellow) = 1 – [6/10 × 5/9 × 4/8] (= 1 – 120/720 or 1 – 1/6) = 600/720 (= 5/6) or equivalent	S1 M1 A1	May be implied by subsequent working. Complete method. ISW FT from part *(a)* consistent use of a wrongly calculated denominator. If no other marks awarded, SC1 for sight of 784/1000 or equivalent (from a method 'with replacement')
Alternative method *P(YRR or RYR or RRY or YYR or YRY or RYY or YYY) or equivalent (allow up to two of these terms to be missing or incorrect for this mark)* *= 4/10×6/9×5/8×3 + 4/10×3/9×6/8×3 + 4/10×3/9×2/8 or equivalent* *(complete method required for this mark)* *= 600/720 (= 5/6) or equivalent ISW*	*S1* *M1* *A1*	 FT *4/10×6/9×5/8×3 + 'their part (a)' × 3 + 4/10×3/9×2/8*

		(4, 4).
14.(a) $\frac{3}{12}\times\frac{2}{11}\times\frac{1}{10}$ $=\frac{6}{1320}\left(=\frac{1}{220}\right)$ ISW	M1 A1	Accept decimal answer of 0.0045(45…)
14.(b) (1–'three vowels'–'three consonants') $=1-\frac{3}{12}\times\frac{2}{11}\times\frac{1}{10}-\frac{9}{12}\times\frac{8}{11}\times\frac{7}{10}$ $=\frac{810}{1320}\left(=\frac{27}{44}\right)$ ISW	M2 A1	M1 for $\frac{3}{12}\times\frac{2}{11}\times\frac{1}{10}+\frac{9}{12}\times\frac{8}{11}\times\frac{7}{10}$ OR $1-\frac{3}{12}\times\frac{2}{11}\times\frac{1}{10}$ OR $1-\frac{9}{12}\times\frac{8}{11}\times\frac{7}{10}$ Accept decimal answer of 0.61(36…) If no marks award SC1 for an answer of $\frac{972}{1728}\left(=\frac{36}{64}\text{ or }\frac{9}{16}\right)$ ISW from working with replacement.
Alternative method *P(Two vowels, one consonant) +* *P(One vowel, two consonants =)* $3\times\frac{3}{12}\times\frac{2}{11}\times\frac{9}{10}+3\times\frac{3}{12}\times\frac{9}{11}\times\frac{8}{10}$ *OR* $3\times\frac{9}{12}\times\frac{3}{11}\left(\times\frac{10}{10}\right)$ $=\frac{810}{1320}\left(=\frac{81}{132}\ or\ \frac{27}{44}\right)$ *ISW*	*M2* *A1*	*M1 for* $3\times\frac{3}{12}\times\frac{2}{11}\times\frac{9}{10}$ *OR* $3\times\frac{3}{12}\times\frac{9}{11}\times\frac{8}{10}$ *OR* $\frac{3}{12}\times\frac{2}{11}\times\frac{9}{10}+\frac{3}{12}\times\frac{9}{11}\times\frac{8}{10}$ *NB: sight of* $\frac{9}{12}\times\frac{3}{11}\times\frac{10}{10}$ *gains M1, but* $\frac{9}{12}\times\frac{3}{11}$ *gains M0.* *Accept decimal answer of 0.61(36…)* *If no marks, award SC1 for an answer of* $\frac{972}{1728}\left(=\frac{36}{64}\ or\ \frac{9}{16}\right)$ *ISW from working with replacement.*

17. (Numerator) $(2x - 5)(x - 4)$ (Denominator) $2(x - 4)$ $\frac{2x-5}{2}$ or $x - \frac{5}{2}$ or equivalent.	B2 B1 B1	B1 for $(2x \ldots\ldots 5)(x \ldots\ldots 4)$ Mark final answer. F.T. provided no more than 1 previous error and provided simplification required.
Alternative method: *(Numerator)* $(x - 5/2)(2x - 8)$ $\frac{2x-5}{2}$ *or* $x - \frac{5}{2}$ *or equivalent.*	*B2* *B2*	*B1 for* $(x \ldots\ldots 5/2)(2x \ldots\ldots 8)$ *Mark final answer.* *F.T. provided at least B1 awarded, no more than 1 previous error and provided simplification required.*
18. (P[same colour] =) 10/16 × 9/15 + 6/16 × 5/15 or equivalent OR (P[different colours] =) 10/16 × 6/15 + 6/16 × 10/15 or equivalent. = 120/240 or equivalent 'Yes' with explanation (must refer to the 'other' probability)	M2 A1 E1	M1 for sight of any correct product. Award for the answer to either probability (total). Mark final answer. Do not ignore incorrect cancelling. If both probabilities are evaluated, accept 240 written as 16 × 15. If M0A0, award SC1 for an answer of 136/256 or 120/256 (method 'without replacement'). If M2A0 or SC1 awarded, then award E1 for 'No', provided only one answer evaluated (from calculating products), and a valid explanation given based on P[same colour] + P[different colours] = 1 or E1 for 'Yes' if both probabilities (incorrectly) evaluated and 'their P[same colour]' = 'their P[different colours]' E0 if both probabilities evaluated and 'their P[same colour]' + 'their P[different colours]' ≠ 1 with 'their P[same colour]' ≠ 'their P[different colours]'.

19. (a) 1/11×6/10 or equivalent	M1	
= 6/110 (= 3/55)	A1	ISW
19. (b) 6/11×5/10 + 4/11×3/10 [+ 1/11×0/10]	M2	FT use of consistent incorrect denominator e.g. 120 Full method for finding P(R, R) + P(G, G) [+ P(Y,Y)] M1 for sight of 6 /11×5/10 or 4/11×3/10
= 42/110 (= 21/55)	A1	ISW If no marks, SC1 for an answer of 53/121 (method with replacement)
19. (c) 1 – 7/11×6/10 or equivalent	M2	FT use of consistent incorrect denominator e.g. 120 M1 for 7/11×6/10
= 68/110 (= 34/55)	A1	ISW
Alternative method 1 *1 – [6/11×5/10 + 6/11×1/10 + 1/11×6/10]* *or equivalent*	*M2*	*FT use of consistent incorrect denominator e.g. 120* *Full method for finding* *1 – [P(R,R) + P(R,Y) + P(Y,R)].* *Allow M1 if any one of the three subtracted products is omitted.*
= 68/110 (= 34/55)	*A1*	*ISW*
Alternative method 2 *4/11×3/10 + 4/11×7/10 + 7/11×4/10 or equivalent*	*M2*	*FT use of consistent incorrect denominator e.g. 120* *Full method for finding* *P(G,G) + P(G,G') + P(G',G).* *Allow M1 for the **sum** of any two of these three products* *NB: P(1st sock green) is equivalent to P(G,G) + P(G,G') or to P(G,G) + P(G',G)* *(i.e. credit cannot be given for only P(1st sock green)=4/11 without considering compound events)*
= 68/110 (= 34/55)	*A1*	*ISW*
Alternative method 3 *4/11×3/10 + 4/11×6/10 + 4/11×1/10 + 6/11×4/10 + 1/11×4/10 or equivalent*	*M2*	*FT use of consistent incorrect denominator e.g. 120* *Full method for finding* *P(G,G) + P(G,R) + P(G,Y) + P(R,G) + P(Y,G).* *Allow M1 for the **sum** of any two of the following* • *P(G,G)* • *P(G,R) + P(G,Y)* • *P(R,G) + P(Y,G)* *NB: P(1st sock green) is equivalent to P(G,G)+P(G,R)+P(G,Y) or to P(G,G)+P(R,G)+P(Y,G)* *(i.e. credit cannot be given for only P(1st sock green)=4/11 without considering compound events)*
= 68/110 (= 34/55)	*A1*	*ISW*
		If no marks, SC1 for an answer of 72/121 [from 1 – 7/11×7/11] (method with replacement)

15. 10 16 - 6√7 26 - 6√7 AND irrational indicated.	B2 B2 B1	B1 for • (numerator of) 20√2 or 10× 2× √2 or • (denominator of) 2√2 or √8 or • appropriate factorisation of both numerator and denominator e.g. $\frac{\sqrt{2}\times\sqrt{2}\times\sqrt{2}\times\sqrt{100}}{\sqrt{2}\times\sqrt{2}\times\sqrt{2}}$ (or √100) B1 for 3 or 4 correct terms within 9 - 3√7 - 3√7 + 7 (e.g. B0 for '2', from 2 sign errors) + √49 might be seen instead of +7. –6√7 is equivalent to 'two correct terms'. Mark final answer. FT for equivalent difficulty (requiring collection of terms) provided either of B2s is awarded AND final answer is irrational AND requires no further simplification.
16. (a) $y=-f(x)$	B1	Correct notation. Allow $y=-fx$
16. (b) $y=f(x-4)$	B1	Must be unambiguous e.g. not missing brackets.
17. (a) $\frac{5}{10}\times\frac{4}{9}\times\frac{1}{8}$ or equivalent $\frac{20}{720}\left(=\frac{1}{36}\right)$ or equivalent	M1 A1	Accept e.g. $\frac{5\times4\times1}{10\times9\times8}$ ISW
17.(b) 1 – P(no blue) $=1-\frac{5}{10}\times\frac{4}{9}\times\frac{3}{8}$ $=\frac{660}{720}\left(=\frac{11}{12}\right)$ or equivalent	S1 M1 A1	May be implied by subsequent working. Complete method. ISW FT from part (a) consistent use of a wrongly calculated denominator. If no other marks awarded, SC1 for sight of $\frac{875}{1000}$ or $\frac{940}{1000}$ or equivalent.
17.(b) Alternative method #1 *1 – P(three red) – P(two red, one green)* $=1-\frac{4}{10}\times\frac{3}{9}\times\frac{2}{8}-\frac{4}{10}\times\frac{3}{9}\times\frac{1}{8}\times3$ $\left(=1-\frac{24}{720}-\frac{36}{720}\right.$ *or* $\left.1-\frac{1}{30}-\frac{1}{20}\right)$ $=\frac{660}{720}\left(=\frac{11}{12}\right)$ *or equivalent*	*S1* *M1* *A1*	*May be implied by subsequent working.* *Complete method. (Missing x3 is S1 M0 A0.)* *ISW* *FT from part (a) consistent use of a wrongly calculated denominator.* *If no other marks awarded,* *SC1 for sight of* $\frac{888}{1000}$ *or* $\frac{940}{1000}$ *or equivalent.*

17.(b) <u>Alternative method #2</u> P(one blue, two not blue OR two blue, one not blue OR three blue) $= \frac{5}{10}\times\frac{5}{9}\times\frac{4}{8} \times 3 + \frac{5}{10}\times\frac{4}{9}\times\frac{5}{8} \times 3 + \frac{5}{10}\times\frac{4}{9}\times\frac{3}{8}$ $= \frac{660}{720}$ $(= \frac{11}{12})$ or equivalent	S1 M1 A1	May be implied by subsequent working. <u>Complete</u> method. (Missing x3 is S1 M0 A0.) ISW FT from part (a) consistent use of a wrongly calculated denominator. If no other marks awarded, SC1 for sight of $\frac{875}{1000}$ or $\frac{660}{1000}$ or equivalent.
17. (b) <u>Alternative method #3</u> P(two red, one blue OR one red, one green, one blue OR two blue, one red OR two blue, one green OR three blue) $= \frac{4}{10}\times\frac{3}{9}\times\frac{5}{8} \times 3 + \frac{4}{10}\times\frac{1}{9}\times\frac{5}{8} \times 6$ $+ \frac{5}{10}\times\frac{4}{9}\times\frac{4}{8} \times 3 + \frac{5}{10}\times\frac{4}{9}\times\frac{1}{8} \times 3 + \frac{5}{10}\times\frac{4}{9}\times\frac{3}{8}$ $= \frac{660}{720}$ $(= \frac{11}{12})$ or equivalent	S1 M1 A1	May be implied by subsequent working. <u>Complete</u> method. (Missing x3 and / or x6 is S1 M0 A0.) ISW FT from part (a) consistent use of a wrongly calculated denominator. If no other marks awarded, SC1 for sight of $\frac{860}{1000}$ or $\frac{660}{1000}$ or equivalent.

18. Strategy P(blue, yellow) and P(yellow, blue)	S1	Any indication e.g. tree diagram with relevant branches identified
7/10 × 5/11 + 3/10 × 9/11	M2	M1 for sight of 7/10 × 5/11 or 3/10 × 9/11 OR M1 for a (consistent) error in a denominator within an otherwise complete calculation
= 62/110 (= 31/55)	A1	ISW If M0 A0, award (S1) SC1 for an answer of 42/90 or 52/100 or 62/120 or equivalent (from non-replacement or replacing with one card only or replacing original card as well as additional cards.)

18.(a) $\frac{1}{9}\times\frac{1}{8}\times\frac{2}{7}$ $=\frac{2}{504}\left(=\frac{1}{252}\right)$	M1 A1	M0 for sight of this method used more than once in the solution. ISW if the fractional answer is simplified, otherwise mark final answer. Accept decimal answer of 0·0039(…) OR 0·004 If M0, award SC1 for sight of $\frac{1}{9}\times\frac{1}{8}\times\frac{2}{7}$ OR $\frac{2}{504}\left(=\frac{1}{252}\right)$ as part of their solution.
18.(b) (['O' AND 'O' AND any other letter] OR ['N' AND 'N' AND any other letter]) $3\times\frac{2}{9}\times\frac{1}{8}\left(\times\frac{7}{7}\right)+3\times\frac{2}{9}\times\frac{1}{8}\left(\times\frac{7}{7}\right)$ OR $3\times\frac{4}{9}\times\frac{1}{8}\left(\times\frac{7}{7}\right)$ or equivalent $=\frac{12}{72}\left(=\frac{1}{6}\right)$	M2 A1	M1 for $3\times\frac{2}{9}\times\frac{1}{8}\left(\times\frac{7}{7}\right)$ OR $\frac{2}{9}\times\frac{1}{8}\left(\times\frac{7}{7}\right)+\frac{2}{9}\times\frac{1}{8}\left(\times\frac{7}{7}\right)$ OR $\frac{4}{9}\times\frac{1}{8}\left(\times\frac{7}{7}\right)$ ISW Accept decimal answer of 0·16(6…) OR 0·17 If no marks, award SC1 for any one of the following answers (from working with replacement):

Either 'O' or 'N' chosen	168/729 or 56/243 ISW
Any letter is chosen twice	288/729 or 32/81 ISW
2 or more cards 'O' or 'N'	184/729 ISW
Any letter is chosen 2 or more times	309/729 or 103/243 ISW

15. (a) P(BBB or YYY) = $\frac{5}{8}\times\frac{4}{7}\times\frac{3}{6} + \frac{3}{8}\times\frac{2}{7}\times\frac{1}{6}$ or equivalent $\frac{66}{336}$ $(=\frac{11}{56})$ or equivalent	M2 A1	M1 for sight of one correct product. M0 for use of an incorrect total e.g. 9. Must show intention to <u>add</u> for second M mark. ISW If no marks awarded, SC1 for an answer of $\frac{152}{512}$ or equivalent (from a method 'with replacement').
15. (b) P(BYY or YBY or YYB) $\frac{5}{8}\times\frac{3}{7}\times\frac{2}{6} + \frac{3}{8}\times\frac{5}{7}\times\frac{2}{6} + \frac{3}{8}\times\frac{2}{7}\times\frac{5}{6}$ or $\frac{5}{8}\times\frac{3}{7}\times\frac{2}{6}\times 3$ or equivalent $\frac{90}{336}$ $(=\frac{15}{56})$ or equivalent	S1 M1 A1	FT from part *(a)* consistent use of a wrongly calculated denominator ($8\times7\times6$) OR use of an incorrect total e.g. 9. Consideration of 3 permutations (may be implied) M1 implies S1. Must show intention to <u>add</u> for second mark. ISW If no marks awarded, SC1 for sight of one correct product or SC1 for an answer of $\frac{135}{512}$ or equivalent (from a method 'with replacement'.
15.(b) *<u>Alternative method</u>:* *1 – P(YYY or YBB or BYB or BBY or BBB)* $= 1 - [\frac{3}{8}\times\frac{2}{7}\times\frac{1}{6} + \frac{3}{8}\times\frac{5}{7}\times\frac{4}{6}\times 3 + \frac{5}{8}\times\frac{4}{7}\times\frac{3}{6}]$ *or equivalent* $= 1 - [\frac{6}{336} + \frac{180}{336} + \frac{60}{336}]$ $\frac{90}{336}$ $(=\frac{15}{56})$ or equivalent	*S1* *M1* *A1*	*A complete method.* *FT 'their P(BBB)' or 'their P(YYY)' or both from (a).* *M1 implies S1.* *ISW* *If no marks awarded,* *SC1 for* $1 - [\frac{3}{8}\times\frac{2}{7}\times\frac{1}{6} + \frac{3}{8}\times\frac{5}{7}\times\frac{4}{6} + \frac{5}{8}\times\frac{4}{7}\times\frac{3}{6}]$ $(=\frac{5}{8})$ *from not considering 3 different permutations of BBY* *or* *SC1 for an answer of* $\frac{135}{512}$ *or equivalent (from a method 'with replacement'.*

17. (P[same colour] =) $\frac{7}{11}\times\frac{6}{10}+\frac{4}{11}\times\frac{3}{10}$ or equivalent OR (P[different colours] =) $\frac{7}{11}\times\frac{4}{10}+\frac{4}{11}\times\frac{7}{10}$ or equivalent	M2	M1 for sight of one product correct.
$=\frac{54}{110}\left(=\frac{27}{55}\right)$ or equivalent OR $=\frac{56}{110}\left(=\frac{28}{55}\right)$ or equivalent	A1	Award for the answer to either probability (total). Mark final answer. Do not ignore incorrect cancelling. If both probabilities are evaluated, accept 110 written as 11 × 10.
'No' or 'Gareth is incorrect' with explanation e.g. P(different colours) = $1-\frac{54}{110}=\frac{56}{110}$ or e.g. each probability would need to be $\frac{55}{110}\left(=\frac{1}{2}\right)$ for them to be equal e.g. P(same colour) = 54/110 AND P(different colours) = 56/110	E1	If M2 A0 (or M1 A0) awarded where only <u>one</u> of P[same colour] or P[different colours] is calculated, FT E1 for 'No' with a valid explanation given based on P[same colour] + P[different colours] = 1. If M2 A1 awarded where <u>both</u> P[same colour] and P[different colours] are calculated, the second probability must also be correct in order to award E1. If M2 A0 (or M1 A0) awarded where <u>both</u> P[same colour] and P[different colours] are incorrectly calculated, do not FT E1. If M0A0, award SC1 (and a possible E1) for an answer of $\frac{65}{121}$ or $\frac{56}{121}$ (method 'with replacement').

17. m°	B1	
18. (1– P(all 3 colours are chosen) =) $1-6\times\frac{3}{15}\times\frac{5}{14}\times\frac{7}{13}$ $=\frac{10}{13}\left(=\frac{2100}{2730}\right)$	M3 A1	M2 for $6\times\frac{3}{15}\times\frac{5}{14}\times\frac{7}{13}\ \left(=\frac{3}{13}=\frac{630}{2730}\right)$ M1 for $1-\frac{3}{15}\times\frac{5}{14}\times\frac{7}{13}\ \left(=\frac{25}{26}=\frac{2625}{2730}\right)$ *CAO* *ISW* *Accept a decimal answer of 0·76(9…) or 0·77.* *If no marks award SC1 for one of the following:* • *Working with replacement leading to an answer of 61/75 (2745/3375) OR 0·81(3) [may be unsupported].* • *Recognising all 21 permutations (and no other) OR recognising up to 27 possible permutations, and then identifying the 21 relevant permutations.*
Alternative method 1 *(P(2 Red & 1 Not Red) OR* *P(2 Blue & 1 Not Blue) OR* *P(2 Yellow & 1 Not Yellow) =)* $3\times\frac{3}{15}\times\frac{2}{14}\times\frac{12}{13}+$ $3\times\frac{5}{15}\times\frac{4}{14}\times\frac{10}{13}+$ $3\times\frac{7}{15}\times\frac{6}{14}\times\frac{8}{13}\ \left(=\frac{304}{455}=\frac{1824}{2730}\right)$ *(P(3 Red) OR P(3 Blue) OR P(3 Yellow) =)* $\left(\frac{3}{15}\times\frac{2}{14}\times\frac{1}{13}\right)+\left(\frac{5}{15}\times\frac{4}{14}\times\frac{3}{13}\right)+\left(\frac{7}{15}\times\frac{6}{14}\times\frac{5}{13}\right)$ $\left(=\frac{46}{455}=\frac{276}{2730}\right)$ *(P(at least 2 counters the same colour) =)* $\frac{10}{13}\left(=\frac{2100}{2730}\right)$	 M2 M1 A1	*May be seen in stages.* *M1 for:* $\left(\frac{3}{15}\times\frac{2}{14}\times\frac{12}{13}\right)+\left(\frac{5}{15}\times\frac{4}{14}\times\frac{10}{13}\right)+\left(\frac{7}{15}\times\frac{6}{14}\times\frac{8}{13}\right)$ $\left(=\frac{12}{455}+\frac{20}{273}+\frac{8}{65}=\frac{304}{1365}\right)$ *OR* $3\times\frac{3}{15}\times\frac{2}{14}\times\frac{12}{13}\ \left(=\frac{36}{455}=\frac{216}{2730}\right)$ *OR* $3\times\frac{5}{15}\times\frac{4}{14}\times\frac{10}{13}\ \left(=\frac{20}{91}=\frac{600}{2730}\right)$ *OR* $3\times\frac{7}{15}\times\frac{6}{14}\times\frac{8}{13}\ \left(=\frac{24}{65}=\frac{1008}{2730}\right)$ *Award M1M1 for an answer of* $\frac{34}{105}$ *from sight of:* *P(R,R,other)+ P(B,B,other)+ P(Y,Y,other) OR* *P(R,R)+ P(B,B)+ P(Y,Y)* *CAO* *ISW* *Accept a decimal answer of 0·76(9…) or 0·77.* *If no marks award SC1 for one of the following:* • *Working with replacement leading to an answer of 61/75 (2745/3375) OR 0·81(3) [may be unsupported].* • *Recognising all 21 permutations (and no other) OR recognising up to 27 possible permutations, and then identifying the 21 relevant permutations.*

	4	
16.(a) (i) Indicates sequence as 'Miss', 'Miss', 'Hit'. 0·7 × 0·7 × 0·3 = 0·147	 S1 M1 A1	
(ii) Indicates three possible situations HMM or MHM or MMH 0·441 Less than a 50% chance.	 M1 A1 A1	May be indicated by 0·3×0·7×0·7 × 3 or equivalent. F.T. 'their 0·147' × 3 F.T. 'their 0·441'
(b) Indicates that the first ball selected is returned to the box before the second ball is selected OR the two attempts are independent.	B1	
	7	

End of solutions