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S1 2641/1 Jun 2003 Mark Scheme Post_Coordination

$= 1 - \frac{6 \times 8}{7 \times 48} = \frac{6}{7}$ (ii) Since r, is quite close to 1 you can say that there seems to be good agreement as to order between the teacher and the moderator. However, the individual marks do not seem to agree very well. 2 (i) P(X = 4) = 0.6 ³ × 0.4 = 0.0864 AG (ii) P(X = 4) = 0.6 ³ × 0.4 = 0.0864 AG (iii) P(4 ≤ X < 9) = P(X > 3) - P(X > 8) = 0.6 ³ - 0.6 ⁸ = 0.199203 = 0.199 (3 s.f) ALITER: P(4 ≤ X < 9) = 0.4 × 0.6 ³ + + 0.4 × 0.6 ⁷ = 0.199 (iii) E(X) = 1/0.4 = 2.5 3(i) No. of hands with 3 spades and 2 clubs = ${}^{13}C_{3} \times {}^{13}C_{2}$ = 286×78 = 22308 (iii) No. of hands with exactly3 spades = ${}^{13}C_{3} \times {}^{13}C_{2}$ = 286×78 = 22308 A1 Correct answer, 22 308 (iii) No. of hands with exactly3 spades = ${}^{13}C_{3} \times {}^{13}C_{2}$ = 286×774 = 211926 A1 Correct answer, 211 926 (iv) $\frac{5!}{3! \times 2!}$ $\frac{5!}{3! \times 2!}$ $\frac{5!}{3! \times 2!}$ $\frac{5!}{3! \times 2!}$ ALITER (iv) P(3 spades and 2 clubs) = ${}^{13}C_{3} \times {}^{13}C_{2}$ ALITER (iv) P(3 spades and 2 clubs) = ${}^{13}C_{3} \times {}^{12}C_{3} \times {}^{13}C_{48} \times {}^{13}C$	Now $\Sigma d^2 = 8$ so that $r_s = 1 - \frac{6\Sigma d^2}{n(n^2 - 1)}$				
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(ii) Since r_{s} is quite close to 1 you can say that there seems to be good agreement as to order between the teacher and the moderator. However, the individual marks do not seem to agree very well.Comment that states r_{s} is (quite) close to 1 so there is good agreement or that the actual marks differ.2 (i) $P(X = 4) = 0.6^{3} \times 0.4 = 0.0864$ AGM1 1 Use of $q^{2}p$ Correct answer, 0.0864 2 (ii) $P(X = 4) = 0.6^{3} \times 0.4 = 0.0864$ AGM1 1 Use of $q^{2}p$ Correct answer, 0.0864 2 (ii) $P(X = 4) = 0.6^{3} \times 0.4 = 0.0864$ AGM1 1 Use of $q^{2}p$ Correct answer, 0.0864 2 (iii) $P(X = 4) = 0.6^{3} \times 0.4 = 0.0864$ AGM1 1 Use of $q^{2}p$ Correct answer, 0.0864 2 (iii) $P(X = 4) = 0.6^{3} \times 0.4 = 0.0864$ AGM1 1 Attempt at $P(4 \le X < 9)$ Wholly correct method Correct answer, 0.0864 1 ALITTER: $P(4 \le X < 9) = 0.4 \times 0.6^{3} + + 0.4 \times 0.6^{7} = 0.199$ M1 1 1 Attempt at $P(4 \le X < 9)$ Wholly correct method Correct answer, 1.1 0.199 (iii) No. of different hands = ${}^{52}C_{5} = 2598$ 960B1 1 $2 598 960$ Correct answer, 2.5 or ${}^{5k}_{2k}$ (iii) No. of hands with 3 spades and 2 clubs = ${}^{13}C_{3} \times {}^{13}C_{2}$ $= 286 \times 78$ $= 22308$ M1 1 $1^{12}C_{3}$ and ${}^{13}C_{2}$ seen $1^{12}C_{3}$ and ${}^{13}C_{2}$ seen $1^{12}C_{3}$ and ${}^{13}C_{2}$ seen $1^{12}C_{3}$ and ${}^{13}C_{2}$ seen $1^{12}C_{3}$ (iii) No. of hands with exactly3 spades $= {}^{13}C_{3} \times {}^{13}C_{2}$ $1^{12}P(3)$ M1 $1^{13}C_{3}$ and ${}^{13}C_{2}$ seen $1^{12}C_{1}$ (iv) P(3 spades and 2 clubs) $= {}^{$	= 0.857				
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a give visy numdiffer.2 (i) $P(X = 4) = 0.6^3 \times 0.4 = 0.0864 \text{ AG}$ M1Use of q^3p Correct answer, 0.0864(ii) $P(4 \le X < 9) = P(X > 3) - P(X > 8) = 0.6^3 - 0.6^8$ $= 0.199203 = 0.199 (3 s.f)$ M1Attempt at $P(4 \le X < 9)$ Wholly correct methodALITER: $P(4 \le X < 9) = 0.4 \times 0.6^3 + + 0.4 \times 0.6^2 = 0.199$ M1Attempt at $P(4 \le X < 9)$ Wholly correct method(iii) $E(X) = 1/0.4 = 2.5$ B1Correct answer, a.r.t. 0.199(iii) $E(X) = 1/0.4 = 2.5$ B1Correct answer, a.r.t. 0.199(iii) No. of different hands = ${}^{52}C_5 = 2$ 598 960B1Correct answer, 2.5 or ${}^{50}/_{2k}$ (iii) No. of hands with 3 spades and 2 clubs = ${}^{13}C_3 \times {}^{13}C_2$ $= 2286 \times 78$ $= 222 308$ M1 ${}^{13}C_3 and {}^{13}C_2 seen$ $= 286 \times 741$ $= 211 926$ (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{13}C_2$ $= {}^{2308/2598 960}3! \times 2!M1{}^{13}C_3 and {}^{13}C_2 seen= 0.00858(3s.f.)(iv) P(3 spades and 2 clubs)5F^{22308/2598 960}3! \times 2!M1Their (ii) + their (i)A1Correct answer, a.r.t.0.00858 \text{ or } {}^{143!}/_{16600k}ALITER(iv) P(3 spades and 2 clubs)5F^{22308/2598 960}3! \times 2!M1{}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times {}^{2}ALITER(iv) P(3 spades and 2 clubs)5F^{22308/2598 960}3! \times 2! {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \text{ or } {}^{13}/_{48} \text{ or } {}^{13}/_{48}$	agree very well.	do not seem to	BI	1	that the <i>actual</i> marks
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AICorrect answer, 0.0864(ii) $P(4 \le X < 9) = P(X > 3) - P(X > 8) = 0.6^3 - 0.6^8$ $= 0.199203 = 0.199 (3 s.f)$ MIAttempt at $P(4 \le X < 9)$ ALITER: $P(4 \le X < 9) = 0.4 \times 0.6^3 + + 0.4 \times 0.6^7 = 0.199$ MIMIWholly correct method Correct answer, a.r.t.(iii) $E(X) = 1/0.4 = 2.5$ B1Correct answer, 2.5 or $\frac{5}{2}\sqrt{2}k$ 3(i) No. of different hands = ${}^{52}C_5 = 2598 960$ B1Correct answer, 2.5 or(iii) No. of hands with 3 spades and 2 clubs = ${}^{13}C_3 \times {}^{13}C_2$ MI ${}^{13}C_3 and {}^{13}C_2$ seen $= 286 \times 78$ $= 22308$ A1Correct answer, 22 308(iii) No. of hands with exactly3 spades = ${}^{15}C_3 \times {}^{13}C_2$ MI ${}^{13}C_3 and {}^{13}C_2$ seen(iii) No. of hands with exactly3 spades = ${}^{15}C_3 \times {}^{13}C_2$ MI ${}^{13}C_3 and {}^{39}C_2$ seen(iv) $P(3$ spades and 2 clubs) $5F^{22308/2598 960}$ MI ${}^{13}C_3 and {}^{39}C_2$ seen(iv) $P(3$ spades and 2 clubs) $5F^{22308/2598 960}$ MICorrect answer, 211 926 $3! \times 2!$ $5!C^{2308/2598 960}$ MICorrect answer, 211 926 $3! \times 2!$ $5!C^{2308/2598 960}$ MICorrect answer, 2.11 926 $3! \times 2!$ $5!C^{2308/2598 960}$ MICorrect answer, a.r.t. $0.00858(3s.f.)$ 2 $1!A_{12}$ Correct answer, 2.11 926 $3! \times 2!$ $5!C^{2308/2598 960}$ MI $1!A_{12}$ $2!A_{12}$ $5!C^{2108/21} (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (1008/21) (10$	2 (i) $P(X = 4) = 0.6^3 \times 0.4 = 0.0864 \text{ AG}$		M1		Use of $q^3 p$
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= 0.199203 = 0.199 (3 s.f) ALITER: P(4 ≤ X < 9) = 0.4 × 0.6 ³ + + 0.4 × 0.6 ⁷ = 0.199 (iii) E(X) = 1/0.4 = 2.5 (iii) No. of different hands = ${}^{52}C_5 = 2598960$ (ii) No. of hands with 3 spades and 2 clubs = ${}^{13}C_3 \times {}^{13}C_2$ $= 286 \times 78$ = 22308 (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{52}C_2$ $= 286 \times 741$ = 211926 (iv) P(3 spades and 2 clubs) $\frac{57}{3!\times 2!}$ ALITER (iv) P(3 spades and 2 clubs) $= {}^{13}C_3 \times {}^{12}C_2$ ALITER (iv) P(3 spades and 2 clubs) $= {}^{13}C_3 \times {}^{12}C_3$ ALITER (iv) P(3 spades and 2 clubs) $= {}^{13}C_3 \times {}^{12}C_3 \times {}^{12}C_3 \times {}^{12}C_3 \times {}^{13}C_3 \times {}^{13}C_2 \times {}^{12}C_3 \times {}^{13}C_3 \times {}^{13}C_3 \times {}^{13}C_2 \times {}^{12}C_3 \times {}^{13}C_3 \times {$	(ii) $P(4 \le X < 9) = P(X > 3) - P(X > 8) = 0.$	$6^3 - 0.6^8$	M1		Attempt at $P(4 \le X < 9)$
ALITER: $P(4 \le X < 9) = 0.4 \times 0.6^{3} + + 0.4 \times 0.6^{7} = 0.199$ (iii) $P(X) = 1/0.4 = 2.5$ 3(i) No. of different hands = ${}^{52}C_{5} = 2598960$ (ii) No. of hands with 3 spades and 2 clubs = ${}^{13}C_{3} \times {}^{13}C_{2}$ $= 286 \times 78$ = 222308 (iii) No. of hands with exactly3 spades = ${}^{13}C_{3} \times {}^{13}C_{2}$ $= 286 \times 741$ = 211926 (iv) $P(3$ spades and 2 clubs) $\frac{5F^{-22308/2 598960}}{3! \times 2!}$ ALITER (iv) $P(3$ spades and 2 clubs) $\frac{5F^{-22308/2 598960}}{3! \times 2!}$ ALITER (iv) $P(3$ spades and 2 clubs) = 0.00858(3s.f.) ALITER (iv) $P(3$ spades and 2 clubs) = 0.00858(3s.f.) ALITER (iv) $P(3$ spades and 2 clubs) = ${}^{13}C_{3} \times {}^{12}C_{48} \times$ ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{48} \times ALITER (iv) $P(3$ spades and 2 clubs) = {}^{13}C_{3} \times {}^{12}C_{51} \times {}^{11}C_{50} \times {}^{13}C_{49} \times {}^{12}C_{48} \times {}^{12}C_{51} \times	= 0.199203 = 0.199 (3 s.f)	M1		Wholly correct method
(iii) $E(x) = 1/0.4 = 2.5$ B1 Correct answer, 2.5 or $\frac{5}{2}/2_{2k}$ 3(i) No. of different hands = $5^{52}C_{5} = 2598 960$ B1 Correct answer, 1 (ii) No. of hands with 3 spades and 2 clubs = $^{13}C_{3} \times ^{13}C_{2}$ B1 Correct answer, 1 (iii) No. of hands with 3 spades and 2 clubs = $^{13}C_{3} \times ^{13}C_{2}$ M1 $^{13}C_{3}$ and $^{13}C_{2}$ seen (iii) No. of hands with exactly3 spades = $^{13}C_{3} \times ^{39}C_{2}$ M1 $^{13}C_{3}$ and $^{39}C_{2}$ seen (iii) No. of hands with exactly3 spades = $^{13}C_{3} \times ^{39}C_{2}$ M1 $^{13}C_{3}$ and $^{39}C_{2}$ seen (iv) P(3 spades and 2 clubs) $5f^{-22308/2598.960}$ M1 Correct answer, 211 926 (iv) P(3 spades and 2 clubs) $5f^{-22308/2598.960}$ M1 Correct answer, a.r.t. $= 0.00858(3s.f.)$ Correct answer, a.r.t. 0.008588 or $^{143k}/_{1660k}$ ALITER $(iv) P(3 spades and 2 clubs)$ $5f^{-22308/2598.960}$ M1 $= ^{13}/_{52} \times ^{12}/_{51} \times ^{11}/_{50} \times ^{13}/_{49} \times ^{12}/_{48} \times$ $X1$ Correct answer, a.r.t. $= 0.00858(3s.f.)$ 2 $X1$ $X1$ Correct answer, a.r.t. $= 0.00858(3s.f.)$ 2 $X1$ $X1$ $X1$ $X1$ $X2$	ALITER: $P(4 \le X < 9) = 0.4 \times 0.6^3 + \dots +$	$0.4 \times 0.6' = 0.199$	A1	2	Correct answer, a.r.t.
3(i) No. of different hands = ${}^{52}C_5 = 2598960$ B1 Correct answer, 2 598 960 (ii) No. of hands with 3 spades and 2 clubs = ${}^{13}C_3 \times {}^{13}C_2$ = 286 × 78 = 22 308 M1 ${}^{13}C_3 and {}^{13}C_2 seen$ (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{39}C_2$ = 286 × 741 = 211 926 M1 ${}^{13}C_3 and {}^{13}C_2 seen$ (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{39}C_2$ = 286 × 741 = 211 926 M1 ${}^{13}C_3 and {}^{39}C_2 seen$ (iv) P(3 spades and 2 clubs) $5\overline{F}_{3!\times 2!}^{22'308/2} {}^{143/_{16660}} {}^{298960} {}^{3!\times 2!} {}^{143/_{16660}} {}^{143k/_{16660k}} {}^{2} {}^{2} {}^{143k/_{16660k}} {}^{2} {}^{2} {}^{12} {}^{2} {}^{12} {}^{2} {}^{12} {}^{2} {}^{12} {}^{2} {}^{12} {}^{12} {}^{2} {}^{12} {}^{12} {}^{13} {}^{2} {}^{2} {}^{2} {}^{12} {}^{2} {}^{12} {}^{12} {}^{12} {}^{12} {}^{12} {}^{12} {}^{12} {}^{12} {}^{12} {}^{12} {}^{12} {}^{13} {}^{12} $	(iii) $E(X) = 1/0.4 = 2.5$		B1	<u> </u>	Correct answer. 2.5 or
3(i) No. of different hands = ${}^{52}C_5 = 2598960$ B1 Correct answer, 2 598960 (ii) No. of hands with 3 spades and 2 clubs = ${}^{13}C_3 \times {}^{13}C_2$ = 286 × 78 = 22 308 M1 ${}^{13}C_3 and {}^{13}C_2 seen$ (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{39}C_2$ = 286 × 741 = 211 926 M1 ${}^{13}C_3 and {}^{13}C_2 seen$ (iv) P(3 spades and 2 clubs) $5\overline{5} \times {}^{12}2^{308}/{2598960}$ M1 ${}^{13}C_3 and {}^{39}C_2 seen$ (iv) P(3 spades and 2 clubs) $5\overline{5} \times {}^{12}2^{308}/{2598960}$ M1 ${}^{13}C_3 and {}^{39}C_2 seen$ (iv) P(3 spades and 2 clubs) $5\overline{5} \times {}^{12}2^{308}/{2598960}$ M1 ${}^{13}C_3 and {}^{13}C_2 seen$ (iv) P(3 spades and 2 clubs) $5\overline{5} \times {}^{12}2^{308}/{2598960}$ M1 ${}^{13}C_3 and {}^{13}C_2 seen$ 2 ${}^{00}C_3 spades and 2 clubs$ $5\overline{5} \times {}^{12}2^{308}/{2598960}$ M1 ${}^{13}C_3 and {}^{13}C_2 seen$ 4.1 ${}^{00}C_3 spades and 2 clubs$ $5\overline{5} \times {}^{12}2^{308}/{2598960}$ M1 ${}^{13}C_3 \times {}^{12}C_3 \times {}^{12}C$			21	1	$\frac{5k}{2k}$
(ii) No. of hands with 3 spades and 2 clubs = ${}^{13}C_3 \times {}^{13}C_2$ = 286 × 78 = 22 308 MI ${}^{13}C_3 and {}^{13}C_2 sen$ (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{39}C_2$ = 286 × 741 = 211 926 MI ${}^{13}C_3 and {}^{39}C_2 sen$ (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{39}C_2$ = 286 × 741 = 211 926 MI ${}^{13}C_3 and {}^{39}C_2 sen$ (iv) P(3 spades and 2 clubs) $5\overline{5}^{143}/_{16660}$ $\overline{3!\times 2!}$ $5\overline{5}^{143}/_{16660}$ $\overline{3!\times 2!}$ MI $Their (ii) \div their (i)$ A1 Correct answer, a.r.t. 0.00858(3s.f.) Correct answer, a.r.t. 0.00858 or ${}^{143k}/_{1660k}$ NI ALITER (iv) P(3 spades and 2 clubs) = ${}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times$ MI ${}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times {}^{12}/_{48} or$	3(i) No. of different hands = ${}^{52}C_5$ = 2 598 9	960	B1		Correct answer,
(ii) No. of hands with exactly3 spades $= \frac{13}{C_3} \times \frac{39}{2}C_2$ $= 286 \times 78$ $= 22 308$ (iii) No. of hands with exactly3 spades $= \frac{13}{C_3} \times \frac{39}{2}C_2$ $= 286 \times 741$ = 211 926 (iv) P(3 spades and 2 clubs) $= \frac{5F}{3! \times 2!} = \frac{13}{3! \times 2!} = \frac{5F}{3! \times 2!} = \frac{13}{2!} 0.008583$ = 0.00858(3s.f.) All $Correct answer, 211 926$ (iv) P(3 spades and 2 clubs) $= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{48} \times \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{13}{48} \text{ or } \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{48} \text{ or } \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{48} \text{ or } \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{48} \text{ or } \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{48} \text{ or } \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{48} \times \frac{12}{48} \text{ or } \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{48} \text{ or } \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{48} \text{ or } \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{499} \times \frac{12}{51} $	(ii) No. of handa with 2 anadas and 2 aluh	$x_{1} = \frac{13}{13}C_{1} \times \frac{13}{13}C_{1}$	M1	.1	2598960 $^{13}C_{2}$ and $^{13}C_{2}$ seen
$= 22 308$ $= 22 308$ (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{39}C_2$ $= 286 \times 741$ $= 211 926$ (iv) P(3 spades and 2 clubs) $= {}^{13}C_2 \times {}^{22} {}^{308}/_2 {}^{598 960}$ $= {}^{22} {}^{308}/_2 {}^{598 960}$ $= {}^{13}C_3 and {}^{39}C_2 {}^{5en}$ Correct answer, 211 926 (iv) P(3 spades and 2 clubs) $= {}^{0.00858(3s.f.)}$ All Correct answer, a.r.t. $= 0.00858(3s.f.)$ Al $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times$ Al $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times$ Al $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times$ Al $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times$ Al $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times$ Al $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times$ $\times a product of 5 fractions$	(n) No. of financial with 5 spaces and 2 citie	$= 286 \times 78$	1011		$C_3 unu C_2$ seen
2 2 (iii) No. of hands with exactly3 spades = ${}^{13}C_3 \times {}^{39}C_2$ M1 ${}^{13}C_3 and {}^{39}C_2 seen$ = 286 × 741 = 211 926 A1 Correct answer, 211 926 (iv) P(3 spades and 2 clubs) $5\overline{\vdash}^{22'308/2 598 960}_{3! \times \overline{2}!} {}^{143/_{16660}}_{2!} {}^{2598 960}_{2!} {}^{3! \times \overline{2}!}_{0.008583}$ M1 Their (ii) ÷ their (i) A1 Correct answer, a.r.t. 0.00858(3s.f.) Correct answer, a.r.t. 0.00858 or ${}^{143k}/_{16660k}$ ALITER (iv) P(3 spades and 2 clubs) = 0.00858(3s.f.) 2 M1 ${}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times {}^{12}/_{48} \text{ or} {}^{12}/_{48$		= 22 308	A1		Correct answer, 22 308
$\begin{array}{c} (\mathbf{iii}) \text{ No. of nands with exactly 5 spades} &= C_3 \times C_2 \\ &= 286 \times 741 \\ &= 211 \ 926 \end{array} \qquad \text{Mi} \qquad C_3 \ and \ C_2 \ \text{seen} \\ \text{Correct answer, 211 926} \\ \hline (\mathbf{iv}) P(3 \text{ spades and 2 clubs}) \\ &= \frac{5!}{3! \times 2!} \qquad \frac{5!}{3! \times 2!} \frac{22308}{2!} \frac{2598 960}{3! \times 2!} \frac{5!}{3! \times 2!} \frac{143}{16660} \\ &= 0.00858(3 \text{ s.f.}) \\ = 0.00858(3 \text{ s.f.}) \\ \text{Al} \\ &= 0.00858(3 \text{ s.f.}) \\ \text{Mi} \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{48} \times \\ &= \frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} \times \frac{13}{49} \times \frac{12}{51} \times 12$		130 390	M1	.2	13 C and 39 C score
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	(III) No. of hands with exactly 3 spades	$= {}^{2}C_{3} \times {}^{2}C_{2}$ = 286 × 741	IVII		C_3 and C_2 seen
$\frac{(iv)_{5}P(3 \text{ spades and } 2 \text{ clubs})}{3! \times 2!} \qquad \frac{5\overline{F}}{3! \times 2!}^{\frac{123}{2} \cdot 308/2 \cdot 598 \cdot 960}}{\underbrace{5\overline{F}}_{3! \times 2!}^{\frac{143}{16660}} = 0.008583} = 0.00858(3s.f.)$ $A1 \qquad Correct answer, a.r.t. 0.00858 \text{ or } {}^{143k}/_{1660k}$ $2 \qquad M1 \qquad \frac{13}{52 \times 12} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times {}^{12}/_{48} \text{ or } {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \text{ or } $		$= 200 \times 741$ = 211 926	A1		Correct answer, 211 926
$\frac{5!}{3! \times 2!} = \frac{5!}{3! \times 2!} = \frac{5!}{3! \times 2!} = \frac{5!}{3! \times 2!} = \frac{143}{1660} = \frac{143}{1660} = \frac{13}{5! \times 2!} = \frac{13}{5!} = \frac{13}{5!} = \frac{13}{5!} = \frac{13}{5!} = \frac{13}{5!} = \frac{13}$		22 308		2	
$3! \times 2! \qquad 3! \times 2! \qquad 3! \times 2! \qquad A1 \qquad Correct answer, a.r.t. = 0.00858(3s.f.) \qquad A1 \qquad Correct answer, a.r.t. 0.00858 or 143k/16660k \qquad 2 \qquad 13/52 × 12/51 × 11/50 × 13/49 × = 13/52 × 12/51 × 11/50 × 13/49 × 12/48 × = 13/52 × 12/51 × 11/50 × 13/50 × $	$(1V) P(3 \text{ spades and } 2 \text{ clubs}) = 5\overline{F}$	$\frac{143}{16660}$ 2 598 960	MI		Their (ii) ÷ their (i)
= 0.00858(3s.f.) ALITER (iv) P(3 spades and 2 clubs) = ${}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times {}^{12}/_{48} \text{ or}$ $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times {}^{12}/_{48} \text{ or}$ $\times \text{ a product of 5 fractions}$	3!× 2! 3!×2	0.008583	A1		Correct answer, a.r.t.
ALITER (iv) P(3 spades and 2 clubs) $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times {}^{12}/_{48} \text{ or} \times \text{a product of 5}$ fractions	=	= 0.00858 (3s.f.)		_	0.00858 or $^{143k}/_{16660k}$
ALITER (iv) P(3 spades and 2 clubs) $= {}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times \times \times \text{ a product of 5}$ fractions				2	
ALITER (iv) P(3 spades and 2 clubs) = ${}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times \times \text{ a product of 5}$ (iv) P(3 spades and 2 clubs) = ${}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times \times \text{ a product of 5}$					
(iv) P(3 spades and 2 clubs) = ${}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48} \times \times \text{ a product of 5}$ fractions	ALITER		M1		$^{13}/_{52} \times ^{12}/_{51} \times ^{11}/_{50} \times ^{13}/_{49} \times$
$= \frac{1}{52} \times \frac{1}{51} \times \frac{1}{50} \times \frac{1}{49} \times \frac{1}{48} \times \frac{1}{48} \times \frac{1}{50} \times \frac{1}{50} \times \frac{1}{49} \times \frac{1}{48} \times \frac{1}{50} \times \frac{1}{50$	(iv) P(3 spades and 2 clubs) 13 (12) (11) (13) (12)				$^{12}/_{48}$ or
× a product of 5	$= \frac{1}{52} \times \frac{1}{51} \times \frac{1}{50} \times \frac{1}{49} \times \frac{1}{48} \times \frac{1}{48} \times \frac{1}{48} \times \frac{1}{50} \times \frac{1}{50$				x a product of 5
					fractions
seen					seen
AI Correct answer, a.r.t.			AI		Correct answer, a.r.t.
2				2	0.00858

4 (i)	B1	At least 3
Class		correct new
Width		frequency
freq		densities
Freq. Density =		
Freq÷ class width	B1	All frequency
		densities correct
$16 \le a < 20$		(dep. on first
4		B1)
8		
2		
$20 \le a < 30$		
10	B1	Correct scales
30		
3	B1	At least 3 bars
		correct
$30 \le a < 50$		
20	B1	Histogram
40		completely
2	_	correct
	5	
$50 \le a < 70$		
20		
16		
0.8		
$70 \le a < 90$		
20		
6		
0.3		
3.5		
3 -		
<u></u> ≩ 2.5 -		
0.5 -		
0		
0 20 40 60 80 100		
Age when divorced		
• • • • • • • • • • • • • • • • • • • •		

(ii)		
Lcb		
ucb		
freq(f)		
centre(<i>x</i>)		
xf		
x^2f	M1	Their $\Sigma x f / \Sigma f$
	A1	Correct answer,
16		a.r.t. 39.3
20	M1	Their $\Sigma x^2 f / \Sigma f$,
8	M1	$\sqrt{Their \Sigma x^2 f/\Sigma f}$
18		$-(their mean)^2$
144	A1	Correct answer,
2592		a.i.r. 16.3 –16.4
	5	Use of
20		calculator can
30		gain full marks
30		
25		
750		
18750		
20		
50		
50		
40		
40		
64000		
04000		
50		
70		
16		
60		
960		
57600		
70		
90		
6		
80		
480		
38400		

]
100	
3934 181342	
Mean = $\sum xf/\sum f = 3934/100 = 39.34 = 39.3$ (3 s.f)	
Standard deviation = $\sqrt{[181342/100 - (39.34)^2]}$ = $\sqrt{265.7844}$ = 16.3 (3 s.f.)	

5(i) $P(D=2) = P(R_1 \cap W_2) = P(R_1) \times P(W_2 R_1)$	M1		Multiplication of $^{3}/_{5} \times p$
$= \frac{3}{5} \times \frac{2}{4} = \frac{3}{10}$ AG.	A1	2	Correct answer with
			correct method clearly
			shown
(ii) $P(D = 3) = P(R_1 \cap R_2 \cap W_3) = \frac{3}{5} \times \frac{2}{4} \times \frac{2}{3}$	M1		Substantially correct
$= {}^{1}/{}_{5}$			attempt at <i>either</i> $P(D = 3)$
$\mathbf{P}(D=4) = \mathbf{P}(R_1 \cap R_2 \cap R_3 \cap W_4)$			or $P(D = 4)$.
$= {}^{3}/_{5} \times {}^{2}/_{4} \times {}^{1}/_{3} \times {}^{2}/_{2} = {}^{1}/_{10}$	M1		Wholly correct attempt at
			one of
Therefore the distribution table is as follows:			P(D=3) or P(D=4).
D	. 1	2	
1	AI	3	Correct answers, $P(D = 2) = \frac{1}{2} I$
2			$P(D=3) = \frac{1}{5}$ and $P(D=4) = \frac{1}{5}$
3			$P(D = 4) = /_{10}$
4			
P(D=a)			
/5 3/			
$^{/10}_{1_{-}}$			
/10			
(iii) $E(D) = \Sigma x p$	M1		$\Sigma x imes their p$
$= 1 \times \frac{2}{5} + 2 \times \frac{3}{10} + 3 \times \frac{1}{5} + 4 \times \frac{1}{10}$			
= 2	A1		Correct answer, 2
$E(D^2) = \Sigma x^2 p$	M1		$\Sigma x^2 \times their p$
$= 1^2 \times \frac{2}{5} + 2^2 \times \frac{3}{10} + 3^2 \times \frac{1}{5} + 4^2 \times \frac{1}{10} = 5$	M1		$\Sigma x^2 p - [their \text{ mean}]^2$
$Var(D) = E(D^2) - [E(D)]^2 = 5 - 4 = 1$	A1		Correct answer, 1
		5	
6 (i) $S \sim B(7, 0.88)$	B1		'Binomial' stated
	B1		$n = 7 \ and \ p = 0.88$
		2	
(ii) Prob. of being able to log-on at the first attempt is	B1		One correct assumption
constant from one day to the next.			in context
Whether I can log-on at the first attempt any given day is	B1		Another correct
not affected by whether I have been able (or not) to log-		~	assumption in context
on at the first attempt on any other day (2)	N/1	2	$11 - 6^{7} - 4^{4} - 3$
(m) $P(S = 4) = C_4 \times 0.88^{\circ} \times 0.12^{\circ} = 0.0363 (3 s.t.)$	IVII N/11		Use of $C_4 \times p^* \times q^3$
	IVII		wholly correct working $1170 - 0.00^4 - 0.10^3$
	Λ1		with $C_4 \times 0.88^\circ \times 0.12^\circ$
	AI	2	Correct answer, a.r.t.
		•	$\Lambda \Lambda 222$
	D1	3	0.0363
$(iv) E(S) = np = 7 \times 0.88 = 6.16$	B1 M1	3	E(S) = 6.16 seen
(iv) $E(S) = np = 7 \times 0.88 = 6.16$ Therefore $P(S > E(S)) = P(S = 7) = 0.88^7 = 0.409$ (3 s.f.)	B1 M1	3	E(S) = 6.16 seen Attempt to find P(S > their E(S))
(iv) $E(S) = np = 7 \times 0.88 = 6.16$ Therefore $P(S > E(S)) = P(S = 7) = 0.88^7 = 0.409$ (3 s.f.)	B1 M1	3	E(S) = 6.16 seen Attempt to find P(S > their E(S))
(iv) $E(S) = np = 7 \times 0.88 = 6.16$ Therefore $P(S > E(S)) = P(S = 7) = 0.88^7 = 0.409$ (3 s.f.)	B1 M1 A1	3	E(S) = 6.16 seen Attempt to find P(S > their E(S)) Correct answer, a.r.t. 0 409

	1	
7 (i)		
60	B1	Correct scales and labels.
50 -		
40 -	D1	Compat concerl "chane"
> 30 -	DI	and 10 points plotted
20		and to points plotted
20	B1	The points with
10 -		coordinates (22, 46);
0		(25, 25); (27.5, 25) and
0 10 20 30 40		(30, 20) plotted
x	3	accurately
	Ũ	
$(ii) C = \sum_{n=1}^{\infty} (\sum_{n=1}^{\infty} \sqrt{\sum_{n=1}^{\infty} \sum_{n=1$		
(ii) $S_{xy} = 2xy - (2x) \times (2y)/n = 7572.8 - (225.8 \times 551)/10$ = -552.78		
$S_{\rm rr} = \sum x^2 - (\sum x)^2 / n = 5368.9 - (225.8)^2 / 10$		
= 270.336		
$S_{yy} = \Sigma y^2 - (\Sigma y)^2 / n = 13577 - (351)^2 / 10$	M1	Calculator or formula
= 1256.9		correctly applied
$r = \frac{S_{xy}}{S_{xy}} = \frac{-552.78}{1256.00} = -0.948309$		
$\sqrt{S_{xx}} \times S_{yy} = \sqrt{(2/0.336 \times 1256.9)} - 0.948 (3 \text{ sf})$	A1	Correct answer, a.r.t.
0.946 (3 5.1.)	2	-0.948
(iii) There seems to be a strong negative correlation	B1	Strong negative
since <i>r</i> is close to -1		correlation,
	B1	because ris near 1 or
		because 7 is near -1 07
	2	my graph shows points in
(iv) $h = S_{m}/S_{m} = -552\ 78/270\ 336 = -2\ 0447$	2 M1	my graph shows points in a straight line
(iv) $b = \underline{S}_{xy} / \underline{S}_{xx} = -552.78/270.336 = -2.0447$ a = y - bx = -2.04 (3 s.f.)	2 M1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used)
(iv) $b = \underline{S}_{xy} / S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - bx_{-} = -2.04 (3 \text{ s.f.})$ $a = \underline{y} - bx = 35.1 - (-2.04) \times 22.58 =$	2 M1 M1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with
(iv) $b = \underline{S}_{xy} / S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - bx_{\perp} = -2.04 (3 \text{ s.f.})$ $a = \underline{y} - bx = 35.1 - (-2.04) \times 22.58 =$ = 81.3 (3 s.f.)	2 M1 M1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with their b (may also be
(iv) $b = \underline{S}_{xy} / S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - b\underline{x} = -2.04 (3 \text{ s.f.})$ $a = \underline{y} - b\underline{x} = 35.1 - (-2.04) \times 22.58 =$ = 81.3 (3 s.f.)	2 M1 M1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with their b (may also be implied)
(iv) $b = \underline{S}_{xy} / S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - bx$ = -2.04 (3 s.f.) $a = \underline{y} - bx = 35.1 - (-2.04) \times 22.58 =$ = 81.3 (3 s.f.) So the equation of the line is $y = 81.3 - 2.04x$	2 M1 M1 A1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with their b (may also be implied) y = a + bx, where a is a r t \$1.2 or \$1.3 and b is
(iv) $b = \underline{S}_{xy} / S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - b\underline{x} = -2.04 (3 \text{ s.f.})$ $a = \underline{y} - b\underline{x} = 35.1 - (-2.04) \times 22.58 =$ = 81.3 (3 s.f.) So the equation of the line is $y = 81.3 - 2.04x$	2 M1 M1 A1 3	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with their b (may also be implied) y = a + bx, where a is a.r.t.81.2 or 81.3 and b is a.i.r. (-2.05) to (-2.04)
(iv) $b = \underline{S}_{xy}/S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - b\underline{x}$ = -2.04 (3 s.f.) $a = \underline{y} - b\underline{x} = 35.1 - (-2.04) \times 22.58 =$ = 81.3 (3 s.f.) So the equation of the line is $y = 81.3 - 2.04x$ (v) When $x = 28.1$, $y = 81.3 - 2.04 \times 28.1 = 23.81$	2 M1 M1 A1 3 B1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with their b (may also be implied) y = a + bx, where a is a.r.t.81.2 or 81.3 and b is a.i.r. (-2.05) to (-2.04) Correct answer, a.i.r
(iv) $b = \underline{S}_{xy} / S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - b\underline{x}$ = -2.04 (3 s.f.) $a = \underline{y} - b\underline{x} = 35.1 - (-2.04) \times 22.58 =$ = 81.3 (3 s.f.) So the equation of the line is $y = 81.3 - 2.04x$ (v) When $x = 28.1$, $y = 81.3 - 2.04 \times 28.1 = 23.81$ = 23.8	2 M1 M1 A1 3 B1 1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with their b (may also be implied) y = a + bx, where a is a.r.t.81.2 or 81.3 and b is a.i.r. (-2.05) to (-2.04) Correct answer, a.i.r 23.75 to 24.0 or 24
(iv) $b = \underline{S}_{xy}/S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - b\underline{x}$ = -2.04 (3 s.f.) $a = \underline{y} - b\underline{x} = 35.1 - (-2.04) \times 22.58 =$ = 81.3 (3 s.f.) So the equation of the line is $y = 81.3 - 2.04x$ (v) When $x = 28.1$, $y = 81.3 - 2.04 \times 28.1 = 23.81$ = 23.8 (vi) Since the product moment correlation coefficient is	2 M1 M1 A1 3 B1 1 B1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with their b (may also be implied) y = a + bx, where a is a.r.t.81.2 or 81.3 and b is a.i.r. (-2.05) to (-2.04) Correct answer, a.i.r 23.75 to 24.0 or 24 Realising $r_{uv} = r_{xy} =$
(iv) $b = \underline{S}_{xy}/S_{xx} = -552.78/270.336 = -2.0447$ $a = \underline{y} - b\underline{x}$ = -2.04 (3 s.f.) $a = \underline{y} - b\underline{x} = 35.1 - (-2.04) \times 22.58 =$ = 81.3 (3 s.f.) So the equation of the line is $y = 81.3 - 2.04x$ (v) When $x = 28.1$, $y = 81.3 - 2.04 \times 28.1 = 23.81$ = 23.8 (vi) Since the product moment correlation coefficient is unchanged by linear transformations, $r_{uv} = r_{xy} = -0.948$	2 M1 M1 A1 3 B1 1 B1 1	my graph shows points in a straight line Use of S_{xy}/S_{xx} (may be implied if calc. used) Using with their b (may also be implied) y = a + bx, where a is a.r.t.81.2 or 81.3 and b is a.i.r. (-2.05) to (-2.04) Correct answer, a.i.r 23.75 to 24.0 or 24 Realising $r_{uv} = r_{xy} =$ -0.948 $\sqrt{if} -1 \le r \le 1$

Supplementary Notes

Question 1

(i) **B1** is for the correct ranks given or for both sets of ranks consistently reversed. The reversed ranks are:

	А	В	С	D	Е	F	G
Teacher	7	6	4	1	2	5	3
Moderator	6	7	2	1	3	5	4
d	1	-1	2	0	-1	0	-1

M1 is for an attempt to find *d* or d^2 from **ranked** data. **M1** is for a correct formula for Spearman **used**. This can be allowed for unranked data as long as it leads to an r_s value such that $|r_s| \le 1$.

A1 is for the correct answer only; either anything rounding to (abbreviated to a.r.t.) 0.857 or a fraction of the form ${}^{6k}/_{7k}$ (where k is assumed to be a positive integer).

Candidates might do this question by applying the P.M.C.C. formula to the ranks. If they decide to do this they get:

 $\Sigma x = \Sigma y = 28$, $\Sigma x^2 = \Sigma y^2 = 140$ and $\Sigma xy = 136$, where *x* denotes the teacher's rank and *y* denotes the moderator's rank.

This gives $S_{xx} = S_{yy} = 140 - \frac{28}{7}^2 = 140 - 112 = 28$, and $S_{xy} = 136 - \frac{28}{7}^2 = 136 - 112 = 24$ From which $r_s = \frac{24}{\sqrt{28 \times 28}} = \frac{6}{7} = 0.857...$, as before. The alternative scheme for this method is: **B1** for wholly correct ranks (as before). **M1** for any one of S_{xy}, S_{xx}, S_{yy} correct (and this could be gained for unranked data). **M1** is for a wholly correct method involving ranks.

A1 is for correct answer only, a.r.t. 0.857 or $^{6k}/_{7k}$.

(ii) **B1** is for an appropriate comment which relates the size of **their** r_s to **their** conclusion. If an r_s value has been calculated the statement the candidate makes must be consistent with that value. The only exception is if the candidate refers sensibly to the table and to the differences in the table. If no r_s value is found they must make a sensible comment about the differences between the entries in the table. A value of $|r_s| > 1$ will not be able to score this

B1 if they refer to the value of r_s . Statements such as "good correlation" score **B0**.

Question 2

(i) M1 is for the geometric probability "pattern" q^3p . q and p may be correct or the reverse of the correct values or indeed **any** p, q pair such that p > 0, q > 0 and p + q = 1.

A1 is for a wholly correct demonstration that P(X = 4) = 0.0864 with no wrong working seen.

(ii) **M1** is for either an attempt at P(X > 3) or P(X > 8) or $P(X \le 3)$ or $P(X \le 8)$ and this will usually appear as q^3 or q^8 or $1 - q^3$ or $1 - q^8$ or for those who decide to answer the question by simply adding P(X = 4) + ... P(X = 8), **M1** is obtained for at least two of the correct five geometric terms added together. Allow follow through here from an incorrect *p*, *q* pair as long as it is consistent with their previous answers.

M1 is for a wholly correct method with only the correct *p* and *q* scoring.

A1 is for the correct answer, a.r.t. 0.199 or $^{77814k}/_{390 625k}$.

(iii) **B1** is for 2.5 c.a.o. or ${}^{5k}/_{2k}$ (where k is assumed to be a positive integer). Unresolved answers such as <u>1</u> are **not** acceptable. 0.4

- (i) **B1** is for correct answer only 2 598 960. ${}^{52}C_5$ is **not** acceptable.
- (ii) M1 is for ${}^{13}C_3$ and ${}^{13}C_2$ seen. This would obviously also be awarded for sight of their numerical equivalents 286 and 78.

A1 is for 22 308 c.a.o.

(iii) M1 is for ${}^{13}C_3$ and ${}^{39}C_2$ seen. This would obviously also be awarded for sight of their numerical equivalents 286 and 741.

A1 is for 211 926 c.a.o.

In this case if the candidate decides to break the problem down into separate cases such as:

3 spades and 2 diamonds : ${}^{13}C_3 \times {}^{13}C_2$ 3 spades and 1 club and 1 diamond : ${}^{13}C_3 \times {}^{13}C_1 \times {}^{13}C_1$ etc. then there must be at least 2 cases added together for the award of the **M1**. [There are 6 cases:

3 spades and 2 diamonds: ${}^{13}C_3 \times {}^{13}C_2 = 286 \times 78 = 22\ 308$ 3 spades and 2 hearts: ${}^{13}C_3 \times {}^{13}C_2 = 286 \times 78 = 22\ 308$ 3 spades and 2 clubs: ${}^{13}C_3 \times {}^{13}C_2 = 286 \times 78 = 22\ 308$ 3 spades and 1 club and 1 diamond: ${}^{13}C_3 \times {}^{13}C_1 \times {}^{13}C_1$ $= 286 \times 13^2 = 48\ 334$ 3 spades and 1 club and 1 heart: ${}^{13}C_3 \times {}^{13}C_1 \times {}^{13}C_1$ $= 286 \times 13^2 = 48\ 334$ 3 spades and 1 heart and 1 diamond: ${}^{13}C_3 \times {}^{13}C_1 \times {}^{13}C_1$ $= 286 \times 13^2 = 48\ 334$ 3 spades and 1 heart and 1 diamond: ${}^{13}C_3 \times {}^{13}C_1 \times {}^{13}C_1$ $= 286 \times 13^2 = 48\ 334$ So total = $3 \times 22\ 308 + 3 \times 48\ 334 = 66924 + 145\ 002 = 211\ 926\ as\ before.$

(iv) M1 is for their (ii) \div their (i) (as long as it leads to an answer ≤ 1). They cannot score this M1 for simply stating that the answer is part (ii) \div part(i). You need to see a calculation.

A1 is for c.a.o. a.r.t. 0.00858 or $^{143k}/_{16\ 660k}$.

ALITER

M1 for either ${}^{13}/_{52} \times {}^{12}/_{51} \times {}^{11}/_{50} \times {}^{13}/_{49} \times {}^{12}/_{48}$ (or equivalent) or for ${}^{5}C_{3} \times p_{1} \times p_{2} \times p_{3} \times p_{4} \times p_{5}$ where $0 \le p_{i} \le 1$ for i = 1, 2, 3, 4, 5.

A1 is for c.a.o. a.r.t. 0.00858 or ${}^{143k}/_{16\,660k}$ (as before).

Some candidates may decide to do part (iv) before part (ii) and then to use part (iv) to answer part (ii). This is acceptable as long as each part is clearly labelled. In this case use the mark scheme as written to mark part (iv) and then in part (ii) award M1 for their part (iv) × their part (i) and A1 as before.

(i) **B1** is for at least 3 new correct frequency densities.

B1 (a second **B1** dependent on the first) is for all of the frequency densities correct.

Both of these **B1**s may be implied from the graph if you do not see the frequency densities written down explicitly.

B1 is for both scales correct and both axes labelled.

Acceptable labels for the horizontal axis are *a*, *age*, *years* but **not** *x* and **not** "*class*". Acceptable labels for the vertical axis are frequency density, freq. dens., "fd" but **not** "frequency", **not** freq., **not** *f* and **not** *y*.

B1 for at least 3 bars at the correct heights and placed at the correct horizontal position. (Allow follow through here from incorrect frequency densities)B1 is for a completely correct histogram (not allowing any follow through).

The last **B1** can be scored for a graph in which the only "error" is the omission of a label.

If a candidate does not use graph paper then the first two B1 marks are available for giving the correct frequency densities but none of the last three **B1** marks can score.

SR **B1** for a perfect histogram drawn with the incorrect scales **or** for a graph which is the correct shape but for which no horizontal scale is given.

(ii) M1 is for the use of Σ (their midpoints $\times f$)/ Σf . So this would not be gained, for example, for $\Sigma x f/5$.

A1 is for a.r.t. 39.3. Do not accept for this accuracy mark an unresolved fraction of the form ${}^{3934k}/{}_{100k}$. You may see 39.3 or 39.34 with no working whatsoever because the candidate has done the entire calculation on their calculator. This still scores **M1**, **A1**. Anything outside the range scores **0**.

M1 is for the use of Σ ([their midpoints]² × *f*)/ Σf . So this would not be gained, for example, for $\Sigma x^2 f/5$.

M1 is independent of the first and is for $\sqrt{\{\text{their version of } \Sigma x^2 f / \Sigma f - [\text{their mean}]^2\}}$. Essentially this method mark is for subtraction of the mean as long as it leads to an answer > 0 and as long as the first term at least resembles a sum of squares. So, for example, $\sqrt{\{[18^2 + 25^2 + ... + 80^2]/5 - 39.34^2\}}}$ would score this **M1**. Note that the square root must be present to score.

A1 is for anything in the range 16.3 to 16.4 inclusive. As with the mean you may see no working, but anything in the range score 3 marks otherwise the score is 0.

ALITER: for those who use the $\frac{\sum (x-\bar{x})^2 f}{\sum f}$ formula:

M1 for one term of the form $(x - \overline{x})^2 f$ with a consistent x, f pair. M1 for a wholly correct method.

A1 is for anything in the range 16.3 to16.4 inclusive.

- (i) M1 is for ${}^{3}/{}_{5} \times p$ seen. So, for example, ${}^{3}/{}_{5} \times {}^{2}/{}_{5}$ would score this mark. A1 is for ${}^{3}/{}_{5} \times {}^{2}/{}_{4}$ seen with no wrong working.
- (ii) M1 is for either a triple product of probabilities with at most one incorrect in an attempt at P(D = 3) or for a quadruple product of probabilities with at most one incorrect in an attempt at P(D = 4). M1 is for one or other of the answers completely correct

A1 is for both answers completely correct.

For both answers completely correct with no working allow all **3** marks. For one answer correct corresponding to the appropriate x value, give **M1,M1** by implication.

(iii) M1 is for a substantially correct attempt at $\Sigma(x \times \text{their } p)$. This is lost if the candidate divides this by "*n*". There must be a sum of at least 2 products to score this mark. It is not necessary for their probabilities to sum to 1. A1 is for the correct answer, 2.

M1 is for a substantially correct attempt at $\Sigma(x^2 \times \text{their } p)$. This is lost if the candidate divides this by "*n*". There must be a sum of at least 2 products to score this mark. It is not necessary for **their** probabilities to sum to 1.

M1 is for their $\sum x^2 p$ – [their mean]² as long as this is > 0.

A1 is for the correct answer, 1.

Beware, the incorrect method

 $\frac{\sum x^2 p}{n} - \left(\frac{\sum x p}{n}\right)^2 = \frac{5}{4} - \left(\frac{2}{4}\right)^2 = 1.$ this should score **M0,M0** but the

answer is correct, so you need to be careful that you check the working.

ALITER for those using the formula $\Sigma(x - \mu)^2 p$.

M1 for a single, non zero $(x - \text{their } \mu)^2 p$ with a consistent *x*, *p* pair. **M1** for a wholly correct method. **A1** for a correct answer.

- (i) **B1** is for "binomial" stated or for a recognisable abbreviation B(or Bin(**B1** (dependent) for n = 7 and p = 0.88 (or equiv.) stated. Be generous here unless you are convinced that the parameters are wrong. So, for example, allow B(0.88, 7) to score **B1, B1**.
- (ii) B1 is for one assumption in context.
 B1 is for a clearly distinct second assumption.
 The three assumptions allowed are independence, constant probability and two mutually exclusive outcomes but they must be stated in context. "Fixed" trials is given and so does not qualify as an assumption.
- (iii) M1 is for the use of the binomial probability pattern ${}^{7}C_{4} \times p^{4} \times q^{3}$. q and p may be correct or the reverse of the correct values or indeed **any** p, q pair such that p > 0, q > 0 and p + q = 1. M1 is for a wholly correct method using ${}^{7}C_{4} \times 0.88^{4} \times 0.12^{3}$. A1 is for a.r.t. 0.0363.
- (iv) B1 is for E(S) = 6.16 seen. M1 is for a substantially correct attempt at P(S > their E(S)). A1 is for a correct answer, a.r.t. 0.409.

The first **B1** mark can be implied by the calculation of P(S = 7) but if you do not see an attempt to calculate P(S = 7), then you must see 6.16 explicitly for this **B1**.

Those who give the geometric as the model in part (i) can score a maximum of the two **B1** marks in part (ii) and the **M1** mark in part (iv).

- (i) B1 for a regular scale on both axes sufficient to accommodate all of the points and for both axes labelled. The *x*-axis must be horizontal.
 B1 for the graph having the correct general "shape" and all 10 points plotted. You should give this unless you can notice some problem "visually".
 B1 for the following points correctly plotted:
 (22, 46) (25, 25) (27.5, 25) (30, 20). Ignore any joining of the points or any lines of best fit plotted.
- (ii) M1 for any of S_{xy} , S_{xx} , S_{yy} correct as long as they appear in a formula which has the structure \underline{a} .

$$(b \times c)$$

You can also allow terms such as nS_{xy} or S_{xy} : n. Hopefully the three terms would be consistent but they do not have to be. Sight any one of the figures, 270336 or 12569 or 55278 together with a formula of the correct structure would imply **M1**.

A1 is for a.r.t. -0.948.

Candidates may do this entirely on their calculator, in which case they score **M1 A1** for a.r.t. -0.948 and **M0 A0** otherwise.

(iii) B1 for either saying "strong negative correlation" (and they must have both "strong" and "negative" to score B1 here) or for saying in context something to the effect that, "The more TV you watch the lower your GCSE points score seems to be."

B1 this is awarded for a justification **either** from the size of *r* **or** from the fact that the points on the scatter diagram lie close to a straight line. For incorrect *r* values where the candidate uses the size of *r* as justification, allow follow through to apply only if r < -0.8. Otherwise candidates with

incorrect r values can only score this **B1** for justification by referring to their scatter diagram.

(iv) M1 for their $S_{xy} \div S_{xx}$ or equivalent. M1 for use of $a = 35.1 - \text{their } b \times 22.58$ A1 for correct answer y = a + bx, where a is a.r.t.81.2 or 81.3 and b is a.i.r. (-2.05) to (-2.04) You can accept for all **3** marks an equation of the form $(y - \overline{y}) = b(x - \overline{x})$ as long as $\overline{y} = 35.1$, $\overline{x} = 22.58$ or 22.6 and b is a.i.r. (-2.05) to (-2.04).

For candidates who find the *x* on *y* line, x = a' + b'y, allow **M1**, **M1**, **A0** for those who find *a* and *b* consistently by using $b' = S_{xy} \div S_{yy}$ and $a' = 22.58 - \text{their } b' \times 35.1$.

Again candidates may do this on their calculator and show no working. Award all the marks if the answer is in the given range and none if it falls outside this range.

ALITER: for use of the normal equationsM1 for one correct normal equationM1 (a further M1) for a second correct normal equationA1 for the correct answer with the ranges for *a* and *b* as given before.The two normal equations are:

$\Sigma y = na + b\Sigma x$	351 = 10a + 225.8b
$\Sigma xy = a\Sigma x + b\Sigma x^2$	7372.8 = 225.8a + 5368.90b

- (v) **B1** for a.i.r 23.75 to 24.0 or 24 with no incorrect working seen in this part or in part (iv).
- (vi) **B1** for correct answer -0.948 or follow through from part (ii) $(\sqrt{)}$ if $-1 \le r \le 1$.