1(i)	Total has Poisson distribution with mean $\lambda = 0.21\times5+0.24\times5 = 2.25$ $P(\geq2) = 1 - e^{-\lambda}(1+\lambda)$ $=0.657$	M1 A1 M1 A1 **4**	With ×5 λ or $1+\lambda$ in brackets (their λ) Or interpolation from tables
(ii)	EITHER: Each length is a random sample OR: Flaws occur independently on the reels	B1 **1** **[5]**	In context Accept randomly
2	H_0: μ =(or ≥) 170 , H_1: $\mu < 170$ $\bar{x}$ =167.5 $s^2 = 5.9$ EITHER: (α) $(167.5 - 170)/\sqrt{(5.9/6)}$ = - 2.52(1) Compare with – 2.015 OR: (β) $170 - t\sqrt{(5.9/6)}$ = 168.0 Compare 167.5 with CV and reject H_0 There is sufficient evidence at the 5% significance level that the machine dispenses less than 170 ml on average.	B1 B1 B1 M1 A1 M1 M1 A1 M1 A1 **[7]**	For both hypotheses; accept words SR 2-tail test: B0B1B1M1A1M1A0 Max 5/7 Standardise 167.5; + or – for M; /6 seen Explicitly Allow 2.571 Finding critical value or region. With t= 2.015 or 2.571 Explicitly. Allow correct use of $\lvert t\rvert$ M0 if z used SR: B1 if no explicit comparison but conclusion "correct"
3(i)	H_0: There is no association between the area in which a shopper lives and the day they shop (H_1: All alternatives) E-Values 27.3 14. 7 37.7 20.3 $\chi^2 = (4.3-0.5)^2(27.3^{-1}+37.7^{-1}+14.7^{-1}+20.3^{-1})$ = 2.606 Compare with 2.706 Do not reject H_0. There is insufficient evidence of an association. SR: If H_0 association, lose 1st B1 and last M1A1	B1 M1 A1 M1 ft A1 A1 M1 A1 **8**	SR difference in proportions B1 define and evaluate p_1 and p_2 with H_0 B1 for p=0.42 M1A1 for $z = \pm1.827$ or 1.835(no pe) M1A0 Max 5/8 At least one E value correct (M1) All correct(A1) At least one χ^2, no or wrong cc, (M1FtE) All correct (A1); 2.606 or 2.61 (A1) Or use calculator (p = 0.106) SR: B1 if no explicit comparison, as Q2 SR: If H_0 association, lose 1st B1 and last M1A1
(ii)	Conclusion the same since critical value > 2.706 (and test statistic unchanged)	B1 **1** **[9]**	OR from $z=\pm2.17$, SR

4(i)	s^2= (1183.65-246.6^2/70)/69 Use $\bar{x} \pm zs/\sqrt{(70)}$ $s/\sqrt{(70)}$ 1.645 (3.10, 3.94)	M1 M1 A1 A1 A1 **5**	AEF Allow without ft or with s^2; with 70 Their s A0 if interval not indicated
(ii)	Change 90 to around 90	B1 **1**	Or equivalent
(iii)	$4(0.9)^3(0.1) + 0.9^4$ =0.9477	M1 A1 **2** **[8]**	Use of bino with p=0.9 or 0.1 and 4 and Correct terms considered. art 0.948
5(i)	$e^{-2.25} - e^{-4}$ × 150 = 13.1 Last: 150 – sum=2.7	M1 A1 A1 A1 ft **4**	Or find last entry using F(x) Or 2.7 if found first Or 13.1 any accuracy
(ii)	(H_0: Data fits the model, H_1: Data does not fit) Combine last two cells $\chi^2 = 7.8^2/33.2 + 11.6^2/61.6 + 7.4^2/39.4 + 11.2^2/15.8$ = 13.3(46) Compare with 9.348 (or 11.14) , reject H_0 **(**There is sufficient evidence at the $2\frac{1}{2}$% significance level that) the model is not a good fit	B1 M1*****Dep A1 A1 M1 A1 ft Dep* **6** **[10]**	At least two correct All correct In range 13.2 to 13.5 SR: If last 2 cells are not combined B0M1A1A1(for 13. 5) M1A1 If no explicit comparison B1 if conclusion follows
6(i)	Anxiety scores; have normal distributions; common variance; independent samples H_0: $\mu_E = \mu_C$, H_1: $\mu_E < \mu_C$ s^2 = (1923.56+1147.58)/29 (= 105.9) (t) = (32.16 – 38.21)/$\sqrt{[105.9(18^{-1}+13^{-1})]}$ = - 1.615 t_{crit} = - 1.699 Compare -1.615 with -1.699 and do not reject H_0 There is insufficient evidence at the 5% significance level to show that anxiety is reduced by listening to relaxation tapes	B2 B1 B1 M1 A1 A1 B1 M1 A1 ft **10**	Context + 2 valid points B2 Context + 1VP, no context +2VP B1 Not in words Allow 1 error; eg s^2= 1923.56/(17or18) + 47.5/(12or13) All correct Or **+** Or **+;** accept art ±1.70 Or **+ , +.** M0 if t not ±1.699,±2.045 In context, not over-assertive OR Find CV or CR: B2B1B1; C= or ≥ st , t = ±1.699 or ±2.015 M1A1 t= ±1.699 B1; G= 6.11(2) A1; 6.112> 6.05 and reject H_0 etcM1A1
(ii)	Sample sizes are too small (to appeal to CLT)	B1 **1** **[11]**	

7(i)	Use $\sum F + \sum M \sim N(\mu, \sigma^2)$ $\mu = 1104.9$ $\sigma^2 = 6\times 9.3^2 + 9\times 8.5^2$ $= 1169.2$ $P(> 1150) = 1 - \Phi([1150 - 1104.9]/\sqrt{1169.2})$ $= 0.0937$	M1 A1 M1 A1 M1 A1 **6**	Sum of indep normal variables is normal Standardise, correct tail. M0 $\sigma/\sqrt{15}$ Accept .094
(ii)	If unknown M, prob $\frac{1}{2}$, 6F and 9M as before. If unknown W, prob $\frac{1}{2}$, 7W and 8M Having N(1093.3,1183.4) $P(> 1150) = 1 - \Phi(1.648) = 0.0497$ $P = \frac{1}{2}\times 0.0936 + \frac{1}{2}\times 0.0497$ $= 0.07165$	M1 B1 B1 A1 M1 A1 **6** **[12]**	Considering two cases Mean and variance Use of $\frac{1}{2}$ ART 0.072
8(i)	$X = \frac{1}{4}S^2$ $F(s) = \int_1^s \frac{8}{3s^3}\,ds = \left[-\frac{4}{3s^2}\right]_1^s$ $= \frac{4}{3}(1 - 1/s^2)$ $G(x) = P(X \le x) = P(S \le 2\sqrt{x})$ $= F(2\sqrt{x})$ $= \frac{4}{3} - \frac{1}{3x}$ $g(x) = \begin{cases} \frac{1}{3x^2} & \frac{1}{4} \le x \le 1, \\ 0 & \text{otherwise.} \end{cases}$	B1 M1 A1 M1 A1 ft M1 B1 **7**	 Ignore range here SR: B1 for $G(x)=F(2\sqrt{x})$ without justification and with correct result ft F For G′ (*a*) For range
(ii)	EITHER: $G(m) = \frac{1}{2}$ $\Rightarrow \frac{4}{3} - \frac{1}{3x} = \frac{1}{2}$ $\Rightarrow m = \frac{2}{5}$ OR: $\int_{1/4}^{m} \frac{1}{3x^2}\,dx = \frac{1}{2}$ $\Rightarrow \left[-\frac{1}{3x}\right]_{1/4}^{m} = \frac{1}{2}$ $\Rightarrow \quad m = \frac{2}{5}$	M1 A1 ft A1 M1 A1 A1 **3** **[10]**	ft G(*x*) in **(i)** CAO Allow wrong $\frac{1}{4}$ Allow wrong $\frac{1}{4}$ CAO