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|---|---|---|---|---|
| **1** | **(i)** | P(20 correct) = $\binom{30}{20} \times 0.6^{20} \times 0.4^{10} = 0.1152$ | M1 $0.6^{20} \times 0.4^{10}$<br>M1 $\binom{30}{20} \times p^{20} q^{10}$<br>A1 CAO | **[3]** |
| | **(ii)** | Expected number = 100 × 0.1152 = 11.52 | M1<br>A1 FT (Must not round to whole number) | **[2]** |
| | | | **TOTAL** | **[5]** |

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| **2** | **(i)** | (*A*) P(Low on all 3 days) = $0.5^3 = 0.125$ or $^1/_8$ | M1 for $0.5^3$<br>A1 CAO | **[2]** |
| | | (*B*) P(Low on at least 1 day) = $1 - 0.5^3 = 1 - 0.125 = 0.875$ | M1 for $1 - 0.5^3$<br>A1 CAO | **[2]** |
| | | (*C*) P(One low, one medium, one high)<br>$= 6 \times 0.5 \times 0.35 \times 0.15 = 0.1575$ | M1 for product of probabilities $0.5 \times 0.35 \times 0.15$ or $^{21}/_{800}$<br>M1 × 6 or × 3! or $^3P_3$<br>A1 CAO | **[3]** |
| | **(ii)** | X ~ B(10, 0.15)<br>(*A*) P(No days) = $0.85^{10} = 0.1969$<br>Or from tables P(No days) = 0.1969 | M1<br>A1 | **[2]** |
| | | (*B*) *Either* P(1 day) $= \binom{10}{1} \times 0.15^1 \times 0.85^9 = 0.3474$<br>*or* from tables P(1 day) = $P(X \le 1) - P(X \le 0)$<br>$= 0.5443 - 0.1969 = 0.3474$ | M1 $0.15^1 \times 0.85^9$<br>M1 $\binom{10}{1} \times p^1 q^9$<br>A1 CAO<br>OR: M2 for 0.5443 – 0.1969<br>A1 CAO | **[3]** |
| | **(iii)** | Let $X$ ~ B(20, 0.5)<br>*Either:* $P(X \ge 15) = 1 - 0.9793 = 0.0207 < 5\%$<br><br>*Or:* Critical region is {15,16,17,18,19,20}<br>15 lies in the critical region.<br><br>So there is sufficient evidence to reject $H_0$ | *Either:*<br>B1 for correct probability of 0.0207<br>M1 for comparison<br>*Or:*<br>B1 for CR,<br>M1 for comparison<br><br>A1 CAO dep on B1M1 | |
| | | Conclude that there is enough evidence to indicate that the probability of low pollution levels is higher on the new street. | E1 for conclusion in context | **[5]** |
| | | $H_1$ has this form as she believes that the probability of a low pollution level is greater in this street. | E1 indep | |
| | | | **TOTAL** | **[17]** |

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| **3 (i)** | X ~ B(15, 0.2)<br><br>(**A**) $P(X = 3) = \binom{15}{3} \times 0.2^3 \times 0.8^{12} = 0.2501$<br><br>OR from tables $0.6482 - 0.3980 = 0.2502$<br><br>(**B**) $P(X \geq 3) = 1 - 0.3980 = 0.6020$<br><br>(**C**) $E(X) = np = 15 \times 0.2 = 3.0$ | M1 $0.2^3 \times 0.8^{12}$<br>M1 $\binom{15}{3} \times p^3 q^{12}$<br>A1 CAO<br><br>OR: M2 for 0.6482 – 0.3980 A1 CAO<br><br>M1 $P(X \leq 2)$<br>M1 $1 - P(X \leq 2)$<br>A1 CAO<br><br>M1 for product<br>A1 CAO | **3**<br><br>**3**<br><br>**2** |
| **(ii)** | (*A*) Let *p* = probability of a randomly selected child eating at least 5 a day<br>$H_0$: $p = 0.2$<br>$H_1$: $p > 0.2$<br>(*B*) $H_1$ has this form as the proportion who eat at least 5 a day is expected to <u>increase</u>. | B1 for definition of *p* in context<br>B1 for $H_0$<br>B1 for $H_1$<br>E1 | **4** |
| **(iii)** | Let $X \sim B(15, 0.2)$<br>$P(X \geq 5) = 1 - P(X \leq 4) = 1 - 0.8358 = 0.1642 > 10\%$<br>$P(X \geq 6) = 1 - P(X \leq 5) = 1 - 0.9389 = 0.0611 < 10\%$<br><br>So critical region is {6,7,8,9,10,11,12,13,14,15}<br><br>7 lies in the critical region, so we reject null hypothesis and we conclude that there is evidence to suggest that the proportion who eat at least five a day has increased. | B1 for 0.1642<br>B1 for 0.0611<br>M1 for at least one comparison with 10%<br>A1 CAO for critical region *dep* on M1 and at least one B1<br><br>M1 *dep* for comparison<br>A1 *dep* for decision and conclusion **in context** | **6** |
| | | **TOTAL** | **18** |