

- 1
- (a) Binomial CD $n = 20, p = 0.41$
 $P(3 < X \leq 7) = P(X \leq 7) - P(X \leq 3) = 0.380 - 0.013 = 0.368$ (M1A1)
- (b) $H_0 : p = 0.3$ $H_1 : p < 0.3$ (B1)
 $X \sim B(40, 0.3)$ $P(X \leq 7) = 0.0553$ (M1A1)
 $0.0553 > 0.05$ (M1)
 There is not enough evidence to suggest the proportion of customers ordering a starter has decreased. (A1)
- (c) The chance of 7 or less ordering a starter is less than 10% ($0.0553 < 0.1$).
 There is evidence, at the 10% sig. level, to suggest the proportion of customers ordering a starter has decreased. (B1)
- (Total for question 1 is 8 marks)

- 2
- (a) $P(X \geq 12) = 1 - P(X \leq 11) = 1 - 0.0151 = 0.9849$ (M1A1)
- (b) $H_0 : p = 0.3$ $H_1 : p > 0.3$ (B1)
 $X \sim B(40, 0.3)$ $P(X \geq 19) = 1 - P(X \leq 18) = 1 - 0.9852 = 0.0148$ (M1A1)
 $0.0148 > 0.01$ (M1)
 There is not enough evidence to suggest the proportion of customers ordering coffee has increased. (A1)
- (c) $0.0148 < 0.05$
 There is evidence at the 5% level of sig. that the proportion of customers ordering coffee has increased. (B1)
- (Total for question 2 is 8 marks)

- 3
- (a) Binomial PD $n = 12, p = 0.25$ $P(X = 2) = 0.232$ (B1)
- (i)
- (a) $P(X > 4) = 1 - P(X \leq 4) = 1 - 0.8424 = 0.1576$ (M1A1)
- (ii)
- (b) $H_0 : p = 0.25$ $H_1 : p > 0.25$ (B1)
 $X \sim B(40, 0.25)$ $P(X \geq 15) = 1 - P(X \leq 14) = 1 - 0.9456 = 0.0544$ (M1A1)
 $0.0544 > 0.05$
 There is not enough evidence to support Alex's claim. (A1)
- (Total for question 3 is 7 marks)

4 $H_0 : p = 0.15$ $H_1 : p > 0.15$ (B1)

$X \sim B(90, 0.15)$ $P(X \geq 20) = 1 - P(X \leq 19) = 1 - 0.957 = 0.043$ (M1A1)

$0.043 < 0.05$ (M1)

There is evidence to support Angela's belief. (A1)

(Total for question 4 is 5 marks)

5 (a) $X \sim B(9, 0.2)$ $P(X \geq 3) = 1 - P(X \leq 2) = 1 - 0.7382 = 0.2618$ (M1A1)

(b) $H_0 : p = 0.2$ $H_1 : p > 0.2$ (B1)

$X \sim B(20, 0.2)$ $P(X \geq 6) = 1 - P(X \leq 5) = 1 - 0.8042 = 0.1958$ (M1A1)

$0.1958 > 0.05$

There is not enough evidence to support Billy's belief. (A1)

(Total for question 5 is 6 marks)

6 (a) $X \sim B(15, 0.08)$ $P(X \geq 2) = 1 - P(X \leq 1) = 1 - 0.6597 = 0.3403$ (M1A1)

(b) $H_0 : p = 0.08$ $H_1 : p > 0.08$ (B1)

$X \sim B(20, 0.08)$ $P(X \geq 3) = 1 - P(X \leq 2) = 1 - 0.7879 = 0.2121$ (M1A1)

$0.2121 > 0.05$ (M1)

There is not enough evidence to support the employee's claim. (A1)

(Total for question 6 is 7 marks)

7 (a) $X \sim B(20, 0.6)$ $P(X = 15) = 0.0746$ (B1)

(i)

(a) $P(X > 15) = 1 - P(X \leq 15) = 1 - 0.9490 = 0.0510$ (M1A1)

(ii)

(b) $H_0 : p = 0.6$ $H_1 : p \neq 0.6$ (two-tailed) (B1)

$X \sim B(50, 0.6)$ $P(X \geq 35) = 1 - P(X \leq 34) = 1 - 0.9045 = 0.0955$ (M1A1)

$0.0955 > 0.05$ (comparing half significance level for two-tailed test)

There is not enough evidence to support Andy's coach's claim. (A1)

(Total for question 7 is 7 marks)

8

(a) $X \sim B(20, 0.4)$ $P(X = 5) = 0.0746$ (B1)

(b) $H_0 : p = 0.4$ $H_1 : p \neq 0.4$ (B1)

(c) $X \sim B(20, 0.4)$ Lower tail: $P(X \leq 3) = 0.0160$ ($P(X \leq 4) = 0.0510$, which is > 0.05)
Upper tail: $P(X \geq 13) = 1 - P(X \leq 12) = 1 - 0.9790 = 0.0210$ ($P(X \geq 12) = 0.0565$, which is > 0.05)

Critical region: $X \leq 3$ and $X \geq 13$ (M1A1M1A1)

(d) $0.0160 + 0.0210 = 0.0370$ (B1)

(e) 11 is not in the critical region (it is in the acceptance region).

There is not enough evidence to support Polly's suspicion. (B1)

(Total for question 8 is 8 marks)
