Topic: Worked Solutions & Mark Scheme
Probability Distributions (Binomial & Normal)
Featuring Casio fx-CG50 Calculator Instructions

Marks are awarded for Method (M), Accuracy (A), and Reasoning (R). (M1) or (A1) indicates an implied mark.
Note on GDC usage: Solutions below explicitly use Casio fx-CG50 syntax found via `Menu 2 (Statistics) -> F5 (DIST)`.

1. **[Paper 1 Style, Short Answer, Easy, 4 marks]**

   (a) Let $W \sim N(20, 3.5^2)$. **(M1)**
   Use `NormCD` [`DIST -> NORM -> Ncd`].
   Set `Lower:` `-1E99`, `Upper:` `15`, σ`:` `3.5`, μ`:` `20`.
   $P(W < 15) = 0.0765637\cdots \approx 0.0766$. **A1**

   (b) Use `NormCD` with bounds 18 and 22. **(M1)**
   Set `Lower:` `18`, `Upper:` `22`.
   $P(18 < W < 22) = 0.431411\cdots \approx 0.431$. **A1**

2. **[Paper 1 Style, Short Answer, Easy, 5 marks]**

   (a) Let X be the number of successful shots. $X \sim B(12, 0.7)$. **(M1)**
   Use `BinomialPD` [`DIST -> BINOMIAL -> Bpd`].
   Set `x:` `9`, `Numtrial:` `12`, `p:` `0.7`. **(M1)**
   $P(X = 9) = 0.239700\cdots \approx 0.240$. **A1**

   (b) "At least 10" means $X \geq 10$.
   Use `BinomialCD` [`DIST -> BINOMIAL -> Bcd`]. **(M1)**
   On the CG50, you can input the bounds directly:
   Set `Lower:` `10`, `Upper:` `12`, `Numtrial:` `12`, `p:` `0.7`.
   $P(X \geq 10) = 0.276326\cdots \approx 0.276$. **A1**

3. **[Paper 1 Style, Short Answer, Easy, 4 marks]**

(a) The normal distribution is perfectly symmetrical about the mean (3.22). **(R1)**
$P(\text{Price} > 3.22) = 0.5$. **A1**

(b) $\text{Price} = \mu + 2\sigma$. **(M1)**
$= 3.22 + 2(0.84) = 3.22 + 1.68$.
$\text{Price} = 4.90$ euros. **A1**

4. **[Paper 1 Style, Short Answer, Medium, 4 marks]**

(a) $X \sim B(40, 0.75)$.
$E(X) = n \times p = 40 \times 0.75$. **(M1)**
$E(X) = 30$. **A1**

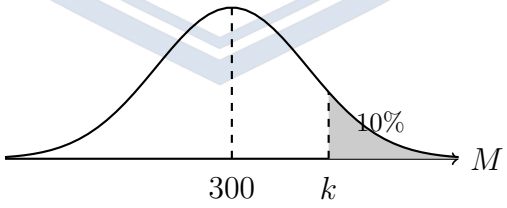
(b) $\text{Var}(X) = n \times p \times (1-p) = 40 \times 0.75 \times 0.25 = 7.5$. **(M1)**
Standard Deviation $\sigma = \sqrt{7.5} = 2.73861\ldots$
$\sigma \approx 2.74$. **A1**

5. **[Paper 1 Style, Short Answer, Medium, 6 marks]**

(a) Let $M \sim N(300, 100^2)$. We need $P(M \geq 450)$. **(M1)**
Use `NormCD`. Set `Lower: 450`, `Upper: 1E99`, σ: `100`, μ: `300`.
$P(M \geq 450) = 0.066807\cdots \approx 0.0668$. **A1A1**

(b) $P(M > k) = 0.10$. **(M1)**
Use `InvNorm` [`DIST -> NORM -> InvN`].
Set `Tail: Right`, `Area: 0.10`, σ: `100`, μ: `300`. **(M1)**
$k = 428.155\cdots \implies k \approx 428$. **A1**

Visual Answer Key:



6. **[Paper 2 Style, Longer Question, Medium, 6 marks]**

(a) Let $W \sim N(500, 3^2)$. We need $P(W < 495)$. **(M1)**
Use `NormCD`. Set `Lower: -1E99`, `Upper: 495`, σ: `3`, μ: `500`.
$P(W < 495) = 0.0477903\cdots \approx 0.0478$. **A1**

(b) This is a binomial experiment: $Y \sim B(10, p)$ where $p = 0.0477903\ldots$. **(M1)**
We need $P(Y = 1)$. **(M1)**
Use `BinomialPD`. Set `x: 1`, `Numtrial: 10`, `p: 0.0477903`.
$P(Y = 1) = 0.314640\cdots \approx 0.315$. **A1A1**

7. **[Paper 2 Style, Longer Question, Medium, 5 marks]**

(a) Let $T \sim N(52, 5^2)$. We need $P(T \geq 60)$. **(M1)**
Use `NormCD`. Set `Lower: 60`, `Upper: 1E99`, σ: `5`, μ: `52`.
$P(T \geq 60) = 0.054799\cdots \approx 0.0548$. **A1A1**

(b) We need $P(45 \leq T \leq 55)$. **(M1)**
Use `NormCD`. Set `Lower: 45`, `Upper: 55`.
$P(45 \leq T \leq 55) = 0.644990\cdots \approx 0.645$. **A1**

8. **[Paper 2 Style, Longer Question, Medium, 6 marks]**

(a) Let X be the number of passengers who arrive. $X \sim B(75, 0.9)$. **(M1)**
We need $P(X = 72)$. **(M1)**
Use `BinomialPD`. Set `x: 72`, `Numtrial: 75`, `p: 0.9`.
$P(X = 72) = 0.038446\cdots \approx 0.0384$. **A1**

(b) The airline pays compensation if strictly more than 72 passengers arrive.
We need $P(X > 72) \implies P(X \geq 73)$. **(M1)**
Use `BinomialCD`. Set `Lower: 73`, `Upper: 75`, `Numtrial: 75`, `p: 0.9`. **(M1)**
$P(X \geq 73) = 0.026437\cdots \approx 0.0264$. **A1**

9. **[Paper 1 Style, Short Answer, Hard, 5 marks]**

(a) The normal curve is symmetric. The only point where the area strictly greater than x equals the area strictly less than x (50% each) is the mean. **(R1)**
$x = \mu = 51$. **A1**

(b) One standard deviation below the mean is $51 - 2 = 49$ cm. **(M1)**
We need $P(L > 49)$.
Use `NormCD`. Set `Lower: 49`, `Upper: 1E99`, σ: `2`, μ: `51`.
$P(L > 49) = 0.841344\cdots \approx 0.841$. **A1A1**

10. **[Paper 2 Style, Longer Question, Hard, 6 marks]**

(a) $P(H < 28) = 0.9$. Using `InvNorm` for the standard normal $Z \sim N(0, 1)$,
Set `Tail: Left`, `Area: 0.9`, σ: `1`, μ: `0`.
$z = 1.28155\ldots$. **(M1)(A1)**
Standardizing formula: $z = \frac{x-\mu}{\sigma} \implies 1.28155 = \frac{28-25}{\sigma}$. **(M1)**
$1.28155\sigma = 3 \implies \sigma = 2.34091\cdots \approx 2.34$. **A1**

(b) First find $P(H > 30)$ for one pilot. **(M1)**
Use `NormCD` with σ: `2.3409`, μ: `25`.
$P(H > 30) = 0.01634\ldots$.
Both pilots: $(0.01634\ldots) \times (0.01634\ldots) = 0.000267\ldots$. **A1**

11. **[Paper 1 Style, Short Answer, Hard, 5 marks]**

(a) Let $M \sim N(400, 50^2)$. 25% premium $\implies P(M > a) = 0.25$.
Use `InvNorm`. Set `Tail: Right`, `Area: 0.25`, σ`: 50`, μ`: 400`. **(M1)**
$a = 433.724\ldots$. **(A1)**
$a \approx 434$ g. **A1**

(b) IQR $= Q_3 - Q_1$. Q_3 is the 75th percentile (433.724 g from part a).
Use `InvNorm`. Set `Tail: Left`, `Area: 0.25`, σ`: 50`, μ`: 400`.
$Q_1 = 366.275\ldots$ g. **(M1)**
IQR $= 433.724 - 366.275 = 67.449\cdots \approx 67.4$ g. **A1**

12. **[Paper 2 Style, Longer Question, Hard, 7 marks]**

(a) Let $W \sim N(502, 2^2)$. We need $P(497.5 < W < 505)$. **(M1)**
Use `NormCD`. Set `Lower: 497.5`, `Upper: 505`, σ`: 2`, μ`: 502`.
$P(\text{Approved}) = 0.920968\cdots \approx 0.921$. **A1A1**

(b) This is conditional probability: $P(W > 502 \mid \text{Approved})$. **(M1)**
$P(W > 502 \cap \text{Approved}) = P(502 < W < 505)$. **(M1)**
Use `NormCD`. Set `Lower: 502`, `Upper: 505`.
$P(502 < W < 505) = 0.433192\ldots$. **(A1)**
Conditional $P = \frac{0.433192}{0.920968} = 0.470366\cdots \approx 0.470$. **A1**

13. **[Paper 2 Style, Longer Question, Very Hard, 6 marks]**

(a) Expected value: $np = 8.4$. **(M1)**
Variance: $np(1-p) = 2.52$. **(M1)**
Substitute $np = 8.4$ into the variance equation: $8.4(1-p) = 2.52$.
$1 - p = \frac{2.52}{8.4} = 0.3 \implies p = 0.7$. **A1**
Substitute $p = 0.7$ back into the mean equation: $n(0.7) = 8.4 \implies n = 12$. **A1**

(b) We need $P(X \leq 8)$ for $X \sim B(12, 0.7)$. **(M1)**
Use `BinomialCD`. Set `Lower: 0`, `Upper: 8`, `Numtrial: 12`, `p: 0.7`.
$P(X \leq 8) = 0.474626\cdots \approx 0.475$. **A1**

14. **[Paper 2 Style, Longer Question, Very Hard, 7 marks]**

(a) $P(T < 20) = 0.10$. Use `InvNorm` with `Tail: Left`, `Area: 0.10`, σ: `1`, μ: `0`.
$z_1 = -1.28155\ldots$. **(M1)**
$P(T > 29) = 0.15$. Use `InvNorm` with `Tail: Right`, `Area: 0.15`, σ: `1`, μ: `0`.
$z_2 = 1.03643\ldots$. **(M1)**
Standardizing Equations:
$\frac{20-\mu}{\sigma} = -1.28155 \implies 20 - \mu = -1.28155\sigma$. **A1**
$\frac{29-\mu}{\sigma} = 1.03643 \implies 29 - \mu = 1.03643\sigma$. **A1**

(b) Subtract equation 1 from equation 2:
$9 = 2.31798\sigma \implies \sigma = 3.88269\cdots \approx 3.88$. **(M1)A1**
Substitute σ back: $\mu = 20 + 1.28155(3.88269) = 24.9758\cdots \approx 25.0$. **A1**

15. **[Paper 1 Style, Short Answer, Very Hard, 6 marks]**

(a) Let $D \sim N(10, 3^2)$. We need $P(D < 13)$. **(M1)**
Use `NormCD`. Set `Lower: -1E99`, `Upper: 13`, σ: `3`, μ: `10`.
$P(D < 13) = 0.841344\cdots \approx 0.841$. **A1**

(b) All 3 darts must land within 13 cm.
Since throws are independent: $P(\text{Point}) = (0.841344\ldots)^3$. **(M1)**
$P(\text{Point}) = 0.595543\cdots \approx 0.596$. **A1**

(c) Let Y be the number of points scored. $Y \sim B(10, 0.595543)$. **(M1)**
We need $P(Y \geq 5)$.
Use `BinomialCD`. Set `Lower: 5`, `Upper: 10`, `Numtrial: 10`, `p: 0.595543`.
$P(Y \geq 5) = 0.843043\cdots \approx 0.843$. **A1**