

NORMAL DISTRIBUTIONS 2 ANSWERS

1)

Notes: Accept any suitable notation, as long as the candidate's intentions are clear.
 The following symbols will be used in the markscheme.
 Girls' height $G \sim N(155, 10^2)$, boys' height $B \sim N(160, 12^2)$
 Height H , Female F , Male M .

(a) $P(G > 170) = 1 - P(G < 170)$ (A1)
 $P(G < 170) = P\left(Z < \frac{170 - 155}{10}\right)$ (A1)
 $P(G > 170) = 1 - \Phi(1.5) = 1 - 0.9332$
 $= 0.0668$ A1 N3
[3 marks]

(b) $z = -1.2816$ (A1)
 Correct calculation (e.g. $x = 155 + -1.282 \times 10$) (A1)
 $x = 142$ A1 N3
[3 marks]

(c) Calculating one variable (A1)
 e.g. $P(B < r) = 0.95$, $z = 1.6449$
 $r = 160 + 1.645(12) = 179.74$
 $= 180$ A1 N2

 Any valid calculation for the second variable, including use of symmetry (A1)
 e.g. $P(B < q) = 0.05$, $z = -1.6449$
 $q = 160 - 1.645(12) = 140.26$
 $= 140$ A1 N2
[4 marks]

2) (a) $z = \frac{180 - 160}{20} = 1$ (A1)
 $\phi(1) = 0.8413$ (A1)
 $P(\text{height} > 180) = 1 - 0.8413$
 $= 0.159$ A1 N3

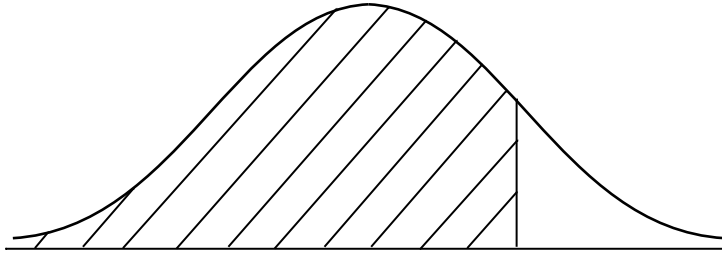
(b) $z = -1.1800$ (A1)
 Setting up equation $-1.18 = \frac{d - 160}{20}$ (M1)
 $d = 136$ A1 N3

3) (a) $P(H < 153) = 0.705 \Rightarrow z = 0.538(836\dots)$ (A1)
 Standardizing $\frac{153 - \mu}{5}$ (A1)
 Setting up **their** equation $0.5388\dots = \frac{153 - \mu}{5}$ M1
 $\mu = 150.30\dots$
 $= 150$ (to 3 s.f) A1 N3

(b) $Z = \frac{156 - \mu}{5} = 1.138\dots$ (accept 1.14 from $\mu = 150.3$, or 1.2 from $\mu = 150$) (A1)
 $P(Z > 1.138) = 0.128$ (accept 0.127 from $z = 1.14$, or 0.115 from $z = 1.2$) A1 N2

- 4) (a) 0.0668 A2 N2
 (b) Using the standardised value 1.645 (A1)
 $k = 26.1$ kg A1 N2

(c)



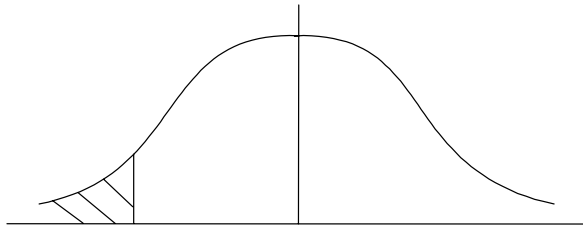
A1A1 N2

Notes: Award **A1** for vertical line to right of the mean,
A1 for shading to left of **their** vertical line.

- 5) (i) (a) (i) $a = -1$ (A1)
 $b = 0.5$ (A1)
 (ii) (a) 0.841 (A2)
 (b) $0.6915 - 0.1587$ (or $0.8413 - 0.3085$) (M1)
 $= 0.533$ (3 s.f.) (A1) (N2)

[6 marks]

- (b) (i) Sketch of normal curve (A1)(A1)



- (ii) $c = 0.647$ (A2)

[4 marks]

- 6) (a) evidence of approach (M1)
e.g. finding 0.84..., using $\frac{23.7 - 21}{\sigma}$
- correct working (A1)
e.g. $0.84... = \frac{23.7 - 21}{\sigma}$, graph
 $\sigma = 3.21$ AI N2
- (b) (i) evidence of attempting to find $P(X < 25.4)$ (M1)
e.g. using $z = 1.37$
 $P(X < 25.4) = 0.915$ AI N2
- (ii) evidence of recognizing symmetry (M1)
e.g. $b = 21 - 4.4$, using $z = -1.37$
 $b = 16.6$ AI N2
[7 marks]
- 7) (a) evidence of attempt to find $P(X \leq 475)$ (M1)
e.g. $P(Z \leq 1.25)$
 $P(X \leq 475) = 0.894$ AI N2
- (b) evidence of using the complement (M1)
e.g. 0.73, $1 - p$
- $z = 0.6128$ (A1)
setting up equation (M1)
e.g. $\frac{a - 450}{20} = 0.6128$
 $a = 462$ AI N3
[6 marks]

- 8)
- (a) evidence of appropriate approach (M1)
e.g. $1 - 0.85$, diagram showing values in a normal curve
 $P(w \geq 82) = 0.15$ AI N2
 [2 marks]
- (b) (i) $z = -1.64$ AI N1
- (ii) evidence of appropriate approach (M1)
e.g. $-1.64 = \frac{x - \mu}{\sigma}$, $\frac{68 - 76.6}{\sigma}$
 correct substitution AI
e.g. $-1.64 = \frac{68 - 76.6}{\sigma}$
 $\sigma = 5.23$ AI N1
 [4 marks]
- (c) (i) $68.8 \leq \text{weight} \leq 84.4$ AIAIAI N3
Note: Award AI for 68.8, AI for 84.4, AI for giving answer as an interval.
- (ii) evidence of appropriate approach (M1)
e.g. $P(-1.5 \leq z \leq 1.5)$, $P(68.76 < y < 84.44)$
 $P(\text{qualify}) = 0.866$ AI N2
 [5 marks]
- 9)
- (a) evidence of approach (M1)
e.g. finding 0.84..., using $\frac{23.7 - 21}{\sigma}$
 correct working (AI)
e.g. $0.84... = \frac{23.7 - 21}{\sigma}$, graph
 $\sigma = 3.21$ AI N2
- (b) (i) evidence of attempting to find $P(X < 25.4)$ (M1)
e.g. using $z = 1.37$
 $P(X < 25.4) = 0.915$ AI N2
- (ii) evidence of recognizing symmetry (M1)
e.g. $b = 21 - 4.4$, using $z = -1.37$
 $b = 16.6$ AI N2
 [7 marks]

10)