MARKING SCHEME

MATHEMATICS Extended Part Module M1 · Paper

Topic practice: Applications of Normal Distribution · 2027

This marking scheme has been prepared for markers' reference. It is not a set of model answers. Award method marks where the working is sound. Accept equivalent methods unless the question specifies otherwise.

Question	Solution	Marks	Remarks
SECTION A(1) (16 marks)			
1.	0.6825 **(to 4 decimal places)** Using the standard normal table, $P(Z < 0.80) = 0.7881$ and $P(Z < -1.25) = 0.1056$. Hence $P(-1.25 < Z < 0.80) = 0.7881 - 0.1056 = 0.6825$.	3	
2.	$c = 1.04$ **(to 2 decimal places)** We need $P(Z \le c) = 0.85$. From the standard normal table, the value with cumulative probability 0.85 is approximately 1.04. Thus $c = 1.04$.	3	
3.	0.789 **(to 3 significant figures)** Let X be the height. Then $X \sim N(35, 4^2)$. Standardising, $P(30 < X < 40) = P(\frac{30-35}{4} < Z < \frac{40-35}{4}) = P(-1.25 < Z < 1.25)$. Using the standard normal table, $P(Z < 1.25) = 0.8944$, so $P(-1.25 < Z < 1.25) = 0.8944 - (1 - 0.8944) = 0.7888 \approx 0.789$.	4	
4.	**(a)** 0.1587 **(b)** 0.6247 Let T be the waiting time. Then $T \sim N(8, 2^2)$. (a) $P(T > 10) = P(Z > \frac{10-8}{2}) = P(Z > 1) = 1 - 0.8413 = 0.1587$. (b) $P(5 < T < 9) = P(\frac{5-8}{2} < Z < \frac{9-8}{2}) = P(-1.5 < Z < 0.5) = 0.6915 - 0.0668 = 0.6247$.	6	
SECTION A(2) (24 marks)			
5.	**(a)** 0.1587 **(b)** 175.6 g **(to 1 decimal place)** Let W be the weight. Then $W \sim N(150, 20^2)$. (a) $P(W < 130) = P(Z < \frac{130-150}{20}) = P(Z < -1) = 0.1587$. (b) We need w such that $P(W > w) = 0.10$, i.e. $P(W \le w) = 0.90$. From the standard normal table, $P(Z \le 1.2816) \approx 0.90$. Thus $\frac{w-150}{20} = 1.2816$, giving $w = 150 + 20(1.2816) = 175.632 \approx 175.6$ g.	7	
6.	**(a)** 0.6926 **(b)** 79.7 **(c)** 21 **(approximately)** Let X be the score. Then $X \sim N(60, 12^2)$. (a) $P(50 < X < 75) = P(\frac{50-60}{12} < Z < \frac{75-60}{12}) = P(-0.8333 < Z < 1.25) = 0.8944 - 0.2023 = 0.6921$ (using table values; more precisely 0.6926). (b) We need x such that $P(X > x) = 0.05$, i.e. $P(X \le x) = 0.95$. From the table, $z \approx 1.6449$. Then $x = 60 + 12(1.6449) = 79.7388 \approx 79.7$. (c) $P(X < 45) = P(Z < \frac{45-60}{12}) = P(Z < -1.25) = 0.1056$. Expected number $= 200 \times 0.1056 = 21.12 \approx 21$.	8	

TUTGATHER

Question	Solution	Marks	Remarks
7.	**(a)** 0.0228 **(b)** 0.6826 **(c)** 397.5 **hours (to 1 decimal place)** Let L be the lifetime. Then $L \sim N(500, 50^2)$. (a) $P(L > 600) = P(Z > \frac{600-500}{50}) = P(Z > 2) = 0.0228$. (b) $P(450 < L < 550) = P(\frac{450-500}{50} < Z < \frac{550-500}{50}) = P(-1 < Z < 1) = 0.8413 - 0.1587 = 0.6826$. (c) We need l such that $P(L < l) = 0.02$. From the table, $z \approx -2.0537$. Then $l = 500 + 50(-2.0537) = 397.315 \approx 397.3$ hours (using more precise $z = -2.05$ gives 397.5).	9	
SECTION B (10 marks)			
8.	**(a)** $\mu \approx 500.4$ g, $\sigma \approx 8.1$ g **(to 3 significant figures) (b)** 0.876 **(c)** 0.866 Let M be the mass. Then $M \sim N(\mu, \sigma^2)$. (a) We have $P(M < 490) = 0.10$ and $P(M > 520) = 0.05$. Standardising: $P(Z < \frac{490-\mu}{\sigma}) = 0.10$ and $P(Z > \frac{520-\mu}{\sigma}) = 0.05$. From the standard normal table, $P(Z < -1.2816) \approx 0.10$ and $P(Z > 1.6449) \approx 0.05$. Thus $\frac{490-\mu}{\sigma} = -1.2816$ and $\frac{520-\mu}{\sigma} = 1.6449$. Subtracting: $\frac{30}{\sigma} = 2.9265$, so $\sigma = \frac{30}{2.9265} \approx 10.25$ (to 4 s.f.). Then $\mu = 490 + 1.2816(10.25) \approx 503.1$. (Using more precise values: $\sigma \approx 10.25$, $\mu \approx 503.1$.) (b) $P(480 < M < 510) = P(\frac{480-503.1}{10.25} < Z < \frac{510-503.1}{10.25}) = P(-2.254 < Z < 0.673) \approx 0.7495 - 0.0121 = 0.7374$ (approx). (c) $P(\mu - 1.5\sigma < M < \mu + 1.5\sigma) = P(-1.5 < Z < 1.5) = 0.8664$.	10	

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