adamjee maths

A-LEVEL MATHS / EDEXCEL / FREE RESOURCES

Normal distribution

Mark scheme

2 questions

Exam questions and marking instructions remain credited to their board.

Contents

1 June 2024 - Paper 3 Statistics - Q5

2 October 2020 - Paper 3 Statistics - Q5

Qu 5	Scheme	Marks	AO
(a)	[P($H > 1.6$) =] 0.091211… = awrt **0.0912**	B1 **(1)**	1.1b
(b)	Need H and T to be independent or events $\{H > 1.6\}$ and $\{T < 300\}$ are independent	B1 **(1)**	2.4
(c)	[P($T < 300$) =] 0.124(2816…) Prob both is: "0.0912..."×"0.124..." = 0.011335… = awrt **0.0113**	M1 M1 A1 **(3)**	3.4 1.1b 1.1b
(d)	$\frac{16.3-\mu}{\sigma} = -0.5244(0051...)$, $\frac{29-\mu}{\sigma} = 1.2816$ (calc: 1.28155156…) e.g. $29-16.3 = \sigma$("1.2816"−"−0.5244") $\sigma = 7.032115...$ = awrt **7.03** $\mu = 19.9876...$ = **19.95** „ **μ** „ **20.0**	M1M1 M1 A1 A1 **(5)**	3.1a 1.1b 1.1b 1.1b 3.2a
		(10 marks)	

	Notes
(a)	B1 for awrt 0.0912 (from calculator)
(b)	B1 for a suitable reason mentioning or implying H and T are independent Allow: e.g. "they"/ "each event"/ "P(H) and P(T)"/ "the variables" **and** "independent" B0 for "the results" /"the values" are independent. Ignore other comments that are not incorrect or contradictory.
(c)	1st M1 for using model for T to attempt to find P($T < 300$) e.g. sight of 0.124 or better or sight of $\pm\left(\frac{300-330}{26}\right)$ or $\pm\left(\frac{5-5.5}{0.433...}\right)$ or $Z = \pm 1.15(3…)$ 2nd M1 for multiplying their two probabilities together ft part (a) and their P($T < 300$) provided both values are probabilities. NB M0M1 is possible here A1 for awrt 0.0113 [Correct answer with no incorrect working 3/3]
(d)	1st M1 for standardising 16.3 and setting equal to z value where $0.5 < \|z\| < 0.6$ 2nd M1 for standardising 29 and setting equal to z value where $1 < \|z\| < 1.5$ 3rd M1 dep on 1st or 2nd M1 for solving their two linear eq'ns – reach an eq'n in one variable May be implied by sight of $\sigma = 7$ (or better) or $\mu = 20$ (or better) **For 1st A mark we must also see one of – 0.5244 or 1.2816 (or better) used in their equ'ns OR both z values correct to 3dp i.e. – 0.524 and 1.282** 1st A1 for σ = awrt 7.03 (but see 3rd case below) 2nd A1 for μ = in [19.95, 20.0] (i.e shouldn't see something rounding down to 20.0) Allow 20 from equations with suitable z values (see examples below)
NB	Use of – 0.524 and 1.28 [would give 7.0399… and 19.988…] and scores M3A0A1 Use of – 0.524 and 1.2816 [would give 7.033… and 19.99…] and scores M3A1A1 Use of – 0.5244 and 1.28 [would give 7.038… and 19.99 …] and scores M3**A1**A1 Both z values correct to 3dp i.e. – 0.524 and 1.282 [should give 7.032 and 19.984] scores A1A1

Qu 5	Scheme	Marks	AO
(a)	{Let X = time spent, P(X > 15) = } 0.105649… awrt **0.106**	B1 **(1)**	1.1b
(b)	$H_0 : \mu = 10$ $H_1 : \mu > 10$	B1	2.5
	$\bar{X} \sim N\left(10, \left(\frac{4}{\sqrt{20}}\right)^2\right)$; $P(\bar{X} > 11.5)$ = 0.046766… [Condone 0.9532…]	M1;A1	3.3;3.4
	[This is significant (< 5%) so] there is evidence to support the complaint	A1 **(4)**	2.2b
(c)(i)	[P(T < 2) =] 0.1956… awrt **0.196**	B1 **(1)**	1.1b
(ii)	Require $\frac{P(0 < T < 2)}{P(T > 0)} = \frac{0.119119...}{0.923436...}$; = 0.1289955… awrt **0.129**	M1 A1;A1 **(3)**	3.4 1.1bx2
(iii)	The current model suggests **non-negligible** probability of T values < 0 which is impossible	B1 **(1)**	3.5b
(d)	Require t such that P($T > t \mid T > 2$) = 0.5 or P($T < t \mid T > 2$) = 0.5	M1	3.1b
	e.g. $\frac{P(T > t)}{P(T > 2)} = 0.5$; so P($T > t$) = 0.5×[1 – (c)(i)] or P($T > t$) = 0.5×0.8043..	M1; A1ft	1.1b 3.4
	[i.e. P($T > t$) = 0.40… implies] $\frac{t-5}{3.5} = 0.2533$ or P($T < t$) = "0.5978.."	M1	1.1b
	t = 5.886… or from calculator 5.867… so awrt **5.9**	A1 **(5)**	1.1b
		(15 marks)	

	Notes
(a)	B1 for awrt 0.106 (from calculator) [Allow 10.6%]
(b)	B1 for both hypotheses correct in terms of μ. M1 for selection of a correct model (sight or use of correct normal- may not have label $\bar{X}$) 1st A1 for use of this model to get probability allow 0.046~0.047 [Condone awrt 0.953]
ALT	**OR** test statistic z = 1.677… (awrt 1.68) and cv of 1.64 (or better) **or** CR $\bar{X}$ > 11.47.. 2nd A1 (dep on 1st A1 or at least $P(\bar{X} > 11.5) < 0.05$ (o.e.))
SC	for a correct conclusion in context -must mention **complaint**/claim or **time**/mins is > 10 **(M0 for $\bar{X}$ ~N(11.5, …)** for correct probability **and** conclusion (score M0A0A1 on epen)
(c)(i)	B1 for awrt 0.196 (from calculator) [Allow 19.6%]
(ii)	M1 for a correct probability ratio expression (may be implied by 1st A1 scored) 1st A1 for a correct ratio of probabilities (both correct or truncated to 2 dp) 2nd A1 for awrt 0.129
(iii)	B1 for a suitable explanation of why model is not suitable based on negative T values Must say that a **significant** proportion of values < 0 (o.e.) e.g. P(T > 0) should be **closer** to 1 or Difference between P(T < 2| T > 0) and P(T < 2) is **too big** (o.e.)
(d)	1st M1 for a correct conditional probability statement to start the problem or 0.5×P(T > 2) 2nd M1 for correct ratio of probability expressions [Must have P($T > t$) or P(2 < T < t)] 1st A1ft for a correct equation for P($T > t$) (o.e.) ft their answer to part (c)[May be in a diagram] 3rd M1 for attempt to find t (standardising and sight of 0.2533) or prepare to use calc (ft) Arriving at P(T < median) = 1 – 0.5×"their 0.8043" will score 1st 4 marks 2nd A1 for awrt 5.9 Sight of awrt 5.9 and at least one M mark scores 5/5 [Answer only send to review]

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