

Mark Scheme (Results) January 2010

GCE

Statistics S2 (6684)

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our website at www.edexcel.com.

If you have any subject specific questions about the content of this Mark Scheme that require the help of a subject specialist, you may find our **Ask The Expert** email service helpful.

Ask The Expert can be accessed online at the following link:

<http://www.edexcel.com/Aboutus/contact-us/>

January 2010

Publications Code UA023029

All the material in this publication is copyright

© Edexcel Ltd 2010

January 2010
6684 Statistics S2
Mark Scheme

Question Number	Scheme	Marks
Q1	<p>(a) $X \sim B(20, 0.05)$</p> <p>(b) $P(X = 0) = 0.95^{20} = 0.3584859\dots$ or 0.3585 using tables .</p> <p>(c) $P(X > 4) = 1 - P(X \leq 4)$ $= 1 - 0.9974$ $= 0.0026$</p> <p>(d) Mean = $20 \times 0.05 = 1$ Variance = $20 \times 0.05 \times 0.95 = 0.95$</p>	<p>B1 B1 (2)</p> <p>M1 A1 (2)</p> <p>M1 A1 (2)</p> <p>B1 B1 (2)</p> <p style="text-align: right;">Total [8]</p>
Q1	<p>Notes</p> <p>(a) 1st B1 for binomial 2nd B1 for 20 and 0.05 o.e These must be in part (a)</p> <p>(b) M1 for finding $(p)^{20}$ $0 < p < 1$ this working needs to be seen if answer incorrect to gain the M1 A1 awrt 0.358 or 0.359.</p> <p>(c) M1 for writing $1 - P(X \leq 4)$ or $1 - [P(X = 0) + P(X = 1) + P(X = 2) + P(X = 3) + P(X = 4)]$ or $1 - 0.9974$ or $1 - 0.9568$ A1 awrt 0.0026 or 2.6×10^{-3}, do not accept a fraction e.g. 26/10000</p> <p>(d) 1st B1 for 1 2nd B1 for 0.95</p> <p>NB In parts b, c and d correct answers with no working gain full marks</p>	

Question Number	Scheme	Marks
Q2 (a)	$P(X < 0) = F(0)$ $= \frac{2}{6} = \frac{1}{3}$	M1 A1 (2)
(b)	$f(x) = \frac{dF(x)}{dx}$ $f(x) = \begin{cases} \frac{1}{6} & -2 \leq x \leq 4 \\ 0 & \text{otherwise} \end{cases}$	M1 A1 B1 (3)
(c)	Continuous Uniform (Rectangular) distribution	B1 (1)
(d)	Mean = 1	B1
(e)	Variance is $\frac{(4 - -2)^2}{12} = 3$	M1 A1 (3)
(e)	$P(X = 1) = 0$	B1 (1) Total [10]
Q2 (a)	<p>Notes</p> <p>M1 for attempting to find $F(0)$ by a correct method eg subst 0 into $F(x)$ or $\int_{-2}^0 \frac{1}{6} dx$</p> <p>Do NOT award M1 for $\int_{-2}^0 \frac{x+2}{6} dx$ or $\frac{1}{2} \times \frac{1}{3} \times 2$ both of which give the correct answer by using $F(x)$ as the pdf</p> <p>A1 1/3 o.e or awrt 0.333</p> <p>Correct answer only with no incorrect working gets M1 A1</p> <p>(b) M1 for attempting to differentiate $F(x)$. (for attempt it must have no xs in)</p> <p>A1 for the first line. Condone $<$ signs</p> <p>B1 for the second line. – They must have $0 < x < -2$ and $x > 4$ only.</p> <p>(c) B1 must have “continuous” and “uniform” or “Rectangular”</p> <p>(d) B1 for mean = 1</p> <p>M1 for attempt to use $\frac{[\pm(b-a)]^2}{12}$, they must subst in values and not just quote the formula, or using $\int_{-2}^4 x^2 (their f(x)) - (their mean)^2$, including limits. Must get x^3 when they integrate.</p> <p>A1 cao .</p> <p>(e) B1 cao</p>	

Question Number	Scheme	Marks
Q3 (a)	$Y \sim \text{Po}(0.25)$ $P(Y=0) = e^{-0.25}$ $= 0.7788$	B1 M1 A1 (3)
(b)	$X \sim \text{Po}(0.4)$ $P(\text{Robot will break down}) = 1 - P(X = 0)$ $= 1 - e^{-0.4}$ $= 1 - 0.067032$ $= 0.3297$	B1 M1 A1 (3)
(c)	$P(X = 2) = \frac{e^{-0.4} (0.4)^2}{2!}$ $= 0.0536$	M1 A1 (2)
(d)	0.3297 or answer to part (b) as Poisson events are <u>independent</u>	B1ft B1 dep (2) Total [10]
Q3 (a)	<p>Notes</p> <p>B1 for seeing or using Po(0.25) M1 for finding $P(Y=0)$ either by e^{-a}, where a is positive (a needn't equal their λ) or using tables if their value of λ is in them Beware common Binomial error using, $p = 0.05$ gives 0.7738 but scores B0 M0 A0 A1 awrt 0.779</p> <p>B1 for stating or a clear use of Po(0.4) in part (b) or (c) M1 for writing or finding $1 - P(X = 0)$ A1 awrt 0.33</p> <p>M1 for finding $P(X=2)$ e.g. $\frac{e^{-\lambda} \lambda^2}{2!}$ with their value of λ in or if their λ is in the table for writing $P(X \leq 2) - P(X \leq 1)$ A1 awrt 0.0536</p> <p>1st B1 their answer to part(b) correct to 2 sf or awrt 0.33 2nd B1 need the word independent. This is dependent on them gaining the first B1 SC Use of Binomial. Mark parts a and b as scheme. They could get (a) B0,M0,A0 (b) B0 M1 A0 In part c allow M1 for ${}^n C_2 (p)^2(1-p)^{n-2}$ with “their n” and “their p”. They could get (c) M1,A0 DO NOT GIVE for $p(x \leq 2) - p(x \leq 1)$ In (d) they can get the first B1 only. They could get (d) B1B0</p>	

Question Number	Scheme	Marks
Q4 (a)	$\int_0^3 k(x^2 - 2x + 2)dx + \int_3^4 3kdx = 1$ $k \left[\frac{1}{3}x^3 - x^2 + 2x \right]_0^3 + [3kx]_3^4 \quad (=1) \quad \text{or} \quad k \left[\frac{1}{3}x^3 - x^2 + 2x \right]_0^3 + 3k \quad (=1)$ $9k = 1$ $k = \frac{1}{9} \quad \text{**given**}$	M1 A1 M1 dep A1 (4)
(b)	<p>For $0 < x \leq 3$, $F(x) = \int_0^x \frac{1}{9}(t^2 - 2t + 2)dt$</p> $= \frac{1}{9} \left(\frac{1}{3}x^3 - x^2 + 2x \right)$ <p>For $3 < x \leq 4$, $F(x) = \int_3^x 3kdt + \frac{2}{3}$</p> $= \frac{x}{3} - \frac{1}{3}$ $F(x) = \begin{cases} 0 & x \leq 0 \\ \frac{1}{27}(x^3 - 3x^2 + 6x) & 0 < x \leq 3 \\ \frac{x}{3} - \frac{1}{3} & 3 < x \leq 4 \\ 1 & x > 4 \end{cases}$	M1 A1 M1 A1 B1 ft B1 (6)
(c)	$E(X) = \int_0^3 \frac{x}{9}(x^2 - 2x + 2)dx + \int_3^4 \frac{x}{3}dx$ $= \frac{1}{9} \left[\frac{1}{4}x^4 - \frac{2}{3}x^3 + x^2 \right]_0^3 + \left[\frac{1}{6}x^2 \right]_3^4$ $= \frac{29}{12} \quad \text{or } 2.416 \quad \text{or awrt } 2.42$	M1 A1 A1 (3)
(d)	$F(m) = 0.5$ $F(2.6) = \frac{1}{27}(2.6^3 - 3 \times 2.6^2 + 6 \times 2.6) = \text{awrt } 0.48$ $F(2.7) = \frac{1}{27}(2.7^3 - 3 \times 2.7^2 + 6 \times 2.7) = \text{awrt } 0.52$ <p>Hence median lies between 2.6 and 2.7</p>	M1 M1 A1 A1 dA (4) Total [17]

<u>Notes</u>	
Q4	<p>(a) 1st M1 attempting to integrate at least one part (at least one $x^n \rightarrow x^{n+1}$) (ignore limits) 1st A1 Correct integration. Limits not needed. 2nd M1 dependent on the previous M being awarded. Adding the two answers together, putting equal to 1 and have the correct limits. 2nd A1 cso</p> <p>(b) 1st M1 Att to integrate $\frac{1}{9}(t^2 - 2t + 2)$ (at least one $x^n \rightarrow x^{n+1}$). Ignore limits for method mark 1st A1 $\frac{1}{9}\left(\frac{x^3}{3} - x^2 + 2x\right)$ allow use of t. Must have used/implied use of limit of 0. This must be on its own without anything else added 2nd M1 attempting to find $\int_3^x 3k + \dots$ (must get $3kt$ or $3kx$) and they must use the correct limits and add $\int_0^3 \frac{1}{9}(t^2 - 2t + 2)$ or $\frac{2}{3}$ or use $+ C$ and use $F(4) = 1$ 2nd A1 $\frac{x}{3} - \frac{1}{3}$ must be correct</p> <p>1st B1 middle pair followed through from their answers. condone them using $<$ or \leq incorrectly they do not need to match up 2nd B1 end pairs. condone them using $<$ or \leq. They do not need to match up</p> <p>NB if they show no working and just write down the distribution. If it is correct they get full marks. If it is incorrect then they cannot get marks for any incorrect part. So if $0 < x \leq 3$ is correct they can get M1 A1 otherwise M0 A0. If $3 < x \leq 4$ is correct they can get M1 A1 otherwise M0 A0. you cannot award B1ft if they show no working unless the middle parts are correct.</p> <p>(c) 1st M1 attempting to use integral of $x f(x)$ on one part 1st A1 Correct Integration for both parts added together. Ignore limits. 2nd A1 cao or awrt 2.42</p> <p>(d) 1st M1 for using $F(X) = 0.5$. This may be implied by subst into $F(X)$ and comparing answers with 0.5. 2nd M1 for substituting both 2.6 and 2.7 into “their $F(X)$” – 0.5 or “their $F(X)$” 1st A1 awrt 0.48 and 0.52 if using “their $F(X)$” and awrt – 0.02 and 0.02 or if using “their $F(X)$” 0.5</p> <p>Other values possible. You may need to check their values for their correct equation NB these last two marks are B1 B1 on ePEN but mark as M1 A1 2nd A1 for conclusion but only award if it follows from their numbers. Dependent on previous A mark being awarded SC using calculators M1 for sign of a suitable equation M1 A1 for awrt 2.66 provided equation is correct A1 correct comment</p>

Question Number	Scheme	Marks
Q5	<p>(a) $X \sim \text{Po}(10)$ $P(X < 9) = P(X \leq 8)$ $= 0.3328$</p> <p>(b) $Y \sim \text{Po}(40)$ Y is approximately $N(40, 40)$ $P(Y > 50) = 1 - P(Y \leq 50)$ $= 1 - P\left(Z < \frac{50.5 - 40}{\sqrt{40}}\right)$ $= 1 - P(Z < 1.660..)$ $= 1 - 0.9515$ $= 0.0485$</p> <p>N.B. Calculator gives 0.048437. Poisson gives 0.0526 (but scores nothing)</p>	<p>B1 M1 A1 (3)</p> <p>M1 A1</p> <p>M1 M1 A1</p> <p>A1 (6) Total [9]</p>
Q5	<p>Notes</p> <p>(a) B1 for using $\text{Po}(10)$ M1 for attempting to find $P(X \leq 8)$: useful values $P(X \leq 9)$ is 0.4579(M0), using $\text{Po}(6)$ gives 0.8472, (M1). A1 awrt 0.333 but do not accept $\frac{1}{3}$</p> <p>(b) 1st M1 for identifying the normal approximation 1st A1 for [mean = 40] and [sd = $\sqrt{40}$ or var = 40] NB These two marks are B1 M1 on ePEN</p> <p>These first two marks may be given if the following are seen in the standardisation formula : 40 and $\sqrt{40}$ or awrt 6.32</p> <p>2nd M1 for attempting a continuity correction (50 or 30 ± 0.5 is acceptable) 3rd M1 for standardising using their mean and their standard deviation and using either 49.5, 50 or 50.5. (29.5, 30, 30.5) accept \pm</p> <p>2nd A1 correct z value awrt ± 1.66 or this may be awarded if see $\pm \frac{50.5 - 40}{\sqrt{40}}$ or</p> <p>$\pm \frac{29.5 - 40}{\sqrt{40}}$</p> <p>3rd A1 awrt 3 sig fig in range 0.0484 – 0.0485</p>	

Question Number	Scheme	Marks
Q6	<p>(a) The set of values of the test statistic for which the null hypothesis is rejected in a hypothesis test.</p> <p>(b) $X \sim B(30, 0.3)$ $P(X \leq 3) = 0.0093$ $P(X \leq 2) = 0.0021$ $P(X \geq 16) = 1 - 0.9936 = 0.0064$ $P(X \geq 17) = 1 - 0.9979 = 0.0021$ Critical region is $(0 \leq) x \leq 2$ or $16 \leq x (\leq 30)$</p> <p>(c) Actual significance level $0.0021 + 0.0064 = 0.0085$ or 0.85%</p> <p>(d) 15 (it) is not in the critical region not significant No significant evidence of a change in $p = 0.3$ accept H_0, (reject H_1) $P(x \geq 15) = 0.0169$</p>	<p>B1 B1 (2)</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>A1A1 (5)</p> <p>B1 (1)</p> <p>Bft 2, 1, 0</p> <p>(2)</p> <p>Total [10]</p>
Q6	<p>Notes</p> <p>(a) 1st B1 for “values/ numbers” 2nd B1 for “reject the null hypothesis” o.e or the test is significant</p> <p>(b) M1 for using $B(30, 0.3)$ 1st A1 $P(x \leq 2) = 0.0021$ 2nd A1 0.0064</p> <p>3rd A1 for $(X) \leq 2$ or $(X) < 3$ They get A0 if they write $P(X \leq 2 / X < 3)$ 4th A1 $(X) \geq 16$ or $(X) > 15$ They get A0 if they write $P(X \geq 16 X > 15)$ NB these are B1 B1 but mark as A1 A1</p> <p>$16 \leq X \leq 2$ etc is accepted To describe the critical regions they can use any letter or no letter at all. It does not have to be X.</p> <p>(c) B1 correct answer only</p> <p>(d) Follow through 15 and their critical region B1 for any one of the 5 correct statements up to a maximum of B2 – B1 for any incorrect statements</p>	

Question Number	Scheme	Marks																
Q7 (a)	<table border="1" data-bbox="225 271 970 394"> <tr> <td>x</td> <td>$1p$</td> <td>$2p$</td> </tr> <tr> <td>$P(X = x)$</td> <td>$\frac{1}{4}$</td> <td>$\frac{3}{4}$</td> </tr> </table> <p data-bbox="225 398 678 465">$\mu = 1 \times \frac{1}{4} + 2 \times \frac{3}{4} = \frac{7}{4}$ or $1\frac{3}{4}$ or 1.75</p> <p data-bbox="225 477 624 651">$\sigma^2 = 1^2 \times \frac{1}{4} + 2^2 \times \frac{3}{4} - \left(\frac{7}{4}\right)^2$ $= \frac{3}{16}$ or 0.1875</p> <p data-bbox="225 678 901 712">(b) (1,1,1), (1,1,2) any order, (1,2,2) any order, (2,2,2)</p> <p data-bbox="225 752 1331 824">(1,2,1) (2,1,1) (2,1,2) (2,2,1) all 8 cases considered. May be implied by $3 * (1,1,2)$ and $3*(1,2,2)$</p> <p data-bbox="225 864 193 898">(c)</p> <table border="1" data-bbox="225 882 1187 1061"> <tr> <td>\bar{x}</td> <td>1</td> <td>$\frac{4}{3}$</td> <td>$\frac{5}{3}$</td> <td>2</td> </tr> <tr> <td>$P(\bar{X} = \bar{x})$</td> <td>$\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4} = \frac{1}{64}$</td> <td>$3 \times \frac{1}{4} \times \frac{1}{4} \times \frac{3}{4} = \frac{9}{64}$</td> <td>$3 \times \frac{1}{4} \times \frac{3}{4} \times \frac{3}{4} = \frac{27}{64}$</td> <td>$\frac{3}{4} \times \frac{3}{4} \times \frac{3}{4} = \frac{27}{64}$</td> </tr> </table>	x	$1p$	$2p$	$P(X = x)$	$\frac{1}{4}$	$\frac{3}{4}$	\bar{x}	1	$\frac{4}{3}$	$\frac{5}{3}$	2	$P(\bar{X} = \bar{x})$	$\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4} = \frac{1}{64}$	$3 \times \frac{1}{4} \times \frac{1}{4} \times \frac{3}{4} = \frac{9}{64}$	$3 \times \frac{1}{4} \times \frac{3}{4} \times \frac{3}{4} = \frac{27}{64}$	$\frac{3}{4} \times \frac{3}{4} \times \frac{3}{4} = \frac{27}{64}$	<p data-bbox="1362 416 1394 450">B1</p> <p data-bbox="1362 510 1394 544">M1</p> <p data-bbox="1362 607 1394 640">A1</p> <p data-bbox="1481 640 1519 674">(3)</p> <p data-bbox="1362 685 1394 719">B1</p> <p data-bbox="1362 752 1394 786">B1</p> <p data-bbox="1481 819 1519 853">(2)</p> <p data-bbox="1362 909 1394 943">B1</p> <p data-bbox="1362 943 1442 976">M1 A1</p> <p data-bbox="1362 976 1474 1010">M1 A1A1</p> <p data-bbox="1481 1088 1519 1122">(6)</p> <p data-bbox="1378 1155 1519 1189">Total [11]</p>
x	$1p$	$2p$																
$P(X = x)$	$\frac{1}{4}$	$\frac{3}{4}$																
\bar{x}	1	$\frac{4}{3}$	$\frac{5}{3}$	2														
$P(\bar{X} = \bar{x})$	$\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4} = \frac{1}{64}$	$3 \times \frac{1}{4} \times \frac{1}{4} \times \frac{3}{4} = \frac{9}{64}$	$3 \times \frac{1}{4} \times \frac{3}{4} \times \frac{3}{4} = \frac{27}{64}$	$\frac{3}{4} \times \frac{3}{4} \times \frac{3}{4} = \frac{27}{64}$														
Q7 (a)	<p data-bbox="220 1234 304 1267">Notes</p> <p data-bbox="220 1290 368 1323">(a) B1 1.75 oe</p> <p data-bbox="220 1323 576 1368">M1 for using $\sum(x^2 p) - \mu^2$</p> <p data-bbox="220 1379 400 1413">A1 0.1875 oe</p> <p data-bbox="220 1447 408 1480">(b) ignore repeats</p> <p data-bbox="220 1514 719 1559">(c) 1st B1 4 correct means (allow repeats)</p> <p data-bbox="220 1559 679 1603">1st M1 for p^3 for either of the ends</p> <p data-bbox="220 1603 916 1637">1st A1 for $1/64$ or awrt 0.016 and $27/64$ or awrt 0.422</p> <p data-bbox="220 1637 979 1682">2nd M1 $3 \times p^2(1-p)$ for either of the middle two $0 < p < 1$</p> <p data-bbox="220 1682 1310 1749">May be awarded for finding the probability of the 3 samples with mean of either $4/3$ or $5/3$.</p> <p data-bbox="220 1749 1318 1794">2nd A1 for $9/64$ (or $3/64$ three times) and $27/64$ (or $9/64$ three times) accept awrt 3dp.</p> <p data-bbox="220 1794 767 1827">3rd A1 fully correct table, accept awrt 3dp.</p>																	

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467
Fax 01623 450481

Email publications@linneydirect.com

Order Code UA023029 January 2010

For more information on Edexcel qualifications, please visit www.edexcel.com/quals

Edexcel Limited. Registered in England and Wales no.4496750
Registered Office: One90 High Holborn, London, WC1V 7BH