GCE EXAMINERS' REPORTS

MATHEMATICS (M1 - M3 and S1 - S3) AS/Advanced

SUMMER 2012

Statistical Information

The Examiner's Report may refer in general terms to statistical outcomes. Statistical information on candidates' performances in all examination components (whether internally or externally assessed) is provided when results are issued.

Annual Statistical Report

The annual Statistical Report (issued in the second half of the Autumn Term) gives overall outcomes of all examinations administered by WJEC.

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MATHEMATICS

General Certificate of Education

Summer 2012

Advanced Subsidiary/Advanced

Principal Examiner: Dr. S. Barham

Unit Statistics

The following statistics include all candidates entered for the unit, whether or not they 'cashed in' for an award. The attention of centres is drawn to the fact that the statistics listed should be viewed strictly within the context of this unit and that differences will undoubtedly occur between one year and the next and also between subjects in the same year.

Unit	**Entry**	**Max Mark**	**Mean Mark**
M1	2707	75	49.0

Grade Ranges

A	62
B	53
C	45
D	37
E	29

N.B. The marks given above are raw marks and not uniform marks.

M1

General Comments

This paper seemed to have been well received by most candidates. Excellent solutions to all the questions were seen. No particular question stood out as causing more problems than others. The standard of the questions is comparable to that of previous papers and there was no evidence that candidates found the paper too long to complete in the allocated time as most candidates managed to attempt all the questions on the paper.

Individual Questions

Q.1 Part (a) of this question was generally well done. Some sign errors were seen usually with the candidates taking downwards as the positive direction and failing to choose the correct negative sign for the acceleration.

Part (b) was also quite well done. However, many candidates failed to isolate the forces acting on the person, and a few had difficulty making the unknown mass M the subject of the consequent equation; an easy bit of algebra which should not be beyond the capabilities of candidates at this level.

Q.2 Both parts of the question caused problems only to the weakest candidates. The most common mistake is a sign error in the N2L equation in (a) such that friction assisted motion instead of opposing it, which lost all the marks available in the question.

Q.3 In part (a), the final velocities of the objects were expressed one in terms of the other. This is slightly unfamiliar to the candidates and caused problems to the weak candidates. Some presented a circular argument, substituting $v_2 = 7.2$ or $v_1 = 3.6$ into the conservation of momentum equation and then concluding that $v_2 = 7.2$ or $v_1 = 3.6$.

The usual sign errors were seen in parts (b) and (c).

Q.4 Candidates were free to calculate the common magnitude of the acceleration of the particles, $4g$, to be 3.92 ms^{-2} and proceed as normal. That is what most candidates presented as their solution which commonly led to a high score. Candidates who noticed that one of the equations gave the tension immediately had an easier time. The unknown mass caused some problems to candidates whose algebraic skills were poor.

Q.5 Part (a) of this question was well done generally.

In part (b), a significant number of candidates omitted either the friction or the component of weight down the slope in applying N2L to the object. No marks were awarded to candidates who wrote down a N2L equation which was not dimensionally correct or in which friction assisted motion instead of opposing it. Similarly, candidates who wrote $\sin\frac{5}{13}$ or $\cos\frac{12}{13}$ gained no marks at all.

Q.6 This turned out to be the least well done of all the questions on this paper. Some candidates were unable to make a decent attempt. Some extremely nice solutions using the triangle of forces were seen, though this method is not generally applicable.

Q.7 This was a high scoring question. Some minor errors with the value of *t* were seen in part (b) in the sketching of the *v*-*t* graph, perhaps caused by candidates not reading the question with sufficient care.

Q.8 This question was much better done than previous questions on this part of the syllabus, though this may be due to the fact that this question was easier than some previous questions on this topic. It would be most helpful if candidates drew a diagram labelling their points and forces and state clearly the point about which moment was being taken. This was not always easy for examiners to determine from the candidates' solution.

Q.9 Part (a) was well answered as usual and this particular problem posed no difficulties with signs. A very small number of candidates did not like the fact that there were three bits of lamina to combine together and tried to reduce the number to two, usually with disastrous consequences.

In part (b), very many candidates did not draw a diagram to assist their thinking and failed to identify the correct right angle triangle to use in writing down the required tangent, losing all three available marks.

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Unit	Entry	Max Mark	Mean Mark
M2	930	75	50.2

Grade Ranges

A	60
B	52
C	44
D	36
E	28

N.B. The marks given above are raw marks and not uniform marks.

M2

General comments

The standard of this paper is commensurate with past papers on this syllabus and candidates were on the whole well prepared for it. All the questions were assessable to the majority of candidates and there is no evidence that the time pressure was excessive as the majority of candidates managed to attempt all nine questions. The slight unusual elements in questions 7 and 9 ensure that these questions were not as well done as usual. Question 8 (c) on horizontal circular motion was also poorly done, but that is the expected response on questions on this topic.

Individual Questions

Q.1 This was a good question to begin the paper. Most candidates obtained full marks with a small number making an error in the integration of 4cos2*t*, usually with the coefficient, though some very strange and incorrect integration were seen.

Q.2 Generally speaking, candidates remembered Hooke's Law and the formula for elastic energy and did well on this question.

Q.3 Apart from the few candidates who were not able to differentiate vectors, obtaining scalar answers, part (a) was well done by the majority. The commonest error is differentiating *t* to obtain 0 rather than 1. Many candidates failed to read the question with sufficient care and found the value of *t* when **r** is perpendicular to the given vector.

Part (b) was generally well done.

Q.4 This was a reasonably well done question with the commonest error in both parts being the omission of either the component of weight down the slope, or more often, the resistance of 600 N in the Newton second law equation.

Q.5 The modal mark for this equation would be 3 marks obtained by candidates finding the kinetic energy and the potential energy correctly. The work done by resistance is more often than not omitted. Even for candidates who remembered to use the Work-Energy Principle, there is often a sign error in the consequent equation.

Q.6 This question on projectiles was not as well done as usual. The unknown initial velocity *V* caused problems for many candidates. In part (c), many candidates did realise that that the most efficient solution involved using $s = ut + \frac{1}{2}at^2$, but there is often confusion with the value of *s*, using the incorrect $s = +5.4$ rather than the correct $s = -5.4$ when considering upwards positive motion.

Q.7 This question was not generally well done but it was no worse than expected with 7 (a) being rather better than 7 (b). Some candidates included the weight of the particle when considering N2L towards the centre of motion which is in the horizontal direction.

Q.8 Parts (a) and (b) were well done generally. Part (c) caused problems to very many candidates and a great many strange and incorrect attempts at a solution were seen. The most successful candidates simply found the position of the ship at $t = 50$ and divided that by the 40 s required for the boat to reach the ship. Many candidates thought that the boat started its journey at the point (8**i** + 7**j**) instead of at the origin.

Q.9 This question was well done as usual with the usual algebraic and arithmetic errors. Very few completely correct solutions were seen. Disappointingly, many candidates presented negative tensions as their answers in part (c) without realising that this is impossible. Some candidates thought the minimum tension must be zero which was incorrect.

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Unit	Entry	Max Mark	Mean Mark
M3	252	75	51.8

Grade Ranges

A	58
B	50
C	42
D	34
E	27

N.B. The marks given above are raw marks and not uniform marks.

M3

General Comments

This paper attracts some extremely capable candidates who did not find the paper difficult and very many near perfect scripts were seen. It was certainly a pleasure to mark. However, there were also some extremely poor scripts. On the whole, very few mediocre scripts were seen. Almost all the questions were generally well done with candidates having most problems with the Statics question 6.

Individual Questions

Q.1 This was a well done question with the most common error being the omission of the minus sign when integrating $(t+3)^{-2}$. Some elementary numerical errors were seen, commonly, candidates were out by a factor of 10 on cancelling down 27000/600.

In part (b), a minority of candidates did not realise that an expression for the displacement can be obtained by integrating the expression for *v* with respect to *t* obtained in part (a).

Q.2 Most candidates had no problems with solving the pair of simultaneous equations in (a) and even those who did not manage part (a) were able to recover and made decent attempts at the rest of the question. Many candidates did not answer the question asked in part (b) but presented the maximum acceleration as their answer, probably because they did not read the question with sufficient care.

Q.3 Not many imperfect solutions were seen and these were usually due to minor errors in algebra. A few candidates tried to use the boundary conditions on the complementary function instead of first finding the particular integral and the general solution.

Q.4 .Candidates who realise that the acceleration *a* needed to be written as $v\frac{dv}{dx}$ were usually successful in presenting a near perfect solution. Candidates who did not use the correct form for the acceleration usually got very few marks. Some candidates used the boundary conditions $x = 0$, $v = 0$ in spite of the different values given in the question, while others assumed that the constant of integration is zero, which was not true in this instance.

Q.5 Few candidates had problems with this question though some had difficulties with finding the initial velocity of the released particle which was a pity as it was a bit of work from the M1 syllabus.

Q.6 Even candidates who presented perfect solution for the previous 5 questions had problems with this question. The most common error is the omission of the friction when taking moments about *B*, or the omission of the component of force $T\cos\theta$ when taking moments about *A*. Many numerical errors were seen with the calculation of the perpendicular distances and sign errors were also common.

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Unit	**Entry**	**Max Mark**	**Mean Mark**
S1	3002	75	45.3

Grade Ranges

A	60
B	51
C	42
D	34
E	26

N.B. The marks given above are raw marks and not uniform marks.

S1

General Comments

The candidature was extremely variable with many candidates completely out of their depth at this level but also many candidates submitting excellent scripts. Solutions to the question on continuous distributions were again generally poor with many candidates showing poor skills in the use of calculus.

Individual Questions

Q.1 Part (a) (i) was well answered by the majority of candidates. Part (a) (ii), however, proved to be difficult for some candidates who failed to realise that $P(A \cap B)$ had to be found before $P(A \cup B)$ could be determined. Some candidates confused the terms ‘mutually exclusive’ and ‘independent’ and answered (a) the wrong way round.

In (b), some candidates failed to realise that $P(A \cap B)$ had to be found before $P(B \mid A)$ could be determined.

Q.2 Most candidates found $\mathrm{E}(X^2)$ correctly although some candidates thought that $\mathrm{E}(X^2) = (\mathrm{E}(X))^2$. Most candidates found E(*Y*) correctly although the calculation caused problems for many candidates with incorrect formulae seen, notably Var(*Y*) = 3Var(*X*) and Var(*Y*) = 9Var(*X*) + 4.

Q.3 Parts (a) and (b) were well answered in general. Some candidates failed to realise that (b) was intended as a signpost to solving (c), making the question much longer by evaluating the probabilities of the four possibilities WWR, WWB, BBR and BBW. Candidates who did this often made arithmetic errors.

Q.4 Part (a)(i) was well answered in general using the binomial formula. In (a)(ii), however, many candidates were unable to carry out the transition from B(10,0.75) to B(10,0.25) correctly. Part (b) was well answered in general although some candidates appear to believe that the terms ‘more than’ and ‘at least ‘are equivalent’.

Q.5 Questions on the use of the Law of Total Probability and Bayes’ Theorem are usually well answered and this question was, by a large margin, the best answered question on the paper.

Q.6 Solutions to this question were disappointing in general and it was the worst answered question on the paper. Many candidates were unable to find the correct probabilities in (b) and (c). Even with the hint in (c), many candidates seemed not to realise that (d) had to be solved by summing an infinite geometric series.

Q.7 Part (a) required the calculation of two fairly straightforward Poisson probabilities and it was well solved in general. Part (b) required an indirect use of the Poisson table and many candidates were unable to obtain the correct answer. Fairly common answers were 17 or 19 which were one row away from the correct answer and 7 which was in the wrong tail of the distribution.

Q.8 Part (a) caused problems for many candidates who were quite unable to see any systematic method for determining the possible range of θ.

Algebraic errors were fairly common in (b) and (c).

The most common errors in (c)(ii) were to fail to realise that a 4 and a 2 could occur in two ways and to believe that a 3 and a 3 could occur in two ways.

Q.9 Solutions to this question were generally disappointing with many candidates showing a poor understanding of calculus. In (a), the integrations were often carried out incorrectly and limits were sometimes omitted completely. As reported on several previous occasions, the incorrect notation $F(x) = \int_1^x f(x)\mathrm{d}x$ was fairly common. Candidates should be encouraged not to use the same letter to denote both the upper limit and the variable of integration – this will only cause confusion to candidates studying mathematics to a higher level. As stated previously, the limits were often omitted – it is of course a valid method to state that $F(x) = \int f(x)\,\mathrm{d}x + \mathrm{C}$ and then choose C so that either $F(x) = 0$ at the lower limit or $F(x) = 1$ at the upper limit. In (b) (ii), it was disappointing to see many candidates using integration to find the probability rather than using the cumulative distribution function as intended. It is of course a valid method to do that and it was given full credit if correct. Many candidates failed to solve (b) (iii) correctly and some rather strange reasons were seen to justify some of the answers.

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Unit	Entry	Max Mark	Mean Mark
S2	877	75	51.1

Grade Ranges

A	60
B	52
C	44
D	36
E	28

N.B. The marks given above are raw marks and not uniform marks.

General Comments

The general standard was good with a handful of excellent scripts. In general, however, continuity corrections continue to be a source of difficulty for many candidates with either incorrect or no correction being used. In some cases, the interpretation of *p*-values is unsatisfactory – candidates are recommended to use the guidelines in the specification. Also, some candidates fail to give a conclusion in context when this is asked for. It was clear from Q.3 that although most candidates are able to calculate a confidence interval, only a tiny minority really understand what they have found. It was extremely disappointing to note in Q.6 that many candidates were unable to carry out a fairly straightforward trigonometrical derivation.

Individual Questions

Q.1 This was well answered by most candidates and it was the best answered question on the paper. The most common error in (b) was to assume that, in the case of independence, because $E(XY) = E(X)E(Y)$, it was also true that $Var(XY) = Var(X)Var(Y)$.

Q.2 Most candidates answered (a) (i) correctly but in (a) (ii) some candidates found the lower quartile instead of the upper quartile.

Parts (b) (i) and (ii) were well answered in general but solutions to (b)(iii) were often based on an incorrect variance.

Q.3 Most candidates found the confidence interval correctly but answers to (b) were almost always incorrect. It is important for candidates to realise that if $[a,b]$ is a 90% confidence interval for some parameter θ, it is incorrect to say that θ lies in the interval $[a,b]$ with probability 0.9 for the simple reason that a,b and θ are all constants and you cannot make a probability statement involving only constants. It is important for candidates to realise that a 90% confidence interval is a realisation of a random interval which contains the unknown parameter with probability 0.9. Or to use more friendly language, if you repeat the process for finding a 90% confidence interval a large number of times, then 90% of these intervals will contain the parameter. This is a difficult concept at this level but confidence intervals are in the syllabus and therefore candidates need to understand what they are.

Q.4 This question was well answered in general. The most common error was the use of either an incorrect or no continuity correction in (b). It is important for candidates to realise that whenever a discrete distribution is approximated by a continuous distribution, then a continuity correction should be applied.

Q.5 This question was well answered in general, confirming that most candidates are confident in using the standard statistical tests. Many candidates lost the last mark by not giving the conclusion in context. It is important for candidates to realise that one of the assessment objectives, AO4, is concerned with the translation of a variety of contexts into mathematics and vice versa.

Q.6 This question was easily the worst answered question on the paper with many candidates unable to show that $X = 4\cos\theta$. This was intended to be a two-line exercise but attempts at solution were generally poor and often took up a page or more. A common solution involved the use of the cosine rule which is perfectly valid but could be regarded as a very large nutcracker to crack a very small nut. Some candidates failed to realise that integration was required to solve (b)(i), a not uncommon solution being that $E(4\cos\theta) = 4\cos[E(\theta)] = 4\cos(\pi/4) = 2\sqrt{2}$. It is important for candidates to realise that the E operator is not that friendly. Very few candidates solved (b)(ii) correctly with most writing that

$$P(X \le 3) = P(\cos\theta \le 0.75)$$
$$= P(\theta \le \cos^{-1}(0.75))$$

This is of course incorrect. Because cos is a decreasing function, the inequality should change direction. Most candidates therefore obtained the incorrect solution 0.46 instead of 0.54.

Q.7 Many candidates made a reasonable attempt at this question although arithmetic errors and incorrect continuity corrections were often seen.

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Unit	**Entry**	**Max Mark**	**Mean Mark**
S3	131	75	53.4

Grade Ranges

A	57
B	49
C	41
D	34
E	27

N.B. The marks given above are raw marks and not uniform marks.

S3

General Comments

The standard of the scripts was generally good with some excellent scripts. Statistical inference is well understood by most of these candidates although questions on estimation theory cause manipulative problems for some candidates. The question on the *t*-distribution was not so well answered as usual with many candidates using the normal distribution instead.

Individual Questions

Q.1 This question was well answered by the majority of candidates.

Q.2 This was the worst answered question on the paper with many candidates failing to realise that the *t*-distribution had to be used since the sample was small and the variance had to be estimated. This was disappointing since the *t*-distribution question has been well answered in previous years. Some candidates lost a mark by not giving the conclusion in context.

Q.3 Part (a) was a straightforward question on confidence intervals and it was well answered by the majority of candidates. Part (b), however, caused problems for some candidates who, having found the unbiased estimate for *p*, failed to see how the given information could be used to solve the remaining parts of the problem.

Q.4 This question was well answered in general. In (a), the variances should have been estimated by dividing by 49 although division by 50 was accepted in view of the large value of *n*. It was strange to see some candidates giving the variance estimates as fractions rather than decimals but this was of course accepted and it does remove the possibility of premature rounding.

Q.5 Candidates are generally well prepared for questions on this topic and most candidates found a and b correctly, almost invariably by first calculating S_{xx} and S_{xy}. As in Q.4, it was strange to see some candidates giving the values of *a* and *b* as fractions. This is of course perfectly acceptable and as in Q.4 it removes the risk of premature rounding. Candidates should, however, be advised to check that their answers are sensible in terms of the data. Here, for example, it is clear that the value of *b* is approximately 15 since the values in the *y* row increase by approximately that amount as *x* increases by 1. Giving the answer $b = \frac{5347}{350}$ makes it more difficult to carry out this check so candidates should look at the answer in decimal form before converting to a fraction.

Q.6 This was a fairly searching question on estimation theory although some excellent solutions were seen. Most candidates knew what had to be done but many made algebraic errors. Some candidates who were unable to solve (b) (i) and (ii) nevertheless carried on to give a correct solution to (b) (iii).

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