GCE EXAMINERS' REPORTS

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

SUMMER 2013

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MATHEMATICS

General Certificate of Education

Summer 2013

Advanced Subsidiary/Advanced

Principal Examiner: Dr S Barham

M1

General Comments

This was a well-received paper of commensurate length and difficulty with previously set papers on this syllabus. Many candidates scored highly, and all questions were assessable. No single question caused candidates problems generally.

Comments on individual questions.

Q.1 (a) Well done generally with a few candidates starting the motion from the origin.

(b) Some candidates correctly found the negative acceleration but did not adjust the answer to the required deceleration losing the last accuracy mark.

(c) Well done generally with some candidates trying to use one suvat equation for the entire motion which was obviously not appropriate.

Q.2 Some candidates got a bit confused with the unknown mass of the lift and had the masses multiplied together in their Newton's Second Law equations.

Q.3. In part (b), as usual with questions of this type, many candidates split up the flight path and found the times for each bit separately. No marks were awarded until a complete method for the required answer was seen. Sign errors, particularly with the value of s, were common.

Q.4 There were a number of ways of doing part (b), all of which were seen on the scripts. Some candidates assumed μ=0.6, found T to be 50.4 N, noted that this value is larger than 5g which is the maximum tension and hence concluded that there was no motion. Others found the acceleration to be -0.28, noted that this was negative and therefore not possible, hence there was no motion. Perhaps the most efficient way is to note that the limiting friction with μ=0.6 is 52.92 N and therefore larger than 5g, thus there cannot be motion. The common mistake is to compare the limiting friction with the answers found in part (a), or to use the acceleration found in part (a) in considering part (b).

Q.5 (a) This question was well done perhaps because no simultaneous equations were involved. As usual errors in calculating distances were common.

(b) Many candidates used the *M* in the question as a weight rather than a mass resulting in a dimensionally incorrect equation. Some candidates realised that the reaction at the pivot *D* is zero, but then resolved vertically to find *M* using the value for the reaction at *C* found in part (a)(i) without realising that this reaction is now different.

Q.6. As with previous questions on this topic, this question was very well done. Some candidates did not appreciate that the particle *P* had reversed its direction of motion after collision, so that there were many sign errors. In part (d), some candidates found the velocity but did not give the speed required by the question.

Q.7. (a) A great many candidates included the weight of the particle *P* in the resultant *Y* component min spite of the fact that the weight acts in a perpendicular direction to *Y*. Otherwise, this question was well done.

Q.8 Some candidates added the masses/weight but subtracted the moments of the circle in their moments equation. This was considered to be an incorrect method and the method mark was withheld, resulting in the loss of all subsequent marks.

MATHEMATICS

General Certificate of Education

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Advanced Subsidiary/Advanced

Principal Examiner: Dr S Barham

M2

General Comments

In this paper, there were some questions which required a little more thought than usual, such as questions 1(b), 5(b) and 8(b). This appeared to have caught out the candidates who like to do things by rote without the use of diagrams. There is some evidence that the paper may be marginally too long as 8(b), the last question on the paper was not well done, though this may be because candidates tend not to draw a force diagram, which compels them to look at the way the forces are acting, before attempting the question.

Comments on individual questions.

Q.1 Part (a) was generally well done with almost all candidates getting full marks. In part (b), some candidates missed the most direct way of calculating the frictional force, i.e. by dividing the work-done (196 Joules) found in part (a) by the distance moved by the object (15 metres). Thus they first found the acceleration using suvat equations ($1.63\ ms^{-2}$) before multiplying this by the mass (8 kg) to obtain the frictional force (13.067 N). As the frictional force is constant, this approach was fine here. However, it will not always work in an energy question where the forces may not be constant.

Q.2 A large number of candidates thought that the displacement vector $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$, in spite of the fact that the velocity is obviously not constant but dependent on time t. A few candidates lost the constant of integration. Part (b) and (c) were better done with some transcription errors and sign error creeping in when multiplying by -2 and removing brackets.

Q.3 This question was reasonably well done though some candidates did not realise that it was horizontal motion they need to consider in part (a). The most common mistake in part (b) is forgetting to add on the distance of 1 metre, which is the height of the point A from the ground. This loses the final accuracy mark. In part (c), many candidates used the values in part (a) and (b) to find the velocity without realising that this was an entirely new problem and the values in (a) and (b) were not relevant.

Q.4 As usual with questions on horizontal circular motion, this was the worse answered question on the paper with many candidates scoring no marks at all. This is a mystery as often the only sensible approach is to resolve vertically and consider Newton's Second Law in the direction towards the centre of motion. A clear force diagram with the forces acting on the particle clearly labelled would be of immense help to the candidates. However, very few were seen.

Q.5 It is most disappointing to see such a simple and already factorised quadratic inequality causing such widespread problems to so many candidates, even to those who scored highly elsewhere on the paper. A simple graph would have helped here, but sadly, extremely few were seen.

In part (b), almost all candidates were able to use integration to find the displacement but most seem happy with the zero answer for the distance travelled in spite of knowing that the particle must have had non-zero velocity. Most candidates did not realise the importance of part (a) to the solution of part (b).

Q.6 This was a generally well done question though many candidates lost the marks allocated to part (a) because they did not know the meaning of the term 'tractive force'. However, they were able to recover in the subsequent parts of the question. The usual mistakes of leaving out either the resistance or the component of weight down the slope were seen on numerous scripts. In part (b), candidates who applied N2L to the trailer sometimes incorrectly included the tractive force in their equation of motion though this force only acts on the tractor.

Q.7 Most candidates were able to find some kind of expressions for the potential energy and the elastic energy but in balancing the energies in the conservation of energy equation, some bits of the energies were left out or included twice resulting in an incorrect equation. Part (b) had a better response and many candidates got full marks here, even some of those who made a mess of part (a).

Q.8 In part (a), most candidates were able to consider the potential and kinetic energies, getting the kinetic energy correct. Many errors were seen in the calculation of the potential energy. Very few completely correct solutions were seen. Most candidates made a sign error in part (b) producing the usual equation for a particle moving on the inner surface of the sphere, which was incorrect here. A clear force diagram would have eliminated these sign errors, but hardly any were seen.

MATHEMATICS

General Certificate of Education

Summer 2013

Advanced Subsidiary/Advanced

Principal Examiner: Dr S Barham

M3

General Comments

This paper is of a similar standard to those set in previous years. It is of an appropriate length and was generally well received by the candidates. The questions all appeared to be assessable causing few problems to the candidates. Very few poor scripts were seen.

Comments on individual questions.

Q.1 Parts (a) and (b) were well done by most candidates, although some candidates stopped with an expression for t in part (a)(ii) instead of inverting the logarithmic expression to obtain v in terms of t as required by the question. In part (c), candidates who realised that the way to obtain x in terms of t is to integrate the expression for v in terms of t, generally did well, with some minor errors in integration (dividing by 2 instead of ½). Those who did not generally got no marks. Some candidates started again treating the differential equation as a second order one and going down the auxiliary equation route. Some hardy candidates were even successful in obtaining all 4 marks.

Q.2 This question was reasonably well done by most candidates though many lost the last B1 mark awarded for stating the positions of the particle when the magnitude of the acceleration was maximum as most candidates only stated one of the two possible positions. Part (c) caused some problems to candidates who were not able to correctly identify the value of x, relevant to their chosen form of displacement, required by the question.

Q.3 Most candidates were able to find the particular solution required in part (a). In (b), candidates were asked for the general solution but many candidates gave a particular solution, using their answer in (a), thus losing the final mark. Some candidates did not seem to realise the difference between a general solution and a particular solution as they went on to do a great deal of unnecessary work to find the particular solution which was not required by the question and therefore carried no marks.

Q.4 This question was well done by almost all candidates. The commonest mistake was in calculating the initial distance dropped by the 5 kg particle.

Q.5 As usual, parts (a) and (b) of this question was well done by most candidates who realised that the correct form of the acceleration here is $v\frac{\mathrm{d}v}{\mathrm{d}x}$. In part (c), some candidates did not realise that they needed to go back to the original expression for the acceleration derived by applying N2L in order to find the correct value of x before substituting this into the expression for v.

Q.6 As this question can be solved without the use of simultaneous equations, candidates on the whole, performed much better than previous questions on this topic. As with all statics questions, it is vital to draw a clearly labelled force diagram isolating the forces on the object for which equilibrium was being considered. Many candidates reproduced the diagram on the paper and also considered forces at the point *D*, which only concern the wall and the string. These forces were not relevant to the equilibrium of *AB* and should therefore not feature in the equilibrium equations whether obtained by considering moments or by resolving forces in two perpendicular directions. Some candidates had more than two perpendicular forces at a particular point without realising that any 2 perpendicular forces is sufficient. Candidates who had a correct force diagram generally scored highly, while those who had an incorrect force diagram with extra or missing forces did not obtain many marks.

MATHEMATICS

General Certificate of Education

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Advanced Subsidiary/Advanced

Principal Examiner: Dr J Reynolds

S1

General Comments

The candidature was extremely variable with some candidates 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. Solutions to Question 8(b) involving a conditional probability set in an unusual context were generally poor.

Comments on Individual Questions

Q.1 Part (a) (i) was well answered by the majority of candidates. Part (a)(ii), however, however, proved to be difficult for some candidates who failed to realise that the answer could not be written down immediately but that an equation involving $P(B)$ had to be solved.

Q.2 This was the best answered question on the paper. Candidates who solved the problem by multiplying probabilities sometimes omitted the combinatorial factor. There is, of course, no comparable error that can be made using the combinatorial method to solve the problem.

Q.3 Solutions to this problem were often disappointing. Most candidates noted that $E(X) = 20$, $\text{Var}(X) = 4$ and that $20a + b = 65$. It was disappointing to see that some candidates were then unable to obtain the second equation, $4a^2 = 36$, so that no further progress could be made. Some of the candidates, who obtained only the one equation, spotted that it was satisfied by $a = 3$, $b = 5$ but this was not accepted as a valid solution.

Q.4 Some candidates appeared to be unfamiliar with the term tetrahedron and, even though the question stated that there were four faces, it was not uncommon to see the probability of throwing a 4 given incorrectly as 0.2. In (b), the probability of obtaining a total of 8 was often given as 0.125, presumably on the grounds that the possible totals are equilikely which, of course, they are not (the fact that there are only seven possible totals was apparently missed).

Q.5 Questions on the use of the Law of Total Probability and Bayes' Theorem are usually the best answered question on the paper but this was not the case this time with some candidates not quite understanding the context.

Q.6 Many candidates solved (a) successfully but (b) proved to be more difficult. A common error was to state that the required sequence was miss-hit-hit, not realising that another possibility was hit-miss-hit. The answer 0.147 was therefore common instead of the correct 0.294.

Q.7 Parts (a) and (b) were well answered in general although the unusual domain of $P(X = x)$ caused problems for some candidates. Part (c), however, was not well answered in general with many candidates failing to realise that the symmetry of the problem meant that $P(X_1 > X_2) = \frac{1}{2}\left(1 - P(X_1 = X_2)\right)$ caused problems for some candidates. Those candidates who answered (c)(ii) by enumerating the possibilities were given no credit.

Q.8 Part (a) was well answered by the majority of candidates but many were unable to solve (b). Few candidates appeared to realise that the solution to (b) required the use of the result

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)} = \frac{P(A)P(B \mid A)}{P(B)}$$

with A = 7 calls between 9am and 10am
B = 10 calls between 9am and 11am
so that $B|A$ = 3 calls between 10am and 11am

Q.9 Solutions to this question were generally disappointing with many candidates showing a poor understanding of calculus. In (a) and (b), the integration was often carried out incorrectly and limits were often mishandled or even completely omitted. In (c) (i), as reported last summer, the incorrect notation $F(x) = \int_0^x f(x)\mathrm{d}x$ 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. Again as stated last summer, the limits were often omitted although it is of course a valid method to state that $F(x) = \int f(x)\,\mathrm{d}x$ + C and then choose C so that either $F(x) = 0$ at the lower limit or $F(x) = 1$ at the upper limit. In (c)(ii), candidates who used integration to find the probability rather than using the cumulative distribution function were given no credit since the word 'hence' required the use of the result obtained in (c) (i).

MATHEMATICS

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Advanced Subsidiary/Advanced

Principal Examiner: Dr J Reynolds

S2

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.

Comments on Individual Questions

Q.1 Part (a)(i) was well answered by most candidates but solutions to (a)(ii) were often disappointing with some candidates finding the 10th percentile instead of the 90th and others using an incorrect *z* value. Part (b)(i) was well answered in general but many candidates gave incorrect solutions to (b)(ii) which usually involved incorrect values of the variance. Many candidates do not understand the difference between the variances of the two expressions nX and $\sum_{i=1}^{n} X_i$.

Q.2 Most candidates answered (a) correctly but some candidates found (b) difficult. A common error was to write the width of the confidence interval as $1.96 \times$ SE instead of $3.92 \times$ SE. It was disappointing to note that some candidates made algebraic errors in finding the minimum sample size and others gave the minimum sample size, incorrectly, as 245.86.

Q.3 This was the best answered question on the paper and most candidates knew what to do and carried out the calculations successfully. Some of the conclusions given were unacceptable, the required answer being along the lines of 'Insufficient evidence to conclude that there is a difference in performance between boys and girls'. Candidates are recommended to use the terminology in the specification and to give the conclusion in context when this is asked for.

Q.4 This question was well answered in general. However, marks were lost in (c) for using an incorrect or no continuity correction and in (b) and (c) for unacceptable conclusions. The required answers were along the lines of:

(b) Insufficient evidence to conclude that the support is greater than 40%.
(c) Strong evidence to conclude that the support is greater than 40%.

Q.5 This question was well answered in general, although continuity corrections were not always correctly applied. Many candidates failed to realise that the same boundary value, 58.5, should be used in both (b)(i) and (b)(ii). Some candidates obtained correct *z* values but then gave complementary probabilities, i.e. a significance level of 94.41% and a Type II error probability of 0.9357. Candidates should be encouraged to look at their answers to see if they are sensible; these answers clearly are not.

Q.6 As reported in previous years, questions on the uniform distribution tend to be the worst answered questions on the paper and this was again the case this time although the candidates found this question more accessible than the question involving a triangle set last summer. The intention in (a)(i) was for candidates to use the formulae for the mean and variance of the uniform distribution which are given in the Formula Booklet and most candidates used that method. Some candidates, however, used integration which took much longer but this method was, of course, accepted. The most common error in (b)(ii) was

$$E(A) = \pi E(R^2) = \pi\big(E(R)\big)^2 = 49\pi$$

This answer is actually very close to the correct answer but it is of course incorrect.

MATHEMATICS

General Certificate of Education

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S3

General Comments

The standard of the scripts was generally good with some excellent scripts. Contrary to last summer, the question on the *t*-distribution was well answered this time. It was also pleasing to note that the long question on estimation theory was well answered by many candidates.

Comments on Individual Questions

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

Q.2 While most candidates were able to find the distributions of *X* and *Y* correctly, it was strange to see that many candidates appeared not to understand the meaning of $|X - Y|$. Perhaps the appearance of modulus signs in a Statistics paper took some of them by surprise.

Q.3 Most candidates estimated the mean and variance correctly and carried on to use the *t*-distribution in the rest of the question.

Q.4 This was a slightly unusual question and it was the worst answered question on the paper. Many candidates failed to realise that all they had to do was to determine the 90^{th} and 95^{th} percentiles and then state the interval between them. Two common errors were to find the 5^{th} and 10^{th} percentiles which gave an interval below 2000 and to find the 95^{th} and 97.5^{th} percentiles which indicated confusion between one and two sided tests. The answers to (b) were often poor with many candidates not realising that it is the Central Limit Theorem which allows the normal distribution to be used in this type of situation.

Q.5 This question was well answered by most candidates.

Q.6 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}. It was strange to see that some candidates gave the values of *a* and *b* as fractions. This is of course perfectly acceptable and it removes the risk of premature rounding. Candidates should, however, be advised to check that their answers are sensible in terms of the data and in this question, it is much easier to see that the answer $y = 9.10 + 0.311x$ fits the data as opposed to $y = \frac{2549}{280} + \frac{87}{280}x$. In (b), some candidates chose the wrong standard error from the Formula Booklet.

Q.7 This was a fairly searching question on estimation theory although some excellent solutions were seen. Many candidates knew what had to be done but algebraic errors were fairly common. In (b)(i), most candidates realised that an expression like $E(X^2) = \mathrm{Var}(X) + \big(E(X)\big)^2$ had to be used but the power of 2 was sometimes omitted and the + sign was sometimes replaced by a – sign. In (c)(i), very few candidates realised that the estimator for q^2 could be deduced very quickly from the estimator for p^2 by simply changing successes to failures so that

$$\frac{X(X-1)}{n(n-1)} \text{ became } \frac{(n-X)(n-X-1)}{n(n-1)}$$

although the longer method of noting that $q^2 = (1-p)^2 = 1-2p+p^2$ and finding unbiased estimators for each of the three terms was accepted.

WJEC
245 Western Avenue
Cardiff CF5 2YX
Tel No 029 2026 5000
Fax 029 2057 5994
E-mail: exams@wjec.co.uk
website: www.wjec.co.uk