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AS/A LEVEL GCE

Examiners' report

MATHEMATICS

3890-3892, 7890-7892

4732/01 Summer 2018 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 4732/01 series overview

General Comments

Candidates generally found this paper readily accessible. Most candidates scored well on the standard calculations such as those in questions 1(ii), 1(iii), 3(i), 3(iii) and 4(i). A few questions contained relatively non-standard requests, eg 2(iii), 5(iv) and 7(iii), these required slightly different approaches which proved more challenging for some candidates.

Few candidates appeared to run out of time but some candidates ran out of space and continued on the back page, or in a separate answer booklet. This is obviously quite acceptable, but centres should emphasise the need for candidates to give a clear indication of the fact that they have used another page.

In order to understand more thoroughly the kinds of answers which are acceptable in the examination context, centres should refer to the published mark scheme.

Answers given in words

Questions 3(v), 4(ii) and 4(iii) were fairly well answered on the whole.

Rounding

A few candidates lost marks by rounding prematurely. It is important to note that although an intermediate answer may be rounded to three significant figures, this rounded version should not be used in subsequent working. The safest approach is to use exact figures (in fraction form) or to keep intermediate answers correct to several more significant figures.

Two common errors in rounding are if the third significant figure is zero, candidates often omit it and some candidates think that, for example, 0.92 is actually three significant figures, the "0" being the first significant figure.

Candidates who give alternative solutions

Some candidates gave two solutions to a particular question and did not indicate which solution they wished to be marked. Examiners are not required to mark both solutions and choose the best one. They are required to mark just one of the given solutions. Centres should emphasise to candidates that they must make a choice between their attempts and should cross out the solution that is not to be marked.

Use of statistical formulae and tables

The formula booklet, MF1, was useful in questions 3(i) & (iii), 4(i) and 6. Candidates generally used the formula booklet well. In question 3(i) very few candidates quoted their own (incorrect) formulae for r rather than using the one from MF1. A small number of candidates thought that, eg, $S_{xy} = \Sigma xy$ or $\Sigma x^2 = (\Sigma x)^2$. Some candidates also tried to use formulae involving, for example, $\Sigma(x - \bar{x})^2$ rather than Σx^2. These candidates almost invariably misused the formula and scored no marks. In question 4(i), Σd^2 was sometimes misinterpreted as $(\Sigma|d|)^2$ or even $(\Sigma d^2)^2$ and the formula was sometimes misquoted as $\frac{6 \times \Sigma d^2}{n(n^2-1)}$ or $\frac{1 - 6 \times \Sigma d^2}{n(n^2-1)}$ or $1 - \frac{6 \times \Sigma d^2}{n}$ or $1 - \frac{6 \times \Sigma d^2}{n^2(n-1)}$, despite the formula being given clearly in MF1.

Centres should note that in the new specification, statistical tables will not be provided (see below).

Use of calculator functions

Increasingly nowadays, calculators can provide answers using statistical functions, without the need to quote a formula and substitute values into it. The problem here is that if candidates write down their answer with no working, they can only score either full marks or no marks, with no possibility of gaining any credit for partially correct working.

It should also be noted that, without working, even a correct answer is not guaranteed to gain full marks.

Centres should note that for the reformed OCR Mathematics A Level and AS Level examinations no statistical tables will be provided. Candidates will need to use a calculator which includes statistical functions. Use of these functions in finding, for example, binomial probabilities will be required. Candidates would be well advised, when using these functions, to do two things. Firstly they should write down the calculation they plan to carry out, for example " $X \sim \mathrm{B}(10, 0.43)$ and $\mathrm{P}(X \le 2)$ ". Secondly they should input all the relevant data twice in order to check their answer.

In addition, statistics in the reformed AS/A Level Mathematics specification will require more interpretation and less mechanical calculation.

Question 1(i)

1 Six cards are numbered 1, 1, 1, 2, 2, 3. Two cards are chosen at random, without replacement. The sum of the numbers on the two cards is denoted by X.

(i) Show that $P(X = 4) = \frac{4}{15}$. **[2]**

Many good answers were seen. Any correct method was acceptable, for example, multiplication and addition of probabilities, "counting" relevant pairs or constructing a sample space table. Some candidates wrote something which was either incorrect or partially correct, and then unconvincingly manipulated it to obtain the given answer. Some candidates ignored the words "without replacement". Many candidates used only some of the possible pairs of numbers.

Question 1(ii)

Part of the probability distribution of X is given in the table.

x	2	3	4	5
$P(X = x)$	$\frac{1}{5}$	$\frac{2}{5}$	$\frac{4}{15}$	

(ii) Calculate $E(X)$ and $Var(X)$. **[6]**

This question was well answered on the whole. A few candidates found Σxp or $\Sigma x^2 p$ correctly but then divided by 4. Others did not square the mean before subtracting from $\Sigma x^2 p$ for the variance. A few found Σxp^2.

Question 2(i)

2 A fair six-sided dice has sides numbered 1, 2, 3, 4, 5, 6.

(i) The dice is thrown once and the score is greater than 2. Find the probability that the score is greater than 3. **[1]**

Many candidates ignored the words "the score is greater than 2" and just found P(the score is greater than 3), without any conditionality. Some used the formula for conditional probability rather than the simpler method of counting possibilities.

Question 2(ii)

(ii) The dice is thrown twice and the sum of the two scores is greater than 8. Find the probability that the sum of the two scores is greater than 10. **[2]**

Many candidates ignored the words "the sum of the two scores is greater than 8" and just found P(the sum of the scores is greater than 10). Some attempted the correct method, but omitted some of the possible pairs, either for the numerator or the denominator or both. Others counted some of the pairs twice. A few candidates counted the possible totals rather than the possible pairs of scores.

Question 2(iii)

(iii) The dice is thrown three times. Find the probability that the score on the third throw is at least twice the sum of the scores on the first two throws. **[3]**

Many candidates omitted some of the possible triples of scores. Others misread the question either as "... at least the sum of ..." or "... greater than twice the sum of ...". Many candidates attempted to list all the possible triples, but omitted some or added extra ones.

Question 3(i)

3 The table shows the age, x years, and the height, y cm, of each of seven randomly selected trees of a certain species.

Age (x years)	10	12	20	29	36	45	50
Height (y cm)	244	320	528	784	792	1026	1212

$n = 7$ $\Sigma x = 202$ $\Sigma y = 4906$ $\Sigma x^2 = 7306$ $\Sigma y^2 = 4\,204\,260$ $\Sigma xy = 174\,858$

(i) Show that the value of the product moment correlation coefficient for the data is 0.99, correct to 2 significant figures. **[2]**

Almost all candidates made the correct calculations and substitution but many did not give an answer to more than two significant figures, before rounding to two. Since the question asked candidates to "Show that . . .", these candidates lost a mark.

A few candidates found $\frac{S_{xy}}{S_x}$.

Question 3(ii)

(ii) State, correct to 2 significant figures, the value of the product moment correlation coefficient for the data if the heights were measured in metres. **[1]**

Most candidates answered correctly but a few "scaled" r by multiplying or dividing 0.99 by 100.

Question 3(iii)

(iii) Find the equation of the regression line of y on x. **[3]**

A large majority answered this correctly. A few found the value of b and then a, but did not write the equation. Some found b but stopped there. A few used 0.99 (the value of r) for the gradient. Some candidates substituted some of the pairs of data into the equation $y = a + bx$ in an attempt to find a and b. Some candidates lost a mark through over-rounding.

Question 3(iv)

(iv) Use your equation to estimate the mean height of a tree of this species with age 25 years. **[1]**

Almost all candidates answered this correctly.

Question 3(v)

(v) Comment on the reliability of your estimate in part **(iv)**. **[2]**

The majority of candidates gave one or other of the two reasons why the estimate is reliable, but few gave both. Some said that the estimate is reliable because the correct regression line had been used. Others stated that the estimate is not reliable because the sample is small. Some candidates gave a well-known (but here inappropriate) quote, stating that the estimate is unreliable because "correlation does not imply causation".

Question 4(i)

4 Two judges each marked six contestants. Their marks are shown in the table.

Contestant	A	B	C	D	E	F
Judge 1	73	67	60	48	39	38
Judge 2	42	50	63	54	71	69

(i) Calculate Spearman's rank correlation coefficient, r_s, between the marks. **[5]**

This mechanical calculation was carried out well by most candidates. Some made errors in the formula, as detailed in the overview above. Others did not find ranks, but found Σd^2 using the raw data and substituted the result into the formula.

Question 4(ii)

(ii) Give an interpretation of your value of r_s in this context. **[1]**

Many answered this well, but some gave a comment that did not involve interpretation, for example, "There is negative correlation between the sets of ranks given by the two judges". Some gave incorrect comments such as "There is little correlation between the judges' views".

Question 4(iii)

(iii) Later, Judge 1 changed her mark for Contestant C from 60 to 61. Without calculation, state whether the value of r_s will increase, decrease or remain the same. Give a reason for your answer. **[2]**

This question was very well answered.

Question 5(i)

5 The lengths of 27 worms were measured in centimetres, correct to the nearest 0.1 cm. The results are shown in the stem-and-leaf diagram.

3	0 3 7 8 8 8 9
4	2 2 3 5 6 8
5	0 0 1 2 4 5
6	0 1 3 3 4 4 5
7	9

Key: 4 | 2 means 4.2 cm

(i) Find the median and interquartile range of these lengths. **[3]**

In parts (i), (iii) and (iv) of question 5 many candidates did not use the key, and assumed that the numbers in the diagram were 30, 33 ... instead of 3.0, 3.3 ...

In Q5 (i) most candidates found the median correctly. Unfortunately, text books give different methods for finding the quartiles, but this question was designed so that all correct methods would result in the same values. However, many candidates used methods for the quartiles that are not quite correct, for example using $\frac{n}{4}$ and $\frac{3n}{4}$ instead of $\frac{n+1}{4}$ and $\frac{3(n+1)}{4}$. Candidates who used such almost-correct methods gained partial credit. Centres might like to note that perhaps the simplest method for the quartiles is to remove the median, and then find the median of the lower 13 lengths and the median of the upper 13 lengths.

Question 5(ii)

(ii) State one advantage of using the median rather than the mean as a measure of the average of these lengths. **[1]**

Many gave correct answers referring to the lack of effect of extreme values on the median compared with the mean. A few stated that the median was better because it is one of the original data items, or because it is easier to calculate than the mean.

Question 5(iii)

A biologist wished to draw a cumulative frequency graph using the data in the stem-and-leaf diagram. He collected the data into five classes, each of width 1 cm.

(iii) List the coordinates of the points that he should plot. **[2]**

Almost no candidates gave the correct *x*-coordinates. Some gave ranges. Some attempted midpoints. Most attempted the end points of the classes but did not take account of the fact that the variable is discrete, so they gave x = 2.9, 3.9 etc, or x = 3, 4 etc, rather than x = 2.95, 3.95 etc. Many gave the correct *y*-coordinates although some gave the frequencies rather than the cumulative frequencies.

Question 5(iv)

The biologist calculated the mean, m, of the given data. He also found the difference, d, between each data item and the mean and calculated Σd^2. His results were $m = 5$ and $\Sigma d^2 = 36.96$.

(iv) Hence calculate the standard deviation of the 27 lengths. **[2]**

A few candidates answered this correctly, although some divided by 26 instead of 27 and others divided by 5. However, most candidates appeared to know only one formula for standard deviation, and did not appreciate that they were given $\Sigma(x-\mu)^2$ rather than Σx^2. Some therefore subtracted 5^2 from 36.96. Others ignored the information that is given and also ignored the helpful "Hence" instruction. These started from scratch with the raw data. A few of these were successful, although this involved a significant waste of time.

Question 6(i)

6 It has been found that 4% of radios made at a factory are faulty. The radios are packed in boxes of 15 for delivery to stores. The number of faulty radios in a box is denoted by X.

(i) Give an appropriate distribution for modelling X, stating a necessary assumption. **[2]**

For the appropriate distribution, many candidates only stated "Binomial" without the parameters. The "stating a necessary assumption" is a standard request which is regularly misunderstood by candidates. Many quoted binomial "conditions" from their text book, such as "repeated trials", which is not an assumption but is given in the question. Others gave a correct assumption, also quoted from a text book, such as "The probability of success is constant", but without being placed in the context given in the question, such answers did not score the mark.

Question 6(ii)

(ii) Find the probability that in 3 randomly chosen boxes there are no faulty radios. **[2]**

Common errors were finding the probability that 3 out of 3 radios are faulty, or 15 out of 15, or 3 out of 15. This is a good example of a question that needs to be read carefully.

Question 6(iii)

(iii) Find the probability that a randomly chosen box contains at least 2 faulty radios. **[4]**

This question was answered correctly by many candidates. Some thought that $P(X \geq 2) = 1 - P(X = 1)$.

Question 6(iv)

(iv) A random sample of 10 boxes is selected. Find the probability that the number of these boxes that contain at least 2 faulty radios is fewer than 4. **[4]**

Most candidates correctly used their answer to part (iii) in a binomial calculation. Some omitted a term or added an extra term. Some omitted the binomial coefficients. A few used 0.04 instead of their answer to (iii).

Question 7(i)(a)

7 Every day William watches for whales from his bedroom window. The probability that he will see whales on any given day is $\frac{1}{4}$. It is assumed that this probability is not affected by whether he has seen whales on any other day.

(i) Calculate the probability that William first sees whales

(a) on the fourth day, **[3]**

Most candidates answered this question correctly.

Question 7(i)(b)

(b) before the seventh day. **[3]**

Many correct answers were seen, although many candidates used the "long" method, in some cases adding an extra term $(0.75^6 \times 0.25)$. A few who attempted the "short" method found $1-0.75^7$ instead of $1-0.75^6$. Some just found 0.75^6.

Question 7(ii)

(ii) Find the expectation of the number of days up to and including the first day on which he sees whales. **[1]**

Most candidates answered this question correctly. A few gave 0.25. Some gave the binomial mean 7×0.25.

Question 7(iii)

William watches for whales every day for two weeks (14 days).

(iii) Calculate the probability that he sees whales on at least 1 day during one of the weeks, but does not see whales during the other week. **[4]**

Many candidates replaced "at least 1 day" by "exactly 1 day". Others tried to consider all 14 days in one binomial calculation.

Question 8(i)

8 A florist has 4 roses, A, B, C and D, all of different varieties, and 3 begonias, X, Y and Z, all of different varieties.

(i) She selects 2 roses and 2 begonias. Find the number of different selections she can make. **[2]**

A few candidates added the combinations instead of multiplying. Others found 4! × 3! or ${}^4P_2 \times {}^3P_2$.

Question 8(ii)(a)

Now the florist arranges all 7 plants in random order in a straight line, regardless of the type of plant.

(ii) **(a)** Find the probability that no 2 roses are next to each other and no 2 begonias are next to each other. **[2]**

Some candidates just found 3! × 4!. Others found $\frac{1}{7!}$. Some strange methods were seen such as $\frac{5!\times 2!\times 2!}{7!}$. A few candidates interchanged the numerator and denominator, ie $\frac{7!}{3!\times 4!}$.

Question 8(ii)(b)

(b) Find the probability that all 3 begonias are next to each other. **[3]**

Many candidates correctly used 5! in their working, but some did not include 3!. Others arranged the roses amongst themselves (4!) and the begonias amongst themselves (3!) but did not attempt to ensure that the three begonias are next to each other. As in the previous part, some candidates did not divide by 7!.

Question 8(iii)

Later, the florist decides to arrange the plants in two sections, roses on the left and begonias on the right, all in a straight line.

(iii) Given that plants A and X are separated by exactly three other plants, how many different arrangements are possible? **[3]**

Many candidates correctly found 3! × 2! but then multiplied by an incorrect number such as 2 or 6 or 4!. A few candidates found the probability rather than the number of arrangements.

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