STATISTICS

Paper 4040/01

Paper 1

General comments

The overall standard of work submitted was very similar to last year. Very few candidates gave the impression of being totally out of their depth, and a few submitted solutions of the highest quality.

Once again, however, it is regrettable to have to remark that a number of the points mentioned under the heading 'General comments' in the report on last year's paper have to be repeated, as they had not been acted upon in many cases. On two points there was, however, a clear improvement. Where a question stated 'copy and complete', in relation to a blank table given in a question, almost all had done so, only a very small number appearing to have completed the table in the question paper. Secondly, the plotting of points on graphs showed a general improvement. However, some candidates are still plotting data by very faint pencil 'dots', some of them scarcely visible. Credit cannot be given to a graph if the points on it cannot be seen. Candidates are recommended to plot data points with small, but firm, x's, and summary points calculated from the data, such as semi-averages, by dots within a small circle.

Two of the major comments in last year's report are however just as valid this year, and they are points on which candidates are losing marks totally needlessly. Where a required level of accuracy is stated in a question, then unless that demand is met, the final mark for that question or part of a question will always be lost. For example, the question about death rates began with the clear statement that all rates should be given to two decimal places, and so, in each part of the question, if the final answer was not given to two decimal places, the final mark for that part was lost.

Once again, the other major cause of loss of marks was failure to answer the 'comment' parts of questions in appropriate detail. It continues to be the case that many candidates produce general comments that have obviously been learned by rote from a textbook or similar source, when what is clearly asked for is a specific comment in the context of the question. There was a further cause of error in relation to such comments this year. In some questions, the comment requested was slightly different from that which had been 'traditionally' required, but many candidates had clearly not read the question sufficiently carefully to realise that this was the case.

Comments on specific questions

Section A

Question 1

Many well-drawn, accurate and clearly-labelled pie charts were presented, and almost all knew the correct method for calculating the required radius. Not giving angles to the nearest degree, or the radius to the level of accuracy requested, were the most frequent causes of lost marks.

Answers: **(i)** 301° 31° 18° 10° **(iii)** 4.6 cm

Question 2

In **(i)** most candidates knew which two measures could be calculated, although accurate calculation was not always as successful. Very few answered **(ii)** correctly, however, many thinking that the standard deviation could be obtained, and others giving a measure of average.

Answers: **(i)** Median = 17 Mode = 15 **(ii)** Inter-quartile Range = 4

Question 3

An error of omission, identical to that in a similar question on last year's paper, and commented upon in the report on that paper, was the most frequent cause of loss of a mark, in what was otherwise a generally well answered question. In **(ii)** a comment on what *y* represented needed to refer not only to the studying of Biology and Chemistry, but also to the fact that Physics was not studied.

Answers: **(i)** 31 **(iii)** 69 **(iv)** 97

Question 4

A very poorly-answered question, far too many failing to answer totally what was being asked. In **(a)** the wording of the question clearly indicated that a comparative answer was required, but on the vast majority of scripts there was simply a description of a method of sampling, or a bland comment such as "simple random sampling is quick". Examples of the type of comments being sought are "quota sampling does not require a sampling frame whereas simple random sampling does", and "the selection of items in simple random sampling is objective whereas in quota sampling it is subjective".

It has frequently been commented upon in past reports that many candidates were selecting a systematic sample incorrectly by taking items which appeared at a regular interval in a table of random numbers. The purpose of **(b)(i),** therefore, was deliberately to request selection of a systematic sample in a context where a table of random numbers was not given. About half of all candidates realised correctly that they needed to evaluate the sampling interval and then apply it to the given first number.

Hardly any marks at all were scored for **(b)(ii)**, with very few candidates being aware of the possible source of bias in systematic sampling if a pattern is repeated at a regular interval in the sampling frame, as this might coincide with the sampling interval.

Answers: **(b)(i)** 37 57 77 97

Question 5

No more than five per cent of all candidates appreciated correctly the hint given by the word 'appropriate' being in bold print. The data in this question is discrete, and therefore the appropriate cumulative frequency graph to illustrate it is a step polygon. It was, however, still possible to score four of the available six marks even if this was not realised, by calculating the cumulative frequencies correctly, using the stated scales, and starting a cumulative frequency graph of any sort from the correct point, (0,2).

Answers: **(i)** 2 4 15 32 56 81 103 115 119 120

Question 6

In contrast to the previous two questions, this one was answered very well indeed, many candidates drawing up a 3×3 table for each part of the question, on which they then based totally-correct solutions. The most common errors were use of a denominator other than 9 in all the probabilities, and incorrect interpretation of 'at most' and 'more than'.

Answers: **(i)(a)** 2/9 **(b)** 5/9 **(ii)(a)** 1/9 **(b)** 5/9

Section B

Question 7

The quality of graphs presented in answer to this question was generally very high. Because the data was presented in the order of increasing values of *x*, an error which had been very prevalent in recent years, that of incorrect division of the points into two sub-groups for calculating the semi-averages, did not arise. Many marks were lost in **(iii)** and **(iv)**, however, because candidates did not answer the question by the methods instructed. In **(iii)** it was required to obtain the value of *m* by using the coordinates of two points on the line, and that of *c* as the intercept of the line with the *y*-axis. Many candidates also lost a mark needlessly by not stating their equation (whatever their values of *m* and *c*) in the requested form. In **(iv)** the question instructed that the equation should be used to obtain the estimate, but many candidates drew lines on their graph instead. Only a minority of candidates realised that **(v)** involved drawing the line $y = x$, and then reading the value of the point of intersection with the line of best fit.

Very few candidates made either of the comments being looked for in **(vi)**, that the nearer the l load to the value of the point of intersection the more accurate the reading was, or that the overestimated masses lower than that value and underestimated masses higher than that value.

Answers: **(ii)** Overall mean (4.4,4.5) Semi-averages (2.2,1.8) (6.6,7.2)

Question 8

Almost all candidates fell into one of two groups, those who applied correctly the 'histogram principle' of area being proportional to frequency, and those who did not; the former tended to score very well, the latter rather poorly. What was rather surprising in **(iv)** was the small number of candidates who appeared to be aware of the 'diagonal line method' for estimating a modal value from a histogram.

Answers: **(i)** 4 10 14 11 13 16 12

Question 9

This was by far the least popular question in ***Section B***, but was generally answered very well by those who attempted it. The most frequently seen error was failure to use a denominator of 49 in **(b)(iii)**. However, many candidates also lost at least one mark through failure to follow the instruction in **(a)** to take the value of π as 3.14, taking instead values such as 22/7 or a 'full accuracy' value given by their calculator. This invariably led to the final probability value not being as calculated on the mark scheme.

Answers: **(a)** 0.717 **(b)(i)** 2/11 **(ii)** 24/55 **(iii)** 18/49 **(iv)** 9/1199 **(c)** 4/9

Question 10

Two points stand out in relation to this question, the first of which is the matter of the accuracy of final answers mentioned in the General Comments earlier in this report. The second is that whereas the vast majority of candidates coped successfully with **(i)**, the exact opposite was the case, for a variety of reasons, with the remaining parts of the question. In **(i)** candidates were required to calculate a crude rate and a standardised rate by the 'standard procedures' (with clear guidance being given for the latter), and this caused few problems. However, it has to be questioned whether these are simply techniques, learned by rote with little or no understanding of what is being done, because in a majority of cases, candidates who had successfully calculated a crude rate as simply 'total deaths divided by total population' in **(i)** came to a grinding halt when faced with calculating the same rate when other information was given in **(ii)**.

In the final two parts, marks were generally not scored because of failure to answer what the question asked. In **(iii)** the question asked for a comparison of the group death rates of two towns. Candidates must appreciate that a 'comparison' involves more than just quoting two sets of figures.

In previous years, the final part of questions on this topic has almost always been a request to state which of two towns/areas has the 'healthier environment', with candidates being expected to choose the one with the lower standardised death rate. This is what a majority of candidates did in this case, but it was not what this question was asking. It asked for an age group for which one of the towns appeared to have a far less healthy environment. Candidates had a choice of two groups, for one of which one SDR was far higher relatively than the other, and for the other far higher absolutely.

Answers: **(i)(a)** 16.22 **(c)** 13.45 **(ii)** 11.66

Question 11

A very popular question, and one on which most candidates scored well, except for the final part. Values were generally read accurately from the graph, and then the correct procedures followed to convert cumulative frequencies to group frequencies, and to use the latter with class mid-points to obtain the mean and standard deviation. Probably the most common calculation error was to include frequencies in the calculation of the mean, but not in that of the standard deviation.

The final part requested a comparison of the values obtained for the mean and the median, but far too many simply produced general 'textbook' comments such as "the mean is affected by extreme values but the median isn't". The comment being looked for was that the two values were similar because, as the graph shows (from the shape of the cumulative frequency curve) the distribution is almost symmetrical and/or there are no extreme values. Even among those who did attempt a comparative comment, the causality was often 'the wrong way round', e.g. statements such as "there are no extreme values because the mean and median are nearly the same".

Answers: **(i)(a)** 45 **(b)** 12-14 **(iii)(a)** 45.2 **(b)** 14.2

STATISTICS

Paper 4040/02

Paper 2

General comments

The overall standard of work submitted was quite similar to last year. As has often been the case in the past, a question on expectation was neither popular nor very well answered, except by high-ability candidates for whom it was a fruitful source of marks. Many candidates also found the ***Section B*** question on probability of considerable difficulty.

While much good work was seen, what are probably two of the major sources of loss of marks once again occurred with frequent regularity, despite their being mentioned in these reports previously. These are firstly that instructions to give an answer to a particular level of accuracy are frequently ignored by many candidates, and a mark is lost every time this occurs, and secondly that comments given are on many occasions just general 'textbook' statements which do not refer in any way to the context of the question. Further details on the latter point are given in the comments on individual questions.

Comments on specific questions

Section A

Question 1

Many candidates scored full marks on this question, but for others there was clearly considerable uncertainty, with answers having been changed a number of times. Being able to classify a variable correctly is of considerable importance, as it can determine exactly which procedure is to be adopted in numerical solutions.

Answers: **(i)** A **(ii)** B **(iii)** D **(iv)** E

Question 2

There was the customary considerable confusion in the minds of many candidates between independence and mutual exclusivity. Even when the two concepts were considered correctly, the reason for their existence or non-existence was not always correct. *A* and *B* were not mutually exclusive because the probability of their intersection was not zero. They were independent because the probability of their intersection equalled the product of their separate probabilities.

Among the solutions of the small minority of candidates who obtained the correct answer to **(ii)**, a variety of valid methods was seen. The most common error, as might have been expected, was finding the probability of *A* or *B* or both occurring.

Answer: **(ii)** 0.54

Question 3

As has happened with similar questions in the past, it was obvious that some candidates did not kn is meant by 'class limits', as they gave the class width as their answer to the request for limits. The limi the lowest and highest possible values which would be included in a class depending on the level approximation which is being used, and whether the data is discrete or continuous. A majority of candidates answered **(i)** and **(ii)** perfectly correctly, but correct answers to **(iii)** were very few and far between. Strangely, most of the few candidates who did answer **(iii)** correctly had not obtained full marks for the other two parts.

Answers: **(i)** 5 9 7 **(ii)** 4.5 9.5 7 **(iii)** 5 10 7.5

Question 4

In general, a very well-answered question, the vast majority of candidates clearly knowing the methods to apply. All the varying definitions of, and approaches to calculating, the median, quartiles and percentiles of a grouped frequency distribution were permitted to score. Almost all candidates used the correct class limits and widths, and what was particularly pleasing was the way in which many solutions contained a clear explanation of what the candidate was doing. Probably the most common cause of loss of marks, other than simple arithmetic errors, was a solution to **(ii)(c)** which stopped after determining which observation corresponded to the 90th percentile instead of going on to find its value.

Answers: **(i)** 10 33 62 88 99 **(ii)(a)** 182.9 **(b)** 176.4 **(c)** 191.0

Question 5

Despite the appropriate totals being given to complement the indication given in the question that a bar was required for each gender, many candidates totalled the column figures and presented a bar for each college. Two other common errors were failure to round results to integers as required by the question, and to present multiple bars rather than the component/sectional ones required.

Answer: Males 51 14 35 Females 26 10 64

Question 6

As has been the case in the past, a majority of candidates gave evidence of a clear understanding of the method of stratified sampling, and applied it correctly. However, many marks were lost as a result of the question not having been read sufficiently carefully, and its instructions followed. Almost all worked out correctly that three males and four females were required for the sample. The question then stated that the genders should be sampled together, whereas some candidates sampled first one and then the other. In **(ii)** a reason was required for the rejection of any numbers encountered 'before the sample was complete', yet many candidates commented on all the numbers given in the table extract.

Answer: 48 64 35 14 30 27 02

Section B

Question 7

This question provided many candidates with an opportunity to score high marks, but three points about it are worthy of note.

Although the entire question was on one general topic, scaling, cases were seen of a candidate who coped totally successfully with **(a)** but experienced difficulty with **(b)** and **(c)**, and vice versa.

The appearance of the word 'state' in a question indicates that it is possible to write down the answer without showing any working, or with one or two lines of working at most. The number of marks available for a part of a question also indicates approximately how much work is required to answer it, two marks implying that only a short answer will be required. Yet despite both these 'hints' a few candidates embarked on many pages of calculations in unsuccessful attempts to answer **(a)**.

Numerous cases were seen of a candidate scoring fourteen of the sixteen marks available for [illegible] without any difficulty whatsoever, but clearly having no idea how to approach **(b)(iii)**, through [illegible] realise that in that case the raw and scaled marks were equal.

Answers: **(a)(i)** 20 8 **(ii)** 2 2 **(iii)** 22 6 **(b)(i)** 80 **(ii)** 75 **(iii)** 85 **(c)** 15

Question 8

Overall marks for this question were not as high as for those on the same topic in the past, due most probably to there being less numerical and more non-numerical work than has usually been the case. However even in the numerical work many candidates penalised themselves. Although answers to **(ii)** were generally correct, those to **(iii)(b)** very often, despite the bold print in the question, took 2002 as base year, and consequently could only score two marks out of the available six. The most common cause of low marks being scored in **(i)** was that answers were simply descriptions rather than the required explanations. The explanation of two price relatives being the same is not that the price relative for the item did not alter, but that the price of the item remained constant, etc. In **(iii)(a)** very few correct descriptions of how weights are evaluated (as ratios of the expenditure on different items) were encountered, while in **(iii)(c)** some of the offered reasons displayed no consideration of the context at all. The index obtained has been based on the prices of the items, and so the reason why it might be inaccurate is obviously related to other possible factors than prices, e.g. a change in quantities purchased.

Answers: **(ii)** 102.91 **(iii)(b)** 101.5

Question 9

Some candidates worked their way methodically through this question, clearly appreciating where it was leading them, and scored full, or nearly full, marks. Others, as is often the case with questions on expectation, lost their way very early on. There were yet others, however, who gave the impression of knowing what was required, but who lost marks through not doing what the question asked. In **(i)** for example, the question asked for the probability of winning each of the possible prizes. Some candidates just gave the overall probability of winning a prize, although if it were possible to ascertain from their solution a sufficiently clear indication of the probability of winning each of the separate prizes it was allowed to score. Others gave expected values instead of probabilities, and then repeated their answer in **(ii)**, where it was correct, and so the marks for **(i)** could not be awarded. A similar error was then usually seen in relation to **(iv)** and **(v)**. Those who had worked their way through the first five parts, either correctly or just with arithmetic errors, almost always deduced the correct conclusion in **(vi)**, which was encouraging as it showed a full understanding of the scenario.

Answers: **(i)** 1/32 1/16 21/64 **(ii)** $1.28 **(iii)** Loss of $0.72 **(iv)** 5/189 1/18 20/63 **(v)** $1.18

Question 10

A clear majority of candidates scored very well on the first three parts. The four values in **(i)** were almost always calculated correctly, and the graph work in **(ii)** and **(iii)** tended to be of a high quality. The last three parts were, however, answered much less successfully. The comments given in **(iv)** usually gave no indication of the context having been considered, the comment that the upward trend in absences would not continue in the long term often being seen unaccompanied by any reason as to why this might be the case. Any valid consideration of 'reality' obtained the mark, for example, the candidate who wrote "absences cannot increase for ever or there would be more absences than pupils on the school roll".

Some candidates are clearly still unaware that seasonal components must sum to zero. Many failed to appreciate that to obtain the estimate required in **(vi)** the value of the seasonal component had to be 'added in' to the trend forecast, and then rounded to an integer as the variable was 'number of absences'.

Answers: **(i)** 60 51 193 41 **(v)** –13.1

Question 11

A few candidates provided perfect, or near-perfect solutions to this question and scored very high. Two common errors were, however, instrumental in meaning that only a small minority of candidates attempted the question scored more than half-marks. Many failed to appreciate the 'without replacement' nature of the scenario, for example that once one worker had been selected from the original thirty, the second could only be one of the remaining twenty nine. Some also misinterpreted what they were being asked to find, a common such error being to regard none travelling by bus as the complement of all travelling by bus. In **(iii)** many clearly thought that evaluating the probability of the fourth person being the first cyclist did not require any consideration of the first three people.

Answers: **(i)(a)** 0.0704 **(b)** 0.436 **(ii)** 0.649 **(iii)** 0.111