1. Overall there were very few errors made when candidates completed their tree diagrams. A small number of candidates repeated their probabilities of $\frac{2}{3}$ (for obtaining a head) and $\frac{1}{3}$ (for obtaining a tail) on the second branches for the fair coin. Occasionally the $\frac{5}{12}$ and $\frac{7}{12}$ probabilities were placed on the wrong branches and, in a few instances, quantities rather than probabilities were used. The vast majority of candidates were able to calculate the probability that Shivani selects a head correctly, or at least follow through the correct method from their tree diagrams, with few errors seen.

In contrast the quality of candidates' attempts at part (c) was extremely varied. Very few candidates quoted the correct formula despite it being given in the formula booklet, and of those who did, few realised that the numerator should be $\frac{5}{12} \times \frac{2}{3}$. The numerator was quite often seen as $\frac{5}{12}$ alone, and a number of candidates failed to recognise that their denominator should be their answer to part (b), leading in some cases to a repeated fraction in the numerator and denominator. P(H/R) was sometimes calculated instead of P(R/H).

The final part of the question was attempted fairly successfully overall. Indeed, many of the candidates who had erred in previous parts of the question were able to gain some credit, as most could identify at least one of $(\frac{5}{12})^2$ or $(\frac{7}{12})^2$. The special case pertaining to no replacement was occasionally seen.

2. Overall this question proved to be quite challenging for candidates and incorrect interpretation of the Venn diagram lost many candidates marks. In spite of this, most candidates had no trouble proving the given probability in part (a).

In part (b), however, quite a number of candidates neglected one of the four components of the numerator, usually the 3, and $\frac{11}{30}$ was consequently an extremely common wrong answer. Other wrong answers included $\frac{9}{30}$, $\frac{13}{30}$ and $\frac{16}{30}$. Some candidates chose to use the addition rule, which was generally written down correctly, although quite often P(A) was given as $\frac{4}{30}$ and P(B) as $\frac{5}{30}$, giving rise to $P(A \cup B) = \frac{7}{30}$.

In contrast, the majority of candidates were able to deduce that $P(A \cap C) = 0$ and quite a few gave explanations as part of their answer, such as 'there is no overlap', or 'no intersection' and some even discussed the idea of mutual exclusivity. A small proportion of candidates had the right idea but failed to give a probability, giving their answer as 'nobody' or in a few cases 'the empty set'. However, not all of the candidates realised that mutually exclusive events have a probability of 0 of occurring together and some mistakenly thought that $P(A \cap C)$ equalled $P(A)P(C)$ here.

Answers to part (d) were extremely varied. Most candidates did not recognise that a conditional probability was required and consequently did not obtain the correct denominator. Common wrong answers were $\frac{6}{30}$, $\frac{6}{20}$ and $\frac{3}{20}$. A significant number attempted to perform some complex calculations in which they tried unsuccessfully to use the formula for conditional probability. Very few candidates used the Venn diagram to calculate the probability directly.

Testing for independence was generally performed successfully overall, with the majority of candidates carrying out suitable tests. However, some candidates did find this challenging and often the wrong probabilities were compared and some incorrect probabilities were obtained. A number of candidates appeared to be confusing independence with mutual exclusivity. Some candidates merely provided a comment on the perceived nature of independence without performing any calculations at all. Of those candidates who were successful, the most common approach was to test whether $P(B \cap C) = P(B)P(C)$, although there were a few cases where $P(A \cap C)$ was compared with $P(A)P(C)$ by mistake. Rather worryingly, a surprisingly high number of candidates failed to recognise $\frac{3}{30}$ and $\frac{1}{10}$ as equivalent fractions and thus concluded that the events were not independent.

3. This proved a straightforward start to the paper. Most gave a correct tree diagram although a few oversimplified using red and not red as their outcomes and this was of no help to them in part (b). It was encouraging to see the vast majority of candidates using fractions for the probabilities and only a handful using "with replacement".

Part (b) was not answered so well with many failing to consider both cases: blue then green and green followed by blue.

4. There were many good answers to this question. The Venn diagram was often totally correct although a number failed to subtract for the intersections and obtained value of 35, 40 and 28 instead of 31, 36 and 24 for the numbers taking two options. Parts (b) and (c) were answered very well with only a minority of candidates failing to give probabilities. Part (d) proved straightforward for those who knew what was required but some attempted complicated calculations, often involving a product of probabilities, whilst others simply gave their answer as 4/180.

5. Part (a) and part (b) were generally very well done with few candidates not knowing the correct structure of the tree diagram. A number did not fully label the tree diagram thus potentially losing the mark for the probabilities. Some candidates do not help themselves or the examiner by drawing very small diagrams. In part (b) it was pleasing to see very few candidates resorting to decimals and those who did seem to have got the message that exact equivalents are required using recurring decimals where appropriate. In part (c) many candidates demonstrated a lack of understanding of conditional probability. They could not transfer the context of the question into a formula and many still use $P(A/B)$ with no explanation as to what A and B represent. Of those who did manage to write $P(F'/L)$ many failed to see the significance of part (b)(ii).

6. Generally this question was not well answered by a large number of candidates. The terms and properties relating to probability do not seem to be fully understood, especially by weaker candidates. Part (a) was done surprising badly, with often the rest of the question fully correct. Part (c) was often correct when all else was wrong, demonstrating that candidates can use the conditional probability formula even if they do not understand it. Too few candidates write down the formula they are trying to use, which in part (d) was helpful in ascertaining if they were trying to use the correct method.

A and *B* represent. Of those who did manage to write P(*F*'/*L*) many failed to see the significance of part (b)(ii).

7. This question was not answered well. It was encouraging to see many attempting to use a diagram to help them but there were often some false assumptions made and only the better candidates sailed through this question to score full marks.

The first problem was the interpretation of the probabilities given in the question. Many thought $\frac{9}{25} = \mathrm{P}(\mathrm{E} \cap \mathrm{B})$ rather than $\mathrm{P}(\mathrm{E}|\mathrm{B})$. All possible combinations of products of two of $\frac{2}{3}, \frac{2}{5}$ and $\frac{9}{25}$ were offered for part (a) but $\frac{9}{25} = \mathrm{P}(\mathrm{E} \cap \mathrm{B})$ was the most common incorrect answer. In part (b) a variety of strategies were employed. Probably the most successful involved the use of a Venn diagram which, once part (a) had been answered could easily be constructed. Others tried using a tree diagram but there were invariably false assumptions made about $\mathrm{P}(\mathrm{E}|\mathrm{B}')$ with many thinking it was equal to $1 - \frac{9}{25}$. A few candidates assumed independence in parts (a) or (b) and did not trouble the scorers. The usual approach in part (c) involved comparing their answer from part (a) with the product of P(*E*) and P(*B*) although a few did use P(*E* | *B*) and P(*E*). Despite the question stressing that we were looking for statistical independence here, many candidates wrote about healthy living and exercise!

The large number of candidates who confused $\mathrm{P}(\mathrm{E} \cap \mathrm{B})$ and P(*E* | *B*) suggests that this is an area where students would benefit from more practice.

8. Part (a) was answered well although a small minority of candidates insisted on dividing by n (where n was usually 4). Part (b), on the other hand, caused great confusion. Some interpreted F(1.5) as E(1.5X), others interpolated between P(X = 1) and P(X = 2) and a few thought that F(1.5) was zero since X has a discrete distribution. Although the majority of candidates gained full marks in part (c) the use of notation was often poor. Statements such as Var(X) = 2 = 2 – 1 = 1 were rife and some wrote Var(X) or $\sum X^2$ when they meant E(X^2). Many candidates can now deal with the algebra of Var(X) but there were the usual errors such as 5Var(X) or 25Var(X) or –3Var(X) and the common -3^2 Var(X) which was condoned if the correct answer followed.

Part (e) was not answered well and some candidates did not attempt it. Those who did appreciate what was required often missed one or more of the possible cases or incorrectly repeated a case such as (2, 2). There were many fully correct responses though often aided by a simple table to identify the 6 cases required.

9. This question was often answered very well. The Venn diagram was usually correct although a few forgot the box and some missed the "1" outside the circles. A small minority of candidates failed to subtract the "90" from the overlaps of each pair and this meant that any attempts to follow through in later parts of the question were hopeless as their probabilities were greater than 1. Part (b) was answered well although some wrote 0.1 instead of 0.01.

Parts (c), (d) and (e) were answered well too but some candidates simply gave integer answers rather than probabilities and a few tried to multiply probabilities together. The conditional probability in part (f) was often identified but some thought that $P(C|A) = \frac{P(C \cap A)}{P(C)}$ and

$P(C \cap A) = 0.03$ was another common error.

10. Many candidates were able to determine the correct answer for part (a) but a very common error was to multiply the two probabilities, incorrectly assuming independence. Many candidates used the Venn diagram to attain the correct solution to part (b). The most common errors were to omit a box or add a third circle. In part (c), as is often the case in this type of question, many failed to realise this was a conditional probability

11. The demand to draw a tree diagram in part (a) was probably a help to some candidates who may not otherwise have been able to get started. Part (a) was usually answered very well but a few did not interpret the conditional probabilities correctly and $P(D|A)$ was sometimes given as $\frac{3}{35}$ instead of 0.03. Sometimes $P(D \cap A)$ was confused with $P(D|A)$. Part (b) was answered well, especially part (i), although sometimes in part (ii), we saw the sum of the conditional probabilities instead of the intersections. Part (c) proved to be more of a discriminator. The correct formula was rarely quoted and even when it was seen the substitutions were often incorrect.

Throughout this question the use of correct notation was often poor: $P(C|D)$ was readily confused with $P(D|C)$ and $P(B \cap D)$ was often replaced with $P(B|D)$. It was also surprising to see how many candidates worked with percentages throughout; sometimes this led to a loss of marks if values marked on the tree diagram were not probabilities.

12. There were many fully correct solutions to this question and the ideas and techniques were clearly understood well. A few candidates misinterpreted the inequalities in part (b) and some worked throughout in decimals rather than fractions and this led to errors usually in parts (c) and (d). Some candidates did not actually carry out their calculations in part (d), they simply assumed that $21.97 - (4.47)^2$ would give them 1.97 and failed to appreciate that at least 4sf were required to obtain the printed answer. Part (e) was where most errors occurred though. Those who knew the correct formula usually obtained the correct answer, but there were a number who tried 2^2 Var(X) and some who did not know how to deal with the minus sign.

13. It was common in the Venn diagram for the value of 41 to be omitted or replaced with a zero. It seems that candidates were assuming that the hundred people in the question all possessed at least one of the attributes, i.e. they didn't bother to add up the other values in the diagram to see that they did not come to 100. Part (b), part (c) and part (d) were generally well answered and usually followed from the values in the diagram. The conditional probability was better answered than has been the case in the past but this is still a good discriminator.

14. Parts (a) and (b) were generally well done though unexpectedly a few candidates failed to provide any sort of diagram. In part (c) relatively few candidates understood conditional probability in a fairly simple question. Poor attempts to use Bayes' theorem usually resulted in no marks being awarded. It was a pity that only a handful of the best candidates just wrote down the answer from the tree.

15. A number of candidates seemingly had not covered Venn diagrams as many had poor diagrams or none at all. Those who knew what to do usually worked straight through and gained full marks. The mark scheme allowed a fairly generous follow through of marks which allowed some marks even after a dubious Venn diagram. Conditional probability worked better here though there were still difficulties and again more poor attempts at Bayes' theorem. In part (d) there were many good answers but a common form of error was to mistake mutually exclusive for independence. Only a few realised that they had just found P(A/B') and it wasn't P(A). Poor accuracy again caused some to lose a mark in part (c) when correct answers were truncated to 2 dps.

16. Many candidates could do this question in their heads and scored full marks. For other candidates this question caused a number of problems.

(a) The majority of candidates began their response with either a Venn diagram or a probability tree; the simpler 2-way table was only seen occasionally. Nethertheless, many candidates were able to answer part (a) correctly.

(b) Candidates who recognized the reduced sample space of 50 students were able to produce very concise solutions although a significant proportion calculated the probability of the student wearing glasses given the student is studying Arts subjects rather than the probability of the student <u>not</u> wearing glasses given the student is studying Arts subjects. Others tried to multiply probabilities without any real consideration as to whether or not the events were independent.

(c) A large number of candidates identified the need to look at all three subjects in turn and then sum. There were however, some candidates that failed to take account of the different number of students studying each subject and just added the percentages and divided by 3. A minority of candidates believed that 0.8 x 0.75 x 0.7 was sufficient.

(d) Recognition of the need for conditional probability in part (d) was good. Some candidates however wanted to divide by probability of the student studying Science subjects rather than the probability of the student being right handed. Some did not see the connection between parts (c) and (d) and tried to calculate the probability of a student being right handed again and achieved a different result to (c). The numerator in the calculation was not always correctly calculated – some candidates did not look at the 80% from science and just used 30 out of 148 as the numerator.

17. A well answered question. A fairly small minority misread the question and calculated the probability of a faulty item. The majority of candidates can draw and use tree diagrams well although a significant minority fail to label them correctly. Also, too many candidates made the mistake of putting incorrect probabilities on the second section of the tree; some were products of probabilities while some were strange fractions such as 3/85, 82/85, etc. Overall, however, many candidates gained full marks on this question

18. Candidates find it hard to translate the written information into a correct Venn Diagram, frequently forgetting to subtract one category from another. Many candidates only had 6 in the right place and 890 instead of 918 was a common error even for more able candidates. As follow through marks were allowed, they didn't lose as many marks as they might have for these initial errors. Conditional probability is not well understood, nor was the need for use of 'without replacement' in part (e). Some weaker candidates still leave answers greater than 1 for probability.

19. Almost all candidates were able to produce an attempt at the Venn diagram, although the rectangle was absent in a minority of scripts. Many excellent answers were seen, but weaker candidates are unable to distinguish between P(AnB') and P(A); the value of P(A'nB') was also frequently omitted.

Part (b) was usually well answered, with most candidates using the algebraic form of the addition law rather than merely adding the three probabilities from their Venn diagram.

Part (c) produced a mixed response. Some very good solutions were given, but many candidates assumed that A and B' were independent.

20. Many candidates did not realise that the phrase 'at least 5' meant that they had to consider three pairs of numbers – (2,3), (3,3) and (3,2). The last one was usually forgotten. A sample space diagram was all that was needed to answer this question but far too many candidates tried to use other methods and obtained the wrong answer.

21. Most candidates made a reasonable attempt to draw a Venn diagram although they did not always put the letters *A, B* and *C* in the correct order. As in previous years candidates did not recognise the meaning of 'mutually exclusive' and 'independent' and consequently were unable to answer parts (b) and (c) with any confidence. The final part of this question required candidates to know the probability rule associated with $P(A \cup C)$, use independence and then solve an equation and too many of them were unable to do so.

22. The concepts involved in this question were generally not understood by many of the candidates, particularly P(*A*Ç*B*) = P(*A*) – P(*A*Ç*B*'). But for follow through, many candidates would not have gained any of the first 7 marks. The usual confusion between 'mutually exclusive' and 'independence' was still in evidence. Candidates need to be advised that to answer this type of question they need to have the rules of probability at their fingertips.

23. Candidates found this question very accessible. Even the weaker candidates often scored highly on this question. The tree diagram was usually well drawn and part (a) was invariably correct even if the rest of the solution was wrong. In part (d) a few candidates produced an alternative answer to the one expected by finding (1 – P(at least two keys)) and this alternative was included in the mark scheme.

24. The first two marks were scored by many of the candidates, but in too many cases very few of the remaining marks were gained. Many candidates could not establish the values of X as 0, 10, 20 and 30 and they were unable to calculate corresponding probabilities. The methods for finding the mean and the standard deviation were usually known and they were often correctly applied to the distribution produced by the candidates. Too many candidates forgot to take the square root to find the standard deviation. Having struggled with part (b) candidates then could not interpret the demand in part (d).

25. Explanations in parts (a) and (b) were very poor with many candidates having no idea how to define a sample space or an event. Apart from a few slips the remaining parts of this question were well answered and many candidates gained full marks for them.

26. Many candidates could not read the given table sufficiently accurately to gain the first six marks on this question. The definition of independence was not known by many candidates and many of those that knew the definition were unable to apply it.

27. No Report available for this question.