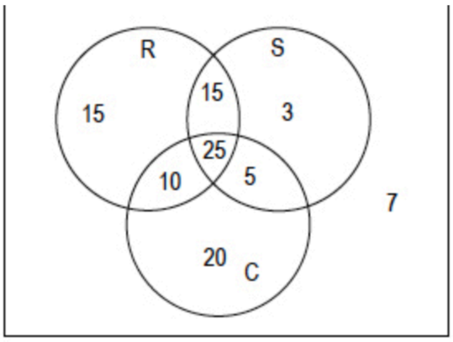
1.

<table>
<tr><td>(a)</td><td>(Discrete) uniform</td><td>B1
(1)</td></tr>
<tr><td>(b)(i)</td><td>$P(X \leqslant 2) = 0.5$ [or $\frac{1}{4}+\frac{1}{4}$]
Probability that no more than 2 on all 3 rolls is $(0.5)^3 = \underline{0.125}$ or $\frac{1}{8}$</td><td>M1
A1 (2)</td></tr>
<tr><td>(ii)</td><td>e.g. sequence 1, 2, 3 probabability is $(0.25)^3$ [$= 0.015625$ or $\frac{1}{64}$]
4 cases (1, 2, 4 etc) and 6 arrangements so probability = $\frac{1}{64}\times 4\times 6$ <u>or</u> $\frac{1}{4^3}\times 4!$
$= \underline{0.375}$ or $\frac{3}{8}$</td><td>M1
M1
A1
(3)</td></tr>
<tr><td>(c)</td><td><table><tr><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>2</td><td>2</td><td>3</td><td>4</td></tr><tr><td>3</td><td>3</td><td>3</td><td>4</td></tr><tr><td>4</td><td>4</td><td>4</td><td>4</td></tr></table></td><td>B2/1/0
(− 1 eeoo)
(2)</td></tr>
<tr><td>(d)</td><td><table><tr><td>m</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>$P(M = m)$</td><td>$\frac{1}{16}$</td><td>$\frac{3}{16}$</td><td>$\frac{5}{16}$</td><td>$\frac{7}{16}$</td></tr></table></td><td>M1
A1ft
(2)</td></tr>
<tr><td>(e)(i)</td><td>$E(M) = \frac{1}{16}[\,1 + 6 + 15 + 28]$
$= \frac{50}{16}$ or $\frac{25}{8}$ or 3.125</td><td>M1
A1ft (2)</td></tr>
<tr><td>(ii)</td><td>$E(M^2) = \frac{1}{16}\left[1+2^2\times 3+3^2\times 5+4^2\times 7\right]$ or $\frac{1}{16}[1+12+45+112]\{=\frac{170}{16}\}$
$\text{Var}(M) = \text{"}\frac{170}{16}\text{"} - (\text{"}\frac{50}{16}\text{"})^2$
$= \frac{55}{64}$ or 0.859375</td><td>M1
M1
A1 (3)</td></tr>
<tr><td>(f)</td><td>Identify the two shaded cases in table of (c) or $\frac{2}{16}\big/\frac{7}{16}$
$= \frac{2}{7}$</td><td>M1
A1 (2)
[17]</td></tr>
</table>

2.

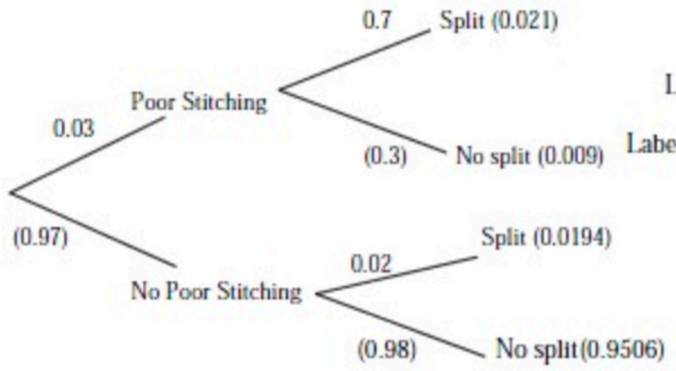
Number		
(a)	(R and S are mutually) exclusive.	B1 (1)
(b)	$\frac{2}{3}=\frac{1}{4}+\mathrm{P}(B)-\mathrm{P}(A\cap B)$ use of Addition Rule	M1
	$\frac{2}{3}=\frac{1}{4}+\mathrm{P}(B)-\frac{1}{4}\times\mathrm{P}(B)$ use of independence	M1 A1
	$\frac{5}{12}=\frac{3}{4}\mathrm{P}(B)$	
	$\mathrm{P}(B)=\frac{5}{9}$	A1 (4)
(c)	$\mathrm{P}(A'\cap B)=\frac{3}{4}\times\frac{5}{9}=\frac{15}{36}=\frac{5}{12}$	M1A1ft (2)
(d)	$\mathrm{P}(B'\mid A)=\frac{(1-(\mathrm{b}))\times 0.25}{0.25}$ or $\mathrm{P}(B')$ or $\frac{\frac{1}{9}}{\frac{1}{4}}$	M1
	$=\frac{4}{9}$	A1 (2)

3.



	15,10,5	A1
	15,3,20	A1
	Labels R, S, C and box	B1
	All values/100 or equivalent fractions award accuracy marks.	(4)
(b)	7/100 or 0.07 M1 for ('their 7' in diagram or here)/100	M1 A1 (2)
(c)	(3+5)/100 = 2/25 or 0.08	M1A1 (2)
(d)	(25+15+10+5)/100 = 11/20 or 0.55	M1 A1 (2)
(e)	$\mathrm{P}(S\cap C'\mid R)=\frac{P(S\cap C'\cap R)}{P(R)}$ Require denominator to be 'their 65' or 'their $\frac{65}{100}$'	M1
	$=\frac{15}{65}$ require 'their 15' and correct denominator of 65	A1
	$=\frac{3}{13}$ or exact equivalents.	A1

4.

Question	Scheme	Marks
(a)	 Shape Labels & 0.03 Labels & 0.7,0.02	B1 B1 B1 (3)
(b)	P(Exactly one defect) = $0.03\times0.3+0.97\times0.02$ or $\text{P}(PS\cup Split)-2\text{P}(PS\cap Split)$ $=[0.009\ +\ 0.0194\ =]$ **<u>0.0284</u>**	M1A1ft A1 cao (3)
(c)	P(No defects) $=(1-0.03)\times(1-0.02)\times(1-0.05)$ (or better) $=0.90307$ **awrt <u>0.903</u>**	M1 A1 cao (2)
(d)	P(Exactly one defect) = (b)$\times(1-0.05)\ +\ (1-0.03)\times(1-0.02)\times0.05$ $=$ "0.0284"$\times0.95+0.97\times0.98\times0.05$ $=[0.02698+0.04753]=0.07451$ **awrt <u>0.0745</u>**	M1 M1 A1ft A1 cao (4) **[12]**
	Notes	

5.

Number	Scheme	Marks
(a)	Only 2 outcomes **Heads** and **Tails oe**	
	Constant probability of **spinning** a **Head/Tail oe**	
	Coin is **spun** a fixed number of times **oe**	
	Each **spin** of the coin is independent **oe**	B1 B1
		(2)
(b)	$T\sim\text{B}(6,\,0.5)$	
	$\text{P}(T\le5)-\text{P}(T\le4)\ =0.9844-0.8906$ or $6\left(\frac{1}{2}\right)^5\left(\frac{1}{2}\right)$ oe	M1
	$=0.09375$ or $\frac{3}{32}$ oe awrt 0.0938	A1
		(2)
(c)	$\text{P}(T=4,5,6)=\ 1-\text{P}(T\le3)$	M1
	$=1-0.6563$	
	$=0.3437$ or $\frac{11}{32}$ awrt 0.344	A1
		(2)
(d)	$\text{P}(H=3,4,5,6)=1-\text{P}(H\le2)$	B1M1d
	$=1-0.8306$	
	$=0.1694$ or $\frac{347}{2048}$ awrt 0.169	A1
		(3)
		Total 9

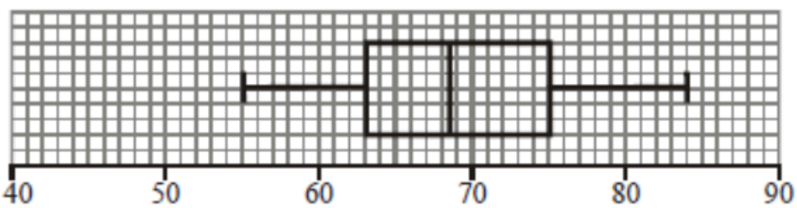
6.

(a)	$X \sim B(15, 0.5)$	B1 B1 (2)
(b)	$P(X = 8) = P(X \le 8) - P(X \le 7)$ or $\left(\frac{15!}{8!7!}(p)^8(1-p)^7\right)$	M1
	$= 0.6964 - 0.5$	
	$= 0.1964$ awrt 0.196	A1 (2)
(c)	$P(X \ge 4) = 1 - P(X \le 3)$	M1
	$= 1 - 0.0176$	
	$= 0.9824$	A1 (2)
(d)	$H_0 : p = 0.5$	B1
	$H_1 : p > 0.5$	B1
	$X \sim B(15, 0.5)$	
	$P(X \ge 13) = 1 - P(X \le 12)$ | $[P(X \ge 12) = 1 - 0.9824 = 0.0176]$ att $P(X \ge 13)$	M1
	$= 1 - 0.9963$ | $P(X \ge 13) = 1 - 0.9963 = 0.0037$	
	$= 0.0037$ | CR $X \ge 13$ awrt 0.0037/ CR $X \ge 13$	A1
	$0.0037 < 0.01$ | $13 \ge 13$	
	Reject H_0 or it is significant or a correct statement in context from their values	M1
	There is sufficient evidence at the 1% significance level that the coin is <u>biased in favour of heads</u> *or* There is evidence that Sue's belief is correct	A1 (6)
		(12 marks)

7.

Question Number	Scheme	Marks
(a)	$\underline{10.5}$	B1 (1)
(b)	$(Q_2 =)\ (15.5+)\ \dfrac{\frac{1}{2}\times 30-14}{8}\times 3$ or $\dfrac{\frac{1}{2}\times 31-14}{8}\times 3$	M1
	$= \underline{15.875 \text{ or } 16.0625}$	A1 (2)
(c)	$\bar{x} = \dfrac{477.5}{30} = \underline{15.9}$ $(15.91\dot{6})$ [Accept $\dfrac{191}{12}$ or $15\frac{11}{12}$]	M1, A1
	$\sigma = \sqrt{\dfrac{8603.75}{30} - \bar{x}^2}$,$= \underline{5.78}$ (accept $s = 5.88$)	M1A1ft, A1 (5)

8.

Question	Scheme	Marks
(a)	[Range = 48 – 9] = **$\underline{39}$**	B1 (1)
(b)	[IQR = 25 – 12]= **$\underline{13}$**	B1 (1)
(c)	Median = $65 + \dfrac{[9]}{13}\times 5 = \dfrac{890}{13}$ = awrt **$\underline{68.5}$**° $\left[\text{Condone: } 65+\dfrac{[9.5]}{13}\times 5 = 68.7\right]$	M1 A1 (2)
(d)	Lower Quartile = $60 + \dfrac{9}{15}\times 5 = \underline{\mathbf{63}}$ (*)	M1 A1cso (2)
(e)(i)	$63 - 1.5\times(75-63) = 45$	M1A1
	$75 + 1.5\times(75-63) = 93$	
	No data above 93 and no data below 45 <u>or</u> 55>45 etc <u>or</u> there are no outliers.	A1
(ii)		M1 A1ft (5)
(f)	Median for the 70°angle is closer (to 70°)[than the 20° median is to 20°]	B1
	The range/IQR for the 70° angle box plot is smaller/shorter	B1
	Therefore, students were more accurate at drawing the 70° angle.	dB1 (3)
		(14 marks)

The random variable X, with the following probability distribution, represents the score when a 4-sided die is rolled.

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

(a) Write down the name of this probability distribution.

(1)

The die is rolled 3 times.

(b) Find the probability that

(i) the score is no more than 2 on each of the 3 rolls of the die,

(2)

(ii) the score on each of the 3 rolls is different.

(3)

The die is now rolled twice. The random variable X_1 represents the score on the first roll and the random variable X_2 represents the score on the second roll.

The random variable M is the maximum of X_1 and X_2

(c) Complete the table below to show the values of M

(a) State in words the relationship between two events R and S when $P(R \cap S) = 0$

(1)

The events A and B are independent with $P(A) = \frac{1}{4}$ and $P(A \cup B) = \frac{2}{3}$

Find

(b) $P(B)$

(4)

(c) $P(A' \cap B)$

(2)

(d) $P(B' | A)$

(2)

The following shows the results of a survey on the types of exercise taken by a group of 100 people.

65 run
48 swim
60 cycle
40 run and swim
30 swim and cycle
35 run and cycle
25 do all three

(a) Draw a Venn Diagram to represent these data.

(4)

Find the probability that a randomly selected person from the survey

(b) takes none of these types of exercise,

(2)

(c) swims but does not run,

(2)

(d) takes at least two of these types of exercise.

(2)

Jason is one of the above group.
Given that Jason runs,

(e) find the probability that he swims but does not cycle.

(3)

A manufacturer carried out a survey of the defects in their soft toys. It is found that the probability of a toy having poor stitching is 0.03 and that a toy with poor stitching has a probability of 0.7 of splitting open. A toy without poor stitching has a probability of 0.02 of splitting open.

(a) Draw a tree diagram to represent this information.

(3)

(b) Find the probability that a randomly chosen soft toy has exactly one of the two defects, poor stitching or splitting open.

(3)

The manufacturer also finds that soft toys can become faded with probability 0.05 and that this defect is independent of poor stitching or splitting open. A soft toy is chosen at random.

(c) Find the probability that the soft toy has none of these 3 defects.

(2)

(d) Find the probability that the soft toy has exactly one of these 3 defects.

(4)

A fair coin is spun 6 times and the random variable T represents the number of tails obtained.

(a) Give two reasons why a binomial model would be a suitable distribution for modelling T.

(2)

(b) Find $P(T = 5)$

(2)

(c) Find the probability of obtaining more tails than heads.

(2)

A second coin is biased such that the probability of obtaining a head is $\frac{1}{4}$

This second coin is spun 6 times.

(d) Find the probability that, for the second coin, the number of heads obtained is greater than or equal to the number of tails obtained.

(3)

Sue throws a fair coin 15 times and records the number of times it shows a head.

(a) State the distribution to model the number of times the coin shows a head.

(2)

Find the probability that Sue records

(b) exactly 8 heads,

(2)

(c) at least 4 heads.

(2)

Sue has a different coin which she believes is biased in favour of heads. She throws the coin 15 times and obtains 13 heads.

(d) Test Sue's belief at the 1% level of significance. State your hypotheses clearly.

(6)

A class of students had a sudoku competition. The time taken for each student to complete the sudoku was recorded to the nearest minute and the results are summarised in the table below.

Time	Mid-point, x	Frequency, f
2 - 8	5	2
9 - 12		7
13 - 15	14	5
16 - 18	17	8
19 - 22	20.5	4
23 - 30	26.5	4

(You may use $\sum fx^2 = 8603.75$)

(a) Write down the mid-point for the 9 - 12 interval.

(1)

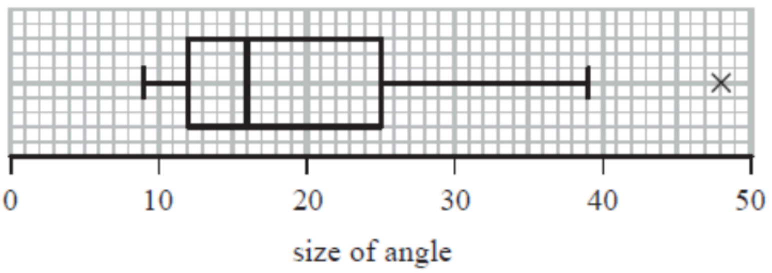
(b) Use linear interpolation to estimate the median time taken by the students.

(2)

(c) Estimate the mean and standard deviation of the times taken by the students.

(5)

Each of 60 students was asked to draw a 20° angle without using a protractor. The size of each angle drawn was measured. The results are summarised in the box plot below.



(a) Find the range for these data.

(1)

(b) Find the interquartile range for these data.

(1)

The students were then asked to draw a 70° angle.
The results are summarised in the table below.

Angle, a, (degrees)	Number of students
$55 \leqslant a < 60$	6
$60 \leqslant a < 65$	15
$65 \leqslant a < 70$	13
$70 \leqslant a < 75$	11
$75 \leqslant a < 80$	8
$80 \leqslant a < 85$	7

(c) Use linear interpolation to estimate the size of the median angle drawn. Give your answer to 1 decimal place.

(2)

(d) Show that the lower quartile is 63°

(2)

For these data, the upper quartile is 75°, the minimum is 55° and the maximum is 84°

An outlier is an observation that falls either
more than 1.5 × (interquartile range) above the upper quartile or
more than 1.5 × (interquartile range) below the lower quartile.

(e) (i) Show that there are no outliers for these data.

(ii) Draw a box plot for these data on the grid on page 3.

(5)

(f) State which angle the students were more accurate at drawing. Give reasons for your answer.

(3)