6. The discrete random variable X has the following probability distribution

x	а	b	c
P(X=x)	$\log_{36} a$	$\log_{36} b$	$\log_{36} c$

where

- a, b and c are distinct integers (a < b < c)
- all the probabilities are greater than zero
- (a) Find
 - (i) the value of a
 - (ii) the value of b
 - (iii) the value of c

Show your working clearly.

(5)

The independent random variables X_1 and X_2 each have the same distribution as X

(b) Find $P(X_1 = X_2)$



4. A large college produces three magazines.

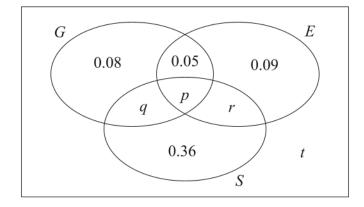
One magazine is about green issues, one is about equality and one is about sports. A student at the college is selected at random and the events G, E and S are defined as follows

G is the event that the student reads the magazine about green issues

E is the event that the student reads the magazine about equality

S is the event that the student reads the magazine about sports

The Venn diagram, where p, q, r and t are probabilities, gives the probability for each subset.



(a) Find the proportion of students in the college who read exactly one of these magazines.

(1)

No students read all three magazines and P(G) = 0.25

- (b) Find
 - (i) the value of p
 - (ii) the value of q

(3)

Given that $P(S \mid E) = \frac{5}{12}$

- (c) find
 - (i) the value of r
 - (ii) the value of t

(4)

(d) Determine whether or not the events $(S \cap E')$ and G are independent. Show your working clearly.



SECTION A: STATISTICS

	Answer ALL questions. Write your answers in the spaces provided.	
1.	Helen believes that the random variable C , representing cloud cover from the large data set, can be modelled by a discrete uniform distribution.	
	(a) Write down the probability distribution for <i>C</i> .	
		(2)
	(b) Using this model, find the probability that cloud cover is less than 50%	
		(1)
	Helen used all the data from the large data set for Hurn in 2015 and found that the proportion of days with cloud cover of less than 50% was 0.315	
	(c) Comment on the suitability of Helen's model in the light of this information.	
		(1)
	(d) Suggest an appropriate refinement to Helen's model.	
		(1)

3. In an experiment a group of children each repeatedly throw a dart at a target. For each child, the random variable *H* represents the number of times the dart hits the target in the first 10 throws.

Peta models H as B(10, 0.1)

(a) State two assumptions Peta needs to make to use her model.

(2)

(b) Using Peta's model, find $P(H \ge 4)$

(1)

For each child the random variable F represents the number of the throw on which the dart first hits the target.

Using Peta's assumptions about this experiment,

(c) find
$$P(F = 5)$$

(2)

Thomas assumes that in this experiment no child will need more than 10 throws for the dart to hit the target for the first time. He models P(F = n) as

$$P(F = n) = 0.01 + (n - 1) \times \alpha$$

where α is a constant.

(d) Find the value of α

(4)

(e) Using Thomas' model, find P(F = 5)

(1)

(f) Explain how Peta's and Thomas' models differ in describing the probability that a dart hits the target in this experiment.

(1)

Answer ALL questions. Write your answers in the spaces provided.

1.	Three bags, A , B	and C , each	contain 1 red	marble and some	green marbles.
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Bag A contains 1 red marble and 9 green marbles only

Bag B contains 1 red marble and 4 green marbles only

Bag C contains 1 red marble and 2 green marbles only

Sasha selects at random one marble from bag A.

If he selects a red marble, he stops selecting.

If the marble is green, he continues by selecting at random one marble from bag B.

If he selects a red marble, he stops selecting.

If the marble is green, he continues by selecting at random one marble from bag C.

(a) L) raw	a	tree	diagram	to	represent	this	information	1
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(2)

(b) Find the probability that Sasha selects 3 green marbles.

(2)

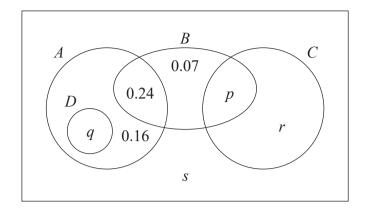
(c) Find the probability that Sasha selects at least 1 marble of each colour.

(2)

(d) Given that Sasha selects a red marble, find the probability that he selects it from bag B.

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1. The Venn diagram shows the probabilities associated with four events, A, B, C and D



(a) Write down any pair of mutually exclusive events from A, B, C and D

(1)

Given that P(B) = 0.4

(b) find the value of p

(1)

Given also that A and B are independent

(c) find the value of q

(2)

Given further that P(B'|C) = 0.64

- (d) find
 - (i) the value of r
 - (ii) the value of s

(4)

4. The discrete random variable D has the following probability distribution

d	10	20	30	40	50
P(D=d)	$\frac{k}{10}$	$\frac{k}{20}$	$\frac{k}{30}$	$\frac{k}{40}$	$\frac{k}{50}$

where k is a constant.

(a) Show that the value of k is $\frac{600}{137}$

(2)

The random variables D_1 and D_2 are independent and each have the same distribution as D.

(b) Find $P(D_1 + D_2 = 80)$ Give your answer to 3 significant figures.

(3)

A single observation of D is made.

The value obtained, d, is the common difference of an arithmetic sequence.

The first 4 terms of this arithmetic sequence are the angles, measured in degrees, of quadrilateral Q

(c) Find the exact probability that the smallest angle of Q is more than 50°

(5)



4. Given that

$$P(A) = 0.35$$

$$P(B) = 0.45$$

and

$$P(A \cap B) = 0.13$$

find

(a) $P(A' \mid B')$

(2)

(b) Explain why the events A and B are not independent.

(1)

The event C has P(C) = 0.20

The events A and C are mutually exclusive and the events B and C are statistically independent.

(c) Draw a Venn diagram to illustrate the events A, B and C, giving the probabilities for each region.

(5)

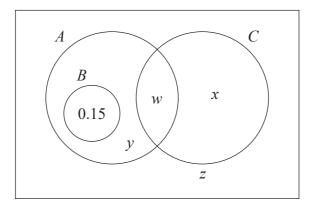
(d) Find $P([B \cup C]')$

2. The Venn diagram, where w, x, y and z are probabilities, shows the probabilities of a group of students buying each of 3 magazines.

A represents the event that a student buys magazine A and P(A) = 0.60

B represents the event that a student buys magazine B and P(B) = 0.15

C represents the event that a student buys magazine C and P(C) = 0.35



(a) State which two of the three events A, B and C are mutually exclusive.

(1)

The events A and C are independent.

(b) Show that w = 0.21

(1)

(c) Find the value of x, the value of y and the value of z.

(4)

(d) Find the probability that a student selected at random buys only one of these magazines.

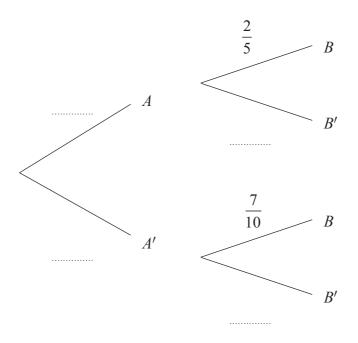
(1)

(e) Find the probability that a student selected at random buys magazine B or magazine C.

(1)

(f) Find $P(A | [B \cup C])$

4. The following incomplete tree diagram shows the relationships between the event A and the event B.



Given that $P(B) = \frac{9}{20}$

(a) find P(A) and complete the tree diagram,

(6)

(b) find P(A' | B').

Leave blank

3. Hugo recorded the purchases of 80 customers in the ladies fashion department of a large store. His results were as follows

20 customers bought a coat

- 12 customers bought a coat and a scarf
- 23 customers bought a pair of gloves
- 13 customers bought a pair of gloves and a scarf

no customer bought a coat and a pair of gloves

14 customers did not buy a coat nor a scarf nor a pair of gloves.

(a) Draw a Venn diagram to represent all of this information.

(4)

- (b) One of the 80 customers is selected at random.
 - (i) Find the probability that the customer bought a scarf.

(1)

(ii) Given that the customer bought a coat, find the probability that the customer also bought a scarf.

(2)

(iii) State, giving a reason, whether or not the event 'the customer bought a coat' and the event 'the customer bought a scarf' are statistically independent.

(2)

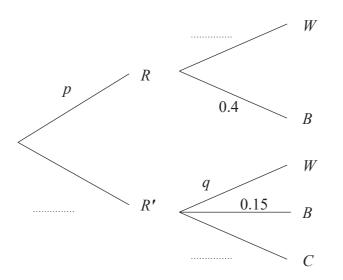
Hugo had asked the member of staff selling coats and the member of staff selling gloves to encourage customers also to buy a scarf.

(c) By considering suitable conditional probabilities, determine whether the member of staff selling coats or the member of staff selling gloves has the better performance at selling scarves to their customers. Give a reason for your answer.





1. The partially completed tree diagram, where p and q are probabilities, gives information about Andrew's journey to work each day.



R represents the event that it is raining

W represents the event that Andrew walks to work

B represents the event that Andrew takes the bus to work

C represents the event that Andrew cycles to work

Given that P(B) = 0.26

(a) find the value of p

(3)

Given also that P(R'|W) = 0.175

(b) find the value of q

(4)

(c) Find the probability that Andrew cycles to work.

(2)

Given that Andrew did not cycle to work on Friday,

(d) find the probability that it was raining on Friday.

Three events A, B and C are such that

$$P(A) = \frac{2}{5}$$

$$P(C) = \frac{1}{2}$$

$$P(C) = \frac{1}{2}$$
 $P(A \cup B) = \frac{5}{8}$

Given that A and C are mutually exclusive find

(a) $P(A \cup C)$

(1)

Given that A and B are independent

(b) show that $P(B) = \frac{3}{8}$

(4)

(c) Find $P(A \mid B)$

(1)

Given that $P(C' \cap B') = 0.3$

(d) draw a Venn diagram to represent the events A, B and C

(5)

3. A company employs 90 administrators. The length of time that they have been employed by the company and their gender are summarised in the table below.

Length of time employed, x years	Female	Male
x < 4	9	16
4 ≤ <i>x</i> < 10	14	20
10 ≤ <i>x</i>	7	24

One of the 90 administrators is selected at random.

((a)) Find the	probability	that the	administrator	is	female.

(1)

(b) Given that the administrator has been employed by the company for less than 4 years, find the probability that this administrator is male.

(2)

(c) Given that the administrator has been employed by the company for less than 10 years, find the probability that this administrator is male.

(2)

(d) State, with a reason, whether or not the event 'selecting a male' is independent of the event 'selecting an administrator who has been employed by the company for less than 4 years'.

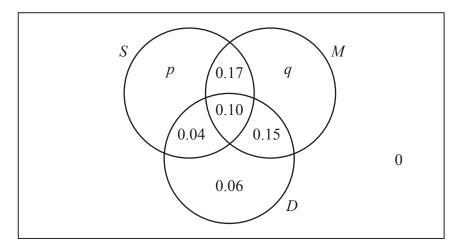
4.	A bag contains 19 red beads and 1 blue bead only.	
	Linda selects a bead at random from the bag. She notes its colour and replaces the be in the bag. She then selects a second bead at random from the bag and notes its colour	
	Find the probability that	
	(a) both beads selected are blue,	(1)
	(b) exactly one bead selected is red.	(2)
	In another bag there are 9 beads, 4 of which are green and the rest are yellow.	
	Linda selects 3 beads from this bag at random without replacement.	
	(c) Find the probability that 2 of these beads are yellow and 1 is green.	(3)
	Linda replaces the 3 beads and then selects another 4 at random without replacement.	
	(d) Find the probability that at least 1 of the beads is green.	(3)
		_

6. The Venn diagram below shows the probabilities of customers having various combinations of a starter, main course or dessert at Polly's restaurant.

S = the event a customer has a starter.

M = the event a customer has a main course.

D = the event a customer has a dessert.



Given that the events S and D are statistically independent

(a) find the value of p.

(4)

(b) Hence find the value of q.

(2)

- (c) Find
 - (i) $P(D \mid M \cap S)$
 - (ii) $P(D \mid M \cap S')$

(4)

One evening 63 customers are booked into Polly's restaurant for an office party. Polly has asked for their starter and main course orders before they arrive.

Of these 63 customers

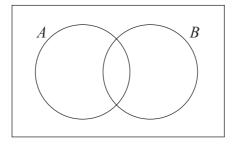
27 ordered a main course and a starter,

36 ordered a main course without a starter.

(d) Estimate the number of desserts that these 63 customers will have.



2. (a) Shade the region representing the event $A \cup B'$ on the Venn diagram below.



(1)

The two events C and D are mutually exclusive.

Given that $P(C) = \frac{1}{5}$ and $P(D) = \frac{3}{10}$

find

- (b) (i) $P(C \cup D)$
 - (ii) P(C|D)

(3)

The two events F and G are independent.

Given that $P(F) = \frac{1}{6}$ and $P(F \cup G) = \frac{3}{8}$

find

- (c) (i) P(G)
 - (ii) P(F|G')

(4)

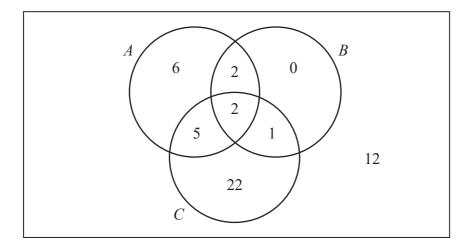
2. An integer is selected at random from the integers 1 to 50 inclusive.

A is the event that the integer selected is prime.

B is the event that the integer selected ends in a 3

C is the event that the integer selected is greater than 20

The Venn diagram shows the number of integers in each region for the events A, B and C



(a) Describe in words the event $(A \cap B)$

(1)

(b) Write down the probability that the integer selected is prime.

(1)

(c) Find $P([A \cup B \cup C]')$

(1)

Given that the integer selected is greater than 20

(d) find the probability that it is prime.

(2)

Using your answers to (b) and (d),

(e) state, with a reason, whether or not the events A and C are statistically independent.

(2)

Given that the integer selected is greater than 20 and prime,

(f) find the probability that it ends in a 3



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5.	In a survey, people were asked if they use a computer every day.	
	Of those people under 50 years old, 80% said they use a computer every day. Of those people aged 50 or more, 55% said they use a computer every day.	
	The proportion of people in the survey under 50 years old is p	
	(a) Draw a tree diagram to represent this information.	(2)
	In the survey, 70% of all people said they use a computer every day.	
	(b) Find the value of p	(2)
	One person is selected at random. Given that this person uses a computer every day,	(2)
	(c) find the probability that this person is under 50 years old.	(2)

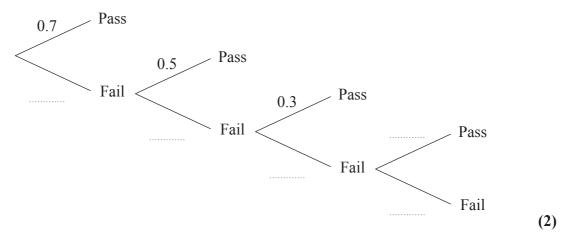


4. A training agency awards a certificate to each student who passes a test while completing a course.

Students failing the test will attempt the test again up to 3 more times, and, if they pass the test, will be awarded a certificate.

The probability of passing the test at the first attempt is 0.7, but the probability of passing reduces by 0.2 at each attempt.

(a) Complete the tree diagram below to show this information.



A student who completed the course is selected at random.

(b) Find the probability that the student was awarded a certificate.

(2)

(c) Given that the student was awarded a certificate, find the probability that the student passed on the first or second attempt.

(3)

The training agency decides to alter the test taken by the students while completing the course, but will not allow more than 2 attempts. The agency requires the probability of passing the test at the first attempt to be p, and the probability of passing the test at the second attempt to be (p-0.2). The percentage of students who complete the course and are awarded a certificate is to be 95%

(d) Show that p satisfies the equation

$$p^2 - 2.2p + 1.15 = 0 ag{3}$$

(e) Hence find the value of p, giving your answer to 3 decimal places.

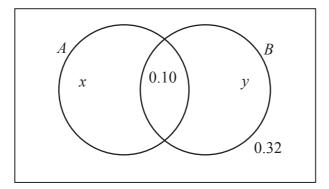
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4. Events *A* and *B* are shown in the Venn diagram below

where x, y, 0.10 and 0.32 are probabilities.



- (a) Find an expression in terms of x for
 - (i) **P**(*A*)
 - (ii) $P(B \mid A)$

(3)

(b) Find an expression in terms of x and y for $P(A \cup B)$

(1)

Given that P(A) = 2P(B)

(c) find the value of x and the value of y

(5)

Leave blank

5. A group of 100 students are asked if they like folk music, rock music or soul music.

All students who like folk music also like rock music

No students like both rock music and soul music

75 students do not like soul music

12 students who like rock music do not like folk music

30 students like folk music

(a) Draw a Venn diagram to illustrate this information.

(4)

(b) State two of these types of music that are mutually exclusive.

(1)

Find the probability that a randomly chosen student

(c) does not like folk music, rock music or soul music,

(1)

(d) likes rock music,

(1)

(e) likes folk music or soul music.

(1)

Given that a randomly chosen student likes rock music,

(f) find the probability that he or she also likes folk music.

In a large college, $\frac{3}{5}$ of the students are male, $\frac{3}{10}$ of the students are left handed and $\frac{1}{5}$ of the male students are left handed. A student is chosen at random. (a) Given that the student is left handed, find the probability that the student is male. **(2)** (b) Given that the student is female, find the probability that she is left handed. **(3)** (c) Find the probability that the randomly chosen student is male and right handed. **(2)** Two students are chosen at random. (d) Find the probability that one student is left handed and one is right handed. **(2)**