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A-LEVEL MATHEMATICS • STATISTICS 1

Probability

Worksheet

Pearson Edexcel International A Level (WST01) & A Level (9MA0) • Calculator and statistical tables allowed: show every step

Free Probability worksheet for A-Level and International A-Level Maths, with full worked solutions



Tap a section to jump straight to it

By the end of this worksheet you can: use Venn diagrams with counts and probabilities • tell mutually exclusive and independent events apart, and test for them • use set notation • find conditional probabilities • use tree diagrams • *Stretch:* unknown probabilities from equations, reverse conditionals, and trials without replacement.

Which questions are for me?

CORE The methods every A-level student must secure. Start here.

STRETCH Venn regions with unknowns, independence that you must test, trees you must complete, and conditionals that run backwards.

Every section has both, clearly labelled. Questions get harder as you go, and every skill in Sections A to D is needed in Section E.

Track your progress

Section	B	C	D	E
Core marks	23	10	13	19
Stretch marks	16	14	17	12
My score				

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A

Worked examples & Your turn

Read each example carefully. Cover it up, then answer the question beside it using the same method.

CORE

Secure the method

Worked example A1: a Venn diagram from counts

Of 50 students, 18 play football (F), 22 play tennis (T) and 7 play both. Find the number who play neither, and $P(F|T)$

Fill from the middle: both 7, F only 11, T only 15

Neither: $50 - 33 = 17$; restrict to the 22 in T

$$17, P(F|T) = \frac{7}{22}$$

Your turn A1

Of 60 people, 26 like tea (T), 30 like coffee (C) and 12 like both. Find the number who like neither, and $P(T|C)$

Worked example A2: set notation

$P(A) = 0.4$, $P(B) = 0.5$ and $P(A \cap B) = 0.15$. Find $P(A \cup B)$ and $P(A' \cap B)$

Addition rule: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$A' \cap B$ is B but not A : $0.5 - 0.15$

$$0.75, 0.35$$

Your turn A2

$P(A) = 0.35$, $P(B) = 0.45$ and $P(A \cup B) = 0.6$. Find $P(A \cap B)$ and $P(A \cap B')$

Worked example A3: a tree without replacement

A bag has 4 red and 6 blue counters. Two are taken without replacement. Find $P(\text{both the same colour})$.

The second branch has one fewer counter in total.

$$\frac{4}{10} \times \frac{3}{9} + \frac{6}{10} \times \frac{5}{9} = \frac{12}{90} + \frac{30}{90}$$

$$\frac{7}{15}$$

Your turn A3

A bag has 5 green and 3 yellow counters. Two are taken without replacement. Find $P(\text{both the same colour})$.



STRETCH

Worked example A4: testing independence

$P(A) = 0.3$, $P(B) = 0.6$ and $P(A \cap B) = 0.18$. Are A and B independent?

Compare $P(A \cap B)$ with $P(A) \times P(B)$, showing both numbers.

$$0.3 \times 0.6 = 0.18 = P(A \cap B)$$

independent

Your turn A4

$P(A) = 0.4$, $P(B) = 0.5$ and $P(A \cup B) = 0.75$. Are A and B independent?

Worked example A5: a reverse conditional

30% of parts come from machine X (5% faulty) and 70% from Y (2% faulty). A part is faulty. Find $P(\text{it came from } X)$.

$$P(X | F) = \frac{P(X \cap F)}{P(F)}, \text{ adding both routes to } F$$

$$\frac{0.3 \times 0.05}{0.3 \times 0.05 + 0.7 \times 0.02} = \frac{0.015}{0.029}$$

0.517

Your turn A5

40% of orders go by courier P (10% late) and 60% by Q (5% late). An order is late. Find $P(\text{it went by } P)$.

Worked example A6: mutually exclusive or independent

$P(A) = 0.3$ and $P(A \cup B) = 0.7$. Find $P(B)$ if (i) A , B are mutually exclusive, (ii) independent.

(i) $0.3 + P(B) = 0.7$; (ii) $0.3 + p - 0.3p = 0.7$, so $0.7p = 0.4$

(i) 0.4 (ii) $\frac{4}{7}$

Your turn A6

$P(A) = 0.2$ and $P(A \cup B) = 0.5$. Find $P(B)$ if (i) A , B are mutually exclusive, (ii) independent.

Worked example A7: an unknown Venn region

In a Venn diagram, $P(A) = 0.4$, B only is 0.3 and $A \cap B$ is x . A and B are independent. Find x

$$P(A \cap B) = P(A)P(B), \text{ with } P(B) = 0.3 + x$$

$$x = 0.4(0.3 + x), \text{ so } 0.6x = 0.12$$

$x = 0.2$

Your turn A7

In a Venn diagram, $P(A) = 0.25$, B only is 0.36 and $A \cap B$ is x . A and B are independent. Find x



B**Fluency**

Each question is a designed sequence. From one part to the next, ask yourself: what changed, and what did it do to the answer?

CORE*Secure the method*

B1 Of 80 shoppers, 45 bought bread, 30 bought milk and 12 bought both.

- (a) How many bought bread only? (b) How many bought neither?
 (c) Find $P(\text{milk but not bread})$. (d) Find $P(\text{bread} \mid \text{milk})$.

[4 marks]

B2 $P(A) = 0.5$, $P(B) = 0.35$ and $P(A \cap B) = 0.2$. Find

- (a) $P(A \cup B)$ (b) $P(A')$
 (c) $P(A \cap B')$ (d) $P((A \cup B)')$

[4 marks]

B3 $P(A) = 0.3$ and $P(B) = 0.5$

- (a) Find $P(A \cup B)$ if A and B are mutually exclusive.
 (b) Find $P(A \cap B)$ and $P(A \cup B)$ if A and B are independent.
 (c) If A and B are independent, find $P(A \mid B)$
 (d) Explain why A and B cannot be both mutually exclusive and independent.

[4 marks]

B4 A student walks to school with probability 0.6, otherwise takes the bus. The probability of being late is 0.1 after walking and 0.25 after the bus.

- (a) Find $P(\text{late})$. (b) Find $P(\text{walks and is on time})$.
 (c) Find $P(\text{bus} \mid \text{late})$. (d) Find $P(\text{on time})$.

[4 marks]

B5 The table shows 100 students.

	Plays sport	No sport
Year 12	24	36
Year 13	16	24

- (a) Find $P(\text{plays sport})$.
 (b) Find $P(\text{plays sport} \mid \text{Year 12})$.
 (c) Is playing sport independent of being in Year 12? Give a reason.

[3 marks]

B6 A box has 5 red, 4 blue and 3 green pens. Two are taken without replacement. Find

- (a) $P(\text{both red})$ (b) $P(\text{both the same colour})$
(c) $P(\text{at least one green})$ (d) $P(\text{two different colours})$

[4 marks]

STRETCH

B7 Of 100 people, 50 use N , 40 use S and 30 use P ; 15 use N and S , 12 use N and P , 10 use S and P , and 6 use all three.

- (a) How many use none? (b) Find $P(\text{exactly one})$.
(c) Find $P(S|N)$ (d) Are N and S independent?

[4 marks]

B8 $P(A) = x$, $P(B) = 0.4$ and $P(A \cup B) = 0.7$, where A and B are independent.

- (a) Find x (b) Find $P(A \cap B)$
(c) Find $P(A|B')$ (d) Find $P(A' \cap B')$

[4 marks]

B9 On each throw, the probability that Ravi hits the target is 0.3, independently. He throws three times.

- (a) Find $P(\text{his first hit is on the third throw})$.
(b) Find $P(\text{at least one hit})$.
(c) Find $P(\text{exactly one hit})$.
(d) Given that he hits at least once, find $P(\text{his first hit is on the third throw})$.

[4 marks]

B10 A shop buys 50% of its items from supplier A , 30% from B and 20% from C . Of their items, 2%, 3% and 5% are faulty.

- (a) Find $P(\text{faulty})$. (b) Find $P(C | \text{faulty})$.
(c) Find $P(A | \text{not faulty})$. (d) Which supplier is most likely, given faulty?

[4 marks]



C**Reasoning**

Show your working and explain your thinking. A correct answer without a reason does not score full marks.

CORE*Secure the method*

- C1** $P(A) = 0.5$, $P(B) = 0.4$ and $P(A \cap B) = 0.2$. Ali writes “ A and B are not independent as they overlap”. Explain his error, and decide correctly. [2 marks]
- C2** $P(A) = 0.5$, $P(B) = 0.4$ and $P(A \cap B) = 0.1$. Bea writes $P(A|B) = \frac{0.1}{0.5} = 0.2$. Explain her error, and find $P(A|B)$. [2 marks]
- C3** A bag has 3 white and 7 black beads. Two are taken without replacement. Cal writes $P(\text{both white}) = 0.3 \times 0.3 = 0.09$. Explain his error, and find the correct probability. [3 marks]
- C4** For the bag in C3, Dina writes $P(\text{exactly one white}) = \frac{3}{10} \times \frac{7}{9} = \frac{7}{30}$. Explain what she has missed, and find the correct probability. [3 marks]

STRETCH

- C5** $P(C) = 0.5$ and $P(D) = 0.4$. To find $P(C \cap D)$, Eva writes $0.5 \times 0.4 = 0.2$. Explain why this is not valid without more information, and find $P(C \cap D)$ given that $P(C|D) = 0.3$. [3 marks]
- C6** $P(C \cup D) = 0.65$, $P(D) = 0.4$ and $P(C \cap D) = 0.15$. Finn writes $P(C) = 0.65 - 0.4 = 0.25$. Explain his error, and find $P(C)$. [3 marks]
- C7** Two players take turns to roll a die, starting with Gia, and the first to roll a six wins. Gia says “ $P(\text{I win on my second roll}) = \frac{5}{6} \times \frac{1}{6}$ ”. Explain her error, and find the correct probability. [3 marks]
- C8** (a) A and B are independent. Show that A and B' are independent. (3)
- (b) Explain why two events with non-zero probabilities cannot be both independent and mutually exclusive. (2)
- [5 marks]

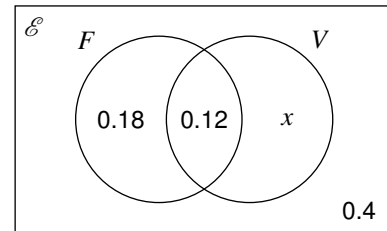


D**Problem solving**

You decide the method. Read the whole question first, and show every step.

CORE*Secure the method*

- D1** A supermarket records whether each customer buys fruit, F , and whether they buy vegetables, V . The Venn diagram in Figure 1 shows the probabilities, where x is a probability.

**Figure 1**

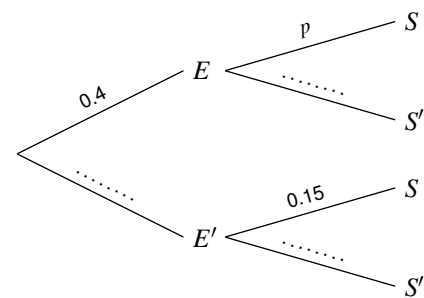
- (a) Find the value of x
- (b) A customer who buys vegetables is chosen at random. Find the probability that this customer also buys fruit, giving your answer as a fraction.

(1)

(2)

[3 marks]

- D2** A garage services cars. 40% of the cars are electric, E , and the rest use petrol. A car needs a new part, S , with probability p if it is electric and 0.15 if it uses petrol. The probability that a randomly chosen car needs a new part is 0.13

**Figure 2**

- (a) Complete the tree diagram in Figure 2.
- (b) Find the value of p
- (c) Given that a car needs a new part, find the probability that it is electric.

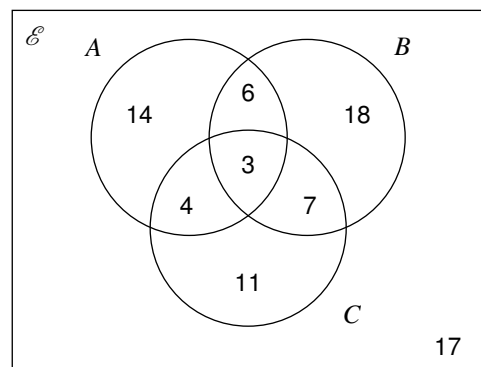
(1)

(2)

(1)

[4 marks]

- D3** The Venn diagram in Figure 3 shows the numbers of 80 visitors to a leisure centre who used the gym, A , the pool, B , and the courts, C , on one day.

**Figure 3**

- (a) Find the probability that a visitor chosen at random used at least two of the three facilities.
- (b) Given that a visitor used the pool, find the probability that they also used the courts.

(1)

(2)

[3 marks]

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- D4** The events A and B are such that $P(A) = x$, $P(B) = y$, $P(A \cup B) = 0.62$, $P(A | B) = 0.4$ and $P(A \cap B') = 0.12$. Form two equations in x and y , and hence find the value of x and the value of y . You must show your working clearly. [3 marks]

STRETCH

- D5** A jar contains n blue sweets and 6 white sweets only. Two sweets are taken at random from the jar, one at a time, without replacement.

(a) Complete the tree diagram in Figure 4, giving your probabilities in terms of n

(1)

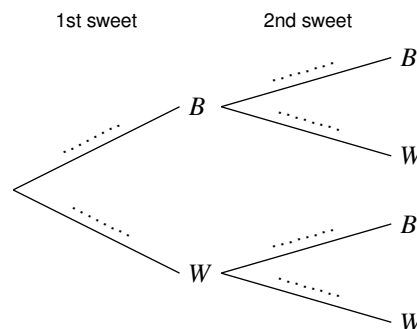


Figure 4

The probability that both sweets are white is $\frac{1}{7}$

(b) Show that $n^2 + 11n - 180 = 0$

(2)

(c) Hence find the number of blue sweets in the jar.

(1)

[4 marks]

- D6** The Venn diagram in Figure 5 shows the probabilities that a student at a college reads for pleasure, R , plays a sport, S , and plays a musical instrument, M , where p and q are probabilities. The probability that a student reads for pleasure is 0.4

(a) Find the value of p and the value of q

(2)

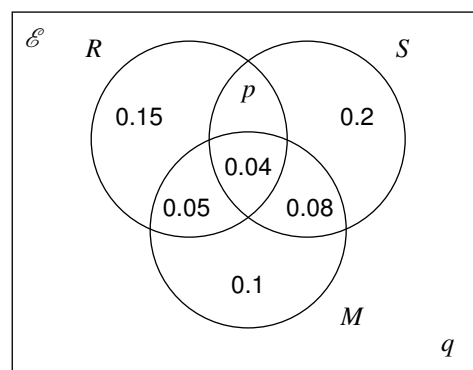


Figure 5

(b) Determine whether the events R and S are independent. You must show your working clearly.

(2)

[4 marks]



- D7** A delivery van uses route A , B or C each day, with probabilities 0.6, 0.3 and 0.1. The probability that the van arrives on time, O , is 0.95 on route A , 0.8 on route B and 0.3 on route C

(a) Complete the tree diagram in Figure 6.

(1)

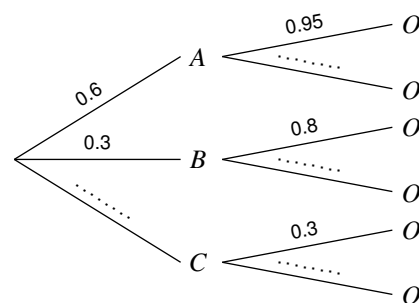


Figure 6

(b) Find the probability that the van arrives on time on a randomly chosen day.

(1)

(c) Given that the van is late on a particular day, find the probability that it used route C

(2)

[4 marks]

- D8** A tin contains n sweets. The numbers of red, green and blue sweets in the tin are in the ratio 3 : 2 : 1. Three sweets are taken from the tin at random, one at a time, without replacement. The probability of taking a red sweet, then a green sweet, then a blue sweet, in that order, is $\frac{2}{55}$

(a) Show that n satisfies the equation $17n^2 - 216n + 144 = 0$

(3)

(b) Hence find the number of sweets in the tin, giving a reason for rejecting the other solution.

(2)

[5 marks]



E**Exam practice**

Full-size exam questions in the style of WST01. Write your answers in the spaces, and show every step.

CORE

Exam questions for everyone

E1 A college surveys all 120 of its students to find out which of three languages each student studies: French, F , German, G , and Spanish, S . The results are

- 50 study French
- 40 study German
- 45 study Spanish
- 15 study French and German
- 18 study French and Spanish
- 12 study German and Spanish
- 6 study all three languages

(a) Using this information, complete the Venn diagram in Figure 7.

(4)

One of these students is chosen at random.

(b) Determine whether or not studying French is statistically independent of studying Spanish for these 120 students. You must show your working clearly.

(2)

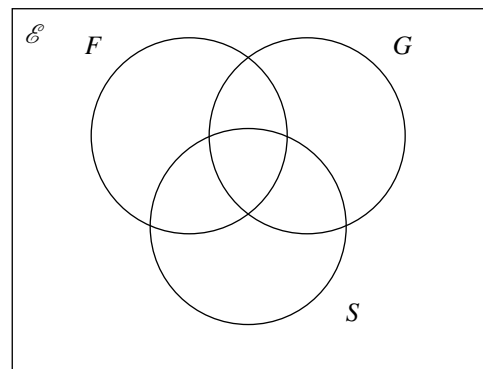


Figure 7

(c) Find the probability that the student chosen studies exactly one of these three languages.

(1)

(d) Given that the student chosen studies Spanish, find the probability that this student also studies German.

(2)

(Total for Question E1 is 9 marks)



- E2** A phone repair shop records the brand of each phone that is brought in for repair, and whether or not the phone has a screen fault, D . 45% of the phones are brand X , 35% are brand Y and the rest are brand Z . The probability of a screen fault is 0.3 for brand X , 0.4 for brand Y and p for brand Z

(a) Complete the tree diagram in Figure 8.

(2)

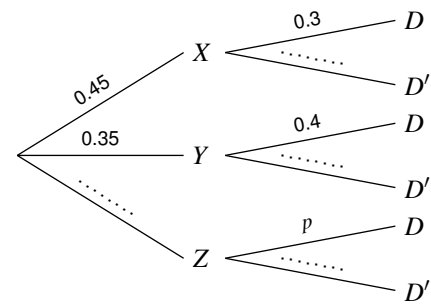


Figure 8

The probability that a randomly chosen phone has a screen fault is 0.335

(b) Find the value of p

(2)

(c) Given that a phone brought into the shop has a screen fault, find the probability that it is brand Y

(2)

On one morning, two phones are brought into the repair shop independently of each other.

(d) Find the probability that exactly one of these two phones has a screen fault.

(2)

(e) Given that both of these phones have a screen fault, find the probability that both of the phones are brand X

(2)

(Total for Question E2 is 10 marks)



STRETCH

- E3** The Venn diagram in Figure 9 shows the probabilities of three events A , B and C , where a , p and q are probabilities. The events B and C do not overlap. It is known that $P(A) = 0.5$, that A and B are independent, and that $P(C|A) = 0.2$

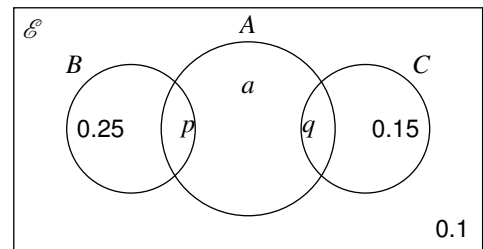


Figure 9

- (a) Explain what the diagram shows about the events B and C

(1)

- (b) Find the value of p

(3)

- (c) Find the value of q and the value of a

(3)

- (d) Find $P(A' | B \cup C)$, giving your answer as a fraction in its simplest form.

(2)

The diagram is used as a model for a large group of people, in which 30 of the people are in the event $A \cap C$

- (e) Use the probabilities in the diagram to estimate how many people in the group are in B but not in A

(2)

- (f) Determine whether or not the events A and C are statistically independent, giving a reason for your answer.

(1)

(Total for Question E3 is 12 marks)

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