FREE SAMPLE: THE FIRST QUESTION

Question One (14 marks)

(a) A survey of 100 households surveyed recorded whether each person have solar panels and whether they use a heat pump. The results are in the table.

(i) Calculate the probability that a randomly chosen person have solar panels and use a heat pump.

(ii) Calculate the probability that a person chosen at random from those who use a heat pump also have solar panels, and compare it with the probability that a person chosen at random from everyone surveyed have solar panels.

(iii) Decide whether ‘have solar panels’ and ‘use a heat pump’ are independent, justifying your decision with probabilities, and explain what your answer means in this context.

[7 marks]

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(b) Of 150 members of a tramping club, 65 own a tent, 27 own a stove, and 15 do both. The rest do neither.

(i) Draw a Venn diagram showing the number in each region.

(ii) Calculate the probability that a randomly chosen member does own a tent or own a stove (or both), and the probability that they do neither.

(iii) Calculate P(own a tent | own a stove). Decide whether the events are mutually exclusive, and whether they are independent, justifying each answer with probabilities.

[7 marks]

THE WORKED ANSWER TO THAT QUESTION

Question 1 (14 marks) [Two-way tables and Venn diagrams]

(a) A survey of 100 households surveyed recorded whether each person have solar panels and whether they use a heat pump. The results are in the table. (i) Calculate the probability that a randomly chosen person have solar panels and use a heat pump. (ii) Calculate the probability that a person chosen at random from those who use a heat pump also have solar panels, and compare it with the probability that a person chosen at random from everyone surveyed have solar panels. (iii) Decide whether 'have solar panels' and 'use a heat pump' are independent, justifying your decision with probabilities, and explain what your answer means in this context.

(a) Answer: (i) $\frac{13}{50}$; (ii) $\frac{26}{59}$ compared with $\frac{37}{100}$; (iii) not independent

- Evidence level: Merit (read the cells of the two-way table, then compare P(A | B) with P(A)).
- (i) P(have solar panels and use a heat pump) = 26 ÷ 100 = $\frac{13}{50}$ = 0.260.
- (ii) P(have solar panels | use a heat pump) = 26 ÷ 59 = $\frac{26}{59}$ = 0.441; P(have solar panels) = 37 ÷ 100 = $\frac{37}{100}$ = 0.370.
- Achievement: (iii) States whether the events are not independent.
- Merit: Links to the probabilities: independent events have P(A | B) = P(A); here they are different.
- Excellence: Full explanation: the events are not independent because P(have solar panels | use a heat pump) = $\frac{26}{59}$ ≠ P(have solar panels) = $\frac{37}{100}$; this means that a person who use a heat pump is more likely to have solar panels than a person chosen from everyone (the events are associated).

> **KEY TAKEAWAY**
> Two-way tables: P(A and B) = cell ÷ total; P(A | B) = cell ÷ column total; events are independent only if P(A | B) = P(A).

(b) Of 150 members of a tramping club, 65 own a tent, 27 own a stove, and 15 do both. The rest do neither. (i) Draw a Venn diagram showing the number in each region. (ii) Calculate the probability that a randomly chosen member does own a tent or own a stove (or both), and the probability that they do neither. (iii) Calculate P(own a tent | own a stove). Decide whether the events are mutually exclusive, and whether they are independent, justifying each answer with probabilities.

(b) Answer: (ii) $\frac{77}{150}$ and $\frac{73}{150}$; (iii) $\frac{5}{9}$; not mutually exclusive; not independent

- Evidence level: Merit (fill the Venn regions from the middle outwards; use P(A or B) = P(A) + P(B) − P(A and B)).
- (i) Both: 15; own a tent only: 65 − 15 = 50; own a stove only: 27 − 15 = 12; neither: 150 − 15 − 50 − 12 = 73.
- (ii) P(own a tent or own a stove) = (50 + 15 + 12) ÷ 150 = 77 ÷ 150 = $\frac{77}{150}$; P(neither) = 73 ÷ 150 = $\frac{73}{150}$.
- (iii) P(own a tent | own a stove) = 15 ÷ 27 = $\frac{5}{9}$. Mutually exclusive? No: P(both) = $\frac{1}{10}$ is not zero. Independent? P(own a tent) × P(own a stove) = $\frac{13}{30} \times \frac{9}{50} = \frac{39}{500}$ ≠ P(both) = $\frac{1}{10}$, so the events are not independent.

> **KEY TAKEAWAY**
> Venn diagrams: P(A or B) = P(A) + P(B) − P(A and B); mutually exclusive means P(A and B) = 0; independent means P(A and B) = P(A) × P(B).

LOS: Two-way tables and Venn diagrams (91585)

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