FREE SAMPLE: THE FIRST QUESTION

Question One (13 marks)

(a) In a town of 10000 people, 1% have a certain condition. A screening test correctly gives a positive result for 95% of people who have the condition, and correctly gives a negative result for 95% of people who do not.

(i) How many people in the town would be expected to test positive?

(ii) A person tests positive. Find the probability that they actually have the condition.

(iii) Explain why this probability is lower than you might expect.

[5 marks]

(b) A bag contains 4 green marbles, 7 blue marbles and 6 yellow marbles. Two marbles are taken from the bag at random, one after the other, WITHOUT replacement.

Find the probability that both marbles are the same colour.

[3 marks]

(c) A survey of 132 students produced the table below.

(i) Find the probability that a randomly chosen person walk to school.

(ii) Find the probability that a person are in a sports team, given that they walk to school.

(iii) Use your answers to decide whether the two events are independent, and explain your decision.

	walk to school	travel by other means	Total
are in a sports team	49	47	96
are not in a sports team	24	12	36
Total	73	59	132

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[5 marks]

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THE WORKED ANSWER TO THAT QUESTION

Question 1 (13 marks) [Trees and conditional probability]

(a) In a town of 10000 people, 1% have a certain condition. A screening test correctly gives a positive result for 95% of people who have the condition, and correctly gives a negative result for 95% of people who do not. (i) How many people in the town would be expected to test positive? (ii) A person tests positive. Find the probability that they actually have the condition. (iii) Explain why this probability is lower than you might expect.

(a) Answer: (i) 590; (ii) 0.161; (iii) healthy people greatly outnumber those with the condition, so false positives swamp true positives

- Evidence level: Excellence (use a tree or natural frequencies, then interpret a conditional probability).
- People with the condition: 1% of 10000 = 100. Without: 9900.
- (i) True positives: 95% of 100 = 95. False positives: 5% of 9900 = 495. Expected positives = 95 + 495 = 590.
- (ii) P(condition | positive) = 95 ÷ 590 = 0.161.
- (iii) Most people do NOT have the condition, so even a small false-positive rate produces many false positives (495) compared with true positives (95).

> **KEY TAKEAWAY**
> Screening tests: build the tree in whole numbers (true and false positives); P(condition | positive) = true positives ÷ all positives, which can be small when the condition is rare.

(b) A bag contains 4 green marbles, 7 blue marbles and 6 yellow marbles. Two marbles are taken from the bag at random, one after the other, WITHOUT replacement. Find the probability that both marbles are the same colour.

(b) Answer: 0.309

- Evidence level: Merit (use a tree or list of cases without replacement).
- P(both the same) = P(both green) + P(both blue) + P(both yellow).
- = $(\frac{4}{17})(\frac{3}{16}) + (\frac{7}{17})(\frac{6}{16}) + (\frac{6}{17})(\frac{5}{16})$.
- = 0.309.

> **KEY TAKEAWAY**
> Without replacement the second probability changes: reduce the total by one, and reduce the count of whatever was removed.

(c) A survey of 132 students produced the table below. (i) Find the probability that a randomly chosen person walk to school. (ii) Find the probability that a person are in a sports team, given that they walk to school. (iii) Use your answers to decide whether the two events are independent, and explain your decision.

(c) Answer: (i) 0.553; (ii) 0.671; (iii) not independent

- Evidence level: Excellence (compare a conditional probability with the unconditional one to test independence).
- (i) P(walk to school) = $\frac{73}{132}$ = 0.553.

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- (ii) Of the 73 who walk to school, 49 are in a sports team: P = $\frac{49}{73}$ = 0.671.
- (iii) Overall P(are in a sports team) = $\frac{96}{132}$ = 0.727. Independent events have P(A | B) = P(A).
- Here 0.671 ≠ 0.727, so the events are NOT independent (the probability changes when we know about the other event).

KEY TAKEAWAY

Independence: events are independent when P(A | B) = P(A); compare the conditional probability with the overall probability from the table totals.

LOS: Trees and conditional probability (91267)

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