Name	Date started	Target end date

GCE AS / A LEVEL — APPLIED MATHEMATICS A QUESTION PACK

0983-01 (Legacy S1) · New spec Unit 2 Topic 2 · AS unit, 25% of A-level, 75 marks, 1h 45min paper

REVISE
.wales

MATHEMATICS — APPLIED A · PROBABILITY - SELECTION & TREE DIAGRAMS

Probability - Selection without Replacement and Tree Diagrams

Tree-diagram, Bayesian and without-replacement selection problems from the legacy WJEC S1 papers (2011-2017)

LEGACY 2008 SPECIFICATION

Estimated time for entire question pack: ~3 hours 6 minutes

*Derived from the legacy S1 paper's pace of **~1.25 min/mark** (149 marks over 20 questions).*

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains questions from the legacy WJEC S1 papers (2008 modular spec) that map onto new-spec AS Unit 2 Topic 2 (2.2.3).

Questions are ordered chronologically.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — method marks are awarded for clear setup.

A calculator is allowed (except where specified by individual questions). The WJEC Formula Booklet and statistical tables may be referred to. Take $g = 9.8\,\text{ms}^{-2}$ for mechanics.

For Examiner's use only

Q	Source	Max	Mark
1	Jun 11 Q1	8	
2	Jun 11 Q6	9	
3	Jan 12 Q1	6	
4	Jan 12 Q5	6	
5	Jun 12 Q3	7	
6	Jun 12 Q5	6	
7	Jan 13 Q3	8	
8	Jan 13 Q7	9	
9	Jun 13 Q2	8	
10	Jun 13 Q5	6	

Q	Source	Max	Mark
11	Jan 14 Q2	8	
12	Jan 14 Q5	8	
13	Jun 14 Q3	7	
14	Jun 14 Q6	9	
15	Jun 15 Q3	7	
16	Jun 15 Q5	8	
17	Jun 16 Q2	6	
18	Jun 16 Q4	7	
19	Jun 17 Q3	6	
20	Jun 17 Q7	10	
Total		**149**	

Probability - Selection without Replacement and Tree Diagrams — what the new spec asks

WJEC GCE AS / A Level Mathematics (from 2017) · Unit 2: Applied Mathematics A · Topic 2.2.3.

Tree diagrams and selection 2.2.3

- Multiply probabilities along a branch; add probabilities of branches that meet the criterion.
- Without replacement: probability of each branch changes once an item is drawn.
- Total-probability law: $P(A) = \sum_i P(A \mid B_i)P(B_i)$ over a partition $\{B_i\}$.

Conditional probability and Bayes 2.2.3

- $P(A \mid B) = \dfrac{P(A \cap B)}{P(B)}$, provided $P(B) > 0$.
- Multiplication rule: $P(A \cap B) = P(A \mid B)P(B) = P(B \mid A)P(A)$.
- Bayes (informal): flip the conditioning using the multiplication rule, often via a tree.

Crib sheet »

Probability - Selection & Tree Diagrams in one page

Quick-reference notes — revisit before each section. Don't use during questions.

Tree diagrams

Branches sum to 1 at each fork.

Multiply along a path; add across paths to a common outcome.

Conditional

$P(A \mid B) = \dfrac{P(A \cap B)}{P(B)}$.

Restricts the sample space to B.

Multiplication rule

$P(A \cap B) = P(A \mid B)P(B) = P(B \mid A)P(A)$.

Use to flip which side of the bar carries the unknown.

Without replacement

After first draw, total reduces by 1 and counts of drawn items reduce by 1.

Each branch needs updated denominator.

Total probability

$P(A) = P(A \mid B)P(B) + P(A \mid B')P(B')$ for any partition.

Bayes-style flip

$P(B \mid A) = \dfrac{P(A \mid B)P(B)}{P(A)}$.

Compute $P(A)$ via total probability, then divide.

SECTION T2

Probability - Selection without Replacement and Tree Diagrams

Questions 1–20 · 149 marks

1. Cyril buys a bag containing 9 sweets of which 5 are red, 3 are green and 1 is yellow. He allows Gwyneth to choose 3 sweets at random from the bag.
Calculate the probability that she chooses

(a) 1 sweet of each colour, [3]

(b) no green sweets, [2]

(c) 3 sweets of the same colour. [3]

6. A box contains three coins. Two of these coins are fair and the third coin is double-headed so that when tossed a head is always obtained. One of these coins is selected at random and tossed three times.

(a) Find the probability that three heads are obtained. [4]

(b) Given that three heads are obtained, find the probability that the double-headed coin was selected. [3]

(c) The selected coin is tossed a fourth time. Find the probability that a head is obtained. [2]

1. A class contains 8 girls and 6 boys. A sub-committee of 3 members of the class is to be formed and it is decided to select its members at random from the class. Calculate the probability that the sub-committee will contain

(a) 3 boys, [2]

(b) more boys than girls. [4]

5. Each of three boxes contains 3 cards. Box A contains 1 red card, Box B contains 2 red cards and Box C contains 3 red cards. One of the boxes is selected at random and a card is chosen at random from that box.

(a) Find the probability that a red card is chosen. [3]

(b) Given that a red card is chosen, find the probability that Box A was selected. [3]

3. A bag contains 9 balls, of which 1 is red, 3 are blue and 5 are white. Ann selects 3 balls at random from the bag without replacement. Calculate the probability that

(a) no white balls are selected, [2]

(b) exactly 2 white balls are selected, [2]

(c) the selection contains 2 balls of the same colour and 1 ball of a different colour. [3]

5. In a certain population, 60% are male and 40% are female. It is known that 8% of males are colour-blind and 3% of females are colour-blind. A member of the population is selected at random.

(a) Find the probability that this person is colour-blind. [3]

(b) Given that this person is colour-blind, find the probability that the person is female. [3]

3. Bill buys a bag of sweets, of which 6 are red, 4 are green and 1 is blue. He selects 3 sweets at random, without replacement, from the bag. Calculate the probability that his selection contains

(a) 2 red sweets and another sweet of a different colour, [3]

(b) 2 sweets of the same colour and another sweet of a different colour. [5]

7. In a mass screening programme, a new diagnostic test is being used to detect the presence or otherwise of a certain disease. When the person being tested has the disease, the test gives a positive result with probability 0·96. When the person being tested does not have the disease, the test gives a positive result with probability 0·01. It is known that 2% of the population have this disease. The test is given to a randomly chosen member of the population.

(a) Find the probability that a positive result is obtained. [3]

(b) Given that a positive result is obtained, find the probability that

(i) this person has the disease,

(ii) a positive result will be obtained if a second test is given to this person. [6]

2. Simon has 3 types of DVDs; 5 war films, 3 cowboy films and 2 horror films. He selects 3 of the DVDs at random to watch one evening. Calculate the probability that he selects

(a) 1 film of each type, [3]

(b) 3 war films, [2]

(c) 3 films all of the same type. [3]

5. Box A contains four balls numbered 1, 2, 3, 4 respectively, Box B contains three balls numbered 1, 2, 3 respectively and Box C contains two balls numbered 1, 2 respectively. Gwen selects one of these boxes at random and then selects a ball at random from that box.

(a) Determine the probability that a ball numbered 1 is selected. [3]

(b) Given that a ball numbered 1 is selected, determine the probability that Box A was selected. [3]

2. Gwyn has three varieties of apples in his fruit bowl, 6 Elstar, 4 Gala and 2 Regent. He decides to select 3 of these 12 apples at random to take to work.
Calculate the probability that he selects

(a) 1 apple of each variety, [3]

(b) 3 Elstar apples, [2]

(c) 3 apples all of the same variety. [3]

5. Three drawers each contain 4 coins. Drawer A contains 4 gold coins. Drawer B contains 3 gold coins and 1 silver coin. Drawer C contains 2 gold coins and 2 silver coins. David selects one of these drawers at random and then selects 2 coins at random from that drawer without replacement.

(a) Determine the probability that he selects 2 gold coins. [5]

(b) Given that he selects 2 gold coins, determine the probability that Drawer A was selected. [3]

3. A bag contains 9 coloured balls, of which 3 are red, 3 are blue and 3 are yellow. Huw selects 3 of these balls at random, without replacement. Calculate the probability that he selects

(a) 1 ball of each colour, [3]

(b) 2 balls of the same colour and 1 ball of a different colour. [4]

6. A purse contains three fair coins and one double-headed coin. A coin is selected at random from the purse and tossed.

(a) Find the probability that a head is obtained. [3]

(b) Given that a head is obtained,

(i) determine the probability that the double-headed coin was selected,

(ii) find the probability that a head will be obtained if the selected coin is tossed a second time. [6]

3. A bag contains 10 sweets of which 5 are red, 3 are green and 2 are yellow. Ann chooses a sweet at random from the bag and immediately puts it in her pocket so that nobody can see what colour it is. Bethan then chooses a sweet at random from the remaining 9 sweets.
Calculate the probability that

(a) Ann chooses a green sweet, [1]

(b) Bethan chooses a yellow sweet, [3]

(c) Ann and Bethan choose sweets of different colours. [3]

5. At a certain university, 60% of the students are male and 40% are female. It is known that 75% of the male students own a bicycle and 30% of the female students own a bicycle. One of the students is selected at random.

(a) Calculate the probability that the selected student

(i) is a male student who owns a bicycle,

(ii) owns a bicycle. [5]

(b) Given that the selected student owns a bicycle, calculate the probability that this student is female. [3]

2. In a certain population, 45% are male and 55% are female. It is known that 3% of the males have red hair while 5% of the females have red hair. One of the members of the population is selected at random.

(a) Calculate the probability that the selected person has red hair. [3]

(b) Given that the selected person has red hair, calculate the probability that this person is female. [3]

4. The committee of a social club contains 8 members, of which 4 are Welsh, 2 are English and 2 are Irish. A sub-committee of 3 members is to be set up and it is decided to select the 3 members at random.

(a) Calculate the probability that the sub-committee contains

(i) no Welsh members,

(ii) one member of each nationality. [5]

(b) Jack is a member of the committee. Find the probability that he is selected for the sub-committee. [2]

3. A box contains nine cards of which four are white, three are red and two are blue. Three of these cards are selected at random without replacement.
Calculate the probability that

(a) one card of each colour is selected, [3]

(b) the three cards selected are all of the same colour. [3]

7. It is known that 5% of animals of a certain species have a particular disease. A diagnostic test can be applied to animals of this species to indicate whether or not they have this disease. When applied to an animal which has this disease, the test gives a positive response with probability 0·96. When applied to an animal which does not have this disease, the test gives a positive response with probability 0·02.

(a) The test is given to a randomly chosen animal.

(i) Calculate the probability that a positive response is obtained. [3]

(ii) Given that a positive response is obtained, find the probability that this animal has the disease. [3]

(b) A randomly chosen animal gave a positive response when tested. It is tested again.

(i) Find the probability that it gives a second positive response.

(ii) Given that this second response is positive, calculate the probability that this animal has the disease. [4]

END OF PROBABILITY - SELECTION & TREE DIAGRAMS PACK

Source: WJEC S1 (2008 modular spec) · 2011–2017
Curated for WJEC Maths 2017 spec AS Unit 2 — Topic 2 (2.2.3)