



General Certificate of Secondary Education
2022

Further Mathematics

Unit 4
Discrete and Decision Mathematics

[GFM41]

WEDNESDAY 22 JUNE, AFTERNOON

**MARK
SCHEME**

GCSE MATHEMATICS

General Marking Instructions

Introduction

The mark scheme normally provides the most popular solution to each question. Other solutions given by candidates are evaluated and credit given as appropriate; these alternative methods are not usually illustrated in the published mark scheme.

The marks awarded for each question are shown in the right hand column and they are prefixed by the letters **M**, **W** and **MW** as appropriate. The key to the mark scheme is given below:

M indicates marks for correct method.

W indicates marks for accurate working, whether in calculation, reading from tables, graphs or answers.

MW indicates marks for combined method and accurate working.

Assessment Objectives

Below are the assessment objectives for GCSE Further Mathematics.

Use and apply standard techniques (AO1)

Candidates should be able to:

- accurately recall facts, terminology and definitions;
- use and interpret notation correctly; and
- accurately carry out routine procedures or set tasks requiring multi-step solutions.

Reason, interpret and communicate mathematically (AO2)

Candidates should be able to:

- make deductions, inferences and draw conclusions from mathematical information;
- construct chains of reasoning to achieve a given result;
- present arguments and proofs; and
- assess the validity of an argument and critically evaluate a given way of presenting information.

Solve problems within mathematics and in other contexts (AO3)

Candidates should be able to:

- translate problems in mathematical or non-mathematical contexts into a process or a series of mathematical processes;
- make and use connections between different parts of mathematics;
- interpret results in the context of the given problem;
- evaluate methods used and results obtained; and
- evaluate solutions to identify how they may have been affected by assumptions made.

A later part of a question may require a candidate to use an answer obtained from an earlier part of the same question. A candidate who gets the wrong answer to the earlier part and goes on to the later part is naturally unaware that the wrong data is being used and is actually undertaking the solution of a parallel problem from the point at which the error occurred. If such a candidate continues to apply correct method, then the candidate's individual working must be **followed through** from the error. If no further errors are made, then the candidate is penalised only for the initial error. Solutions containing two or more working or transcription errors are treated in the same way. This process is usually referred to as "follow-through marking" and allows a candidate to gain credit for that part of a solution which follows a working or transcription error.

It should be noted that where an error trivialises a question, or changes the nature of the skills being tested, then as a general rule, it would be the case that not more than half the marks for that question or part of that question would be awarded; in some cases the error may be such that no marks would be awarded.

Positive marking:

It is our intention to reward candidates for any demonstration of relevant knowledge, skills or understanding. For this reason we adopt a policy of **following through** their answers, that is, having penalised a candidate for an error, we mark the succeeding parts of the question using the candidate's value or answers and award marks accordingly.

Some common examples of this occur in the following cases:

- (a) a numerical error in one entry in a table of values might lead to several answers being incorrect, but these might not be essentially separate errors;
- (b) readings taken from candidates' inaccurate graphs may not agree with the answers expected but might be consistent with the graphs drawn.

When the candidate misreads a question in such a way as to make the question easier, only a proportion of the marks will be available (based on the professional judgement of the examiner).

COVID-19 Context

Given the unprecedented circumstances presented by the COVID-19 public health crisis, senior examiners, under the instruction of CCEA awarding organisation, are required to train assistant examiners to apply the mark scheme in case of disrupted learning and lost teaching time. The interpretation and intended application of the mark scheme for this examination series will be communicated through the standardising meeting by the Chief or Principal Examiner and will be monitored through the supervision period. This paragraph will apply to examination series in 2021–2022 only.

1 (i) ${}_5P_5 = 5 \times 4 \times 3 \times 2 \times 1 = 120$ ways

M1 W1

(ii) ${}_5P_3 = 5 \times 4 \times 3 = 60$ ways

MW1

2 (i) $y \geq 20$

W1

(ii) $50x + 25y \geq 2100$
 $2x + y \geq 84$

M1 W1

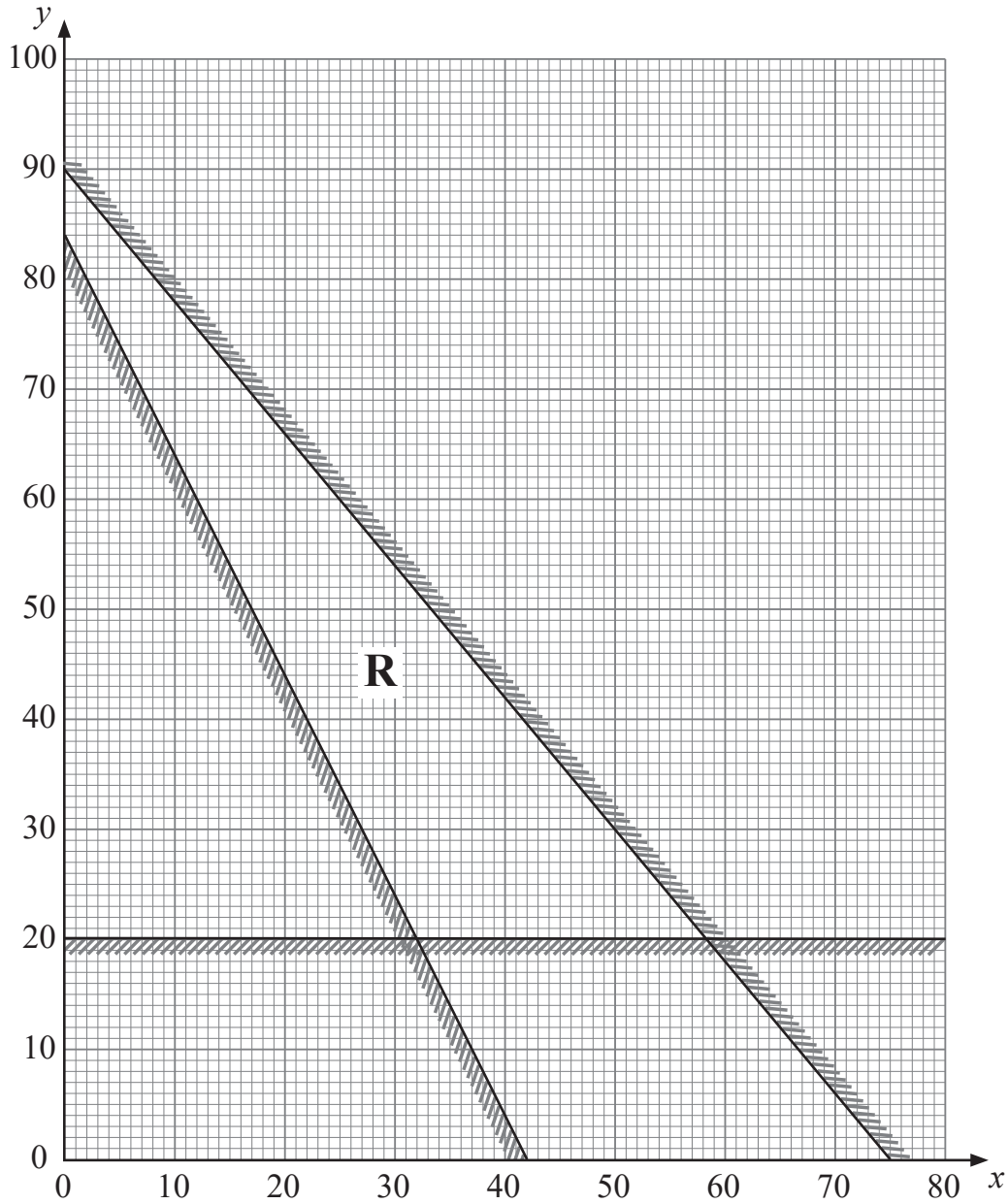
(iii) $120x + 100y \leq 9000$
 $6x + 5y \leq 450$

M1 W1

AVAILABLE
MARKS

3

(iv)



AVAILABLE
MARKS

Line $y = 20$ and correct shading

MW1

Line through $(0, 84)$ and $(42, 0)$ and correct shading

MW1

Line through $(0, 90)$ and $(75, 0)$ and correct shading

MW1

(shading may be omitted if **R** marked correctly)

(v) Profit $P = 1.5x + y$

M1

Key points in region **R** are

$(58, 20), (32, 20)$

M1

$(58, 20)$ gives $P = \text{£}107$

$(32, 20)$ gives $P = \text{£}68$

W1

Alternative Solution

Use line search $y = -1.5x + c$

M1

Optimum vertex is $(58, 20)$

W1

Maximum profit when 58 Skyrockets
and 20 Rainbow Candles

W1

(vi) Time = $50x + 25y$

$= 50 \times 58 + 25 \times 20$

$= 3400$ seconds

MW1

AVAILABLE
MARKS

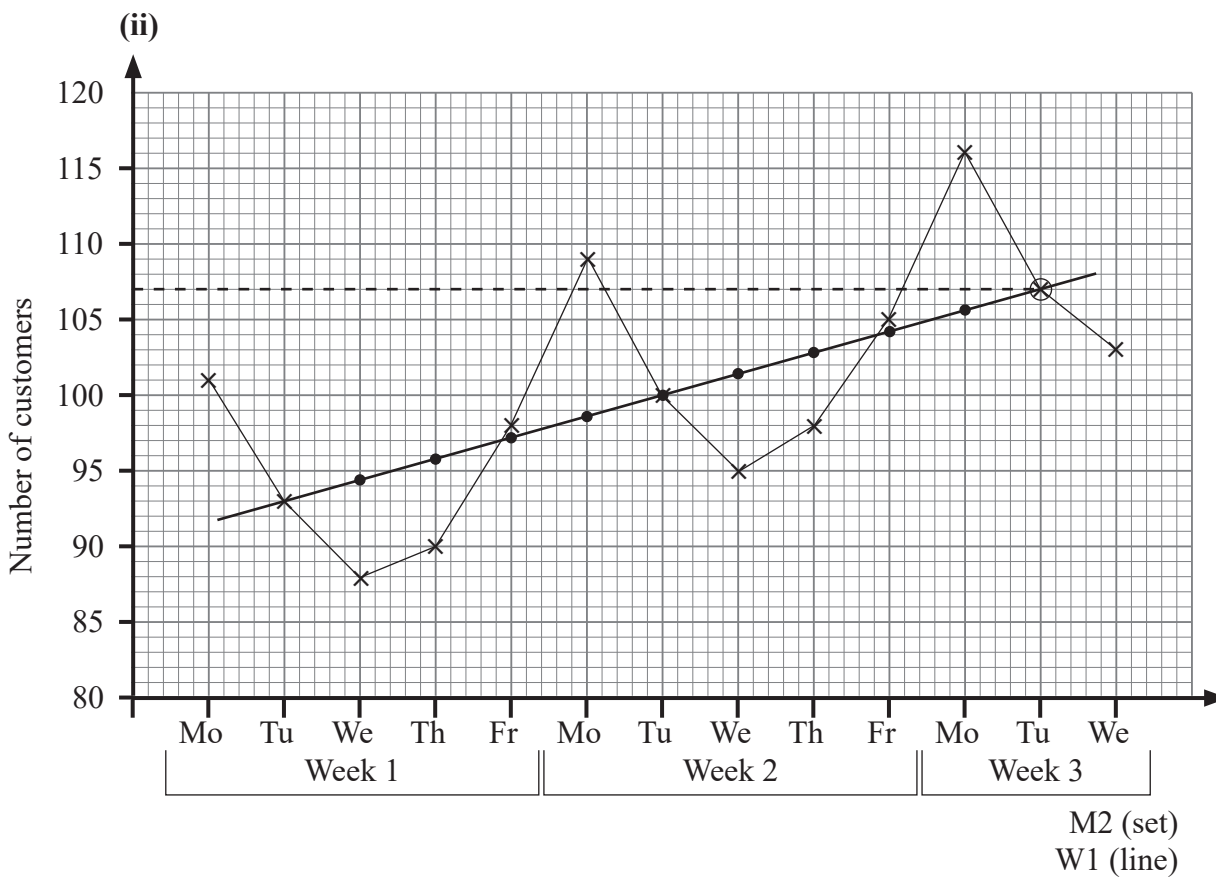
13

3 (i) Use five-point moving averages

M1

101	
93	
88	94
90	95.6
98	97
109	98.4
100	100
95	101.4
98	102.8
105	104.2
116	105.8
107	
103	

W2



(iii) $\frac{105 + 116 + 107 + 103 + x}{5} = 107$

M1 W1

$x = 104$

W1

AVAILABLE
MARKS

4 (i)

p	q	r	$p \text{ or } q$	$p \text{ or } r$	$(p \text{ or } q) \text{ and } (p \text{ or } r)$	$q \text{ and } r$	$p \text{ or } (q \text{ and } r)$
T	T	T	T	T	T	T	T
T	T	F	T	T	T	F	T
T	F	T	T	T	T	F	T
T	F	F	T	T	T	F	T
F	T	T	T	T	T	T	T
F	T	F	T	F	F	F	F
F	F	T	F	T	F	F	F
F	F	F	F	F	F	F	F

(a) (b) (c) (d) (e)

(a), (b), (c), (d), (e)

5 × MW1

Column (c) is identical to column (e)

M1

(ii) Using equivalent statements from (c) and (e) and in (i)

M1

“Either Adam loves cheese or both Bernie hates football and Cally plays table tennis.”

W1

8

5 (i) Number of ways to choose the 2 fairies is ${}_7C_2 = 21$ ways

MW1

Number of ways to choose the 3 elves is ${}_8C_3 = 56$ ways

W1

Number of ways to choose the 3 pixies is ${}_6C_3 = 20$ ways

W1

Overall number of combinations = $21 \times 56 \times 20 = 23\,520$

MW1

(ii) Choice of hero = 14 ways

Choice of villain in $14 - 1 = 13$ ways

Choice of joker in $13 - 1 = 12$ ways

M1 W1

Number of ways to choose the 4 fairies is ${}_7C_4 = 35$ ways

MW1

Overall number of combinations = $14 \times 13 \times 12 \times 35 = 76\,440$

MW1

8

AVAILABLE MARKS

