Pearson Edexcel Level 3 GCE

Friday 16 May 2025

Afternoon

Paper reference **8FM0/27**

Further Mathematics

Advanced Subsidiary
Further Mathematics options
27: Decision Mathematics 1
(Part of options D, F, H and K)

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator,
D1 Answer Book (enclosed)

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of the answer book with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the answer book provided
  – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.
- Do not return the question paper with the D1 Answer Book.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 40. There are 4 questions.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

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1

16 10 25 30 13 12 28 22 23 20

The list of ten numbers above is to be sorted into **ascending** order.

(a) Carry out a bubble sort, starting at the left-hand end of the list, to produce the sorted list. You should only give the state of the list after each pass.

(3)

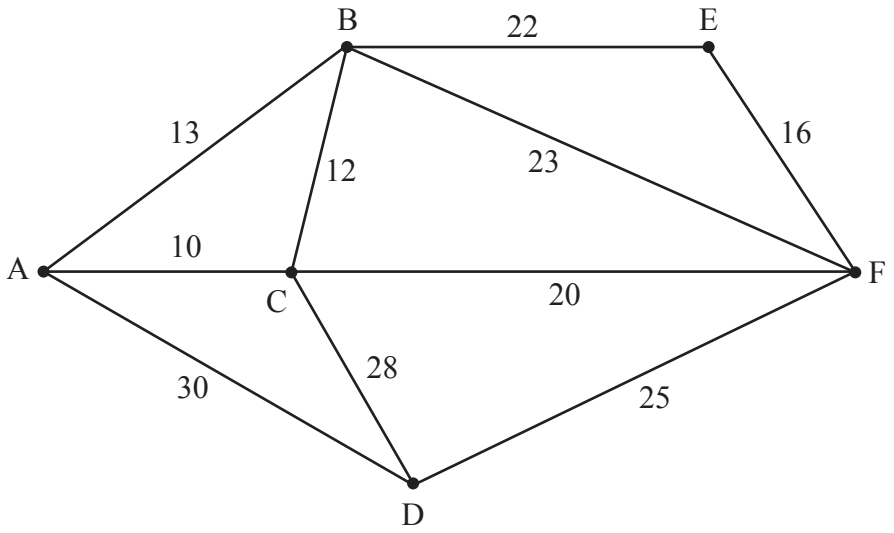


Figure 1

(b) Use Prim's algorithm, starting at A, to find the minimum spanning tree for the network in Figure 1. You must list the arcs in the order in which you select them.

(2)

(c) (i) Draw the minimum spanning tree on Diagram 1 in the answer book.

(ii) Find the weight of the minimum spanning tree.

(2)

(Total for Question 1 is 7 marks)

2

Activity	Immediately preceding activities
A	-
B	-
C	-
D	B
E	A, B
F	B
G	B
H	C, D
I	G, H
J	E
K	E, F, I
L	G, H
M	G, H

(a) Explain how you can deduce from the precedence table that at least one dummy will be needed when drawing the activity network. Your explanation should refer to specific activities.

(1)

(b) Draw the activity network described in the precedence table, using activity on arc. Your activity network must contain the minimum number of dummies only.

(5)

Each activity in the precedence table takes 3 hours to complete.

(c) State the minimum completion time.

(1)

One of the activities now needs to be chosen to be extended by an hour. When the change is made the minimum completion time must not be affected.

(d) List the activities that could be chosen.

(1)

(Total for Question 2 is 8 marks)

3

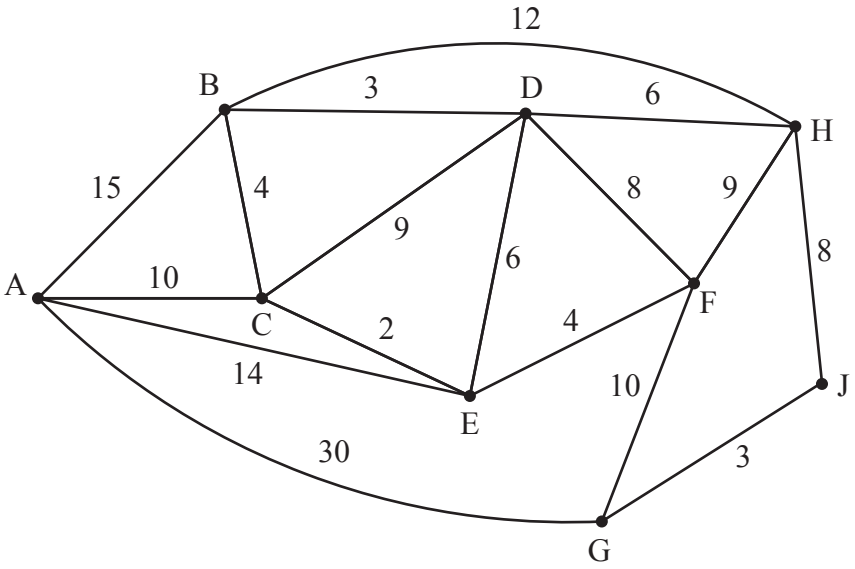


Figure 2

[*The total weight of the network is* **153]**

Figure 2 models a network of roads in a town, where the nodes represent road junctions. The numbers on the edges are the times, in minutes, taken to walk along the corresponding roads.

(a) State, with a reason, whether the graph in Figure 2 is Eulerian, semi-Eulerian or neither.

(1)

(b) (i) Use Dijkstra's algorithm to find the quickest path from A to J.

(ii) State the shortest time needed to walk from A to J.

(6)

Ruby manages road maintenance from her office located at junction B. She needs to walk along each road at least once, starting and finishing at her office. Road AE is temporarily blocked so she is unable to walk along it. Ruby wishes to minimise her journey time.

(c) (i) Use an appropriate algorithm to find the roads that Ruby needs to traverse twice. You must make your method and working clear.

(ii) Calculate Ruby's journey time.

(5)

Ruby can save some time by choosing to start her route from any junction and to finish at her home at A. Road AE is still blocked and Ruby again wishes to minimise her journey time.

(d) (i) Write down the junction at which Ruby should start.

(ii) Calculate how much time she would save.

(2)

(Total for Question 3 is 14 marks)

4

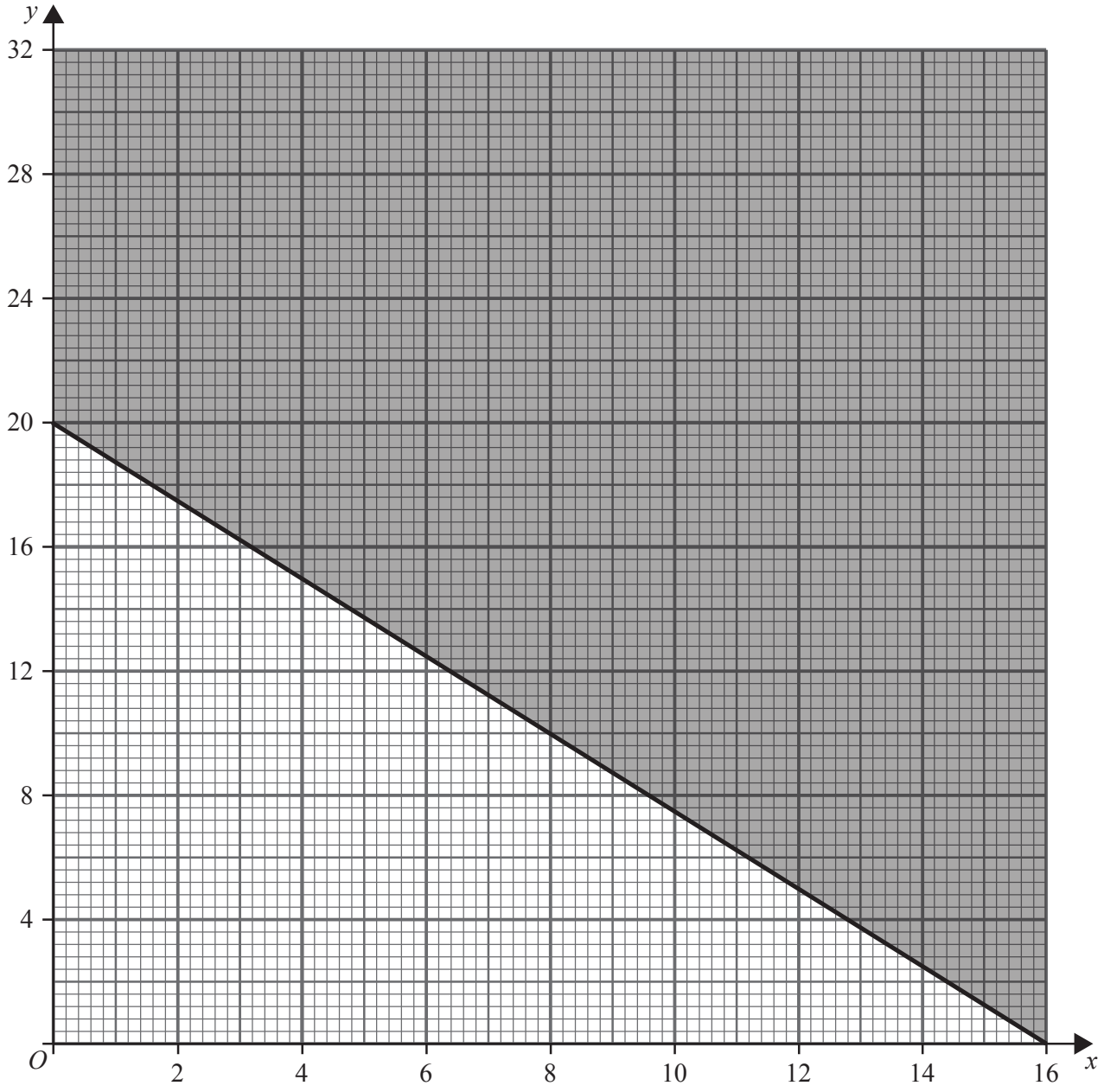


Figure 3

George is a baker who bakes x sponge cakes and y fruit cakes every day.

One of George's constraints is shown on Figure 3.

(a) Write down this constraint as a simplified inequality with integer coefficients.

(1)

Three further constraints are

- George must bake at least four fruit cakes every day
- for every two sponge cakes George bakes, he must bake at most three fruit cakes
- George needs 200 g of butter for each sponge cake and 100 g for each fruit cake and has 2.8 kg of butter available each day

(b) (i) Write down the three inequalities which model these constraints. Give your answers in simplified form with integer coefficients.

(ii) Add lines and shading to Diagram 1 in the answer book to represent these three constraints. Hence determine the feasible region and label it R.

(5)

George makes £8 profit from each sponge cake he sells and £5 profit from each fruit cake he sells. Given that he wishes to maximise his profit,

(c) use the vertex method to determine the number of sponge cakes and the number of fruit cakes George should bake each day. You must make your method and working clear.

(5)

(Total for Question 4 is 11 marks)

TOTAL FOR DECISION MATHEMATICS 1 IS 40 MARKS

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Please check the examination details below before entering your candidate information

Candidate surname StemUp Model Solution | Other names

Centre Number | Candidate Number

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Total Marks

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1

	16	10	25	30	13	12	28	22	23	20
(a)										
Pass 1	10	16	25	13	12	28	22	23	20	30
Pass 2	10	16	13	12	25	22	23	20	28	30
Pass 3	10	13	12	16	22	23	20	25	28	30
Pass 4	10	12	13	16	22	20	23	25	28	30
Pass 5	10	12	13	16	20	22	23	25	28	30
Pass 6	10	12	13	16	20	22	23	25	28	30

No swaps in pass 6, so the sort is complete.

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Question 1 continued

(b) Prim's algorithm starting at A, arcs selected in order:
AC (10), BC (12), CF (20), EF (16), DF (25)
(vertices added in the order A, C, B, F, E, D)

(c) (i)

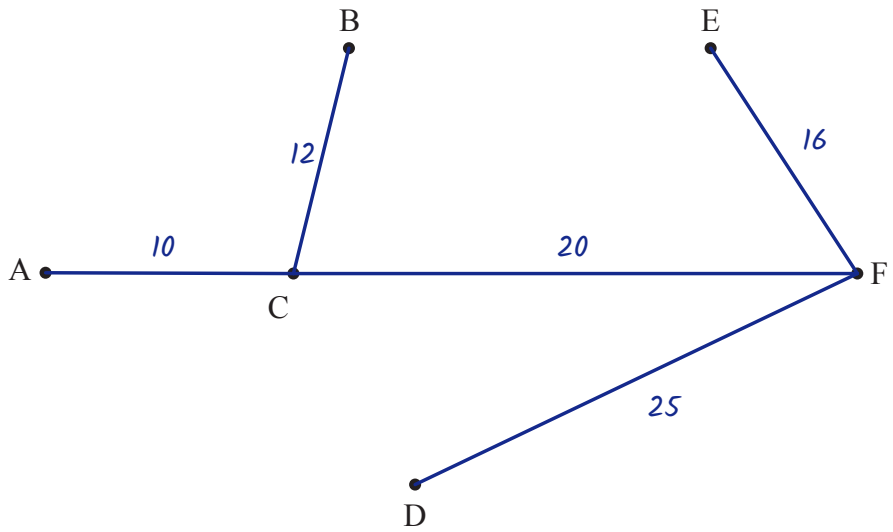


Diagram 1

(c) (ii)

Weight = 10 + 12 + 20 + 16 + 25 = 83

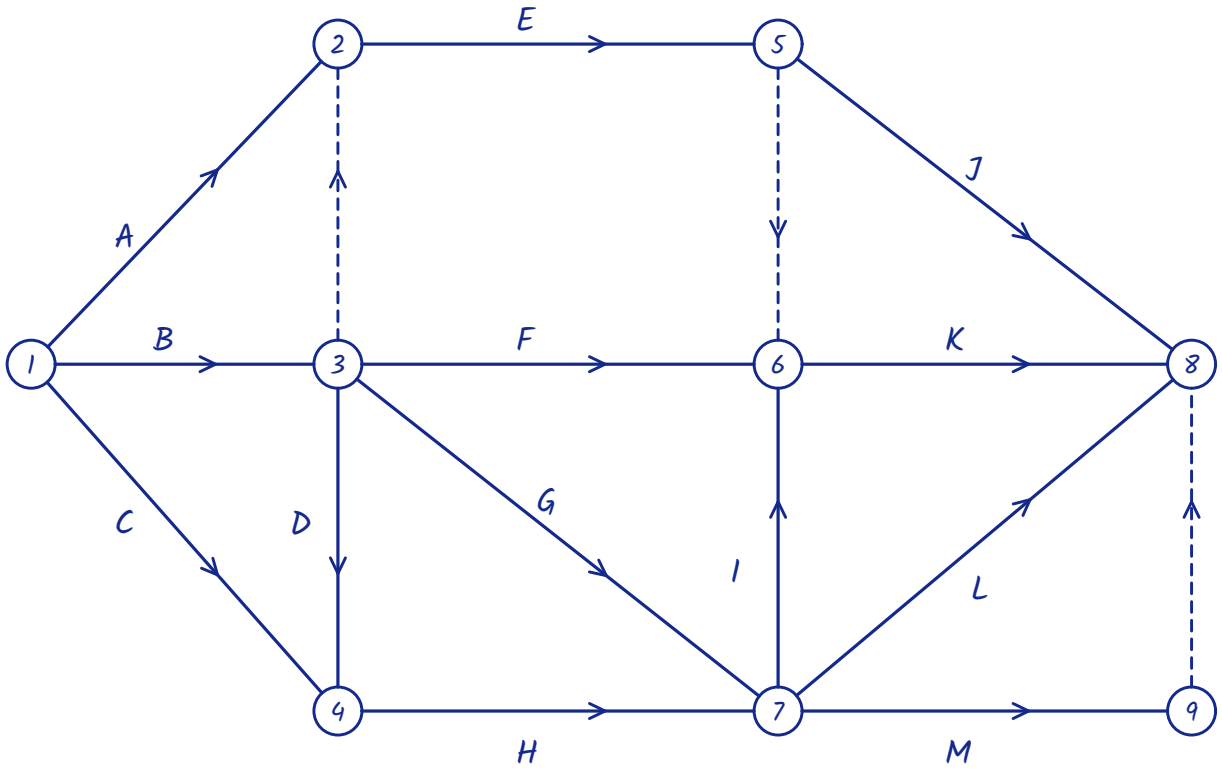
(Total for Question 1 is 7 marks)

2.

(a)

Activity D is preceded by activity B only, but activity E is preceded by both activities A and B, so a dummy is needed from the end of B to the end of A (D and E cannot both start from the same event).

(b)



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Question 2 continued

(c) Critical path B, D, H, I, K: 5 × 3 = 15 hours

(d) Non-critical activities (each has a float of at least 3 hours):

A, C, E, F, G, J, L, M

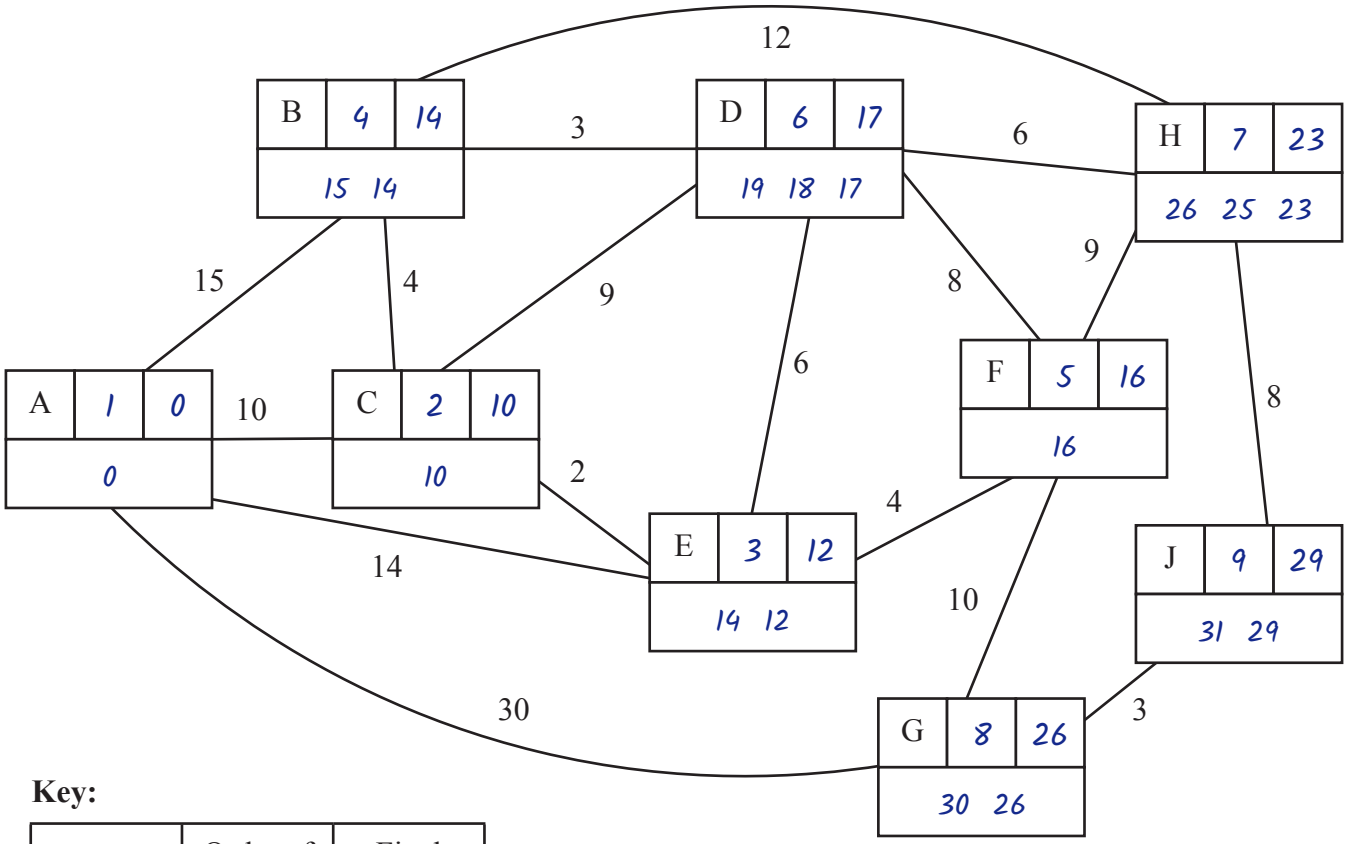
(Total for Question 2 is 8 marks)

3.

(a)

Semi-Eulerian, because exactly two vertices (D and G) have odd degree.

Degrees: A 4, B 4, C 4, D 5, E 4, F 4, G 3, H 4, J 2



Key:

Vertex	Order of labelling	Final value
Working values		

Quickest path A C E F G J

Shortest time 29 minutes

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Question 3 continued

(c)(i) Route inspection. With AE removed, the odd vertices are A, D, E, G

Pairings (shortest routes):

AD + EG = 17 + 14 = 31 (A C B D, E F G)

AE + DG = 12 + 17 = 29 (A C E, D H J G)

AG + DE = 26 + 6 = 32 (A C E F G, D E)

Least is 29, so the roads traversed twice are

AC, CE, DH, HJ and JG

(ii) Journey time = 153 − 14 + 29 = 168 minutes

(d)(i) She finishes at A, so A is an end; repeat the shortest path joining the other two odd vertices: start D: EG = 14, start E: DG = 17, start G: DE = 6

Least is DE = 6, so start at G

(ii) Time saved = 29 − 6 = 23 minutes

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Question 3 continued

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Question 3 continued

(Total for Question 3 is 14 marks)

4.

(a) $5x + 4y \leq 80$

(b)(i) At least four fruit cakes: $y \geq 4$

Ratio: $y/x \leq 3/2 \Rightarrow 3x \geq 2y$

Butter: $200x + 100y \leq 2800 \Rightarrow 2x + y \leq 28$

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Question 4 continued

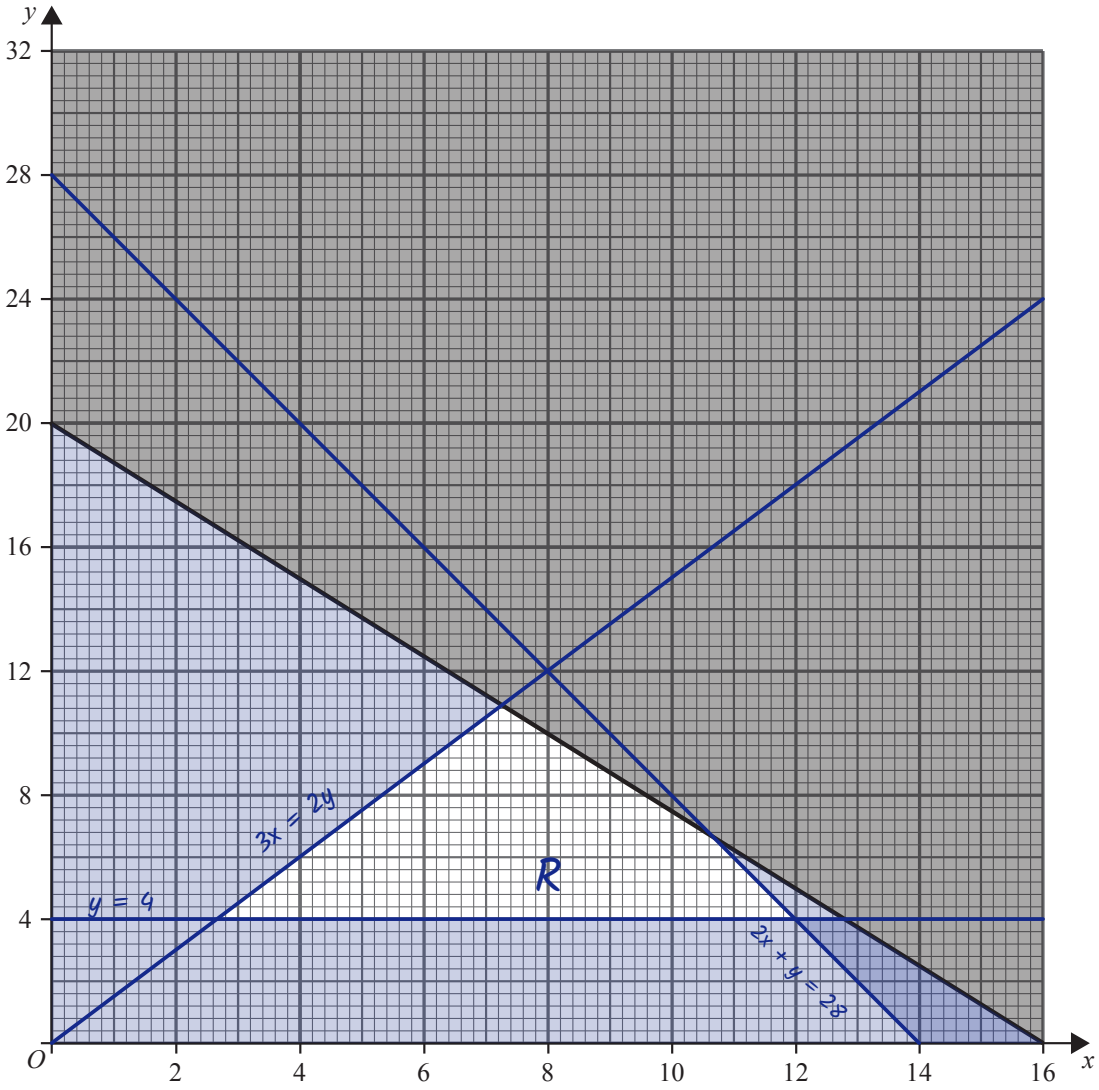


Diagram 1

(c) Vertices of R and profit P = 8x + 5y:

y = 4 and 3x = 2y: x = 8/3 ⇒ (2 2/3, 4) P = 41 1/3

3x = 2y and 5x + 4y = 80: y = 1.5x ⇒ 5x + 6x = 80

x = 80/11, y = 120/11 ⇒ (7 3/11, 10 10/11) P = 112 8/11

y = 4 and 2x + y = 28: 2x = 24 ⇒ (12, 4) P = 116

5x + 4y = 80 and 2x + y = 28: y = 28 − 2x

5x + 112 − 8x = 80 ⇒ 3x = 32 ⇒ x = 32/3, y = 20/3

(10 2/3, 6 2/3) P = 8(32/3) + 5(20/3) = 356/3 = 118 2/3

Optimal vertex is (10 2/3, 6 2/3), but cakes must be whole numbers.

Integer points in R near this vertex:

(10, 7): P = 80 + 35 = 115 (12, 4): P = 116

(11, 6): 5(11) + 4(6) = 79 ≤ 80, 2(11) + 6 = 28 ≤ 28, 33 ≥ 12

P = 88 + 30 = 118 (largest)

Question 4 continued

George should bake 11 sponge cakes and 6 fruit cakes each day

(Total for Question 4 is 11 marks)

TOTAL FOR DECISION MATHEMATICS 1 IS 40 MARKS

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