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EDEXCEL INTERNATIONAL GCSE MATHS: QUESTIONS BY TOPIC

Transformations & Vectors (G3)

International GCSE Mathematics A (4MA1) · Higher tier

42 questions · 192 marks · Mark schemes included

Past papers June 2018 - June 2025 · 2 sub-topics

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 Piccadilly Business Centre, Unit C, Aldow Enterprise Park
Blackett Street, Manchester, M12 6AE

HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.

A gold bar in the left margin marks exactly where the question sits on the original page.

Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.

Each question is filed under its main topic; longer questions may also test skills from other topics.

QUESTION	SOURCE	MARKS	PAGE
G3a TRANSFORMATIONS		12 Qs · 52 marks	3
1. Q8	IGCSE Paper 1H January 2020	2	4
2. Q10	IGCSE Paper 1HR June 2023	2	5
3. Q3	IGCSE Paper 1HR June 2018	3	6
4. Q2	IGCSE Paper 2HR January 2023	3	7
5. Q1	IGCSE Paper 2HR June 2022	4	8
6. Q2	IGCSE Paper 2HR June 2024	4	9
7. Q5	IGCSE Paper 2HR June 2025	4	10
8. Q3	IGCSE Paper 2H November 2023	5	12
9. Q2	IGCSE Paper 2H June 2025	5	13
10. Q2	IGCSE Paper 1H January 2019	6	14
11. Q5	IGCSE Paper 2HR January 2021	6	16
12. Q4	IGCSE Paper 1H June 2023	8	18
G3b VECTORS		30 Qs · 140 marks	20
13. Q13	IGCSE Paper 1HR January 2021	2	21
14. Q16	IGCSE Paper 2HR January 2023	2	22
15. Q14	IGCSE Paper 2H June 2019	3	23
16. Q23	IGCSE Paper 2H January 2020	3	24
17. Q19	IGCSE Paper 2H November 2020	3	25
18. Q17	IGCSE Paper 2H November 2024	3	26
19. Q18	IGCSE Paper 2HR June 2025	3	27
20. Q22	IGCSE Paper 1HR January 2019	4	28
21. Q17	IGCSE Paper 1H June 2018	5	29
22. Q23	IGCSE Paper 2HR June 2018	5	30
23. Q23	IGCSE Paper 2H January 2019	5	31
24. Q24	IGCSE Paper 1HR June 2019	5	32
25. Q26	IGCSE Paper 2HR January 2020	5	33
26. Q25	IGCSE Paper 2HR November 2020	5	34
27. Q26	IGCSE Paper 1H June 2021	5	36
28. Q22	IGCSE Paper 1H January 2022	5	38
29. Q24	IGCSE Paper 1HR January 2022	5	40
30. Q21	IGCSE Paper 2H June 2022	5	42
31. Q25	IGCSE Paper 2HR June 2022	5	43
32. Q24	IGCSE Paper 1H January 2023	5	44
33. Q22	IGCSE Paper 1HR January 2023	5	46



QUESTION	SOURCE	MARKS	PAGE
34. Q19	IGCSE Paper 1H June 2023	5	48
35. Q19	IGCSE Paper 1HR June 2023	5	50
36. Q22	IGCSE Paper 2H November 2023	5	51
37. Q23	IGCSE Paper 1H June 2025	5	53
38. Q23	IGCSE Paper 1H January 2021	6	55
39. Q24	IGCSE Paper 2H June 2024	6	57
40. Q25	IGCSE Paper 2HR June 2024	6	59
41. Q24	IGCSE Paper 1H November 2024	6	61
42. Q14	IGCSE Paper 1H November 2021	8	63



QUESTIONS

42 questions · 192 marks · 2 sub-topics

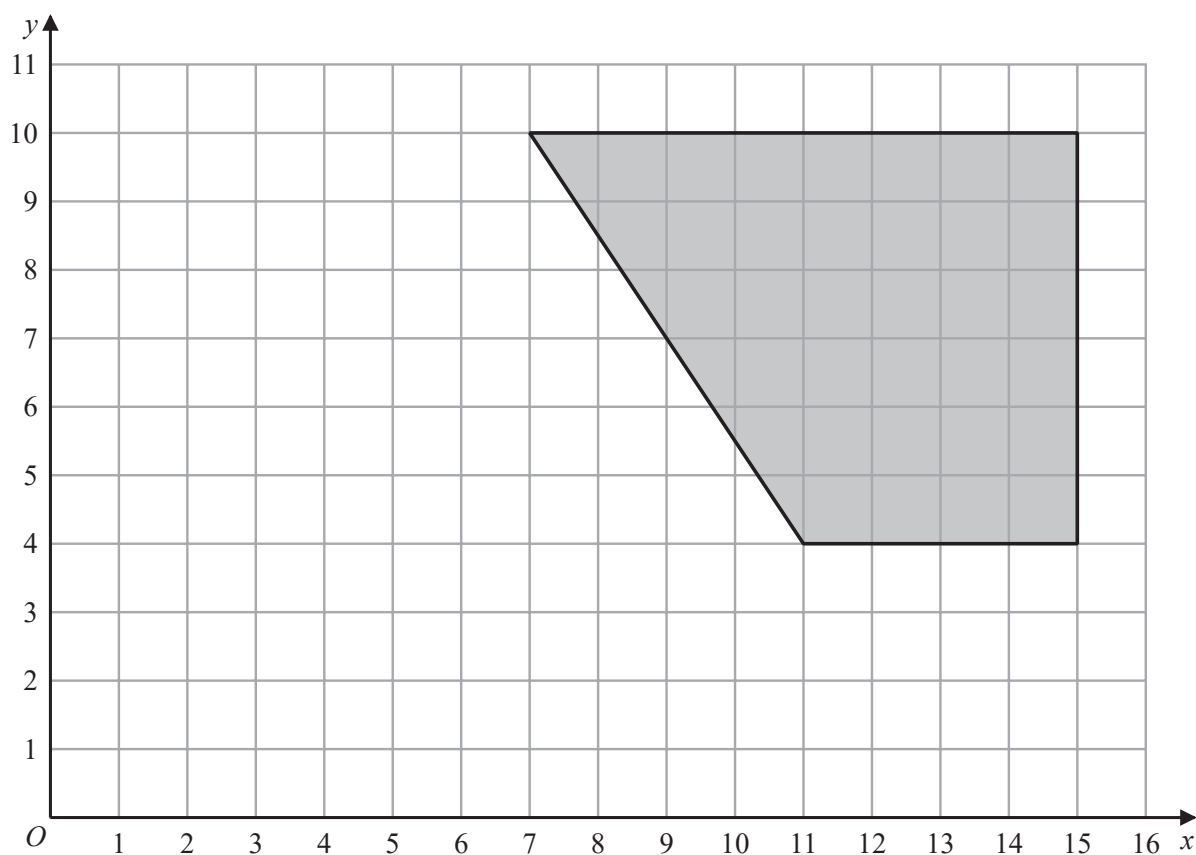
SUB-TOPIC G3a

TRANSFORMATIONS

Sub-topic G3a · 12 questions · 52 marks · lowest tariff first



8

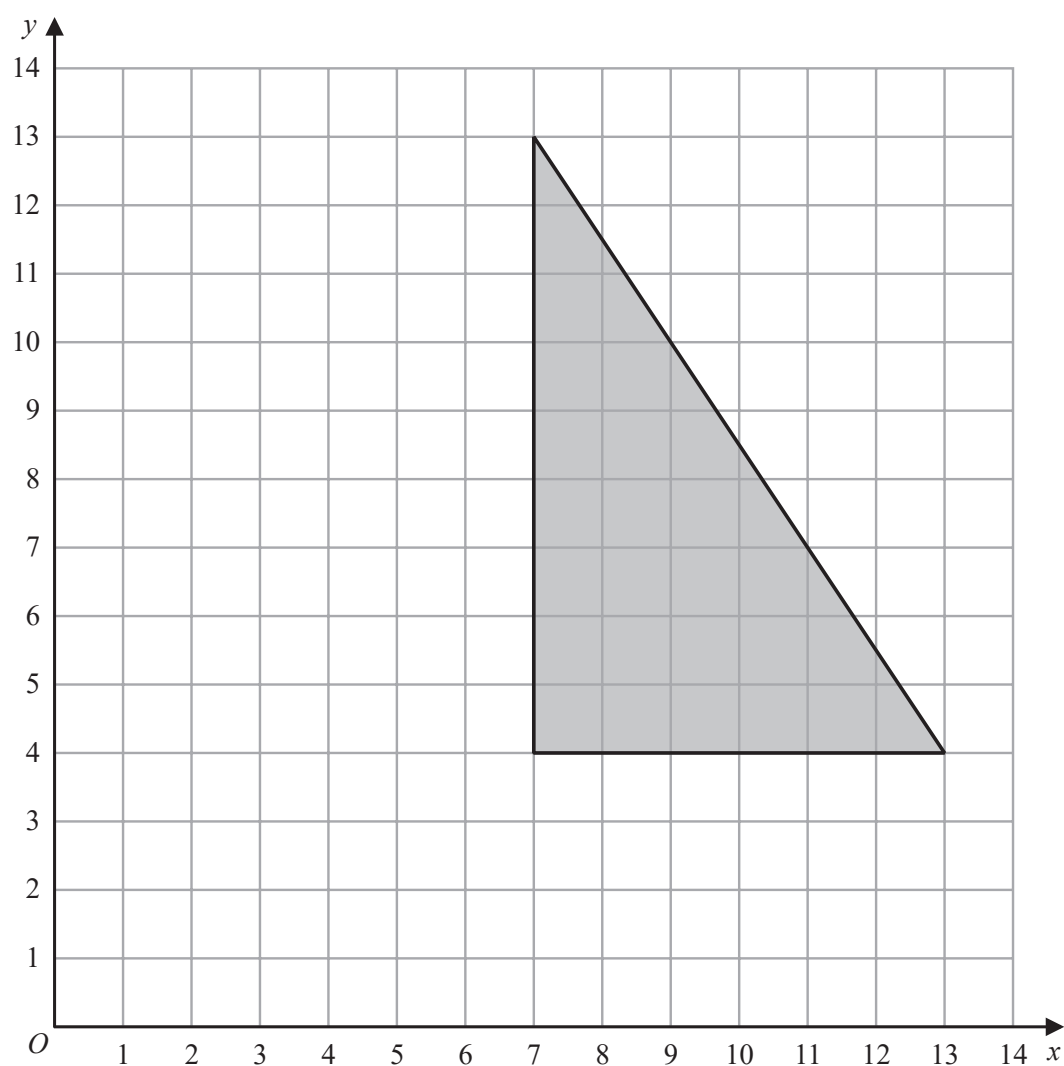


On the grid, enlarge the shaded shape with scale factor $\frac{1}{2}$ and centre (1, 2)

(Total for Question 8 is 2 marks)



10

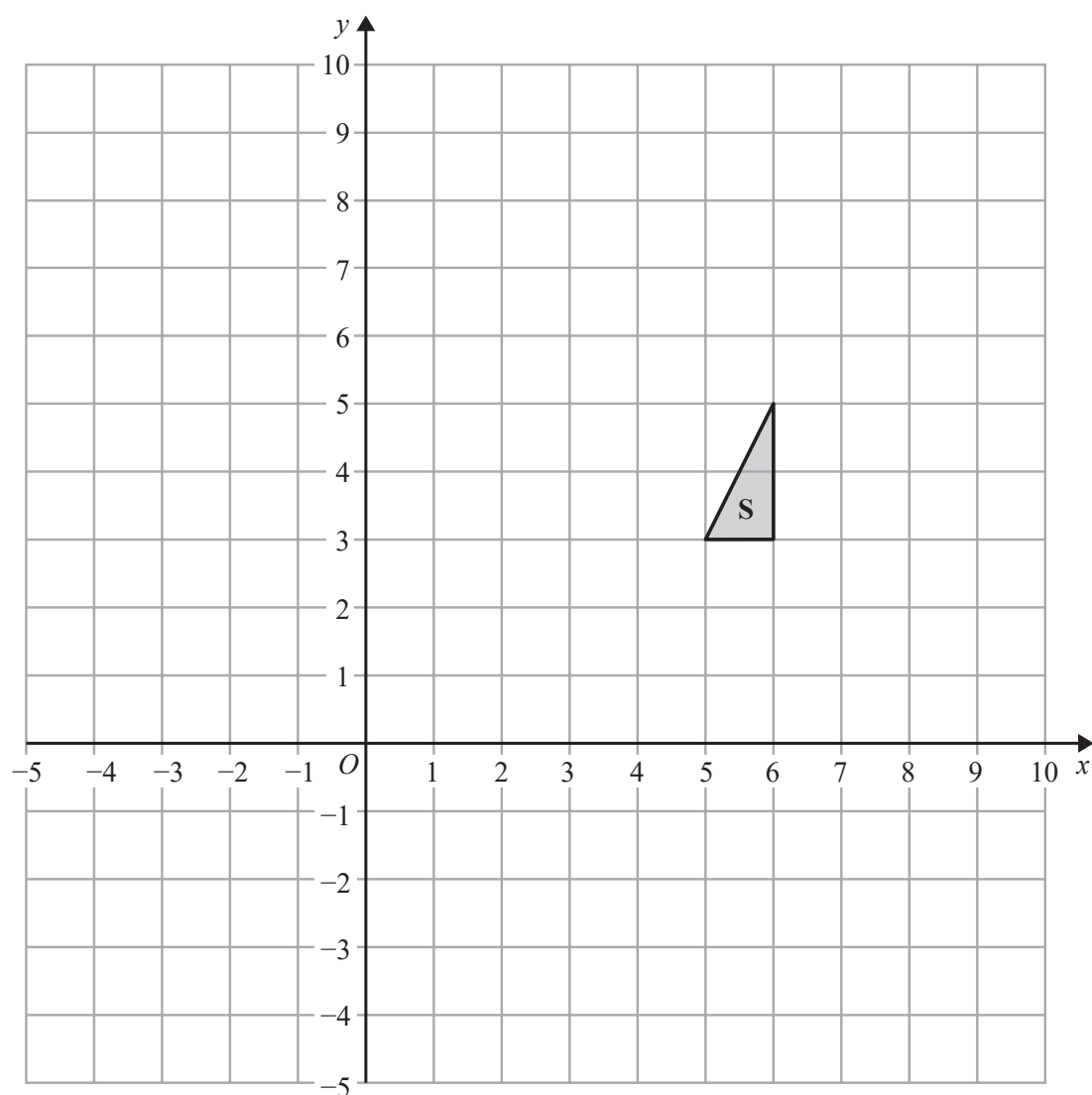


On the grid, enlarge the shaded shape with scale factor $\frac{1}{3}$ and centre (1, 7)

(Total for Question 10 is 2 marks)



3



- (a) Reflect triangle **S** in the line $y = x$
Label the new triangle **R**.

(2)

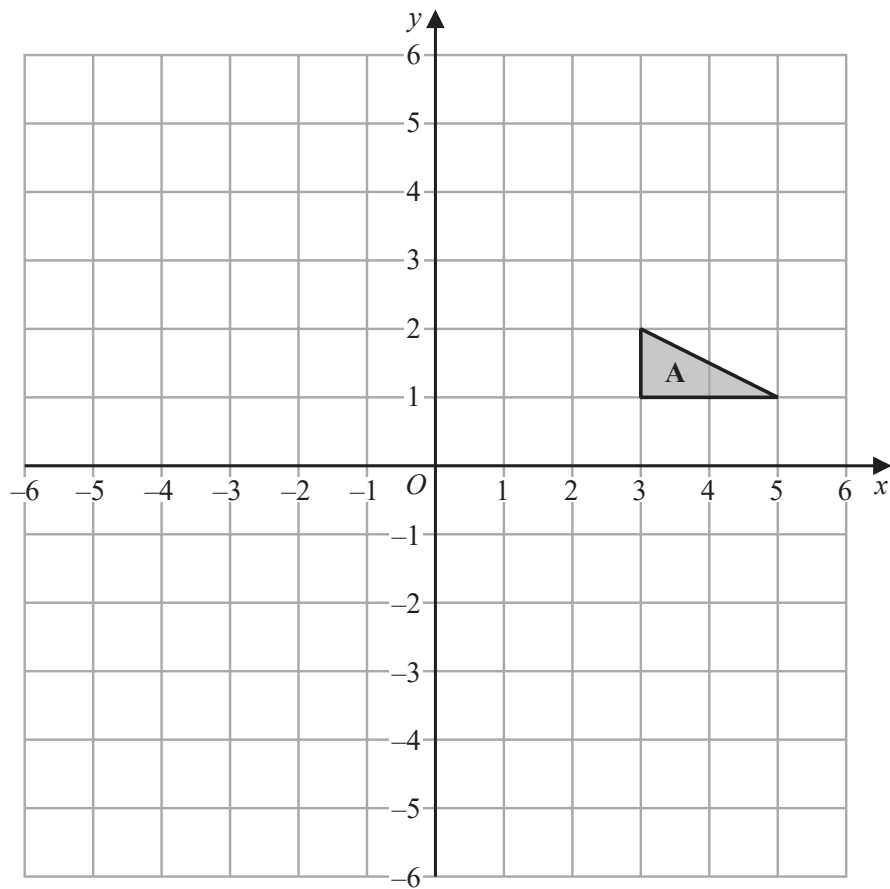
- (b) Translate triangle **S** by the vector $\begin{pmatrix} -4 \\ -6 \end{pmatrix}$
Label the new triangle **T**.

(1)

(Total for Question 3 is 3 marks)



2



- (a) On the grid, rotate triangle A 180° about $(1, -1)$
Label the new triangle **B**

(2)

- (b) On the grid, translate triangle A by the vector $\begin{pmatrix} -7 \\ 3 \end{pmatrix}$

Label the new triangle **C**

(1)

(Total for Question 2 is 3 marks)

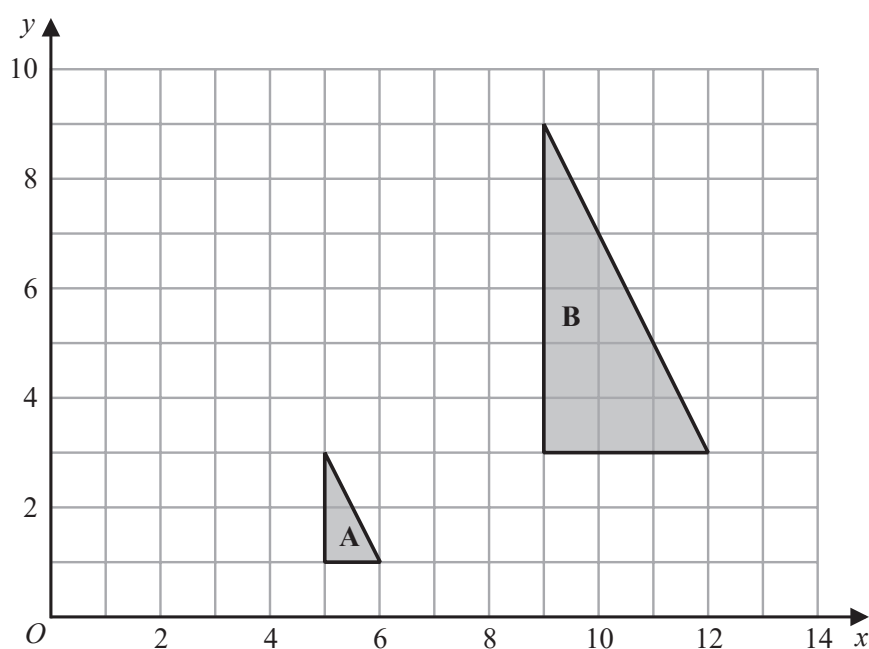


Answer ALL TWENTY FIVE questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1



(a) Describe fully the single transformation that maps triangle A onto triangle B

(3)

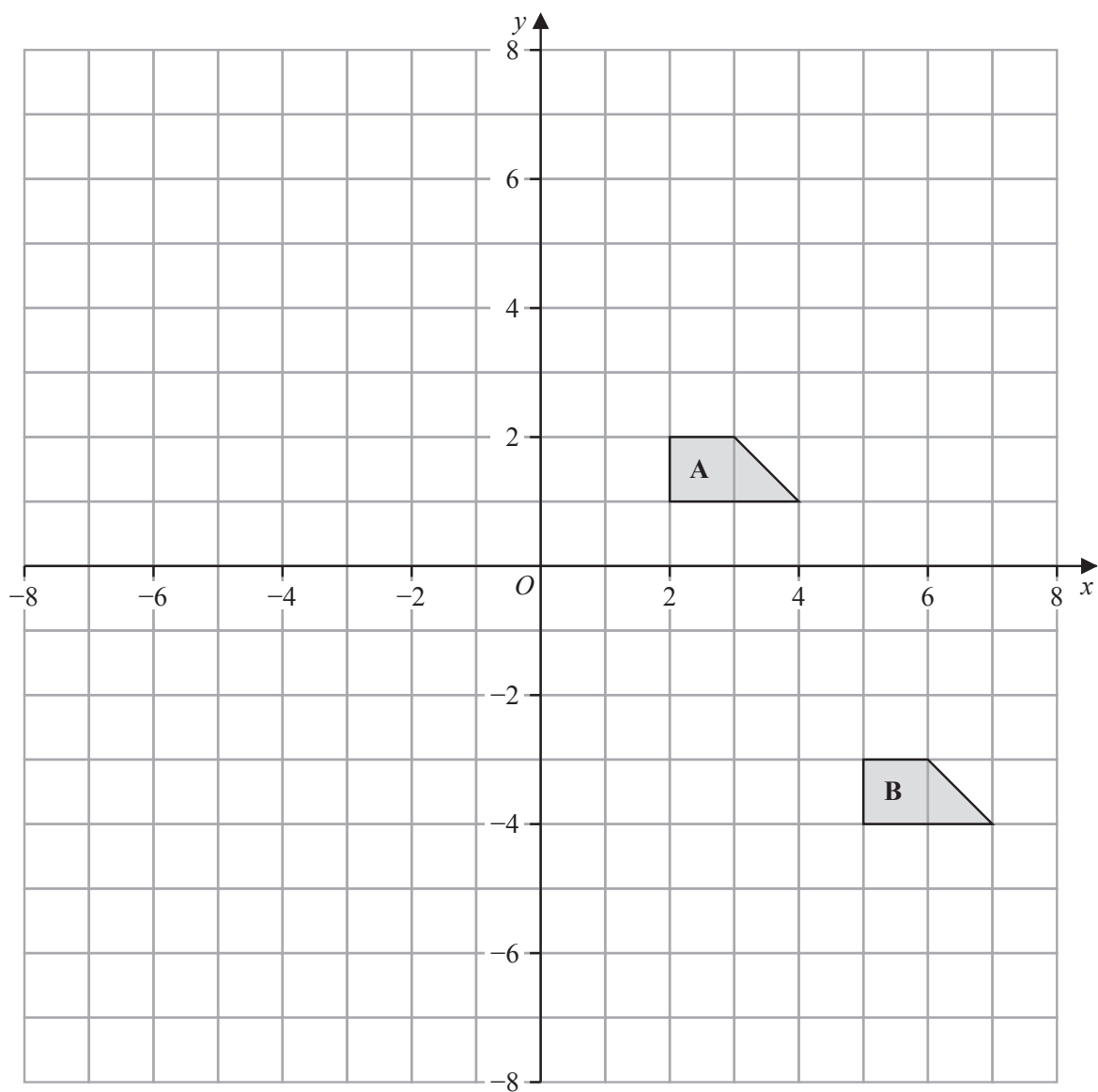
(b) On the grid above, translate triangle A by the vector $\begin{pmatrix} -4 \\ 3 \end{pmatrix}$

Label your triangle C

(1)

(Total for Question 1 is 4 marks)

2



(a) Describe fully the single transformation that maps shape A onto shape B

.....

.....

(2)

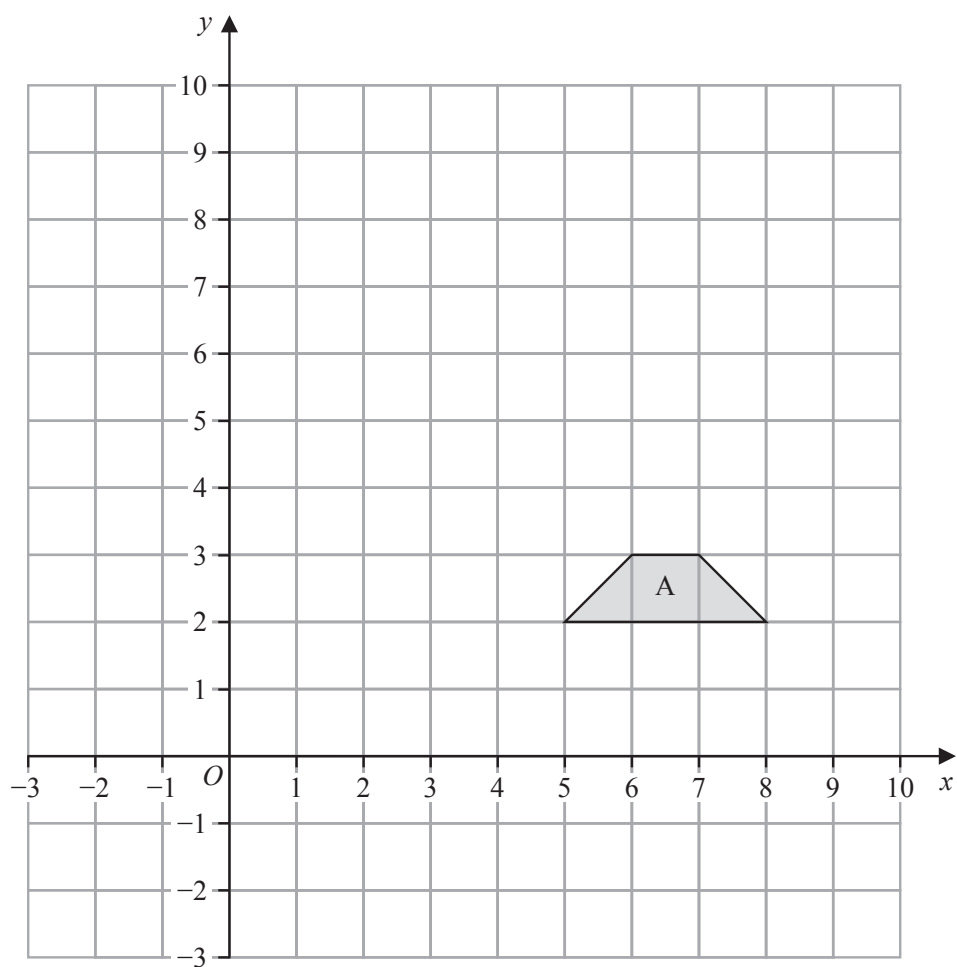
(b) On the grid above, rotate shape A 180° about $(-1, 0)$
Label your shape C

(2)

(Total for Question 2 is 4 marks)



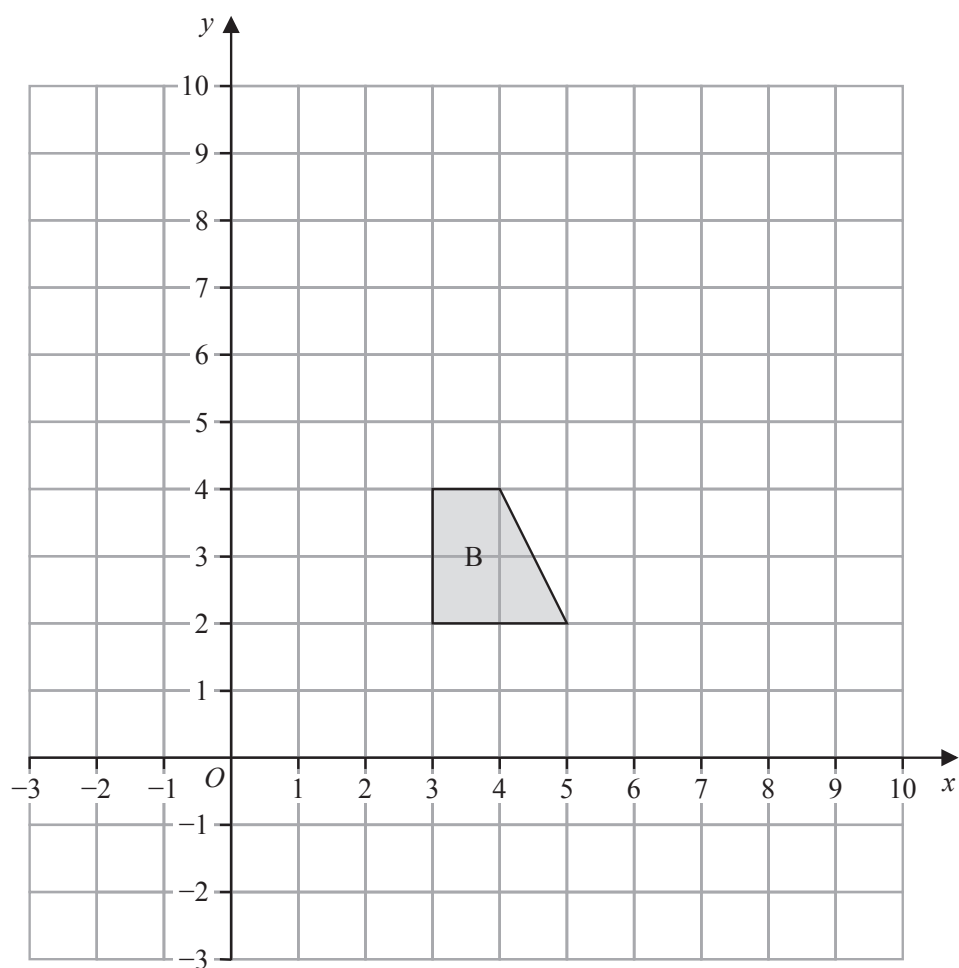
5



(a) On the grid above, reflect shape A in the line $y = x$

(2)





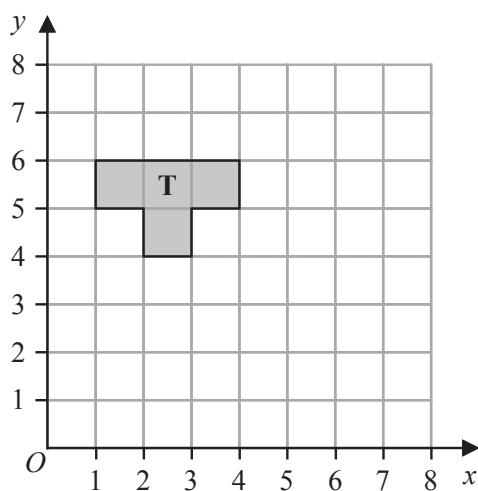
(b) On the grid above, enlarge shape **B** by scale factor 2 with centre (1, 1)

(2)

(Total for Question 5 is 4 marks)

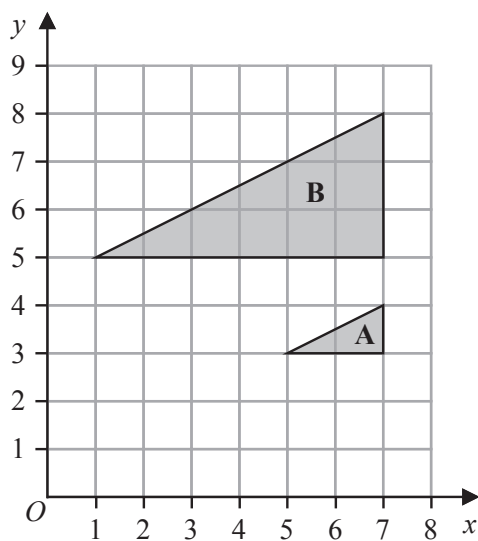


3



(a) Reflect shape **T** in the line $y = x$

(2)



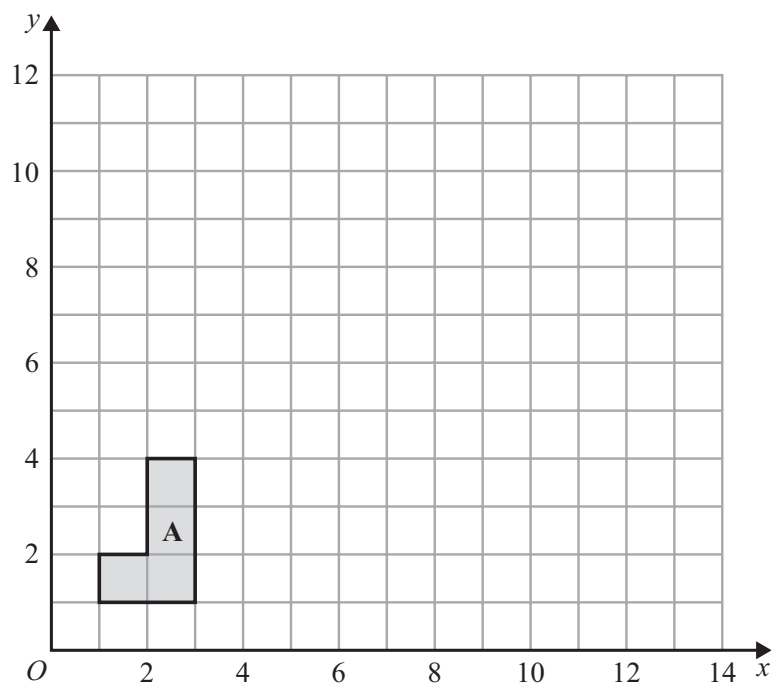
(b) Describe fully the single transformation that maps triangle **A** onto triangle **B**

(3)

(Total for Question 3 is 5 marks)

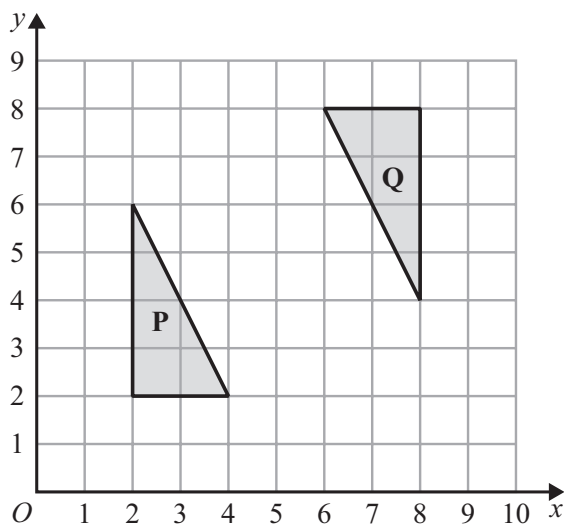


2



(a) On the grid, enlarge shape A with scale factor 3 and centre (0, 1)

(2)



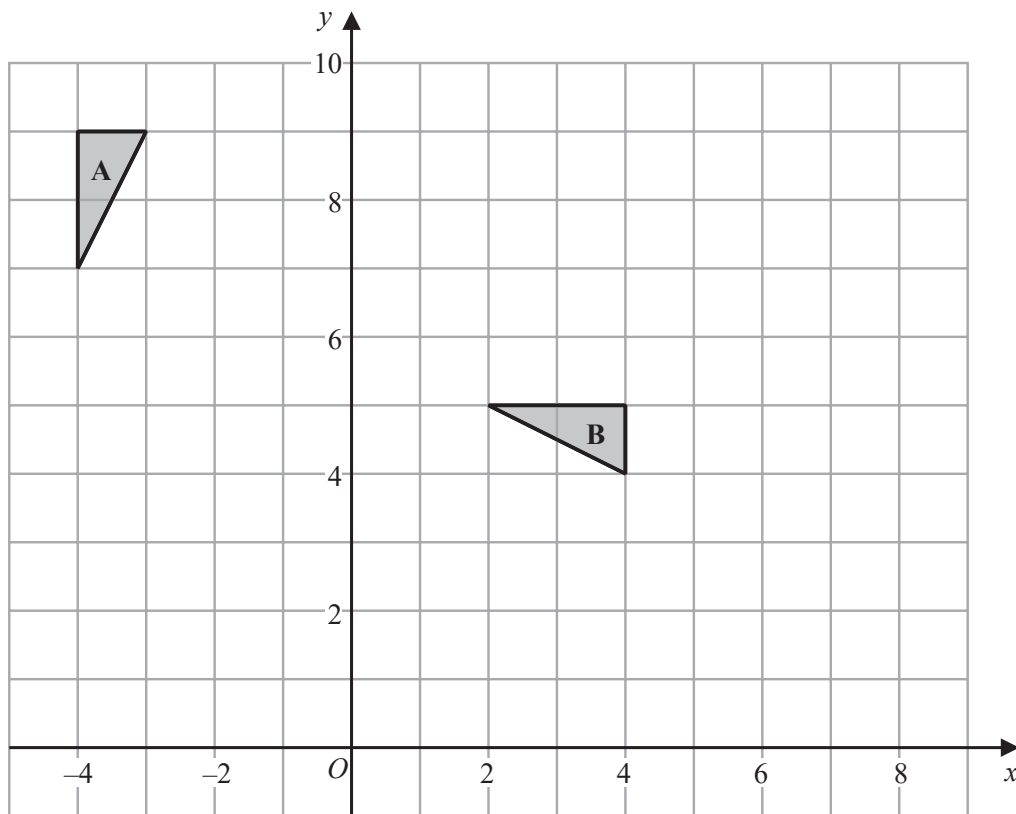
(b) Describe fully the single transformation that maps triangle P onto triangle Q

(3)

(Total for Question 2 is 5 marks)



2



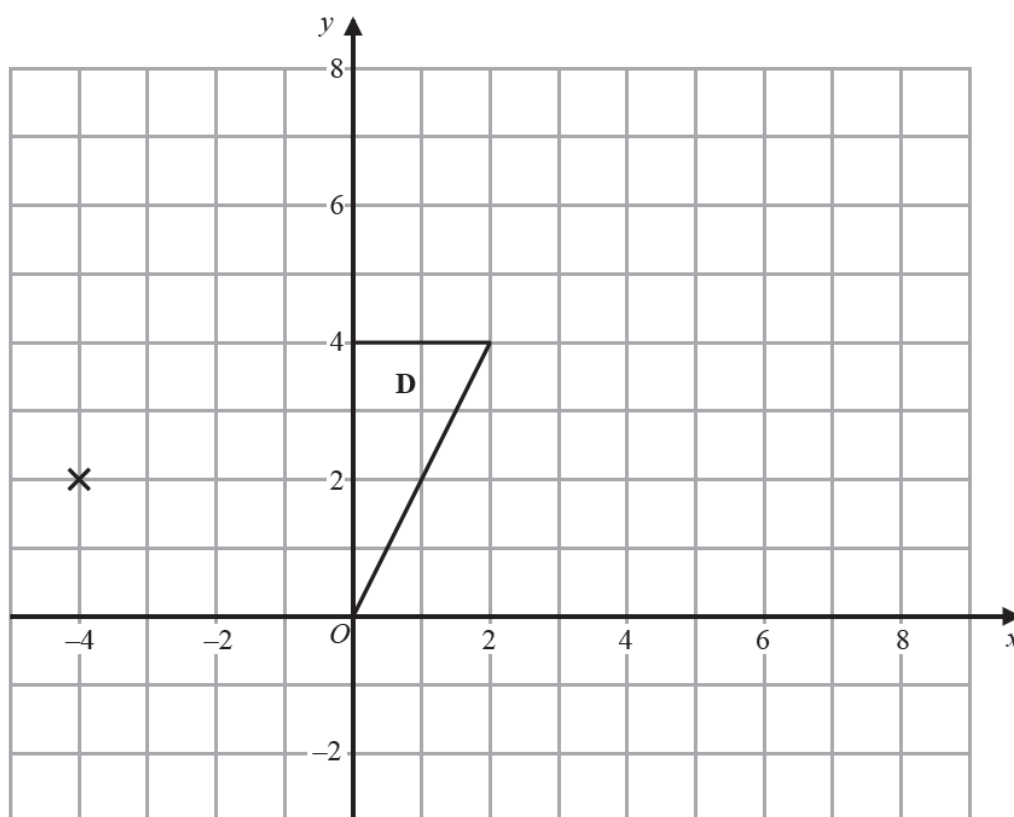
(a) Describe fully the single transformation that maps triangle **A** onto triangle **B**.

(3)

(b) On the grid, translate triangle **A** by the vector $\begin{pmatrix} 2 \\ -5 \end{pmatrix}$
Label the new triangle **C**.

(1)



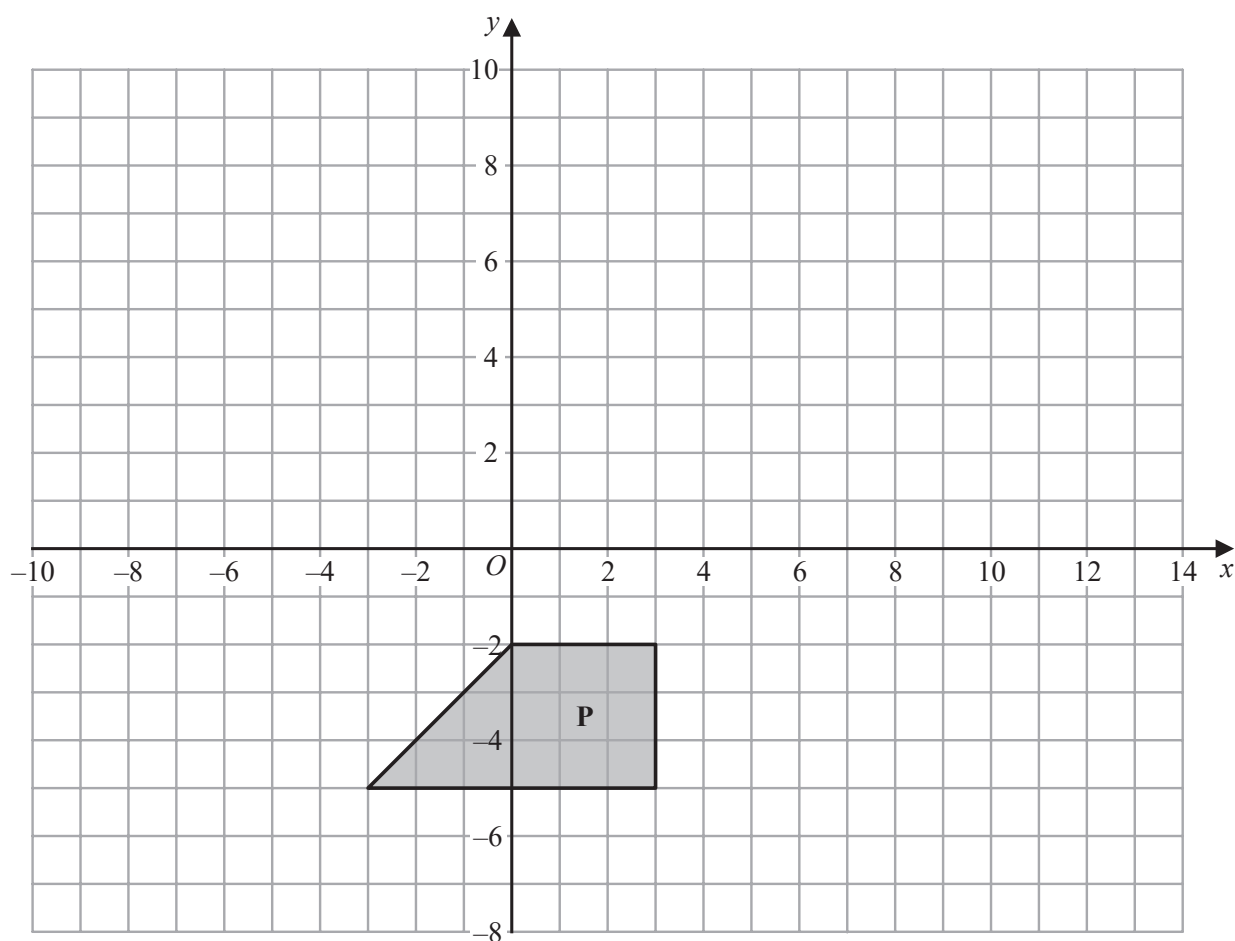


(c) On the grid, enlarge triangle **D** with scale factor $\frac{1}{2}$ and centre $(-4, 2)$

(2)

(Total for Question 2 is 6 marks)

5 Here is a shape **P** drawn on a grid of squares.



- (a) On the grid, rotate shape **P** 180° about the point $(-3, 2)$
Label the new shape **Q**.

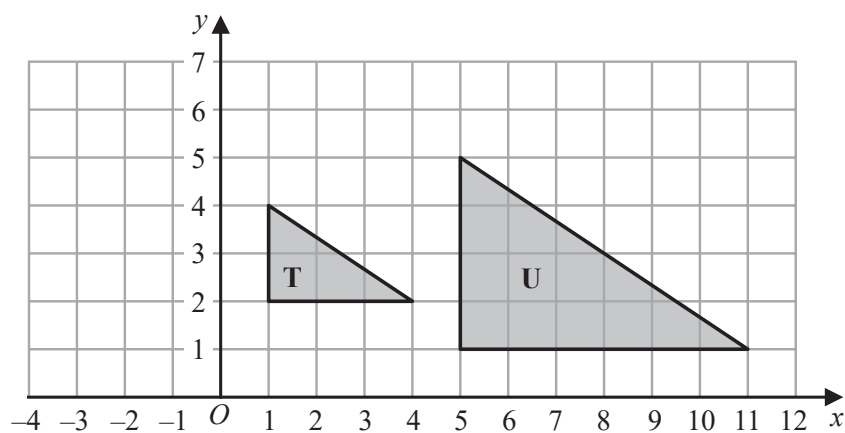
(2)

- (b) On the grid, translate shape **P** by the vector $\begin{pmatrix} 10 \\ 8 \end{pmatrix}$
Label the new shape **R**.

(1)



Here are triangle **T** and triangle **U** drawn on a grid of squares.



(c) Describe fully the single transformation that maps triangle **T** onto triangle **U**.

(3)

(Total for Question 5 is 6 marks)

- 6 On Wednesday, the price of 1 litre of petrol was £1.26
The price of petrol on Wednesday was 5% more than the price of petrol on the previous Monday.

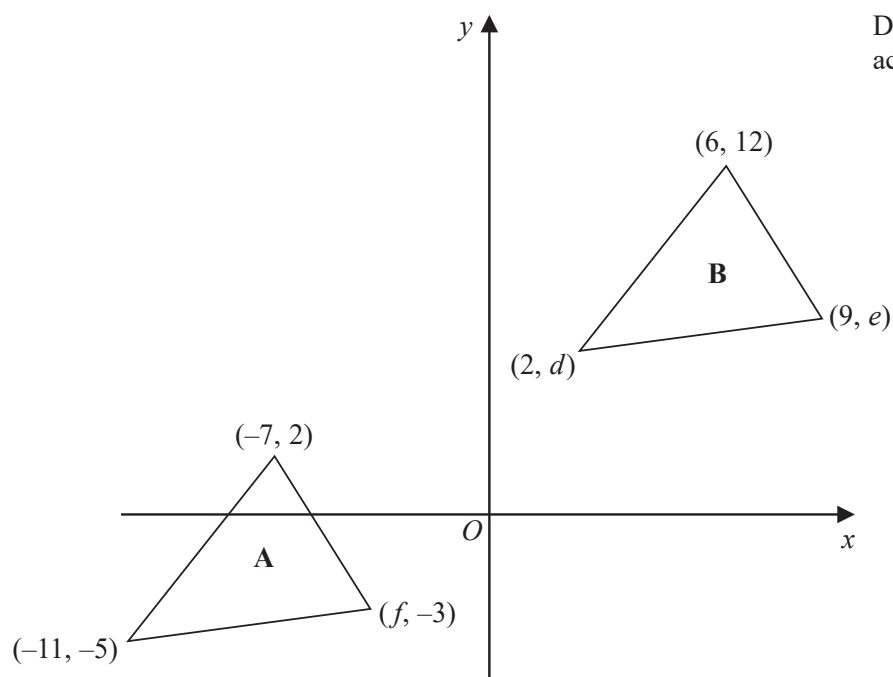
Calculate the price of 30 litres of petrol on the previous Monday.

£.....

(Total for Question 6 is 3 marks)



- 4 The diagram shows a sketch of triangle **A** and triangle **B** on a coordinate grid.



- (a) Given that triangle **A** has been translated to give triangle **B**, work out the value of d , the value of e and the value of f

$$d = \dots\dots\dots$$

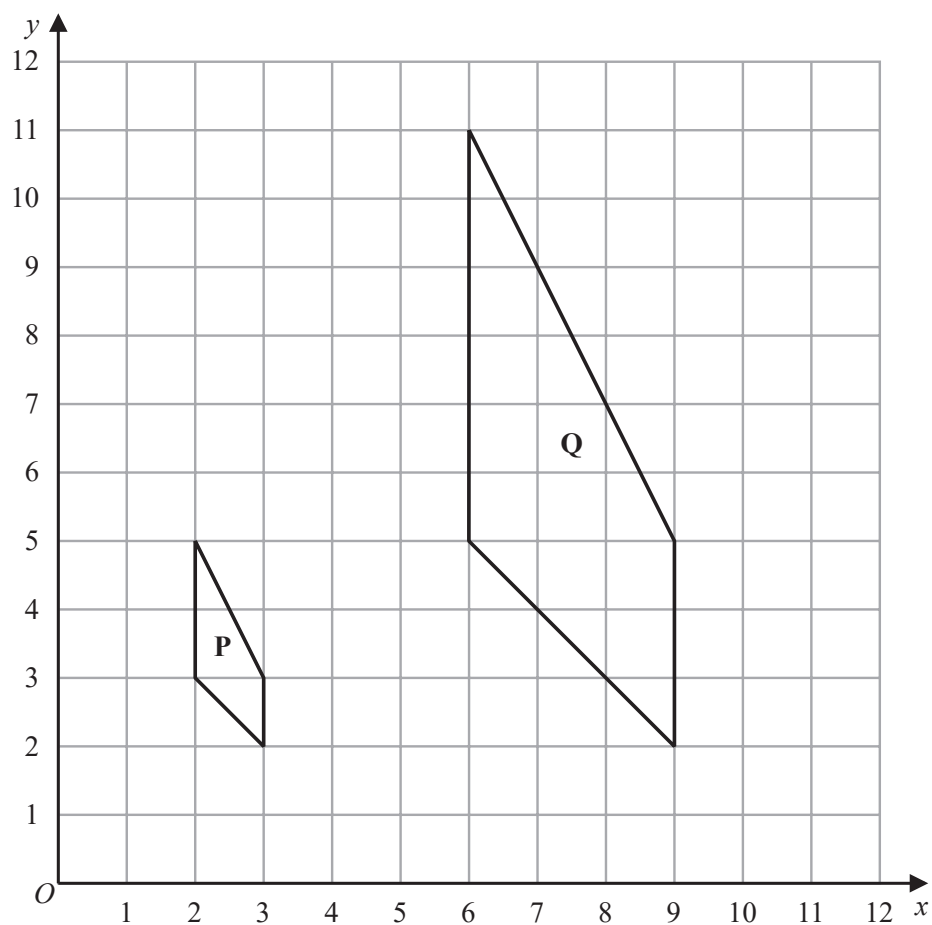
$$e = \dots\dots\dots$$

$$f = \dots\dots\dots$$

(3)



The diagram shows shape **P** and shape **Q** drawn on a grid.



(b) Describe fully the single transformation that maps shape **P** onto shape **Q**

(3)

(c) On the grid above, rotate shape **P** 90° clockwise about (3, 5)
Label your shape **R**

(2)

(Total for Question 4 is 8 marks)



SUB-TOPIC G3b

VECTORS

Sub-topic G3b · 30 questions · 140 marks · lowest tariff first



13 Here are two vectors.

$$\overrightarrow{AB} = \begin{pmatrix} 5 \\ 3 \end{pmatrix} \quad \overrightarrow{CB} = \begin{pmatrix} -2 \\ 4 \end{pmatrix}$$

Find, as a column vector, $\overrightarrow{AC}$

(Total for Question 13 is 2 marks)



16 Here are two vectors.

$$\overrightarrow{BA} = \begin{pmatrix} -5 \\ 4 \end{pmatrix} \quad \overrightarrow{BC} = \begin{pmatrix} 9 \\ 1 \end{pmatrix}$$

Find $\overrightarrow{AC}$ as a column vector.

$$\overrightarrow{AC} = \begin{pmatrix} \\ \\ \end{pmatrix}$$

(Total for Question 16 is 2 marks)



14 Here are two vectors.

$$\vec{AB} = \begin{pmatrix} 6 \\ -9 \end{pmatrix} \quad \vec{CB} = \begin{pmatrix} 1 \\ 3 \end{pmatrix}$$

Find the magnitude of $\vec{AC}$.

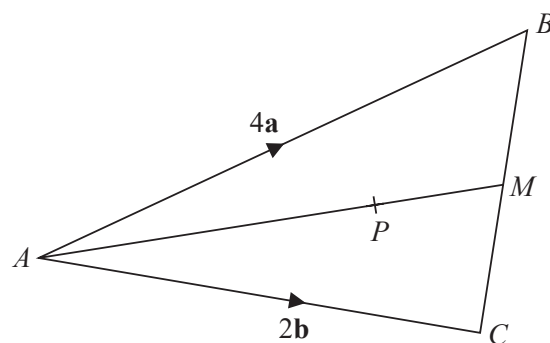
(Total for Question 14 is 3 marks)

15 Make x the subject of the formula $y = \sqrt{\frac{3x-2}{x+1}}$

(Total for Question 15 is 4 marks)



23

Diagram **NOT**
accurately drawn

ABC is a triangle.
The midpoint of BC is M .
 P is a point on AM .

$$\vec{AB} = 4\mathbf{a}$$

$$\vec{AC} = 2\mathbf{b}$$

$$\vec{AP} = \frac{3}{2}\mathbf{a} + \frac{3}{4}\mathbf{b}$$

Find the ratio $AP:PM$

(Total for Question 23 is 3 marks)



19 OAB is a triangle.

$$\vec{OA} = \mathbf{a} \quad \vec{OB} = \mathbf{b}$$

The point C lies on OA such that $OC : CA = 1 : 2$

The point D lies on OB such that $OD : DB = 1 : 2$

Using a vector method, prove that $ABDC$ is a trapezium.

(Total for Question 19 is 3 marks)



17 Here are two vectors.

$$\vec{FG} = \begin{pmatrix} -5 \\ 2 \end{pmatrix} \quad \vec{HG} = \begin{pmatrix} 4 \\ 14 \end{pmatrix}$$

Calculate the magnitude of the vector $\vec{HF}$

(Total for Question 17 is 3 marks)



18 OAB is a triangle.

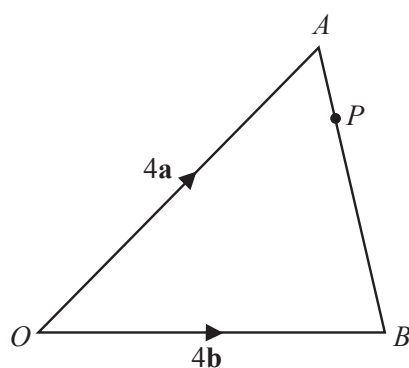


Diagram **NOT**
accurately drawn

$$\vec{OA} = 4\mathbf{a}$$

$$\vec{OB} = 4\mathbf{b}$$

P is the point on AB such that $AP : PB = 1 : 3$

(a) Write down $\vec{AB}$ in terms of $\mathbf{a}$ and $\mathbf{b}$

(1)

(b) Express $\vec{OP}$ in terms of $\mathbf{a}$ and $\mathbf{b}$
Give your answer in its simplest form.

(2)

(Total for Question 18 is 3 marks)



22 $ABCDEF$ is a regular hexagon.

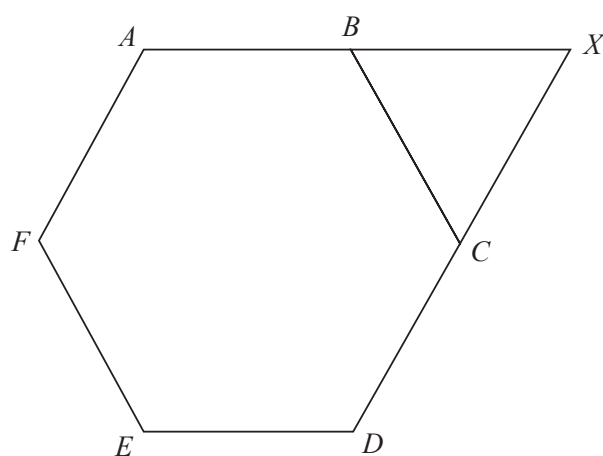


Diagram **NOT**
accurately drawn

ABX and DCX are straight lines.

$$\vec{AB} = \mathbf{a} \quad \vec{BC} = \mathbf{b}$$

Find $\vec{EX}$ in terms of $\mathbf{a}$ and $\mathbf{b}$.

Give your answer in its simplest form.

(Total for Question 22 is 4 marks)



17 The diagram shows parallelogram $ABCD$.

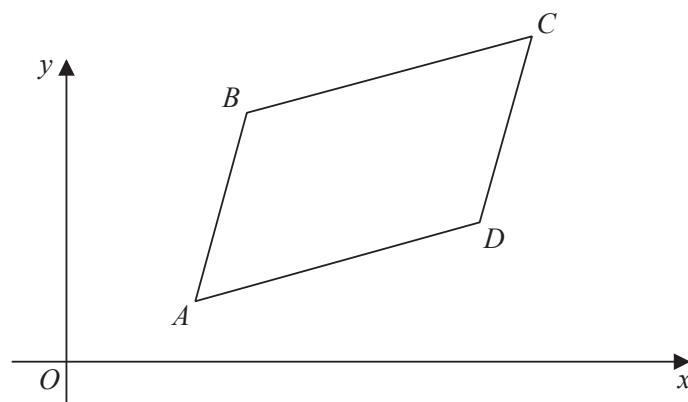


Diagram **NOT**
accurately drawn

$$\vec{AB} = \begin{pmatrix} 2 \\ 7 \end{pmatrix} \quad \vec{AC} = \begin{pmatrix} 10 \\ 11 \end{pmatrix}$$

The point B has coordinates $(5, 8)$

(a) Work out the coordinates of the point C .

(....., ...)
(3)

The point E has coordinates $(63, 211)$

(b) Use a vector method to prove that ABE is a straight line.

(2)

(Total for Question 17 is 5 marks)



23 OAB is a triangle.

$$\vec{OA} = \mathbf{a} \quad \vec{OB} = \mathbf{b}$$

C is the midpoint of OA .

D is the point on AB such that $AD:DB = 3:1$

E is the point such that $\vec{OB} = 2\vec{BE}$

Using a vector method, prove that the points C , D and E lie on the same straight line.

(Total for Question 23 is 5 marks)



23 $ABCD$ is a trapezium.

$$\vec{DC} = 3\vec{AB}$$

$$\vec{DA} = \begin{pmatrix} -2 \\ 3 \end{pmatrix} \quad \vec{DB} = \begin{pmatrix} -1 \\ 7 \end{pmatrix}$$

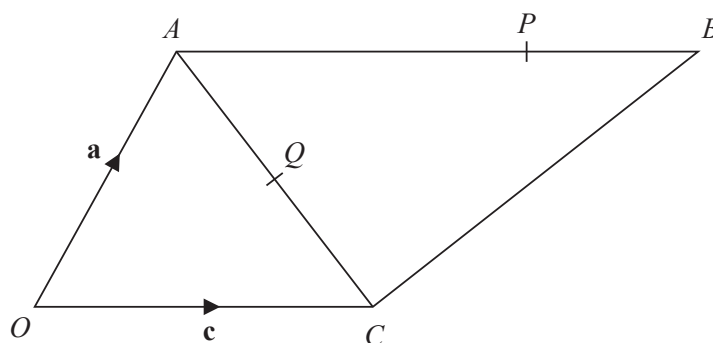
Find the exact magnitude of $\vec{BC}$

(Total for Question 23 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS



24

Diagram **NOT**
accurately drawn

$$\vec{OA} = \mathbf{a} \quad \vec{OC} = \mathbf{c} \quad \vec{AB} = 2\mathbf{c}$$

P is the point on AB such that $AP : PB = 3 : 1$

Q is the point on AC such that OQP is a straight line.

Use a vector method to find $AQ : QC$

Show your working clearly.

$$AQ : QC = \dots\dots\dots$$

(Total for Question 24 is 5 marks)



26 The diagram shows trapezium $OACB$.

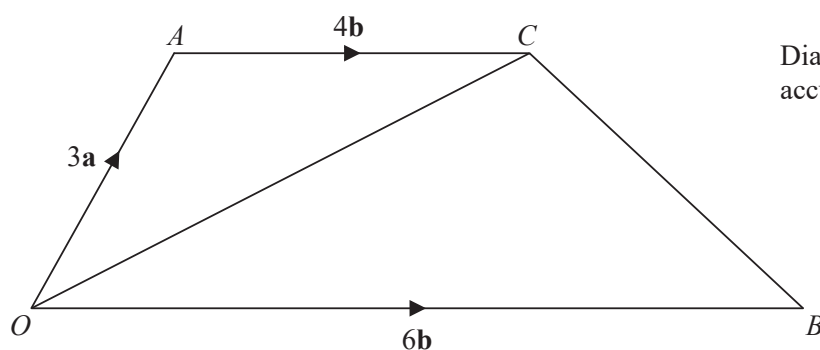


Diagram **NOT**
accurately drawn

$$\vec{OA} = 3\mathbf{a} \quad \vec{OB} = 6\mathbf{b} \quad \vec{AC} = 4\mathbf{b}$$

N is the point on OC such that ANB is a straight line.

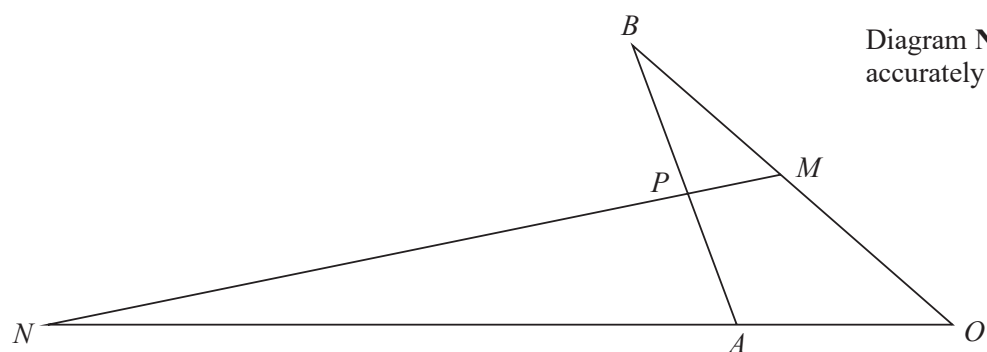
Find $\vec{ON}$ as a simplified expression in terms of $\mathbf{a}$ and $\mathbf{b}$.

(Total for Question 26 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS



25

Diagram **NOT**
accurately drawn

OAN , OMB , APB and MPN are straight lines.

$$OA:AN = 1:4$$

$$OM:MB = 1:1$$

$$\vec{OA} = 2\mathbf{a} \quad \vec{OB} = 2\mathbf{b}$$

By using a vector method, find the ratio $AP:PB$
Give your answer in its simplest form.

(Total for Question 25 is 5 marks)

Turn over for Question 26



26 $OACB$ is a trapezium.

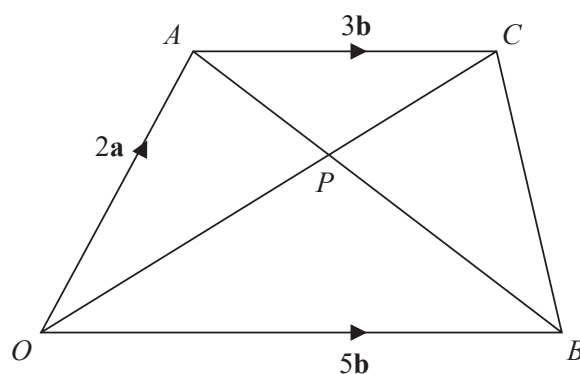


Diagram **NOT**
accurately drawn

$$\vec{OA} = 2\mathbf{a} \quad \vec{OB} = 5\mathbf{b} \quad \vec{AC} = 3\mathbf{b}$$

The diagonals, OC and AB , of the trapezium intersect at the point P .

Find and simplify an expression, in terms of $\mathbf{a}$ and $\mathbf{b}$, for $\vec{OP}$
Show your working clearly.

$$\vec{OP} = \dots\dots\dots$$

(Total for Question 26 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS



22 The diagram shows triangle OAB

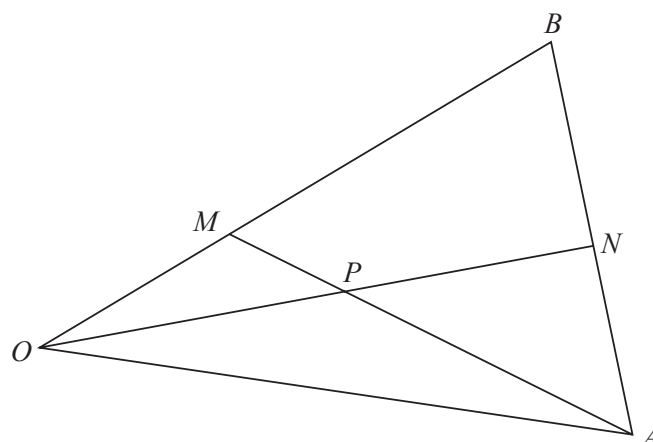


Diagram **NOT**
accurately drawn

$$\vec{OA} = 8\mathbf{a} \quad \vec{OB} = 6\mathbf{b}$$

M is the point on OB such that $OM:MB = 1:2$

N is the midpoint of AB

P is the point of intersection of ON and AM

Using a vector method, find $\vec{OP}$ as a simplified expression in terms of $\mathbf{a}$ and $\mathbf{b}$
Show your working clearly.

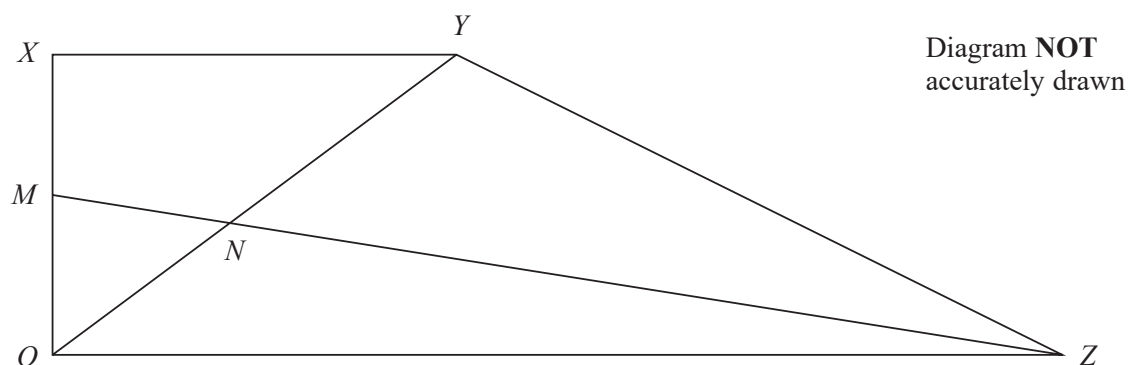
$$\overrightarrow{OP} = \dots\dots\dots$$

(Total for Question 22 is 5 marks)

Turn over for Question 23



24 $OXYZ$ is a trapezium.



$$\overrightarrow{OX} = \mathbf{a}$$

$$\overrightarrow{XY} = \mathbf{b}$$

$$\overrightarrow{OZ} = 3\mathbf{b}$$

M is the midpoint of OX

N is the point such that MNZ and ONY are straight lines.

Given that $ON : OY = \lambda : 1$

use a vector method to find the value of λ



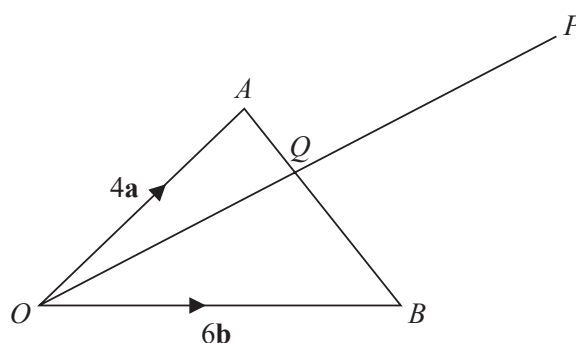
$$\lambda = \dots\dots\dots$$

(Total for Question 24 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS



21

Diagram **NOT**
accurately drawn OAB is a triangle. Q is the point on AB such that OQP is a straight line.

$$\vec{OA} = 4\mathbf{a} \quad \vec{OB} = 6\mathbf{b} \quad \vec{AP} = 2\mathbf{a} + 8\mathbf{b}$$

Using a vector method, find the ratio $AQ:QB$

$$AQ:QB = \dots\dots\dots$$

(Total for Question 21 is 5 marks)



25 $ABCD$ is a parallelogram and ADM is a straight line.

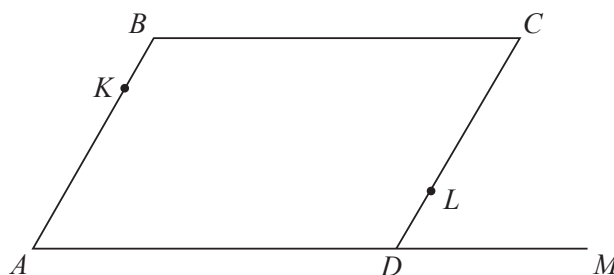


Diagram **NOT**
accurately drawn

$$\vec{AB} = \mathbf{a} \quad \vec{BC} = \mathbf{b} \quad \vec{DM} = \frac{1}{2} \mathbf{b}$$

K is the point on AB such that $AK:AB = \lambda:1$

L is the point on CD such that $CL:CD = \mu:1$

KLM is a straight line.

Given that $\lambda:\mu = 1:2$

use a vector method to find the value of λ and the value of μ

$$\lambda = \dots\dots\dots$$

$$\mu = \dots\dots\dots$$

(Total for Question 25 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS



24 $OAED$ is a quadrilateral.

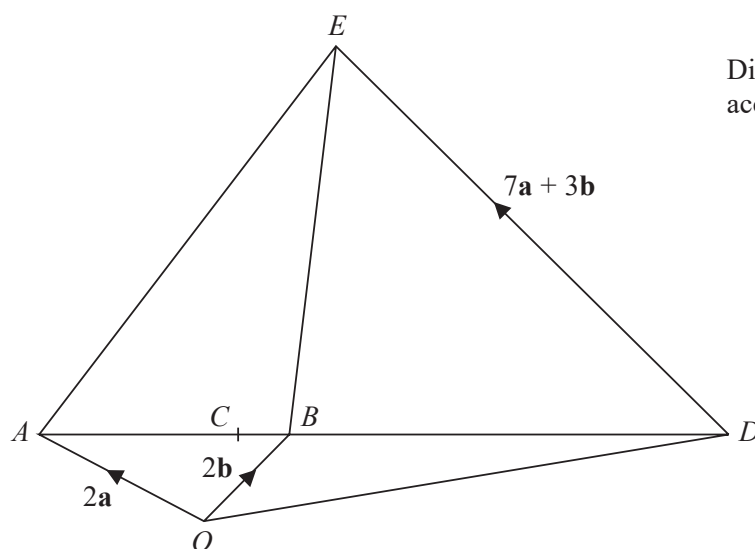


Diagram **NOT**
accurately drawn

$$\vec{OA} = 2\mathbf{a} \quad \vec{OB} = 2\mathbf{b} \quad \vec{DE} = 7\mathbf{a} + 3\mathbf{b}$$

$$AB:BD = 1:2$$

The point C on AB is such that OCE is a straight line.

Use a vector method to find the ratio of $OC:CE$



TOTAL FOR PAPER IS 100 MARKS



22 The diagram shows triangle OAB with OA extended to E

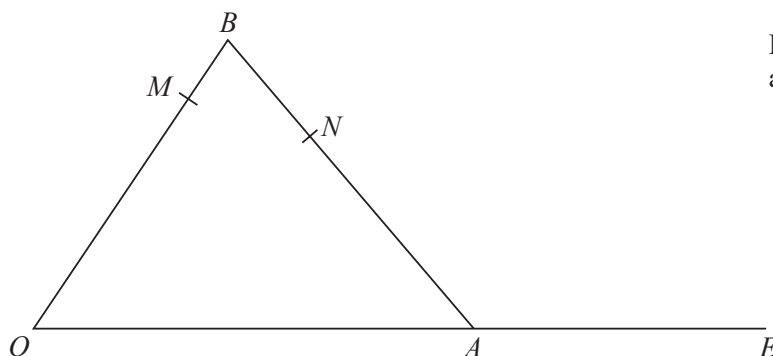


Diagram **NOT**
accurately drawn

$$\vec{OA} = \mathbf{a} \quad \vec{OB} = \mathbf{b}$$

M is the point on OB such that $OM:MB = 4:1$

N is the point on AB such that $AN:NB = 3:2$

$$OA:AE = 5:3$$

- (a) Find an expression for $\vec{ON}$ in terms of $\mathbf{a}$ and $\mathbf{b}$
Give your answer in its simplest form.

$$\vec{ON} = \dots\dots\dots (2)$$



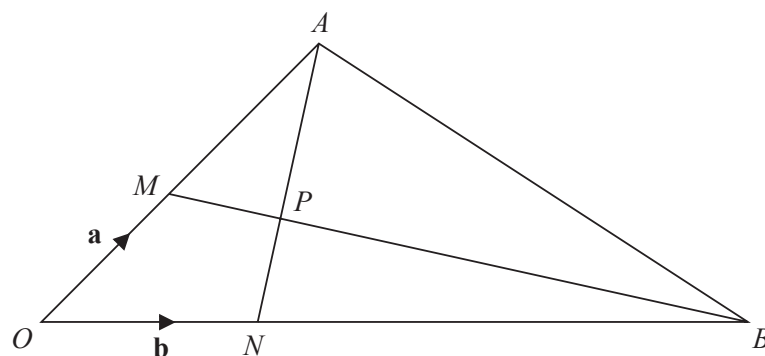
(b) Use a vector method to show that MNE is a straight line.

(3)

(Total for Question 22 is 5 marks)



19

Diagram **NOT**
accurately drawn

OMA , ONB , MPB and NPA are straight lines.

M is the midpoint of OA

$ON:NB = 1:5$

$$\vec{OM} = \mathbf{a} \quad \vec{ON} = \mathbf{b}$$

(a) Find in terms of $\mathbf{a}$ and $\mathbf{b}$ the vector $\vec{AN}$

(1)

(b) Use a vector method to find the ratio $AP:PN$

$$AP:PN = \dots\dots\dots$$

(4)

(Total for Question 19 is 5 marks)

Turn over for Question 20



- 19 The diagram shows a triangle ABC where A , B and C represent the positions of three towns.

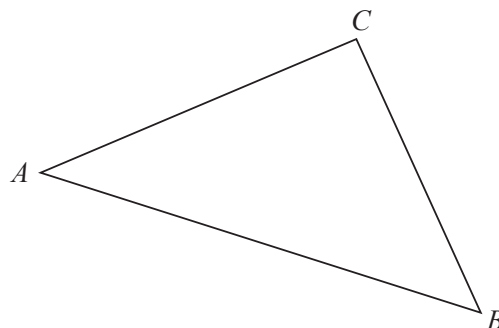


Diagram **NOT**
accurately drawn

$$\vec{AB} = \begin{pmatrix} 7 \\ -2 \end{pmatrix} \quad \vec{BC} = \begin{pmatrix} -3 \\ 5 \end{pmatrix}$$

Pru travels directly from A to B and then directly from B to C

Yang travels directly from A to C

Given that the values for $\vec{AB}$ and $\vec{BC}$ are in kilometres,

work out how much further Pru travels than Yang travels.

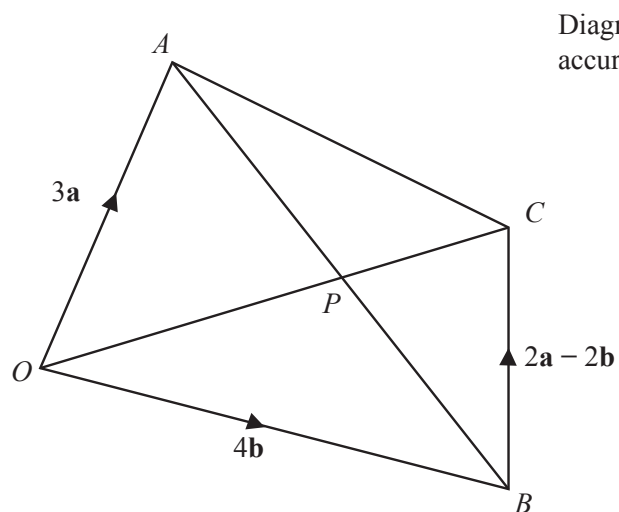
Give your answer in km, correct to one decimal place.

..... km

(Total for Question 19 is 5 marks)



22

Diagram **NOT**
accurately drawn $OACB$ is a quadrilateral.

$$\vec{OA} = 3\mathbf{a} \quad \vec{OB} = 4\mathbf{b} \quad \vec{BC} = 2\mathbf{a} - 2\mathbf{b}$$

- (a) (i) Find the vector $\vec{OC}$ in terms of $\mathbf{a}$ and $\mathbf{b}$
Simplify your answer.

$$\vec{OC} = \dots\dots\dots (1)$$

- (ii) Find the vector $\vec{AB}$ in terms of $\mathbf{a}$ and $\mathbf{b}$

$$\vec{AB} = \dots\dots\dots (1)$$



The point P lies on AB and on OC

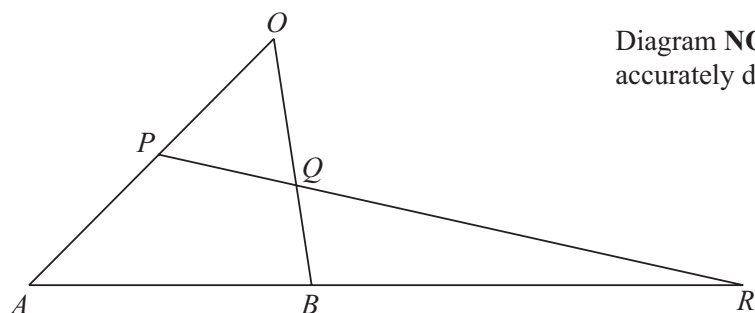
- (b) Using a vector method, find the ratio $AP : PB$
Show your working clearly.

.....
(3)

(Total for Question 22 is 5 marks)



23

Diagram **NOT**
accurately drawn OAB is a triangle. P is the midpoint of OA Q is a point on OB ABR and PQR are straight lines.

$$\vec{OA} = 12\mathbf{a} \quad \vec{OB} = 8\mathbf{b}$$

(a) Express $\vec{AB}$ in terms of $\mathbf{a}$ and $\mathbf{b}$

(1)

$$AB:BR = 1:2 \quad \vec{OQ} = n\mathbf{b}$$

(b) Use a vector method to find the value of n 

$n = \dots\dots\dots$
(4)

(Total for Question 23 is 5 marks)

Turn over for Question 24

23 OAB is a triangle.

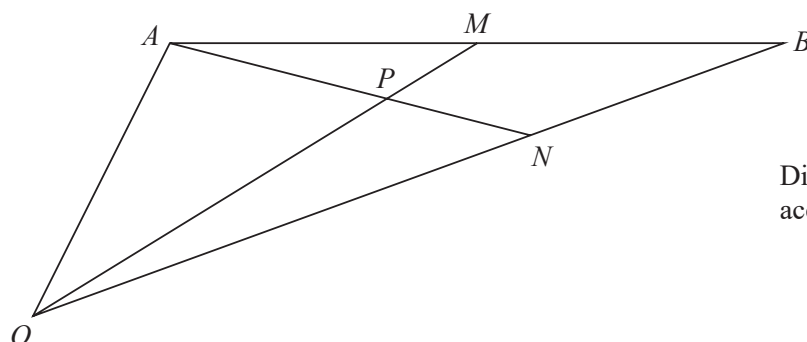


Diagram **NOT**
accurately drawn

$$\vec{OA} = 2\mathbf{a} \text{ and } \vec{OB} = 2\mathbf{b}$$

M is the midpoint of AB .

N is the point on OB such that $ON:NB = 2:1$

P is the point on AN such that OPM is a straight line.

Use a vector method to find $OP:PM$

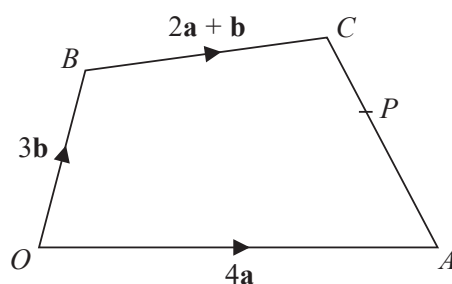
Show your working clearly.

(Total for Question 23 is 6 marks)

Turn over for Question 24



24

Diagram **NOT**
accurately drawn

The diagram shows a quadrilateral $OACB$ in which

$$\vec{OA} = 4\mathbf{a} \quad \vec{OB} = 3\mathbf{b} \quad \vec{BC} = 2\mathbf{a} + \mathbf{b}$$

- (a) Find $\vec{AC}$ in terms of $\mathbf{a}$ and $\mathbf{b}$
Give your answer in its simplest form.

$$\vec{AC} = \dots\dots\dots (2)$$



The point P lies on AC such that $AP:PC = 3:2$

The point Q is such that OPQ and BCQ are straight lines.

- (b) Using a vector method, find $\overrightarrow{OQ}$ in terms of $\mathbf{a}$ and $\mathbf{b}$
Give your answer in its simplest form.
Show your working clearly.

$$\overrightarrow{OQ} = \dots\dots\dots (4)$$

(Total for Question 24 is 6 marks)

Turn over for Question 25



25 $OPQR$ is a parallelogram.

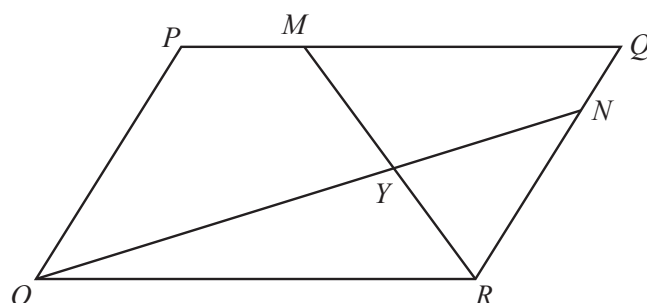


Diagram **NOT**
accurately drawn

$$\vec{OP} = 2\mathbf{a} \quad \text{and} \quad \vec{OR} = 3\mathbf{b}$$

The point M lies on PQ such that $PM = \frac{1}{4}PQ$

The point N lies on RQ such that $RN = \frac{4}{5}RQ$

(a) Find, in terms of $\mathbf{a}$ and $\mathbf{b}$, giving your answers in simplest form

(i) $\vec{ON}$

(1)

(ii) $\vec{MR}$

(1)

MR and ON intersect at the point Y

Given that

$$OY = k \times ON$$

(b) use a vector method to find the value of k

$$k = \dots\dots\dots (4)$$

(Total for Question 25 is 6 marks)

Turn over for Question 26



24 OAB is a triangle.

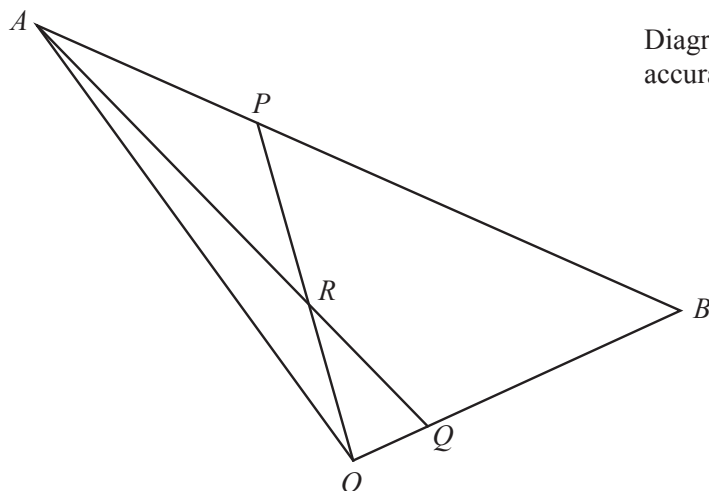


Diagram **NOT**
accurately drawn

$$\vec{OA} = 10\mathbf{a} \quad \vec{OB} = 10\mathbf{b}$$

ARQ and ORP are straight lines.

$$\vec{AP} = \frac{1}{4} \vec{AB} \quad \text{and} \quad \vec{OQ} = \frac{1}{5} \vec{OB}$$

Write the following vectors in terms of $\mathbf{a}$ and $\mathbf{b}$
Simplify your answers.

(i) $\vec{AQ}$

.....
(1)

(ii) $\vec{OP}$

.....
(1)



(iii) $\vec{OR}$

(4)

(Total for Question 24 is 6 marks)

Turn over for Question 25



14 $ABCDEF$ and $GHIJKL$ are regular hexagons each with centre O .

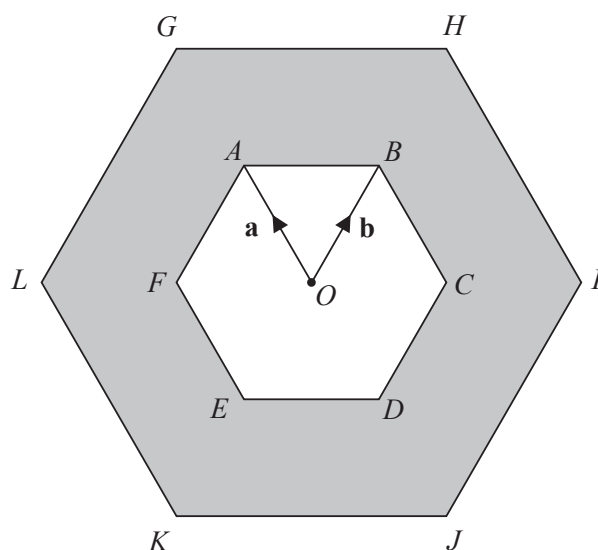


Diagram **NOT** accurately drawn

$GHIJKL$ is an enlargement of $ABCDEF$, with centre O and scale factor 2

$$\vec{OA} = \mathbf{a} \quad \vec{OB} = \mathbf{b}$$

(a) Write the following vectors, in terms of $\mathbf{a}$ and $\mathbf{b}$.
Simplify your answers.

(i) $\vec{AB}$

.....
(1)

(ii) $\vec{KI}$

.....
(2)

(iii) $\vec{LD}$

.....
(2)



The triangle OAB has an area of 5 cm^2

(b) Calculate the area of the shaded region.

..... cm^2
(3)

(Total for Question 14 is 8 marks)



MARK SCHEMES

official mark schemes, in the same order as the questions



10		Triangle with vertices (3, 6) (3, 9) (5, 6)	2	B2 for a fully correct shape with correct orientation and in the correct position. (B1 for a shape of correct size and orientation or 2 or 3 points plotted correctly)
				Total 2 marks

11	$(V =) \frac{1950}{7.8} (= 250) \text{ or } 7.8 = \frac{1950}{w \times 5 \times 4} \text{ or } 7.8 = \frac{1950}{w \times 20}$		3	M1 for correct method to find volume using mass $\div$ density or a correct equation with correct expression for volume (may be embedded in another calculation)
	eg $w = \frac{1950}{7.8 \times 5 \times 4}$ or $20w = \frac{1950}{7.8}$ or $20w = "250"$ or $4 \times 5 \times w = "250"$ OR eg $\frac{1950}{5 \times 4 \times 7.8}$ or $1950 \div (20 \times 7.8)$ or $1950 \div 156$ or $"250" \div 20$			M1 for a fully correct equation in w or a fully correct calculation to find the value of w (may be labelled eg x or L)
	Correct answer scores full marks (unless from obvious incorrect working)	12.5		A1
				Total 3 marks

2	$1 \times 5 + 3 \times 9 + 5 \times 24 + 7 \times 40 + 9 \times 7 (= 495)$ or $5 + 27 + 120 + 280 + 63 (= 495)$	5.8	4	M2 for at least 4 correct products added (need not be evaluated) If not M2 then award M1 for consistent use of value within interval (including end points) for at least 4 products which must be added OR correct mid-points used for at least 4 products and not added
	"495" $\div 85$			M1 dep on at least M1 Allow division by their $\sum f$ provided addition or total under column seen
				A1 for $5.8 - 5.824$
Total 4 marks				

3	(a)	Correct R (5,6), (3,6), (3,5)	2	B2 fully correct If not B2 then B1 for correct orientation of R but in wrong position
	(b)	Correct T (2,-1), (2,-3), (1,-3)	1	B1
Total 3 marks				

4	$675 \div (5 + 4) \times 5 (= 375)$	225	3	M1	M2 $675 \div (5 + 4) \times 3$
	"375" $\div 5 \times 3$			M1 dep M1	
				A1	
Total 3 marks					

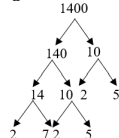
2	(a)		Triangle drawn at $(-1, -3) (-1, -4) (-3, -3)$	2	B2 for a correct triangle with correct orientation and position If not B2 then award B1 for a correct triangle drawn with correct orientation in wrong position or triangle drawn with 2 out of 3 correct vertices
	(b)		Triangle drawn at $(-4, 4) (-4, 5) (-2, 4)$	1	B1 cao
					Total 3 marks

3	(a)		$-3, -2, -1, 0, 1$	2	B2 for $-3, -2, -1, 0, 1$ If not B2 then award B1 for 4 correct values and no incorrect values (eg $-3, -2, -1, 0$) or for 6 values with no more than one incorrect value (eg $-4, -3, -2, -1, 0, 1$)
	(b)		$x > -1$	1	B1 accept $-1 < x$
					Total 3 marks



International GCSE Maths				
Apart from Questions 2, 6a, 17, 19, 21, 25 the correct answer, unless clearly obtained by an incorrect method, should be taken to imply a correct method				
Q	Working	Answer	Mark	Notes
1 (a)	enlargement, enlarge, enlarged	Enlargement	3	B1 for enlargement with no mention of translate, reflect, rotate, move, flip
	scale factor 3, SF 3, $\times 3$, factor of 3, 'three' times	Scale factor 3		B1 for (scale factor =) 3 with no mention of a vector, line of symmetry or angle
	allow (3, 0) 3, 0	Centre (3, 0)		B1 for (centre =) (3, 0)
(b)		Triangle drawn at (1, 4) (1, 6) (2, 4)	1	B1 condone missing label
				Total 4 marks



International GCSE Maths																		
Apart from Questions 1, 6a, 10, 18, 20, 22 and 25 the correct answer, unless clearly obtained by an incorrect method, should be taken to imply a correct method																		
Values in quotation marks must come from a correct method previously seen unless clearly stated otherwise.																		
Q	Working	Answer	Mark	Notes														
1	eg $2 \times 2 \times 350$ or $2 \times 7 \times 100$ or $2 \times 5 \times 140$ or $5 \times 7 \times 40$ or $5 \times 5 \times 56$ or $(14 \times 100 =) 2 \times 7 \times 100$ or $(28 \times 50 = 4 \times 7 \times 50 =) 2 \times 2 \times 7 \times 50 =$ or <table border="1"><tr><td>2</td><td>1400</td></tr><tr><td>2</td><td>700</td></tr><tr><td></td><td>350</td></tr></table>	2	1400	2	700		350		3	M1 for 2 correct stages in prime factorisation with 0 incorrect stages or at least 3 stages in prime factorisation with no more than 1 incorrect stage. Each stage gives 2 factors – may be in a factor tree or a table or listed eg 2, 2, 350 (see LHS for examples of the amount of work needed for the award of this mark). Example of 3 stages with 1 incorrect stage: stage: $1400 = 10 \times 14 = 2 \times 5 \times 2 \times 7$								
2	1400																	
2	700																	
	350																	
	eg 2, 2, 2, 5, 5, 7 <table border="1"><tr><td>eg</td><td></td></tr><tr><td>2</td><td>1400</td></tr><tr><td>2</td><td>700</td></tr><tr><td>5</td><td>350</td></tr><tr><td>2</td><td>70</td></tr><tr><td>5</td><td>35</td></tr><tr><td></td><td>7</td></tr></table> eg 	eg		2	1400	2	700	5	350	2	70	5	35		7			M1 dep on M1 for $2 \times 2 \times 2 \times 5 \times 5 \times 7$ or $2^3, 5^2, 7$ or $2^3 + 5^2 + 7$ (Ignore 1's) (may be seen in a fully correct factor tree or ladder)
eg																		
2	1400																	
2	700																	
5	350																	
2	70																	
5	35																	
	7																	
		$2^3 \times 5^2 \times 7$		A1 dep on M2 (do not allow 1 in the final answer) Can be in any order (allow $2^3 \cdot 5^2 \cdot 7$) but must be in index form as asked for.														
	Working required			Total 3 marks														

2	(a)	Allow translated translating translate Allow misspelling of the word eg translat	Translation	2	B1 for translation (with none of reflection, rotation, enlargement, mirrored, turned, move or flipped stated) NB Move with translation is acceptable
			$\begin{pmatrix} 3 \\ -5 \end{pmatrix}$		B1 for (vector $\Rightarrow$) $\begin{pmatrix} 3 \\ -5 \end{pmatrix}$
	(b)		Shape drawn at (-6, -1) (-4, -1) (-4, -2) (-5, -2)	2	B2 condone missing label If not B2 then B1 for a correct trapezium drawn with correct orientation in wrong position or 3 points plotted correctly)
					Total 4 marks

3		(x $\Rightarrow$ 11 (and) (y $\Rightarrow$ 14	2	B2 for x = 11 and y = 14 (B1 for x = 11 or y = 14) SC B1 for x = 14 and y = 11
				Total 2 marks



5	(a)		Vertices at (2, 5) (2, 8) (3, 6) (3, 7)	2	B2 for correct shape in correct position (B1 for correct orientation of shape but wrong position or for 3 out of 4 vertices correct or for $y = x$ drawn)
	(b)		Vertices at (5, 3) (5, 7) (7, 7) (9, 3)	2	B2 for correct shape in correct position (B1 for correct size and orientation of shape but wrong position or for 3 out of 4 vertices correct)
					Total 4 marks

6	(a)		1	1	B1 cao
	(b)	eg $(5^3 \div 5^3 =) 5^6$ or $(5^3, 5^{-2} =) 5^{11}$ or $(5^{-3}, 5^{-2} =) 5^{-1}$ or $(5^k \div 5^{-2} =) 5^{k+2}$ or $9 - 3 = k - 2$ oe or $9 - 3 = -2$ or $9 - 3 + 2$ <i>Correct answer scores full marks (unless from obvious incorrect working)</i>		2	M1 for one correct application of an index rule (must be seen in powers of 5) this could be after an initial mistake – working will need to be clearly seen or for forming a correct equation in the indices alone or for a complete method for the value of k
			8		A1 condone 5^8
	(c)		$8d^{12}e^{15}$	2	B2 for a correct answer (B1 for answer of the form $kd^m e^n$ where at least two of $k = 8, m = 12$ and $n = 15$ are correct)
					Total 5 marks



Question	Working	Answer	Mark	Notes
3 (a)	(4, 2), (4, 3), (5, 3), (5, 4), (6, 4), (6, 1), (5, 1), (5, 2)	Correct shape	2	B2 For the correct shape with all 8 points correct (B1 for the line $y = x$ drawn or a shape of the correct orientation and size anywhere on the grid)
(b)	Enlarged, enlarge etc	Enlargement	3	B1 With no mention of any other transformation words or turn, move, flip, transform, up, right etc
	3 or $\times 3$ or tripled or three or three times (not three times smaller)	(Scale factor) 3		B1 Allow $\times 3$ or 3 times bigger or tripled (do not allow -3)
	No need for 'centre' Do not allow a column vector for coordinates.	(Centre) (7, 2)		B1 Just coordinates needed – allow without brackets
				Total 5 marks

International GCSE Maths				
Values in quotation marks must come from a correct method previously seen unless clearly stated otherwise.				
Question	Working	Answer	Mark	Notes
1*		1 st card = 4	3	B1
		2 nd card = 6		B1 or a list of 6 numbers with a mode of 6
		4 th card = 9		B1
				SCB2 for 4, 6 and 9 in the incorrect order
Total 3 marks				

Question	Working	Answer	Mark	Notes	
2 (a)		Correct shape drawn in correct position	2	B2	Shape drawn with coordinates (3, 1), (9, 1), (9, 10), (6, 10), (6, 4), (3, 4) (B1 for a shape of the correct size but in the wrong position)
(b)	'Turn' is not sufficient	Rotation	3	B1	with no mention of any other transformation words or move, flip, transform, up, right etc
		180°		B1	allow 'half turn'
		(centre) (5, 5)		B1	must be a coordinate and not a vector
Total 5 marks					

Question	Working	Answer	Mark	Notes
2 (a)		Rotation, 90° clockwise, centre $(-2, 3)$	3	B1 for rotation B1 90° clockwise or -90° (or 270° anticlockwise) B1 (centre) $(-2, 3)$ Note: Do not accept $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$ for centre Award no marks is more than one transformation explicitly stated (the sight of a vector is not a second transformation) eg. moved and then rotated; rotation and translation
(b)		Triangle at $(-2, 2), (-2, 4), (-1, 4)$	1	B1 cao
(c)		Triangle at $(-2, 1), (-2, 3), (-1, 3)$	2	B2 If not B2 then award B1 for a triangle of the correct size and orientation or the wrong size but enlarged correctly from $(-4, 2)$ with a sf other than 0.5 e.g. a triangle at $(4, -2), (4, 6), (8, 6)$



3	(a) (i)		24, 30	1	B1	No repeats, omissions or extra values
	(ii)		21, 23, 25, 27, 29	1	B1	No repeats, omissions or extra values
	(b)		$(A \cup B)'$ or $A' \cap B'$	1	B1	or $(B \cup A)'$ or $B' \cap A'$
Total 3 marks						
4	(a)		$81k^8$	2	B2	B1 for 81 or k^8 seen in their final answer.
	(b)		$7m^4n^6$	2	B2	B1 for $7m^4$ or n^6 in a product with no other terms in m or n
Total 4 marks						
5	(a)	vertices at $(-9, 6)$ $(-9, 9)$ $(-3, 9)$ $(-6, 6)$	Shape in correct position	2	B2	B1 for congruent shape in correct orientation but wrong position or quadrilateral with 2 or 3 vertices correct.
	(b)	vertices at $(7, 3)$ $(10, 6)$ $(13, 6)$ $(13, 3)$	Shape in correct position	1	B1	
	(c)		enlargement scale factor 2 centre $(-3, 3)$	3	B1 B1 B1	for enlargement, enlarge, etc so long as no mention of rotation, reflection or translation, flip, move etc. SF 2, double, two times etc. $(-3, 3)$ stated. Accept about, from etc. with no mention of line, or column vector.
Total 6 marks						

4	(a)	eg $\begin{pmatrix} 6 & -7 \\ 12 & -2 \end{pmatrix} \begin{bmatrix} 13 \\ 10 \end{bmatrix}$ or $\begin{pmatrix} -7 & -6 \\ 2 & -12 \end{pmatrix} \begin{bmatrix} -13 \\ -10 \end{bmatrix}$		3	M1 with or without brackets, allow 13 right and 10 up or (13, 10) or 13 left and 10 down or (-13, -10) or for one of $-5 + 10 (= 5)$ or $-3 + 10 (= 7)$ or $9 - 13 (= -4)$
					M1 for two of $-5 + 10 (= 5)$ or $-3 + 10 (= 7)$ or $9 - 13 (= -4)$
		Correct answer scores full marks (unless from obvious incorrect working)	$d = 5, e = 7,$ $f = -4$		A1
	(b)		Enlargement	3	B1 with no mention of any other transformation or words such as move, flip, shift
			Scale factor 3		B1 with no mention of a vector, angle of rotation or line of symmetry
			Centre (0, 2)		B1
	(c)		Correct shape with coordinates (0, 5), (1, 6), (3, 6), (1, 5)	2	B2 B1 for a correct shape with the correct orientation in the incorrect position or for 3 out of 4 vertices correct or for a correct rotation of 90° anticlockwise about (3, 5)
					Total 8 marks

13	e.g. $\begin{pmatrix} 5 \\ 3 \end{pmatrix} - \begin{pmatrix} -2 \\ 4 \end{pmatrix}$ or $\begin{pmatrix} 5 \\ 3 \end{pmatrix} + \begin{pmatrix} 2 \\ -4 \end{pmatrix}$		2	M1 or for $\begin{pmatrix} 7 \\ a \end{pmatrix}$ where $a \neq -1$ or $\begin{pmatrix} b \\ -1 \end{pmatrix}$ where $b \neq 7$
		$\begin{pmatrix} 7 \\ -1 \end{pmatrix}$		A1
				Total 2 marks

14	$BFD = 39^\circ$	$BED = 39^\circ$		4	B1
	$BDE = 180 - (18 + 39)$	$EBD = 18^\circ$ and $BDE = 180 - (18 + 39)$			M1
			123		A1
					B1 dep on M1 for all correct circle theorems relevant for their method e.g. <u>alternate segment theorem and opposite angles</u> in a <u>cyclic quadrilateral</u> sum to 180° or <u>alternate segment theorem and angles in same segment</u> are equal
					Total 4 marks



16	eg $-\begin{pmatrix} -5 \\ 4 \end{pmatrix} + \begin{pmatrix} 9 \\ 1 \end{pmatrix}$ or $\begin{pmatrix} 5 \\ -4 \end{pmatrix} + \begin{pmatrix} 9 \\ 1 \end{pmatrix}$ or $\begin{pmatrix} 14 \\ a \end{pmatrix}$ $a \neq -3$ or $\begin{pmatrix} b \\ -3 \end{pmatrix}$ $b \neq 14$		2	M1 or an answer of $\begin{pmatrix} -14 \\ 3 \end{pmatrix}$
	Correct answer scores full marks (unless from obvious incorrect working)	$\begin{pmatrix} 14 \\ -3 \end{pmatrix}$		A1
				Total 2 marks



14					M2 for $\sqrt{5^2 + (-12)^2}$ or $\sqrt{(-5)^2 + 12^2}$ or $\sqrt{5^2 + 12^2}$ If not M2 then M1 for $\begin{pmatrix} 6 \\ -9 \end{pmatrix} - \begin{pmatrix} 1 \\ 3 \end{pmatrix}$ or $\begin{pmatrix} 6 \\ -9 \end{pmatrix} + \begin{pmatrix} -1 \\ -3 \end{pmatrix} (= \begin{pmatrix} 5 \\ -12 \end{pmatrix})$ or or $\begin{pmatrix} 1 \\ 3 \end{pmatrix} - \begin{pmatrix} 6 \\ -9 \end{pmatrix}$ or $\begin{pmatrix} 1 \\ 3 \end{pmatrix} + \begin{pmatrix} -6 \\ 9 \end{pmatrix} (= \begin{pmatrix} -5 \\ 12 \end{pmatrix})$
			13	3	A1
Total 3 marks					

15		$y^2 = \frac{3x-2}{x+1}$			M1 squaring both sides to get a correct equation
		$xy^2 + y^2 = 3x - 2$ oe			M1 for multiplying by the denominator and expanding the bracket
		$y^2 + 2 = x(3 - y^2)$ oe			M1 for isolating terms in x and factorising the correct expression of the equation
			$x = \frac{2+y^2}{3-y^2}$	4	A1 accept $x = \frac{-2-y^2}{y^2-3}$ oe
Total 4 marks					



23	$\overrightarrow{PM} = -\frac{3}{2}\mathbf{a} - \frac{3}{4}\mathbf{b} + 4\mathbf{a} + \frac{1}{2}(2\mathbf{b} - 4\mathbf{a}) \left(= \frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b} \right)$ $\overrightarrow{AM} = 4\mathbf{a} + \frac{1}{2}(2\mathbf{b} - 4\mathbf{a}) (= 2\mathbf{a} + \mathbf{b})$ $\overrightarrow{AM} = 2\mathbf{b} + \frac{1}{2}(4\mathbf{a} - 2\mathbf{b}) (= 2\mathbf{a} + \mathbf{b})$ $\overrightarrow{MA} = \frac{1}{2}(2\mathbf{b} - 4\mathbf{a}) - 2\mathbf{b} (= -2\mathbf{a} - \mathbf{b})$ $\overrightarrow{MA} = \frac{1}{2}(4\mathbf{a} - 2\mathbf{b}) - 4\mathbf{a} (= -2\mathbf{a} - \mathbf{b})$		3	M1 for finding $\overrightarrow{PM}$ or $\overrightarrow{AM}$ or $\overrightarrow{MA}$
	$(AP : PM) = \left \frac{3}{2}\mathbf{a} + \frac{3}{4}\mathbf{b} \right : \left \frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b} \right \text{ oe}$ $(AP : AM) = \left \frac{3}{2}\mathbf{a} + \frac{3}{4}\mathbf{b} \right : 2\mathbf{a} + \mathbf{b} (= 3 : 4) \text{ oe}$ $(AM : PM) = 2\mathbf{a} + \mathbf{b} : \left \frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b} \right (= 4 : 1) \text{ oe}$ $AP = 3PM \text{ oe eg } \frac{3}{2}\mathbf{a} + \frac{3}{4}\mathbf{b} = 3\left(\frac{1}{2}\mathbf{a} + \frac{1}{4}\mathbf{b}\right) \text{ oe}$ $AM = \frac{4}{3}AP \text{ oe}$ $AM = 4PM \text{ oe}$			M1 For use of a correct ratio or fraction linking AP and PM or AP and AM or AM and PM (in either order) vectors must be in form $p\mathbf{a} + q\mathbf{b}$
		3 : 1		A1
				Total 3 marks

19	$\overrightarrow{AB} = -\mathbf{a} + \mathbf{b}$ or $\overrightarrow{BA} = \mathbf{a} - \mathbf{b}$			M1	Correct diagram (condone missing vector labels or arrows – with C on line segment OA and D on line segment OB) OR for finding $\overrightarrow{AB}$ or $\overrightarrow{BA}$ - may be seen as part of later working
	$\overrightarrow{CD} = \frac{1}{3}(-\mathbf{a} + \mathbf{b})$ or $\overrightarrow{DC} = \frac{1}{3}(\mathbf{a} - \mathbf{b})$ oe			M1	Method to find $\overrightarrow{CD}$ or $\overrightarrow{DC}$
		Correct vectors and conclusion including <u>parallel</u> and <u>trapezium</u>	3	A1	eg $\overrightarrow{AB}$ (AB) and $\overrightarrow{CD}$ (CD) are parallel therefore $ABDC$ is a trapezium
Total 3 marks					

17	$(\overrightarrow{HF}) = \begin{pmatrix} 4 \\ 14 \end{pmatrix} + \begin{pmatrix} 5 \\ -2 \end{pmatrix} = \begin{pmatrix} 9 \\ 12 \end{pmatrix}$ or $\begin{pmatrix} 4 \\ 14 \end{pmatrix} - \begin{pmatrix} -5 \\ 2 \end{pmatrix} = \begin{pmatrix} 9 \\ 12 \end{pmatrix}$ oe $(\overrightarrow{FH}) = \begin{pmatrix} -5 \\ 2 \end{pmatrix} + \begin{pmatrix} -4 \\ -14 \end{pmatrix} = \begin{pmatrix} -9 \\ -12 \end{pmatrix}$ or $\begin{pmatrix} -5 \\ 2 \end{pmatrix} - \begin{pmatrix} 4 \\ 14 \end{pmatrix} = \begin{pmatrix} -9 \\ -12 \end{pmatrix}$ oe		3	M1 a correct calculation for $\overrightarrow{HF}$ or $\overrightarrow{FH}$ (for this mark allow written as coordinates) Also allow eg $9\mathbf{i} + 12\mathbf{j}$
	$\sqrt{{}^n9{}^{n2} + {}^{n12}{}^{n2}}$ or $\sqrt{({}^n-9{}^n)^2 + ({}^n-12{}^n)^2}$ Allow a complete method using their values for $\overrightarrow{HF}$ or $\overrightarrow{FH}$ Provided it is from $\begin{pmatrix} \pm 4 \\ \pm 14 \end{pmatrix} - \begin{pmatrix} \pm 5 \\ \pm 2 \end{pmatrix}$			M1indep Allow their $\overrightarrow{HF}$ or $\overrightarrow{FH}$ provided it is from $\begin{pmatrix} \pm 4 \\ \pm 14 \end{pmatrix} - \begin{pmatrix} \pm 5 \\ \pm 2 \end{pmatrix}$ allowing any sign error if used $(-9)^2$ and $(-12)^2$ condone missing brackets if recovered
	Correct answer scores full marks (unless from obvious incorrect working) Watch out for a correct answer from wrong working eg $-5 + 2 + 4 + 14 = 15$	15		A1 from fully correct figures eg use of $\begin{pmatrix} 9 \\ -12 \end{pmatrix}$ would give the correct answer but would not gain this accuracy mark
Total 3 marks				



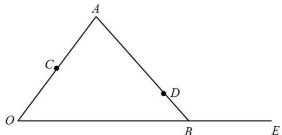
18	(a)		$-4\mathbf{a} + 4\mathbf{b}$	1	B1 oe eg $4(\mathbf{b} - \mathbf{a})$
	(b)	$4\mathbf{a} + \frac{1}{4}(-4\mathbf{a} + 4\mathbf{b})$ oe or $4\mathbf{a} + \frac{1}{4}[\overline{AB}]$ or $4\mathbf{b} - \frac{3}{4}(-4\mathbf{a} + 4\mathbf{b})$ oe or $4\mathbf{b} - \frac{3}{4}[\overline{AB}]$		2	M1ft for a correct expression ft their (a) where $[\overline{AB}]$ is their answer to (a) of the form $m\mathbf{a} + n\mathbf{b}$, $m, n \neq 0$
		Correct answer only scores full marks (unless from obviously incorrect working)	$3\mathbf{a} + \mathbf{b}$		A1 allow $\mathbf{b} + 3\mathbf{a}$
Total 3 marks					

19	(a)		$-\frac{1}{2}$	1	B1 oe Accept $x = -\frac{1}{2}$, accept $x \neq -\frac{1}{2}$ Do not allow inequalities, eg $x > -\frac{1}{2}$ or $x \leq -\frac{1}{2}$
	(b)	$\frac{3x - 4}{2(3x - 4) + 1}$		2	M1 for a correct unsimplified expression for gf(x)
		Correct answer only scores full marks (unless from obviously incorrect working)	$\frac{3x - 4}{6x - 7}$		A1 oe eg $\frac{4 - 3x}{7 - 6x}$ Correct answer seen followed by incorrect subsequent working scores M1A0
Total 3 marks					

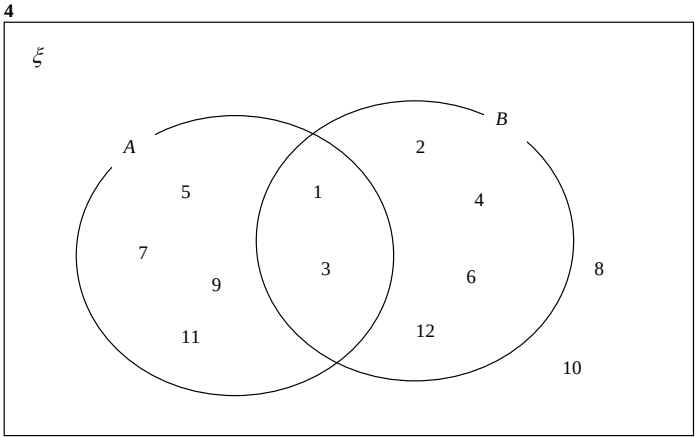
Question	Working	Answer	Mark	Notes
22	$\overrightarrow{EX} = \overrightarrow{ED} + \overrightarrow{DC} + \overrightarrow{CX}$ or $\overrightarrow{EX} = \overrightarrow{EF} + \overrightarrow{FA} + \overrightarrow{AX}$ $\overrightarrow{DC} = -\mathbf{b} + \mathbf{a}$ or $\overrightarrow{CX} = -\mathbf{b} + \mathbf{a}$ or $\overrightarrow{FA} = -\mathbf{b} + \mathbf{a}$ $\overrightarrow{EX} = \mathbf{a} + 2(-\mathbf{b} + \mathbf{a})$	$3\mathbf{a} - 2\mathbf{b}$	4	M1 a correct statement for $\overrightarrow{EX}$ M1 M1 for a complete method which gives a correct but unsimplified expression for $\overrightarrow{EX}$ A1

Question	Working	Answer	Mark	Notes
17 a	$\begin{pmatrix} \overrightarrow{BC} \end{pmatrix} = \begin{pmatrix} -2 \\ -7 \end{pmatrix} + \begin{pmatrix} 10 \\ 11 \end{pmatrix} = \begin{pmatrix} 8 \\ 4 \end{pmatrix}$ $\begin{pmatrix} 5 \\ 8 \end{pmatrix} + \begin{pmatrix} 8 \\ 4 \end{pmatrix} \text{ or } \begin{pmatrix} 10 \\ 11 \end{pmatrix} + \begin{pmatrix} 3 \\ 1 \end{pmatrix}$	(13, 12)	3	M1 or coordinates (5 – 2, 8 – 7) (= (3, 1)) assigned to A (may be seen in vector form) or (13, y) or (x, 12) given as coordinates for C M1 for coordinates (5 – 2 + 10, 8 – 7 + 11) assigned to C A1
b	e.g. $\begin{pmatrix} 63 \\ 211 \end{pmatrix} - \begin{pmatrix} 5 \\ 8 \end{pmatrix} = \begin{pmatrix} 58 \\ 203 \end{pmatrix}$ with e.g. “58” ÷ 2 (=29) and “203” ÷ 7 (=29) OR e.g. $\begin{pmatrix} 63 \\ 211 \end{pmatrix} - \begin{pmatrix} 3 \\ 1 \end{pmatrix} = \begin{pmatrix} 60 \\ 210 \end{pmatrix}$ with e.g. “60” ÷ 2 (=30) and “210” ÷ 7 (=30)	Proof	2	M1 may work with A and E, in which case may need to ft for method mark from (a) A1 proof with justification eg. $\overrightarrow{BE} = 29 \begin{pmatrix} 2 \\ 7 \end{pmatrix}$ (or $\overrightarrow{AE} = 30 \begin{pmatrix} 2 \\ 7 \end{pmatrix}$) with ABE is a straight line or 210 ÷ 60 = 3.5 and 7 ÷ 2 = 3.5 so ABE is a straight line

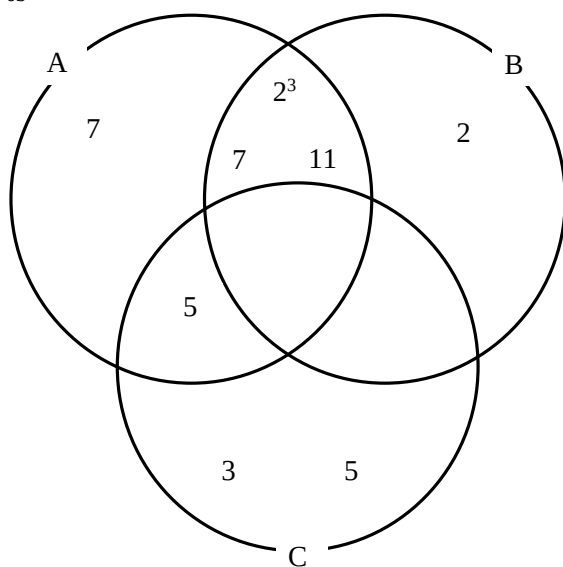


Question	Working	Answer	Mark	Notes
23	 $\overrightarrow{AB} = \mathbf{b} - \mathbf{a} \text{ or } \overrightarrow{BA} = \mathbf{a} - \mathbf{b}$		5	M1 Correct diagram (only points needed, condone missing vector labels) OR for finding $\overrightarrow{AB}$ or $\overrightarrow{BA}$ - may be seen as part of later working
	$\overrightarrow{AD} = \frac{3}{4}(\mathbf{b} - \mathbf{a}) \text{ or } \overrightarrow{DA} = \frac{3}{4}(\mathbf{a} - \mathbf{b})$ $\text{or } \overrightarrow{DB} = \frac{1}{4}(\mathbf{b} - \mathbf{a}) \text{ or } \overrightarrow{BD} = \frac{1}{4}(\mathbf{a} - \mathbf{b})$			M1 method to find $\overrightarrow{AD}$ or $\overrightarrow{DA}$ or $\overrightarrow{DB}$ or $\overrightarrow{BD}$ - may be seen as part of later working
	$\overrightarrow{CD} = \frac{1}{2}\mathbf{a} + \frac{3}{4}(\mathbf{b} - \mathbf{a}) (= \frac{3}{4}\mathbf{b} - \frac{1}{4}\mathbf{a})$ $\text{or } \overrightarrow{DE} = \frac{1}{4}(\mathbf{b} - \mathbf{a}) + \frac{1}{2}\mathbf{b} (= \frac{3}{4}\mathbf{b} - \frac{1}{4}\mathbf{a})$ $\text{or } \overrightarrow{CE} = -\frac{1}{2}\mathbf{a} + \mathbf{b} + \frac{1}{2}\mathbf{b} (= \frac{3}{2}\mathbf{b} - \frac{1}{2}\mathbf{a})$			M1 oe, method to find $\overrightarrow{CD}$ or $\overrightarrow{DE}$ or $\overrightarrow{CE}$
				M1 A correct vector expression in terms of $\mathbf{a}$ and $\mathbf{b}$ for two of $\overrightarrow{CD}$, $\overrightarrow{DE}$, $\overrightarrow{CE}$
				A1 A correct conclusion eg $\overrightarrow{CD} = \overrightarrow{DE}$ so CDE is a straight line $\overrightarrow{CE} = 2\overrightarrow{CD}$ so CDE is a straight line $\overrightarrow{CE} = 2\overrightarrow{DE}$ so CDE is a straight line
		Correct simplified vectors for two of $\overrightarrow{CD}$, $\overrightarrow{DE}$, $\overrightarrow{CE}$ with a correct explanation		Total 5 marks

Question	Working	Answer	Mark	Notes
23	e.g. $\overrightarrow{AB} = \overrightarrow{AD} + \overrightarrow{DB}$ or $\begin{pmatrix} 2 \\ -3 \end{pmatrix} + \begin{pmatrix} -1 \\ 7 \end{pmatrix}$ $\overrightarrow{AB} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$ $\overrightarrow{DC} = 3 \times \begin{pmatrix} 1 \\ 4 \end{pmatrix} = \begin{pmatrix} 3 \\ 12 \end{pmatrix}$ $\overrightarrow{BC} = \begin{pmatrix} 1 \\ -7 \end{pmatrix} + \begin{pmatrix} 3 \\ 12 \end{pmatrix} = \begin{pmatrix} 4 \\ 5 \end{pmatrix}$ oe or $\overrightarrow{BC} = \begin{pmatrix} -1 \\ -4 \end{pmatrix} + \begin{pmatrix} 2 \\ -3 \end{pmatrix} + \begin{pmatrix} 3 \\ 12 \end{pmatrix} = \begin{pmatrix} 4 \\ 5 \end{pmatrix}$ oe	$\sqrt{41}$ cao	5	M1 for a correct vector equation for $\overrightarrow{AB}$ A1 M1 M1 A1 No isw



6b



24	$\overrightarrow{AP} = \frac{3}{4} \times 2\mathbf{c} (= \frac{3}{2}\mathbf{c})$ oe		5	M1 For $\overrightarrow{AP} = \frac{3}{2}\mathbf{c}$ oe, eg could be part of $\overrightarrow{OP} = \mathbf{a} + \frac{3}{2}\mathbf{c}$ oe or on diagram
	$\overrightarrow{AC} = \mathbf{c} - \mathbf{a}$ oe or $\overrightarrow{CA} = \mathbf{a} - \mathbf{c}$ oe			M1
	$\overrightarrow{OQ} = \mathbf{c} + n(\mathbf{a} - \mathbf{c})$ or $\overrightarrow{OQ} = \mathbf{a} + n(\mathbf{c} - \mathbf{a})$ or $\overrightarrow{QP} = n(\mathbf{a} - \mathbf{c}) + \frac{3}{2}\mathbf{c}$			M1
	$\frac{n}{1-n} = \frac{2}{3} \Rightarrow n = \frac{2}{5}$ oe or $\frac{1-n}{n} = \frac{2}{3} \Rightarrow n = \frac{3}{5}$ oe or $\frac{n}{\frac{3}{2}-n} = \frac{2}{3} \Rightarrow n = \frac{3}{5}$ oe			M1
		3 : 2		A1 oe, dep on M3
				Total 5 marks



Question	Working	Answer	Mark	Notes
26	$OC = 3\mathbf{a} + 4\mathbf{b}$		5	B1 Correct expression for OC
	$ON = t(3\mathbf{a} + 4\mathbf{b})$			M1 Correct expressions for ON
	$ON = 3\mathbf{a} + s(-3\mathbf{a} + 6\mathbf{b})$			M1
	$t(3\mathbf{a} + 4\mathbf{b}) = 3\mathbf{a} + s(-3\mathbf{a} + 6\mathbf{b})$ $\rightarrow t = 0.6, s = 0.4$			A1 t or s value correct
		$ON = 1.8\mathbf{a} + 2.4\mathbf{b}$ oe		A1 e.g. $ON = \frac{3}{5}(3\mathbf{a} + 4\mathbf{b})$
	Alt:			
	$AB = -3\mathbf{a} + 6\mathbf{b}$			B1 Correct expression for AB
	$AN = s(-3\mathbf{a} + 6\mathbf{b})$			M1
	$AN = -3\mathbf{a} + t(3\mathbf{a} + 4\mathbf{b})$			M1 Correct expressions for AN
	$-3\mathbf{a} + t(3\mathbf{a} + 4\mathbf{b}) = s(-3\mathbf{a} + 6\mathbf{b})$ $\rightarrow t = 0.6, s = 0.4 \rightarrow AN = -1.2\mathbf{a} + 2.4\mathbf{b}$ $ON = 3\mathbf{a} + AN$			A1 t or s value correct
		$ON = 1.8\mathbf{a} + 2.4\mathbf{b}$ oe		A1 e.g. $ON = \frac{3}{5}(3\mathbf{a} + 4\mathbf{b})$
	Alt:			
	$OC = 3\mathbf{a} + 4\mathbf{b}$			B1 Correct expression for OC
	$ON : NC = 6 : 4$ (i.e 3:2)			M1
	$ON = \frac{3}{5} OC$			M2
		$ON = 1.8\mathbf{a} + 2.4\mathbf{b}$ oe		A1 e.g. $ON = \frac{3}{5}(3\mathbf{a} + 4\mathbf{b})$
				Total 5 marks
				Total: 100 marks



25	$AB = 2b - 2a$ or $BA = 2a - 2b$ $MN = 10a - b$ or $NM = -10a + b$		5	M1 for finding AB or BA or MN or NM
	eg $MP = -b + 2a + k(2b - 2a)$ and $MP = l(10a - b)$ or eg $MP = b + k(2a - 2b)$ and $MP = l(10a - b)$ or eg $PN = 8a + k(2a - 2b)$ and $PN = l(10a - b)$ or eg $AP = 8a + k(b - 10a)$ and $AP = l(2b - 2a)$ or eg $AP = -2a + b + k(10a - b)$ and $AP = l(2b - 2a)$ or eg $AM = k(2b - 2a) + l(b - 10a)$ and $AM = -2a + b$			M2 for writing eg MP or PN or AP or AM in two different ways in terms of a and b (M1 for writing eg MP or PN or AP or AM in one way) These may be written as eg PM in place of MP
	eg $2 - 2k = 10\lambda$ and $-1 + k = -\lambda$ (from MP 1st) or eg $2k = 10\lambda$ and $1 - 2k = -\lambda$ (from MP 2nd) or eg $8 + 2k = 10\lambda$ and $-2k = -\lambda$ (from PN) or eg $8 - 10k = -2\lambda$ and $k = 2\lambda$ (from AP 1st) or eg $-2 + 10k = -2\lambda$ and $1 - k = 2\lambda$ (from AP 2nd) or eg $-2k - 10\lambda = -2$ and $2k + \lambda = 1$ (from AM)			M1 dep M3 for writing a pair of equations using their variables. MP (1st) leads to $\lambda = \frac{1}{9}, k = \frac{4}{9}$ MP (2nd) leads to $\lambda = \frac{1}{9}, k = \frac{5}{9}$ PN leads to $\lambda = \frac{8}{9}, k = \frac{4}{9}$ AP (1st) leads to $\lambda = \frac{4}{9}, k = \frac{8}{9}$ AP (2nd) leads to $\lambda = \frac{4}{9}, k = \frac{1}{9}$ AM leads to $\lambda = \frac{1}{9}, k = \frac{4}{9}$
		4 : 5		A1 cao
Total 5 marks				

26		eg $\overrightarrow{OP} = n(2\mathbf{a} + 3\mathbf{b})$ or $\overrightarrow{OP} = 2\mathbf{a} + m(5\mathbf{b} - 2\mathbf{a})$ or $\overrightarrow{OP} = 5\mathbf{b} + x(2\mathbf{a} - 5\mathbf{b})$		5	M1 for a vector equation for $\overrightarrow{OP}$
		eg $\overrightarrow{OP} = n(2\mathbf{a} + 3\mathbf{b})$ and $\overrightarrow{OP} = 2\mathbf{a} + m(5\mathbf{b} - 2\mathbf{a})$ or eg $\overrightarrow{OP} = n(2\mathbf{a} + 3\mathbf{b})$ and $\overrightarrow{OP} = 5\mathbf{b} + x(2\mathbf{a} - 5\mathbf{b})$ oe			M1 2 vector equations for $\overrightarrow{OP}$ that can be used to find $\overrightarrow{OP}$ - must be in terms of $\mathbf{a}$ and $\mathbf{b}$ and a scalar
		eg $5m = 3n$ or $m = \frac{3}{5}n$ or $2n = 2 - 2m$ or $n = 1 - m$ oe and $2 - 2 \times \frac{3}{5}n = 2n$ or $2 \times \frac{5}{3}m = 2 - 2m$ oe or eg $2n = 2x$ or $n = x$ or $3n = 5 - 5x$ oe and $3x = 5 - 5x$ or $3n = 5 - 5n$ oe			M1 Writing one equation in terms of only one scalar eg one of n or m or x etc
		eg $m = \frac{3}{8}$ or $n = \frac{5}{8}$ or $x = \frac{5}{8}$ oe			M1 for a correct value for one scalar
		Working is required	$\frac{5}{4}\mathbf{a} + \frac{15}{8}\mathbf{b}$		A1 oe (dep on M1) but terms in $\mathbf{a}$ and terms in $\mathbf{b}$ should be simplified. eg $\frac{1}{8}(10\mathbf{a} + 15\mathbf{b})$ or $\frac{5}{8}(2\mathbf{a} + 3\mathbf{b})$ etc
					Total 5 marks
		Alternative method as a vector method not requested			
		eg $\overrightarrow{OP} = n(2\mathbf{a} + 3\mathbf{b})$		5	M1 for a vector equation for $\overrightarrow{OP}$

		eg $CP : OP = 3 : 5$ or $CP : CO = 3 : 8$ or $\frac{CP}{OP} = \frac{3}{5}$ or $\frac{CP}{CO} = \frac{3}{8}$ oe		M2	for a correct ratio for two sides in triangle ACP and triangle BOP that help to find $\vec{OP}$ as a fraction of $\vec{OC}$ (could be seen on the diagram)
		$\vec{OP} = \frac{5}{8}\vec{OC}$ or $n = \frac{5}{8}$		M1	
		Working is required	$\frac{5}{4}\mathbf{a} + \frac{15}{8}\mathbf{b}$	A1	oe (dep on M1) but terms in $\mathbf{a}$ and terms in $\mathbf{b}$ should be simplified. eg $\frac{1}{8}(10\mathbf{a} + 15\mathbf{b})$ or $\frac{5}{8}(2\mathbf{a} + 3\mathbf{b})$ etc
					Total 5 marks

22	eg $\overrightarrow{ON} = 8\mathbf{a} + \frac{1}{2}(6\mathbf{b} - 8\mathbf{a}) (= 3\mathbf{b} + 4\mathbf{a})$ or $\overrightarrow{ON} = 6\mathbf{b} + \frac{1}{2}(-6\mathbf{b} + 8\mathbf{a}) (= 3\mathbf{b} + 4\mathbf{a})$ or $\overrightarrow{NO} = \frac{1}{2}(8\mathbf{a} - 6\mathbf{b}) - 8\mathbf{a} (= -4\mathbf{a} - 3\mathbf{b})$ or $\overrightarrow{NO} = -6\mathbf{b} + \frac{1}{2}(6\mathbf{b} - 8\mathbf{a}) (= -3\mathbf{b} - 4\mathbf{a})$ or $\overrightarrow{AM} = -8\mathbf{a} + \frac{1}{3}(6\mathbf{b}) (= 2\mathbf{b} - 8\mathbf{a})$ or $\overrightarrow{AM} = -8\mathbf{a} + 6\mathbf{b} - \frac{2}{3}(6\mathbf{b}) (= 2\mathbf{b} - 8\mathbf{a})$ or $\overrightarrow{MA} = 8\mathbf{a} - \frac{1}{3}(6\mathbf{b}) (= 8\mathbf{a} - 2\mathbf{b})$ or $\overrightarrow{MA} = \frac{2}{3}(6\mathbf{b}) + 8\mathbf{a} - 6\mathbf{b} (= 8\mathbf{a} - 2\mathbf{b})$		5	M1 a correct expression for $\overrightarrow{ON}$ or $\overrightarrow{NO}$ or $\overrightarrow{AM}$ or $\overrightarrow{MA}$
	$\overrightarrow{OP} = \mu(3\mathbf{b} + 4\mathbf{a})$ and one of eg $\overrightarrow{OP} = 8\mathbf{a} + \lambda(2\mathbf{b} - 8\mathbf{a}) (= (8 - 8\lambda)\mathbf{a} + 2\lambda\mathbf{b})$ or $\overrightarrow{OP} = 2\mathbf{b} + \gamma(8\mathbf{a} - 2\mathbf{b}) (= (2 - 2\gamma)\mathbf{b} + 8\gamma\mathbf{a})$			M2 oe (M1 for one correct expression for $\overrightarrow{OP}$) (where μ, λ, γ are scalars)
	eg $\frac{4}{3} = \frac{8\gamma}{2 - 2\gamma}$ or $\frac{4}{3} = \frac{8 - 8\lambda}{2\lambda}$ oe or $3\mu = 2\lambda$ and $4\mu = 8 - 8\lambda$ or $3\mu = 2 - 2\gamma$ and $4\mu = 8\gamma$			M1 A correct expression to find the position of P along ON or two correct simultaneous equations coming from the expressions for $\overrightarrow{OP}$
		$2\mathbf{a} + \frac{3}{2}\mathbf{b}$		A1 dep on M3, oe eg $2\mathbf{a} + 1.5\mathbf{b}$
Total 5 marks				

23	(i)		(-4, 7)	1	B1
	(ii)		(5, 10)	1	B1
Total 2 marks					



24	$(\overrightarrow{ON} \Rightarrow) \lambda(\mathbf{a} + \mathbf{b}) (= \lambda\mathbf{a} + \lambda\mathbf{b})$ or $(\overrightarrow{NY} \Rightarrow) (1 - \lambda)(\mathbf{a} + \mathbf{b}) (= (1 - \lambda)\mathbf{a} + (1 - \lambda)\mathbf{b})$		5	M1 for finding a vector for $\overrightarrow{ON}$ or $\overrightarrow{NY}$ or $\overrightarrow{NO}$ or $\overrightarrow{YN}$ in terms $\mathbf{a}$ and $\mathbf{b}$ and using λ oe (can be embedded)
	$(\overrightarrow{MN} = \overrightarrow{MO} + \overrightarrow{ON} \Rightarrow) -0.5\mathbf{a} + \lambda\mathbf{a} + \lambda\mathbf{b} (= (\lambda - 0.5)\mathbf{a} + \lambda\mathbf{b})$ or $(\overrightarrow{MZ} = \overrightarrow{MO} + \overrightarrow{OZ} \Rightarrow) -0.5\mathbf{a} + 3\mathbf{b}$ or $(\overrightarrow{MN} = \overrightarrow{MX} + \overrightarrow{XY} + \overrightarrow{YN} \Rightarrow) 0.5\mathbf{a} + \mathbf{b} + (\lambda - 1)(\mathbf{a} + \mathbf{b}) (= (\lambda - 0.5)\mathbf{a} + \lambda\mathbf{b})$			M1 for finding a vector for $\overrightarrow{MN}$ or $\overrightarrow{NM}$ or $\overrightarrow{MZ}$ or $\overrightarrow{ZM}$
	$(\overrightarrow{MN} = \mu\overrightarrow{MZ} \Rightarrow) \mu(-0.5\mathbf{a} + 3\mathbf{b}) (= -0.5\mu\mathbf{a} + 3\mu\mathbf{b})$ or $(\overrightarrow{ON} = \overrightarrow{OM} + \overrightarrow{MN} \Rightarrow) 0.5\mathbf{a} + \mu(-0.5\mathbf{a} + 3\mathbf{b}) (= (0.5 - 0.5\mu)\mathbf{a} + 3\mu\mathbf{b})$ or $(\overrightarrow{NY} = \overrightarrow{NM} + \overrightarrow{MX} + \overrightarrow{XY} \Rightarrow) -\mu(-0.5\mathbf{a} + 3\mathbf{b}) + 0.5\mathbf{a} + \mathbf{b} (= (0.5 + 0.5\mu)\mathbf{a} + (1 - 3\mu)\mathbf{b})$			M1 for finding a vector for $\overrightarrow{MN}$ or $\overrightarrow{ON}$ or $\overrightarrow{NY}$ or $\overrightarrow{NM}$ or $\overrightarrow{NO}$ or $\overrightarrow{YN}$ using another variable e.g. μ oe
	$-0.5\mu = -0.5 + \lambda$ oe $3\mu = \lambda$ oe	$1 - \lambda = 0.5\mu + 0.5$ oe $1 - \lambda = 1 - 3\mu$ oe		M1 for setting up two simultaneous equations using the components of $\mathbf{a}$ and $\mathbf{b}$ for $\overrightarrow{MN}$ or $\overrightarrow{ON}$ or $\overrightarrow{NY}$ oe
			$\frac{3}{7}$	A1 (allow $\frac{3}{7} = 0.42(8571\dots)$ to 2 sf truncated or rounded)
				Total 5 marks

24 ALT	$(\overrightarrow{ON} \Rightarrow) \lambda(\mathbf{a} + \mathbf{b}) (= \lambda\mathbf{a} + \lambda\mathbf{b})$ or $(\overrightarrow{NY} \Rightarrow) (1 - \lambda)(\mathbf{a} + \mathbf{b}) (= (1 - \lambda)\mathbf{a} + (1 - \lambda)\mathbf{b})$		5	M1 for finding a vector for $\overrightarrow{ON}$ or $\overrightarrow{NY}$ or $\overrightarrow{NO}$ or $\overrightarrow{YN}$ in terms $\mathbf{a}$ and $\mathbf{b}$ and using λ oe
	$(\overrightarrow{MN} = \overrightarrow{MO} + \overrightarrow{ON} \Rightarrow) -0.5\mathbf{a} + \lambda\mathbf{a} + \lambda\mathbf{b} (= (\lambda - 0.5)\mathbf{a} + \lambda\mathbf{b})$ or $(\overrightarrow{MN} = \overrightarrow{MX} + \overrightarrow{XY} + \overrightarrow{YN} \Rightarrow) 0.5\mathbf{a} + \mathbf{b} + (\lambda - 1)(\mathbf{a} + \mathbf{b}) (= (\lambda - 0.5)\mathbf{a} + \lambda\mathbf{b})$			M1 for finding a vector for $\overrightarrow{MN}$ or $\overrightarrow{NM}$ in terms $\mathbf{a}$ and $\mathbf{b}$ and using λ oe
	$(\overrightarrow{NZ} = \overrightarrow{NO} + \overrightarrow{OZ} \Rightarrow) -\lambda(\mathbf{a} + \mathbf{b}) + 3\mathbf{b} (= -\lambda\mathbf{a} + (3 - \lambda)\mathbf{b})$ or $(\overrightarrow{NZ} = \overrightarrow{NY} + \overrightarrow{YZ} \Rightarrow) (1 - \lambda)(\mathbf{a} + \mathbf{b}) - \mathbf{b} - \mathbf{a} + 3\mathbf{b} (= -\lambda\mathbf{a} + (3 - \lambda)\mathbf{b})$			M1 for finding a vector for $\overrightarrow{NZ}$ or $\overrightarrow{ZN}$ in terms $\mathbf{a}$ and $\mathbf{b}$ and using λ oe
	$\frac{\lambda - 0.5}{-\lambda} = \frac{\lambda}{3 - \lambda}$ oe			M1 for setting up an equation using the components of $\overrightarrow{MN}$ and $\overrightarrow{NZ}$ oe
			$\frac{3}{7}$	A1 (allow $\frac{3}{7} = 0.42(8571\dots)$ to 2 sf truncated or rounded)
				Total 5 marks

21	$\overrightarrow{OP} = 4\mathbf{a} + 2\mathbf{a} + 8\mathbf{b} (= 6\mathbf{a} + 8\mathbf{b})$ oe OR $\overrightarrow{PO} = -6\mathbf{a} - 8\mathbf{b}$ oe or $\overrightarrow{AB} = 6\mathbf{b} - 4\mathbf{a}$ oe OR $\overrightarrow{BA} = 4\mathbf{a} - 6\mathbf{b}$ oe or $\overrightarrow{BP} = 6\mathbf{a} + 2\mathbf{b}$ oe OR $\overrightarrow{PB} = -6\mathbf{a} - 2\mathbf{b}$ oe		5	M1 oe for one of $\overrightarrow{OP}$ or $\overrightarrow{PO}$ or $\overrightarrow{AB}$ or $\overrightarrow{BA}$ or $\overrightarrow{BP}$ or $\overrightarrow{PB}$ (may be seen as part of another vector calculation)
	$\overrightarrow{OQ} = 4\mathbf{a} + \lambda(6\mathbf{b} - 4\mathbf{a})$ oe OR $6\mathbf{b} + \mu(4\mathbf{a} - 6\mathbf{b})$ oe OR $x(6\mathbf{a} + 8\mathbf{b})$ oe or $\overrightarrow{BQ} = \mu(4\mathbf{a} - 6\mathbf{b})$ oe OR $-6\mathbf{b} + \lambda(6\mathbf{a} + 8\mathbf{b})$ oe OR $4\mathbf{a} - 6\mathbf{b} + x(6\mathbf{b} - 4\mathbf{a})$ oe or $\overrightarrow{AQ} = y(6\mathbf{b} - 4\mathbf{a})$ oe OR $-4\mathbf{a} + x(6\mathbf{a} + 8\mathbf{b})$ oe OR $6\mathbf{b} - 4\mathbf{a} + \mu(4\mathbf{a} - 6\mathbf{b})$ oe OR $2\mathbf{a} + 8\mathbf{b} + m(6\mathbf{a} + 8\mathbf{b})$ oe or $\overrightarrow{QP} = \lambda(6\mathbf{a} + 8\mathbf{b})$ oe OR $\mu(4\mathbf{a} - 6\mathbf{b}) + 2\mathbf{a} + 8\mathbf{b}$ oe			M1 for one of $\overrightarrow{OQ}$ or $\overrightarrow{QO}$ or $\overrightarrow{BQ}$ or $\overrightarrow{QB}$ or $\overrightarrow{AQ}$ or $\overrightarrow{QA}$ or $\overrightarrow{QP}$ or $\overrightarrow{PQ}$
				M1 for a second correct expression for the same vector OR for two correct expressions for parallel vectors eg 2 of $\overrightarrow{OQ}$, $\overrightarrow{OP}$, $\overrightarrow{QP}$ oe AND using ratios to form an equation in one variable that can lead to a solution eg $\overrightarrow{OQ} = 4\mathbf{a} + k(6\mathbf{b} - 4\mathbf{a})$ and $\overrightarrow{QP} = 2\mathbf{a} + 8\mathbf{b} - k(6\mathbf{b} - 4\mathbf{a})$ and $\frac{4 - 4k}{2 + 4k} = \frac{6k}{8 - 6k}$
	eg $\lambda = \frac{8}{17}$ or $\mu = \frac{9}{17}$ or $AQ:QB = \frac{4x}{3} : \frac{3x}{2}$ oe			A1 oe
		8 : 9		A1 oe
				Total 5 marks



25	$\text{eg } \overrightarrow{AK} = \lambda \mathbf{a}$ $\overrightarrow{KB} = (1 - \lambda) \mathbf{a}$ $\overrightarrow{CL} = -\mu \mathbf{a}$ $\overrightarrow{DL} = (1 - \mu) \mathbf{a}$	$\text{eg } \overrightarrow{AK} = \frac{1}{2} \mu \mathbf{a}$ $\overrightarrow{KB} = (1 - \frac{1}{2} \mu) \mathbf{a}$ $\overrightarrow{CL} = -2\lambda \mathbf{a}$ $\overrightarrow{DL} = (1 - 2\lambda) \mathbf{a}$	SEE NEXT PAGE FOR MISREAD	5	M1 for correctly using the ratio to form an expression for a vector passing through K or L could be in terms of λ or μ $\overrightarrow{AK}$ or $\overrightarrow{KA}$, $\overrightarrow{KB}$ or $\overrightarrow{BK}$, $\overrightarrow{CL}$ or $\overrightarrow{LC}$, $\overrightarrow{DL}$ or $\overrightarrow{LD}$ (may be seen as part of another expression)
	$\text{eg } \overrightarrow{KL} = -\lambda \mathbf{a} + \mathbf{b} + (1 - \mu) \mathbf{a}$ or $= (1 - \lambda - \mu) \mathbf{a} + \mathbf{b}$ $\overrightarrow{LM} = (\mu - 1) \mathbf{a} + 0.5 \mathbf{b}$ $\overrightarrow{KM} = -\lambda \mathbf{a} + \mathbf{b} + 0.5 \mathbf{b} (= -\lambda \mathbf{a} + 1.5 \mathbf{b})$	$\text{eg } \overrightarrow{KL} = \mathbf{b} + (1 - \frac{3}{2} \mu) \mathbf{a}$ or $\overrightarrow{KL} = \mathbf{b} + (1 - 3\lambda) \mathbf{a}$ $\overrightarrow{LM} = (2\lambda - 1) \mathbf{a} + \frac{1}{2} \mathbf{b}$ or $\overrightarrow{KM} = -\lambda \mathbf{a} + \frac{3}{2} \mathbf{b}$ or			M1 for finding an expression in λ and/or μ for one of $\overrightarrow{KL}$ (or $\overrightarrow{LK}$), $\overrightarrow{LM}$ (or $\overrightarrow{ML}$), $\overrightarrow{KM}$ (or $\overrightarrow{MK}$) [If this mark is awarded it assumes the first M1]
	Two of the above – may have used $2\lambda = \mu$ to write all in one of λ or μ May be simplified or not – so may have brackets or not				M1 for finding an expression in λ or μ for two of the following: $\overrightarrow{KL}$ (or $\overrightarrow{LK}$), $\overrightarrow{LM}$ (or $\overrightarrow{ML}$), or $\overrightarrow{KM}$ (or $\overrightarrow{MK}$)
	$\text{eg using } \overrightarrow{KM} = -\lambda \mathbf{a} + 1.5 \mathbf{b} \text{ and } \overrightarrow{LM} = (2\lambda - 1) \mathbf{a} + \frac{1}{2} \mathbf{b}$ $\overrightarrow{LM} = x \overrightarrow{KM}$ gives $\frac{-\lambda x}{2\lambda - 1} = \frac{1.5x}{0.5} \Rightarrow 3.5\lambda = 1.5 \Rightarrow \lambda = \frac{3}{7}$ oe		$\lambda = \frac{3}{7}$ or $\mu = \frac{6}{7}$		A1 dep on M2 for one value correct or both values but written the wrong way round ($\mu = \frac{3}{7}$ $\lambda = \frac{6}{7}$)
			$\lambda = \frac{3}{7}$ & $\mu = \frac{6}{7}$		A1 dep on M2 for both values
	Total 5 marks				



25	$\text{eg } \overrightarrow{AK} = \left(\frac{\lambda}{\lambda+1}\right)\mathbf{a}$ $\overrightarrow{KB} = \left(\frac{1}{\lambda+1}\right)\mathbf{a}$ $\overrightarrow{CL} = \left(\frac{-\mu}{1+\mu}\right)\mathbf{a}$ $\overrightarrow{DL} = \left(\frac{1}{1+\mu}\right)\mathbf{a}$	$\text{eg } \overrightarrow{AK} = \left(\frac{\frac{1}{2}\mu}{\frac{1}{2}\mu+1}\right)\mathbf{a} \left(= \left(\frac{\mu}{\mu+2}\right)\mathbf{a} \right)$ $\overrightarrow{KB} = \left(\frac{1}{\frac{1}{2}\mu+1}\right)\mathbf{a} \left(= \left(\frac{2}{\mu+2}\right)\mathbf{a} \right)$ $\overrightarrow{CL} = \left(\frac{-2\lambda}{1+2\lambda}\right)\mathbf{a}$ $\overrightarrow{DL} = \left(\frac{1}{1+2\lambda}\right)\mathbf{a}$	MISREAD $\overrightarrow{AK}:\overrightarrow{KB}=\lambda:1$ and $\overrightarrow{CL}:\overrightarrow{LD}=\mu:1$	M1 For using the ratio to form an expression for a vector passing through K or L could be in terms of λ or μ $\overrightarrow{AK}$ or $\overrightarrow{KA}$, $\overrightarrow{KB}$ or $\overrightarrow{BK}$, $\overrightarrow{CL}$ or $\overrightarrow{LC}$, $\overrightarrow{DL}$ or $\overrightarrow{LD}$ (may be seen as part of another expression)
	$\text{eg } \overrightarrow{KL} = \left(\frac{-\lambda}{\lambda+1}\right)\mathbf{a} + \mathbf{b} + \left(\frac{1}{1+\mu}\right)\mathbf{a}$ or $\overrightarrow{LM} = \left(\frac{-1}{1+\mu}\right)\mathbf{a} + 0.5\mathbf{b}$ $\overrightarrow{KM} = \left(\frac{-\lambda}{1+\lambda}\right)\mathbf{a} + \frac{3}{2}\mathbf{b}$ oe	$\text{eg } \overrightarrow{KL} = \left(\frac{-\frac{1}{2}\mu}{\frac{1}{2}\mu+1}\right)\mathbf{a} + \mathbf{b} + \left(\frac{1}{1+\mu}\right)\mathbf{a}$ $\overrightarrow{LM} = \left(\frac{-1}{1+2\lambda}\right)\mathbf{a} + \frac{1}{2}\mathbf{b}$ or $\overrightarrow{KM} = \left(\frac{-\frac{1}{2}\mu}{\frac{1}{2}\mu+1}\right)\mathbf{a} + \frac{3}{2}\mathbf{b}$ oe		M1 for finding an expression in λ and/or μ using the above misread for one of $\overrightarrow{KL}$ (or $\overrightarrow{LK}$), $\overrightarrow{LM}$ (or $\overrightarrow{ML}$), $\overrightarrow{KM}$ (or $\overrightarrow{MK}$) [If this mark is awarded it assumes the first M1]
	Two of the above – may have used $2\lambda = \mu$ to write all in one of λ or μ May be simplified or not – so may have brackets or not			M1 for finding an expression in λ or μ for two of $\overrightarrow{KL}$ (or $\overrightarrow{LK}$), $\overrightarrow{LM}$ (or $\overrightarrow{ML}$), $\overrightarrow{KM}$ (or $\overrightarrow{MK}$)
	(Giving answers of $\lambda = 0.5(1+\sqrt{7})$, $\mu = 1+\sqrt{7}$)			A MAXIMUM OF 3 MARKS CAN BE AWARDED FOR THIS MISREAD



24	e.g. $(\overrightarrow{AB}) = 2\mathbf{b} - 2\mathbf{a}$ oe or $(\overrightarrow{BA}) = 2\mathbf{a} - 2\mathbf{b}$ oe or $(\overrightarrow{BD}) = 2(2\mathbf{b} - 2\mathbf{a}) (= 4\mathbf{b} - 4\mathbf{a})$ oe or $(\overrightarrow{AD}) = 3(2\mathbf{b} - 2\mathbf{a}) (= 6\mathbf{b} - 6\mathbf{a})$ oe		5	M1
	e.g. $(\overrightarrow{OE}) = 2\mathbf{b} + 2(2\mathbf{b} - 2\mathbf{a}) + 7\mathbf{a} + 3\mathbf{b} (= 3\mathbf{a} + 9\mathbf{b})$ oe or $(\overrightarrow{OC}) = 2\mathbf{a} + \lambda(2\mathbf{b} - 2\mathbf{a}) = (2 - 2\lambda)\mathbf{a} + 2\lambda\mathbf{b}$ oe or $2\mathbf{b} + \lambda(2\mathbf{a} - 2\mathbf{b})$ or $(\overrightarrow{CE}) = (2\mathbf{b} - 2\mathbf{a}) - \lambda(2\mathbf{b} - 2\mathbf{a}) + 2(2\mathbf{b} - 2\mathbf{a}) + 7\mathbf{a} + 3\mathbf{b} = (1 + 2\lambda)\mathbf{a} + (9 - 2\lambda)\mathbf{b}$			M2 for 2 correct paths seen M1 for 1 correct path seen Any correct path for OC passing through A or B involving a variable
	e.g. $\frac{2 - 2\lambda}{2\lambda} = \frac{1 + 2\lambda}{9 - 2\lambda}$ oe or $\frac{2 - 2\lambda}{2\lambda} = \frac{3}{9}$ oe or $\frac{(1 + 2\lambda)}{(9 - 2\lambda)} = \frac{1}{3}$ oe or $\lambda = \frac{3}{4}$ or $(2 - 2\lambda)\mathbf{a} + 2\lambda\mathbf{b} = \mu(3\mathbf{a} + 9\mathbf{b})$ or $\lambda = \frac{3}{4}$ or $\mu = \frac{1}{6}$ or $2\mathbf{b} + \lambda(2\mathbf{a} - 2\mathbf{b}) = \mu(3\mathbf{a} + 9\mathbf{b})$ or $\lambda = \frac{1}{4}$ or $\mu = \frac{5}{6}$			M1 for comparing coefficients of a and b for (OC and CE) or (OC and OE) or (CE and OE) OC is a multiple of OE Two different paths for OC
		1 : 5		A1 dep M2 oe e.g 2 : 10
	Working required			Total 5 marks



24 ALT	e.g. $(\overrightarrow{AB}) = 2\mathbf{b} - 2\mathbf{a}$ oe or $(\overrightarrow{BA}) = 2\mathbf{a} - 2\mathbf{b}$ oe or $(\overrightarrow{BD}) = 2(2\mathbf{b} - 2\mathbf{a}) (= 4\mathbf{b} - 4\mathbf{a})$ oe or $(\overrightarrow{AD}) = 3(2\mathbf{b} - 2\mathbf{a}) (= 6\mathbf{b} - 6\mathbf{a})$ oe		5	M1
	e.g. $(\overrightarrow{OE}) = 2\mathbf{b} + 2(2\mathbf{b} - 2\mathbf{a}) + 7\mathbf{a} + 3\mathbf{b} (= 3\mathbf{a} + 9\mathbf{b})$ oe			M1
	e.g. $(\overrightarrow{AE}) = 2\mathbf{b} - 2\mathbf{a} + 2(2\mathbf{b} - 2\mathbf{a}) + 7\mathbf{a} + 3\mathbf{b} (= \mathbf{a} + 9\mathbf{b})$ oe			M1
	$[\overrightarrow{AE} = \lambda \overrightarrow{AD} + \mu \overrightarrow{OE}]$ $\mathbf{a} + 9\mathbf{b} = \lambda(6\mathbf{b} - 6\mathbf{a}) + \mu(3\mathbf{a} + 9\mathbf{b})$ oe or $1 = -6\lambda + 3\mu$ oe and $9 = 6\lambda + 9\mu$ oe or or $\lambda = \frac{1}{4}$ or $\mu = \frac{5}{6}$			M1
		1 : 5		A1 dep on M2 oe e.g 2 : 10
	Working required			Total 5 marks



22	(a)	$\overrightarrow{ON} = \mathbf{b} + \frac{2}{5}(\mathbf{a} - \mathbf{b})$ oe or $\overrightarrow{ON} = \mathbf{a} + \frac{3}{5}(\mathbf{b} - \mathbf{a})$ oe		2	M1
		Correct answer scores full marks (unless from obvious incorrect working)	$\frac{2}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}$		A1 oe eg $\frac{1}{5}(2\mathbf{a} + 3\mathbf{b})$ but must be one term in $\mathbf{a}$ and one in $\mathbf{b}$
	(b)	$\overrightarrow{ME} = \frac{8}{5}\mathbf{a} - \frac{4}{5}\mathbf{b}$ $\overrightarrow{NE} = \frac{6}{5}\mathbf{a} - \frac{3}{5}\mathbf{b}$ (all oe but simplified) $\overrightarrow{MN} = \frac{2}{5}\mathbf{a} - \frac{1}{5}\mathbf{b}$		3	M1ft for one of $\overrightarrow{ME}$, $\overrightarrow{NE}$ or $\overrightarrow{MN}$ or one of $\overrightarrow{EM}$, $\overrightarrow{EN}$ or $\overrightarrow{NM}$ ft (dep on M1 in (a)) their expression for $\overrightarrow{ON}$ for this mark only [$\overrightarrow{ME} = \overrightarrow{ON} + \frac{6}{5}\mathbf{a} - \frac{7}{5}\mathbf{b}$ $\overrightarrow{MN} = \overrightarrow{ON} - \frac{4}{5}\mathbf{b}$, $\overrightarrow{NE} = -\overrightarrow{ON} + \frac{11}{3}\mathbf{a}$]
		$\overrightarrow{ME} = \frac{8}{5}\mathbf{a} - \frac{4}{5}\mathbf{b}$ $\overrightarrow{NE} = \frac{6}{5}\mathbf{a} - \frac{3}{5}\mathbf{b}$ (all oe but simplified) $\overrightarrow{MN} = \frac{2}{5}\mathbf{a} - \frac{1}{5}\mathbf{b}$			M1 for two of $\overrightarrow{ME}$, $\overrightarrow{NE}$ or $\overrightarrow{MN}$ or two of $\overrightarrow{EM}$, $\overrightarrow{EN}$ or $\overrightarrow{NM}$ must be correct
		Evidence of a vector method needed	shown		A1 eg $\overrightarrow{ME} = 4 \times \overrightarrow{MN}$ or $\overrightarrow{NE} = 3 \times \overrightarrow{MN}$ or $\overrightarrow{ME} = \frac{4}{3} \times \overrightarrow{NE}$ or showing they are multiples of the same vector eg $\overrightarrow{MN} = \frac{1}{5}(2\mathbf{a} - \mathbf{b})$ and $\overrightarrow{NE} = \frac{3}{5}(2\mathbf{a} - \mathbf{b})$
Total 5 marks					

19	(a)		- 2a + b	1	B1	oe
	(b)	eg $\vec{OP} = \mathbf{a} + y(-\mathbf{a} + 6\mathbf{b})$ and $\vec{OP} = 2\mathbf{a} + x(-2\mathbf{a} + \mathbf{b})$ $\vec{AP} = -\mathbf{a} + y(-\mathbf{a} + 6\mathbf{b})$ and $\vec{AP} = x(-2\mathbf{a} + \mathbf{b})$ $\vec{AB} = x(-2\mathbf{a} + \mathbf{b}) + y(-\mathbf{a} + 6\mathbf{b})$ and $\vec{AB} = -2\mathbf{a} + 6\mathbf{b}$ $\vec{NP} = -\mathbf{b} + \mathbf{a} + y(-\mathbf{a} + 6\mathbf{b})$ and $\vec{NP} = x(-2\mathbf{a} - \mathbf{b})$ $\vec{MP} = x(-\mathbf{a} + 6\mathbf{b})$ and $\vec{MP} = \mathbf{a} + y(-2\mathbf{a} + \mathbf{b})$		4	M2	ft from (a), for writing eg $\vec{OP}$ or $\vec{AP}$ or $\vec{AB}$ or $\vec{NP}$ or $\vec{MP}$ or similar in two different ways in terms of $\mathbf{a}$ and $\mathbf{b}$ (M1 for writing eg $\vec{OP}$ or $\vec{AP}$ or $\vec{AB}$ or $\vec{NP}$ or $\vec{MP}$ or similar in one way in terms of $\mathbf{a}$ and $\mathbf{b}$) These may be written as eg $\vec{PO}$ in place of $\vec{OP}$
		eg $x = 6y$ and $2 - 2x = 1 - y$ (from $\vec{OP}$) $x = 6y$ and $-2x = -1 - y$ (from $\vec{AP}$) $6 = x + 6y$ and $-2 = -2x - y$ (from $\vec{AB}$) $2x = 1 - y$ and $-x = -1 + 6y$ (from $\vec{NP}$) $-x = 1 - 2y$ and $6x = y$ (from $\vec{MP}$)			M1	dep M2 for writing a pair of equations using their variables $\vec{OP}$ leads to $x = \frac{6}{11}, y = \frac{1}{11}$ $\vec{AP}$ leads to $x = \frac{6}{11}, y = \frac{1}{11}$ $\vec{AB}$ leads to $x = \frac{6}{11}, y = \frac{10}{11}$ $\vec{NP}$ leads to $x = \frac{5}{11}, y = \frac{1}{11}$ $\vec{MP}$ leads to $x = \frac{1}{11}, y = \frac{6}{11}$
		Vector method required	6 : 5		A1	dep on M2, oe eg $\frac{6}{11}, \frac{5}{11}$
						Total 5 marks



19	eg $\begin{pmatrix} 7 \\ -2 \end{pmatrix} + \begin{pmatrix} -3 \\ 5 \end{pmatrix}$ or $\begin{pmatrix} 4 \\ 3 \end{pmatrix}$ or $-\begin{pmatrix} 7 \\ -2 \end{pmatrix} - \begin{pmatrix} -3 \\ 5 \end{pmatrix}$ or $\begin{pmatrix} -4 \\ -3 \end{pmatrix}$		5	M1 for a method for finding $\overrightarrow{AC}$ or $\overrightarrow{CA}$ or for sight of $\begin{pmatrix} 4 \\ 3 \end{pmatrix}$ or $\begin{pmatrix} -4 \\ -3 \end{pmatrix}$
	eg $(\overrightarrow{AC}) = \sqrt{{}^n4^2 + {}^n3^2} (= \sqrt{25} = 5)$			M1 (dep on previous M1) for a method to find the magnitude of $\overrightarrow{AC}$ or $\overrightarrow{CA}$
	eg $(\overrightarrow{AB}) = \sqrt{7^2 + (\pm 2)^2} (= \sqrt{53} = 7.28(010))$ or $(\overrightarrow{BC}) = \sqrt{(\pm 3)^2 + 5^2} (= \sqrt{34} = 5.83(095))$			M1 (indep) for a method to find the magnitude of either $\overrightarrow{AB}$ or $\overrightarrow{BC}$
	" $\sqrt{7^2 + (\pm 2)^2}$ " + " $\sqrt{(\pm 3)^2 + 5^2}$ " or " $\sqrt{53}$ " + " $\sqrt{34}$ " (= 13.1(110)) or "7.28" + "5.83" (= 13.1(110))			M1 (dep on previous M1) for a complete method to find Pru's distance travelled
	Correct answer scores full marks (unless from obvious incorrect working)	8.1		A1 accept 8.1 – 8.2, to award full marks $\overrightarrow{AC}$ must be correct
				Total 5 marks



Question	Working	Answer	Mark	Notes
22 (a) (i)		$2\mathbf{a} + 2\mathbf{b}$	2	B1 oe but must be simplified
(ii)		$4\mathbf{b} - 3\mathbf{a}$		B1 oe need not be simplified
(b)	eg $\overrightarrow{AP} = \lambda(4\mathbf{b} - 3\mathbf{a})$ and $\overrightarrow{AP} = -3\mathbf{a} + k(2\mathbf{a} + 2\mathbf{b})$ oe $[\overrightarrow{AP} = 2\mathbf{b} - \mathbf{a} - x(2\mathbf{a} + 2\mathbf{b})]$ oe eg $\overrightarrow{BP} = \mu(3\mathbf{a} - 4\mathbf{b})$ and $\overrightarrow{BP} = -4\mathbf{b} + m(2\mathbf{a} + 2\mathbf{b})$ oe $[\overrightarrow{BP} = 2\mathbf{a} - 2\mathbf{b} - v(2\mathbf{a} + 2\mathbf{b})]$ eg $\overrightarrow{OP} = x(2\mathbf{b} + 2\mathbf{a})$ and $\overrightarrow{OP} = 3\mathbf{a} + y(4\mathbf{b} - 3\mathbf{a})$ oe $[\overrightarrow{OP} = 4\mathbf{b} + t(3\mathbf{a} - 4\mathbf{b})]$		3	M1 ft fit their answers in (a) Writing $\overrightarrow{AP}$ or $\overrightarrow{BP}$ or $\overrightarrow{OP}$ as correct vectors in 2 different independent ways – there may be other equivalent vectors Students may use other variations such as $\overrightarrow{PA}$, $\overrightarrow{PB}$, $\overrightarrow{PO}$
	eg $4\lambda = 2k$ and $-3\lambda = -3 + 2k$ or $3\mu = 2m$ and $-4\mu = -4 + 2m$ or $4y = 2x$ and $2x = 3 - 3y$			M1 2 correct equations gained from comparing coefficients
	Working required	3 : 4		A1 oe Dep on M1 Any correct equivalent form eg 6 : 8, 0.75 : 1, $1 : \frac{4}{3}$, 1 : 1.3(333...) etc
Total 5 marks				



23	(a)		$-12\mathbf{a} + 8\mathbf{b}$	1	B1	oe
	(b)	$(\overrightarrow{PR} =) 6\mathbf{a} + 3(" -12\mathbf{a} + 8\mathbf{b} ") (= -30\mathbf{a} + 24\mathbf{b})$ oe or $(\overrightarrow{RP} =) -3(" -12\mathbf{a} + 8\mathbf{b} ") - 6\mathbf{a} (= 30\mathbf{a} - 24\mathbf{b})$		4	M1	for method to find $\overrightarrow{PR}$ or $\overrightarrow{RP}$, ft their $\overrightarrow{AB}$
		$(\overrightarrow{PQ} =) -6\mathbf{a} + n\mathbf{b}$ oe eg $(\overrightarrow{PQ} =) -6\mathbf{a} + m \times 8\mathbf{b}$ or $(\overrightarrow{OQ} =) 6\mathbf{a} + k(" -30\mathbf{a} + 24\mathbf{b} ")$ or $(\overrightarrow{AQ} =) -12\mathbf{a} + n\mathbf{b}$			M1	for method to find $\overrightarrow{PQ}$ or $\overrightarrow{OQ}$ or $\overrightarrow{AQ}$
		$\overrightarrow{PQ} = \lambda \overrightarrow{PR}$ eg $-6\mathbf{a} + n\mathbf{b} = \lambda(" -30\mathbf{a} + 24\mathbf{b} ")$ or $-6 = -30\lambda$ oe or $\lambda = \frac{1}{5}$ oe OR $\mu \overrightarrow{PQ} = \overrightarrow{PR}$ eg $\mu(-6\mathbf{a} + n\mathbf{b}) = "-30\mathbf{a} + 24\mathbf{b} "$ or $-6\mu = -30$ oe or $\mu = 5$ OR $\overrightarrow{OQ} = \overrightarrow{OP} + k \overrightarrow{PR}$ eg $n\mathbf{b} = 6\mathbf{a} + k(" -30\mathbf{a} + 24\mathbf{b} ")$ or $0 = 6 - 30k$ or $k = \frac{1}{5}$ oe OR $\overrightarrow{AQ} = \overrightarrow{AR} + x \overrightarrow{RP}$ eg $-12\mathbf{a} + n\mathbf{b} = 3(" -12\mathbf{a} + 8\mathbf{b} ") + x(" 30\mathbf{a} - 24\mathbf{b} ")$ or $-36 + 30x = -12$ or $x = \frac{4}{5}$ oe			M1	for setting up an equation to find the value of the unknown coefficient(s)
		Working required	4.8		A1	oe eg $\frac{24}{5}$, dep on M1
					Total 5 marks	

23	$\overrightarrow{AB} = 2\mathbf{b} - 2\mathbf{a}$ oe or $\overrightarrow{BA} = 2\mathbf{a} - 2\mathbf{b}$ oe or $\overrightarrow{AM} = \mathbf{b} - \mathbf{a}$ oe or $\overrightarrow{MA} = \mathbf{a} - \mathbf{b}$ oe or $\overrightarrow{BM} = \mathbf{b} - \mathbf{a}$ oe or $\overrightarrow{MB} = \mathbf{a} - \mathbf{b}$ oe		6	M1 for finding $\overrightarrow{AB}$ or $\overrightarrow{BA}$ or $\overrightarrow{AM}$ or $\overrightarrow{MA}$ or $\overrightarrow{BM}$ or $\overrightarrow{MB}$
	e.g. $\overrightarrow{OM} = 2\mathbf{a} + (\mathbf{b} - \mathbf{a}) (= \mathbf{a} + \mathbf{b})$ oe or $\overrightarrow{MO} = (\mathbf{b} - \mathbf{a}) - 2\mathbf{b} (= -\mathbf{a} - \mathbf{b})$ oe or $\overrightarrow{AN} = \frac{4}{3}\mathbf{b} - 2\mathbf{a}$ oe or $\overrightarrow{NA} = 2\mathbf{a} - \frac{4}{3}\mathbf{b}$ oe			M1 for finding $\overrightarrow{OM}$ or $\overrightarrow{MO}$ or $\overrightarrow{AN}$ or $\overrightarrow{NA}$
	e.g. $\overrightarrow{OP} = 2\mathbf{a} + \lambda\left(\frac{4}{3}\mathbf{b} - 2\mathbf{a}\right)$ oe or $\overrightarrow{OP} = \frac{4}{3}\mathbf{b} + \lambda\left(2\mathbf{a} - \frac{4}{3}\mathbf{b}\right)$ oe or $\overrightarrow{OP} = \mu(\mathbf{a} + \mathbf{b})$ oe OR $\overrightarrow{MP} = \mathbf{a} - \mathbf{b} + k\left(\frac{4}{3}\mathbf{b} - 2\mathbf{a}\right)$ oe or $\overrightarrow{MP} = \mathbf{b} - \mathbf{a} - \frac{2}{3}\mathbf{b} + k\left(2\mathbf{a} - \frac{4}{3}\mathbf{b}\right)$ oe or $\overrightarrow{MP} = t(-\mathbf{a} - \mathbf{b})$ oe			M1 for finding $\overrightarrow{OP}$ or $\overrightarrow{PO}$ or $\overrightarrow{MP}$ or $\overrightarrow{PM}$
	e.g. $2\mathbf{a} + \lambda\left(\frac{4}{3}\mathbf{b} - 2\mathbf{a}\right) = \mu(\mathbf{a} + \mathbf{b})$ oe or $\frac{4}{3}\mathbf{b} + \lambda\left(2\mathbf{a} - \frac{4}{3}\mathbf{b}\right) = \mu(\mathbf{a} + \mathbf{b})$ oe or $\mathbf{a} - \mathbf{b} + k\left(\frac{4}{3}\mathbf{b} - 2\mathbf{a}\right) = t(-\mathbf{a} - \mathbf{b})$ oe or $\mathbf{b} - \mathbf{a} - \frac{2}{3}\mathbf{b} + k\left(2\mathbf{a} - \frac{4}{3}\mathbf{b}\right) = t(-\mathbf{a} - \mathbf{b})$ oe			M1 for setting up an equation for $\overrightarrow{OP}$ or $\overrightarrow{MP}$
	$\mu = \frac{4}{5}$ or $t = \frac{1}{5}$			M1 for finding μ or t for either $\overrightarrow{OP} = \mu\overrightarrow{OM}$ or $\overrightarrow{MP} = t\overrightarrow{MO}$
		4 : 1		A1 cao (dep on M3)
Total 6 marks				



24	(a)	eg $\overrightarrow{AC} = \overrightarrow{AO} + \overrightarrow{OB} + \overrightarrow{BC}$ or eg $-4\mathbf{a} + 3\mathbf{b} + 2\mathbf{a} + \mathbf{b}$		2	M1
		Correct answer scores full marks (unless from obvious incorrect working)	$4\mathbf{b} - 2\mathbf{a}$		A1 oe but must be simplified eg $-2\mathbf{a} + 4\mathbf{b}$, $2(2\mathbf{b} - \mathbf{a})$
	(b)	eg $\overrightarrow{OP} = 4\mathbf{a} + \frac{3}{5}(4\mathbf{b} - 2\mathbf{a})$ ($= \frac{14}{5}\mathbf{a} + \frac{12}{5}\mathbf{b}$ or $2.8\mathbf{a} + 2.4\mathbf{b}$) oe or eg $\overrightarrow{OP} = 3\mathbf{b} + 2\mathbf{a} + \mathbf{b} - \frac{2}{5}(4\mathbf{b} - 2\mathbf{a})$ ($= \frac{14}{5}\mathbf{a} + \frac{12}{5}\mathbf{b}$) oe		4	M1ft For $\overrightarrow{OP}$ (could be part of another vector equation) ft their $\overrightarrow{AC}$
		eg $\overrightarrow{OQ} = \lambda(\frac{14}{5}\mathbf{a} + \frac{12}{5}\mathbf{b})$ or eg $\overrightarrow{OQ} = 3\mathbf{b} + \mu(2\mathbf{a} + \mathbf{b})$ or eg $\overrightarrow{OQ} = 4\mathbf{b} + 2\mathbf{a} + \omega(2\mathbf{a} + \mathbf{b})$	eg $\overrightarrow{PQ} = k(2.8\mathbf{a} + 2.4\mathbf{b})$ or eg $\overrightarrow{PQ} = \frac{2}{5}(4\mathbf{b} - 2\mathbf{a}) + m(2\mathbf{a} + \mathbf{b})$		M1ft ft their $\overrightarrow{AC}$ (This mark can be awarded without the previous mark awarded) a correct expression for $\overrightarrow{OQ}$ or $\overrightarrow{PQ}$ oe
		eg $\overrightarrow{OQ} = \lambda(\frac{14}{5}\mathbf{a} + \frac{12}{5}\mathbf{b})$ and eg $\overrightarrow{OQ} = 3\mathbf{b} + \mu(2\mathbf{a} + \mathbf{b})$ or $4\mathbf{b} + 2\mathbf{a} + \omega(2\mathbf{a} + \mathbf{b})$	eg $\overrightarrow{PQ} = k(2.8\mathbf{a} + 2.4\mathbf{b})$ and eg $\overrightarrow{PQ} = \frac{2}{5}(4\mathbf{b} - 2\mathbf{a}) + m(2\mathbf{a} + \mathbf{b})$		M1ft ft their $\overrightarrow{AC}$ 2 correct expressions for $\overrightarrow{OQ}$ or $\overrightarrow{PQ}$ oe ft dep on previous M1
		working required	$\frac{42}{5}\mathbf{a} + \frac{36}{5}\mathbf{b}$		A1 oe dep on M2 $8.4\mathbf{a} + 7.2\mathbf{b}$
Total 6 marks					

25 (a) (i)		$\frac{8}{5}\mathbf{a} + 3\mathbf{b}$	1	B1oe must be in simplest form eg $1.6\mathbf{a} + 3\mathbf{b}$ or $\frac{8\mathbf{a} + 15\mathbf{b}}{5}$
(ii)		$\frac{9}{4}\mathbf{b} - 2\mathbf{a}$	1	B1oe must be in simplest form eg $2.25\mathbf{b} - 2\mathbf{a}$ or $\frac{9\mathbf{b} - 8\mathbf{a}}{4}$
(b)	eg $(\overline{OM}) = 2\mathbf{a} + \frac{3}{4}\mathbf{b}$ oe or $(\overline{OY}) = k\left(\frac{8}{5}\mathbf{a} + 3\mathbf{b}\right)$ oe or $(\overline{YN}) = (1-k)\left(\frac{8}{5}\mathbf{a} + 3\mathbf{b}\right)$ oe or $(\overline{OY}) = 2\mathbf{a} + \frac{3}{4}\mathbf{b} + \lambda\left(\frac{9}{4}\mathbf{b} - 2\mathbf{a}\right)$ oe or $(\overline{OY}) = 3\mathbf{b} - \mu\left(\frac{9}{4}\mathbf{b} - 2\mathbf{a}\right)$ oe		4	M1ft fit their answers in (a) for a correct expression for a vector eg $\overline{OM}$ or $\overline{OY}$ or $\overline{YN}$ Students may use other variations eg $\overline{MO}$ or $\overline{YO}$ or $\overline{NY}$ For all M marks Allow any letter for k eg n, λ Allow any letter for λ eg μ
	eg $(\overline{OY}) = k\left(\frac{8}{5}\mathbf{a} + 3\mathbf{b}\right)$ oe and $2\mathbf{a} + \frac{3}{4}\mathbf{b} + \lambda\left(\frac{9}{4}\mathbf{b} - 2\mathbf{a}\right)$ oe or $(\overline{OY}) = k\left(\frac{8}{5}\mathbf{a} + 3\mathbf{b}\right)$ oe and $3\mathbf{b} - \mu\left(\frac{9}{4}\mathbf{b} - 2\mathbf{a}\right)$ oe or $(\overline{OM}) = 2\mathbf{a} + \frac{3}{4}\mathbf{b}$ oe and $k\left(\frac{8}{5}\mathbf{a} + 3\mathbf{b}\right) - \lambda\left(-2\mathbf{a} + \frac{9}{4}\mathbf{b}\right)$ oe or $(\overline{YN}) = (1-k)\left(\frac{8}{5}\mathbf{a} + 3\mathbf{b}\right)$ oe and $-\lambda\left(-2\mathbf{a} + \frac{9}{4}\mathbf{b}\right) + \frac{3}{4}(3\mathbf{b}) - \frac{1}{5}(2\mathbf{a})$ oe or $(\overline{OY}) = 2\mathbf{a} + \frac{3}{4}\mathbf{b} + \lambda\left(\frac{9}{4}\mathbf{b} - 2\mathbf{a}\right)$ and $3\mathbf{b} - \mu\left(\frac{9}{4}\mathbf{b} - 2\mathbf{a}\right)$			M1ft for 2 independent expressions for the same vector (may be embedded in a correct equation)
	eg $3k = \frac{3}{4} + \frac{9}{4}\left(1 - \frac{4}{5}k\right)$ oe or $3k = 3 - \frac{9}{4}\left(\frac{4}{5}k\right)$ oe or $4k = 3\left(\frac{5-4k}{5}\right) + 1$ oe or $\lambda = 0.5$ oe or $\mu = 0.5$ oe			M1 a correct equation for k or the correct value of λ or μ (cannot assume that Y is the midpoint of MR)
	Question requires a complete vector method to be awarded marks	$\frac{5}{8}$		A1oe dep on M2
				Total 6 marks



24	(i)		$-10\mathbf{a} + 2\mathbf{b}$	1	B1 or $2\mathbf{b} - 10\mathbf{a}$ Must be simplified
	(ii)		$\frac{15}{2}\mathbf{a} + \frac{5}{2}\mathbf{b}$	1	B1 oe eg $7\frac{1}{2}\mathbf{a} + 2\frac{1}{2}\mathbf{b}$ or $7.5\mathbf{a} + 2.5\mathbf{b}$ Must be simplified
	(iii)	eg $(\overrightarrow{OR} = k\overrightarrow{OP}) \Rightarrow k\left(\frac{15}{2}\mathbf{a} + \frac{5}{2}\mathbf{b}\right)$ oe		4	M1 ft from part (ii) for $\overrightarrow{OR}$ $\overrightarrow{OP}$ must be in terms of $\mathbf{a}$ and $\mathbf{b}$ (lower case)
		eg $(\overrightarrow{OR} = \overrightarrow{OA} + \overrightarrow{AR}) \Rightarrow 10\mathbf{a} + \lambda(-10\mathbf{a} + 2\mathbf{b}) \Rightarrow (10 - 10\lambda)\mathbf{a} + 2\lambda\mathbf{b}$ oe or $(\overrightarrow{OR} = \overrightarrow{OQ} + \overrightarrow{QR}) \Rightarrow 2\mathbf{b} - \mu(-10\mathbf{a} + 2\mathbf{b}) \Rightarrow 10\mu\mathbf{a} + (2 - 2\mu)\mathbf{b}$ oe			M1 ft from part (i) for another path for $\overrightarrow{OR}$ $\overrightarrow{AQ}$ must be in terms of $\mathbf{a}$ and $\mathbf{b}$ (lower case)
		eg $\frac{15}{2}k = 10 - 10\lambda$ oe and $\frac{5}{2}k = 2 - 2\lambda$ oe or $\lambda = \frac{5}{8}$ oe or $\frac{5}{2}k = 2 - 2\mu$ and $\frac{15}{2}k = 10\mu$ oe or $k = 0.5$ oe			M1 for correct equations (not followed through equations)
		Correct answer scores full marks (unless from obvious incorrect working)	$\frac{15}{4}\mathbf{a} + \frac{5}{4}\mathbf{b}$		A1 oe eg $3\frac{3}{4}\mathbf{a} + 1\frac{1}{4}\mathbf{b}$ or $3.75\mathbf{a} + 1.25\mathbf{b}$
					Total 6 marks

14	(a)(i)		b – a	1	B1 oe
	(ii)	E.g. ($KI = KJ + JI \Rightarrow$ $2(\mathbf{b} - \mathbf{a}) + 2\mathbf{b}$ oe		2	M1ft (i) for any valid correct path (oe) in capitals or lower case letters
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	4b – 2a		A1 oe simplified
	(iii)	E.g. ($LD = LF + FE + ED \Rightarrow$ $(\mathbf{b} - \mathbf{a}) + (\mathbf{b} - \mathbf{a}) - \mathbf{a}$ oe		2	M1ft (i) for any valid correct path (oe) in capitals or lower case letters
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	2b – 3a		A1 oe simplified
	(b)	($GHIJKL \Rightarrow$) $6 \times 5 \times 2^2 (= 120)$ or ($GABH \Rightarrow$) $5 \times 2^2 - 5 (= 15)$ or $3 \times 5 (= 15)$ or (Number of triangles in shaded region $\Rightarrow$) ($6 \times 4) - 6 (= 18)$		3	M1
		“120” – (6×5) or $6 \times$ “15” or “18” $\times 5$			M1
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	90		A1
					Total 8 marks

