1

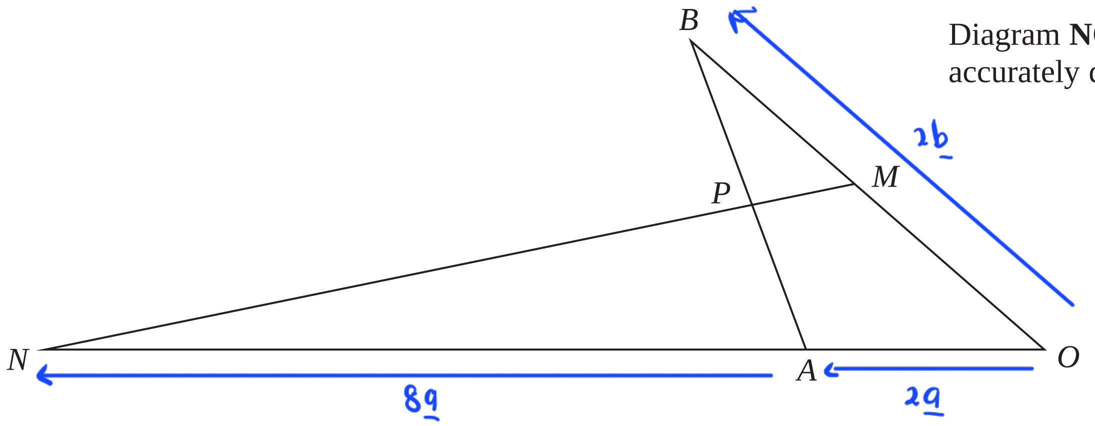


Diagram **NOT** accurately drawn

OAN, *OMB*, *APB* and *MPN* are straight lines.

$OA : AN = 1 : 4$

$OM : MB = 1 : 1$

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

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

$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB}$

$= -2\underline{a} + 2\underline{b}$ (1)

$\overrightarrow{NM} = \overrightarrow{NO} + \overrightarrow{OM}$

$= -10\underline{a} + \underline{b}$

Let X = fraction of NM

Y = fraction of AB

$\overrightarrow{AP} = \overrightarrow{AN} + \overrightarrow{NP}$

$= 8\underline{a} + X(-10\underline{a} + \underline{b})$ (1)

$\overrightarrow{AP} = Y(-2\underline{a} + 2\underline{b})$ (1)

$\therefore\ 8\underset{\sim}{a} + x(-10\underset{\sim}{a} + \underset{\sim}{b}) = y(-2\underset{\sim}{a} + 2\underset{\sim}{b})$

$8\underset{\sim}{a} - 10\underset{\sim}{a}x + \underset{\sim}{b}x = -2\underset{\sim}{a}y + 2\underset{\sim}{b}y$

$8\underset{\sim}{a} = 10\underset{\sim}{a}x - 2\underset{\sim}{a}y + 2\underset{\sim}{b}y - \underset{\sim}{b}x$

$8\underset{\sim}{a} = \underset{\sim}{a}(10x - 2y) + \underset{\sim}{b}(2y - x)$ (1)

$\underset{\sim}{b}$ term : $0 = 2y - x$

$2y = x$ — (1)

$\underset{\sim}{a}$ term : $8 = 10x - 2y$ — (2)

substitute (1) into (2)

$8 = 10(2y) - 2y$

$8 = 20y - 2y$

$y = \frac{8}{18} = \frac{4}{9}$

since y = fraction of AB,

$\overrightarrow{AP} = \frac{4}{9}\overrightarrow{AB}$

$AP = \frac{4}{9}$, hence $PB = \frac{5}{9}$

$AP : PB = 4 : 5$

4 : 5 (1)

(Total for Question 1 is 5 marks)

2 The diagram shows trapezium *OACB*.

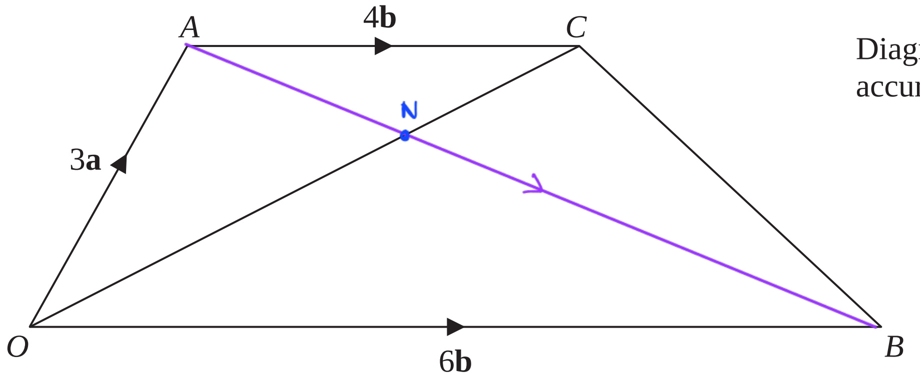


Diagram **NOT** accurately drawn

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

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

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

$\overrightarrow{OC} = \overrightarrow{OA} + \overrightarrow{AC}$

$= 3\underline{a} + 4\underline{b}$ (1)

$\overrightarrow{ON} = x(\overrightarrow{OC})$

$= x(3\underline{a} + 4\underline{b})$ (1)

$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB}$

$= -3\underline{a} + 6\underline{b}$

$\overrightarrow{AN} = y(\overrightarrow{AB})$

$= y(-3\underline{a} + 6\underline{b})$

$\overrightarrow{ON} = \overrightarrow{OA} + \overrightarrow{AN}$

$= 3\underline{a} + y(-3\underline{a} + 6\underline{b})$

$\therefore\ x(3\underline{a} + 4\underline{b}) = 3\underline{a} + y(-3\underline{a} + 6\underline{b})$ (1)

$\underline{a}$ term : $3x = 3 - 3y$

$x = 1 - y$

$\underline{b}$ term : $4x = 6y$

$4(1-y) = 6y$

$4 - 4y = 6y$

$4 = 10y$

$y = \frac{4}{10} = 0.4$, $x = 0.6$ (1)

$\overrightarrow{ON} = 0.6(3\underline{a} + 4\underline{b})$

$= 1.8\underline{a} + 2.4\underline{b}$ (1)

$\overrightarrow{ON} = 1.8\underline{a} + 2.4\underline{b}$ ....

(Total for Question 2 is 5 marks)

3

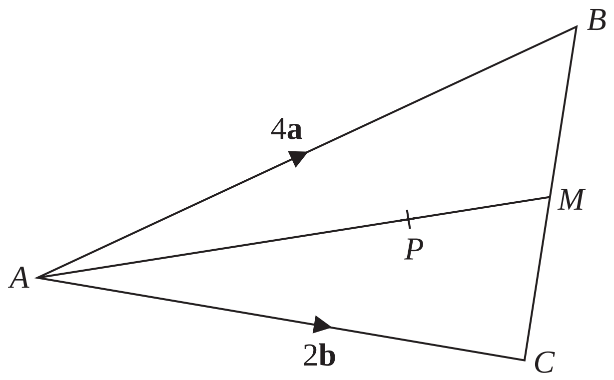


Diagram **NOT** accurately drawn

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

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

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

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

$\overrightarrow{BC} = \overrightarrow{BA} + \overrightarrow{AC}$

$= -4\underline{a} + 2\underline{b}$

Find the ratio *AP* : *PM*

$\overrightarrow{PM} = \overrightarrow{PA} + \overrightarrow{AB} + \overrightarrow{BM}$

$= -\frac{3}{2}\underline{a} - \frac{3}{4}\underline{b} + 4\underline{a} + \frac{1}{2}(-4\underline{a} + 2\underline{b})$

$= -\frac{3}{2}\underline{a} + 4\underline{a} - 2\underline{a} - \frac{3}{4}\underline{b} + \underline{b}$

$= \frac{1}{2}\underline{a} + \frac{1}{4}\underline{b}$ (1)

$\overrightarrow{AP} = 3\left(\frac{1}{2}\underline{a} + \frac{1}{4}\underline{b}\right)$

$= 3\overrightarrow{PM}$ (1)

$\overrightarrow{AM} = \frac{4}{3}\overrightarrow{AP}$

$\overrightarrow{AM} = 4\overrightarrow{PM}$

$\therefore AP : PM = 3 : 1$ (1)

3 : 1

(Total for Question 3 is 3 marks)

4 *OACB* is a trapezium.

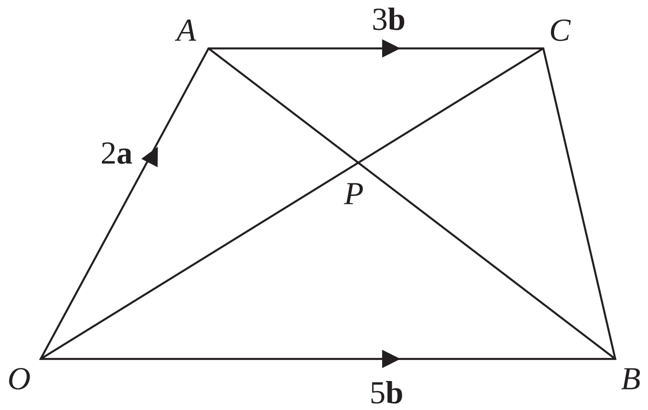


Diagram **NOT** accurately drawn

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

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

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

$\overrightarrow{OC} = \overrightarrow{OA} + \overrightarrow{AC}$

$= 2\underline{a} + 3\underline{b}$

$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB}$

$= -2\underline{a} + 5\underline{b}$

$\overrightarrow{OP} = n(\overrightarrow{OC})$

$= n(2\underline{a} + 3\underline{b})$ (1)

$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$

$= 2\underline{a} + m(\overrightarrow{AB})$

$= 2\underline{a} + m(-2\underline{a} + 5\underline{b})$

$n(2\underline{a} + 3\underline{b}) = 2\underline{a} + m(-2\underline{a} + 5\underline{b})$ (1)

$2n\,\underline{a} + 3n\,\underline{b} = (2 - 2m)\underline{a} + 5m\,\underline{b}$

$\underline{a}: \; 2n = 2 - 2m$

$n = 1 - m$ — (1)

$\underline{b}: \; 3n = 5m$ — (2)

Substitute (1) into (2)

$3(1 - m) = 5m$ (1)

$3 - 3m = 5m$

$3 = 8m$

$m = \frac{3}{8}$, $\quad n = 1 - \frac{3}{8} = \frac{5}{8}$ (1)

$\overrightarrow{OP} = n(2\underline{a} + 3\underline{b})$

$= \frac{5}{8}(2\underline{a} + 3\underline{b})$

$= \frac{5}{4}\underline{a} + \frac{15}{8}\underline{b}$ (1)

$\overrightarrow{OP} = \frac{5}{4}\underline{a} + \frac{15}{8}\underline{b}$

(Total for Question 4 is 5 marks)

5 Here are two vectors.

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

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

$$\overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC}$$

$$= \begin{pmatrix} 5 \\ 3 \end{pmatrix} + \begin{pmatrix} 2 \\ -4 \end{pmatrix} \quad 1$$

$$= \begin{pmatrix} 7 \\ -1 \end{pmatrix} \quad 1$$

$\begin{pmatrix} 7 \\ -1 \end{pmatrix}$ ....

(Total for Question 5 is 2 marks)

6 *OAB* is a triangle.

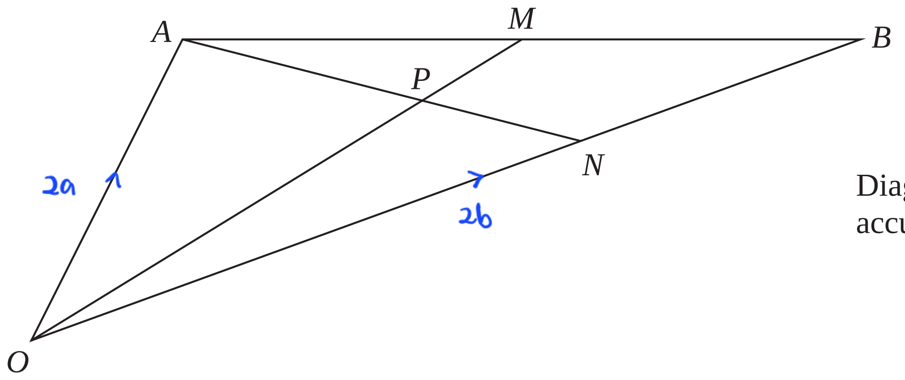


Diagram **NOT** accurately drawn

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

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.

$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB}$

$= -2a + 2b$ (1)

$\overrightarrow{AM} = \dfrac{-2a + 2b}{2}$

$= -a + b$

$\overrightarrow{OM} = \overrightarrow{OA} + \overrightarrow{AM}$

$= 2a + (-a + b)$

$= a + b$ (1)

$\overrightarrow{OP} = n(\overrightarrow{OM})$

$= n(a + b)$ (1)

$\overrightarrow{ON} = \frac{2}{3} 2b$

$= \frac{4}{3} b$

$\overrightarrow{AN} = \overrightarrow{AO} + \overrightarrow{ON}$

$= -2a + \frac{4}{3} b$

$\overrightarrow{AP} = m(\overrightarrow{AN})$

$= m(-2a + \frac{4}{3} b)$

$\overrightarrow{AP} = \overrightarrow{AO} + \overrightarrow{OP}$

$m(-2a + \frac{4}{3} b) = -2a + n(a + b)$ (1)

$a : -2m = -2 + n$ — (2)

$b : \frac{4}{3} m = n$ — (1)

subs 1 into 2

$-2m = -2 + \frac{4}{3}m$

$2 = \frac{4}{3}m + 2m$

$2 = \frac{10}{3}m$

$m = \frac{3}{5}$

$n = \frac{4}{5}$ 1

$\overrightarrow{OP} = \frac{4}{5}(a+b)$

$\overrightarrow{OP} = \frac{4}{5}(\overrightarrow{OM})$

$\overrightarrow{PM} = \frac{1}{5}(\overrightarrow{OM})$

$\overrightarrow{OP} : \overrightarrow{PM} = 4 : 1$ 1

4 : 1

(Total for Question 6 is 6 marks)

7 *ABCD* is a parallelogram and *ADM* is a straight line.

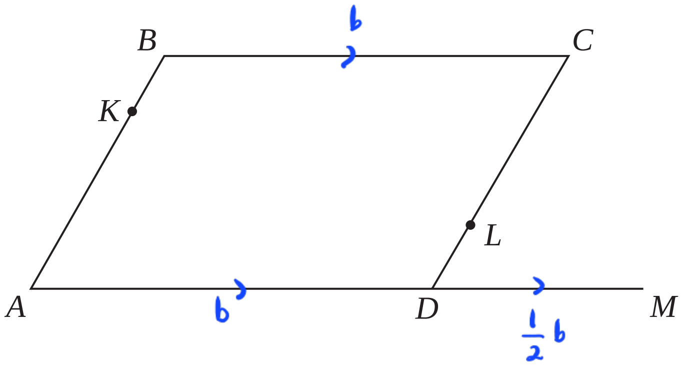


Diagram **NOT** accurately drawn

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

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

$\overrightarrow{AK} = \lambda \underline{a}$, $\overrightarrow{KB} = (1-\lambda)\underline{a}$, $\overrightarrow{CL} = -\mu \underline{a}$, $\overrightarrow{DL} = (1-\mu)\underline{a}$ 1

$\overrightarrow{KL} = \overrightarrow{KA} + \overrightarrow{AD} + \overrightarrow{DL}$

$= -\lambda \underline{a} + \underline{b} + (1-\mu)\underline{a}$ 1

$\mu = 2\lambda$

$\overrightarrow{LM} = \overrightarrow{LD} + \overrightarrow{DM}$

$= -(1-\mu)\underline{a} + \frac{1}{2}\underline{b} = -(1-2\lambda)\underline{a} + \frac{1}{2}b$ 1

$\overrightarrow{KM} = \overrightarrow{KA} + \overrightarrow{AD} + \overrightarrow{DM}$

$= -\lambda \underline{a} + \underline{b} + \frac{1}{2}\underline{b}$

$\overrightarrow{LM} = x\,\overrightarrow{KM}$

$\underline{a}$: $2\lambda - 1 = -\lambda x$ — ①

$\underline{b}$: $\frac{1}{2} = \frac{3}{2}x$

$x = \frac{1}{3}$ - ②

Substitute ② into ① :

$2\lambda - 1 = -\frac{1}{3}\lambda$, $\lambda = \frac{3}{7}$ 1 , $\mu = 2 \times \frac{3}{7} = \frac{6}{7}$ 1

$\lambda =$ ......$\frac{3}{7}$......

$\mu =$ ......$\frac{6}{7}$......

(Total for Question 7 is 5 marks)

8

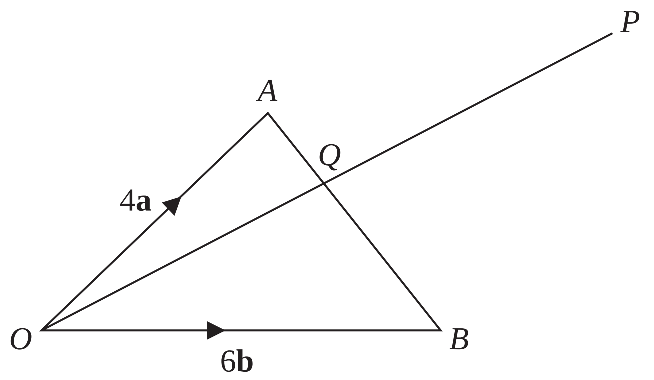


Diagram **NOT** accurately drawn

OAB is a triangle.
Q is the point on *AB* such that *OQP* is a straight line.

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

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

$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$
$= 4\underline{a} + 2\underline{a} + 8\underline{b}$ (1)
$= 6\underline{a} + 8\underline{b}$

$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB}$
$= -4\underline{a} + 6\underline{b}$

$\overrightarrow{AQ} = \lambda \overrightarrow{AB}$
$= \lambda(-4\underline{a} + 6\underline{b})$ (1)
$= -4\lambda\underline{a} + 6\lambda\underline{b}$

$\overrightarrow{AQ} = \overrightarrow{AO} + \overrightarrow{OQ}$
$= -4\underline{a} + \mu\overrightarrow{OP}$
$= -4\underline{a} + \mu(6\underline{a} + 8\underline{b})$
$= (-4 + 6\mu)\underline{a} + 8\mu\underline{b}$ (1)

$\underline{a}$ terms : $-4\lambda = -4 + 6\mu$
$\underline{b}$ terms : $6\lambda = 8\mu$
$\mu = \frac{3}{4}\lambda$
$-4\lambda = -4 + 6\left(\frac{3}{4}\lambda\right)$
$-4\lambda = -4 + \frac{9}{2}\lambda$
$\lambda = \frac{8}{17}$ (1)

$AQ : QB$
$\lambda : 1 - \lambda$
$\frac{8}{17} : \frac{9}{17}$

$AQ : QB =$ 8 : 9 (1)

(Total for Question 8 is 5 marks)

9 *OXYZ* is a trapezium.

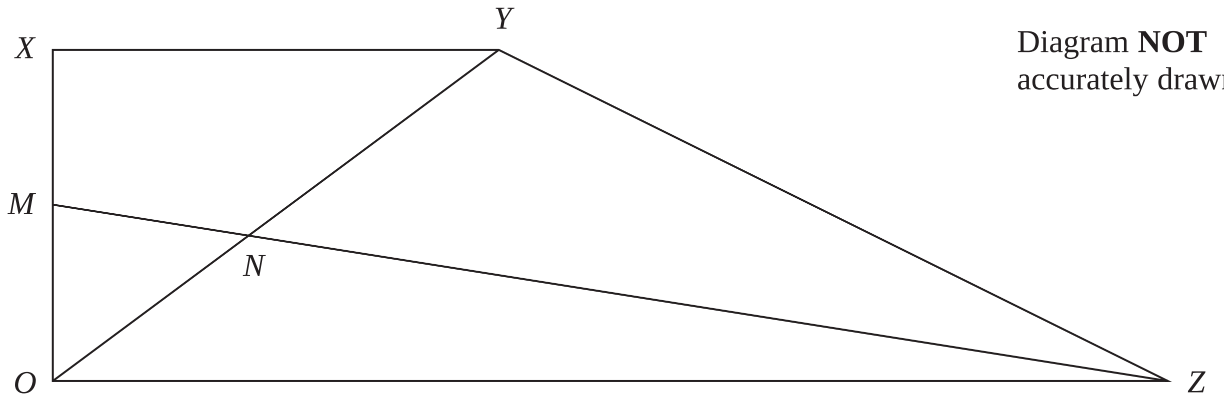


Diagram **NOT** accurately drawn

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

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

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

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

$\overrightarrow{ON} = \lambda(\overrightarrow{OY})$ (1)

$= \lambda(\overrightarrow{OX} + \overrightarrow{XY})$

$= \lambda(\underline{a} + \underline{b})$

$\overrightarrow{MN} = \overrightarrow{MO} + \overrightarrow{ON}$ (1)

$= -0.5\underline{a} + \lambda\underline{a} + \lambda\underline{b}$

$\overrightarrow{MN} = \mu(\overrightarrow{MZ})$ (1)

$= \mu(\overrightarrow{MO} + \overrightarrow{OZ})$

$= \mu(-0.5\underline{a} + 3\underline{b})$

$(\lambda - 0.5)\underline{a} + \lambda\underline{b} = (-0.5\mu)\underline{a} + (3\mu)\underline{b}$

$\underline{a}$ term : $\lambda - 0.5 = -0.5\mu$ — (1)

$\underline{b}$ term : $\lambda = 3\mu$ — (2) (1)

Substitute ② into ① :

$$3\mu - 0.5 = -0.5\mu$$

$$3.5\mu = 0.5$$

$$\mu = \frac{1}{7}$$

$$\lambda = 3\left(\frac{1}{7}\right)$$

$$= \frac{3}{7}$$ (1)

$\lambda =$ $\frac{3}{7}$

(Total for Question 9 is 5 marks)

10 The diagram shows triangle *OAB*

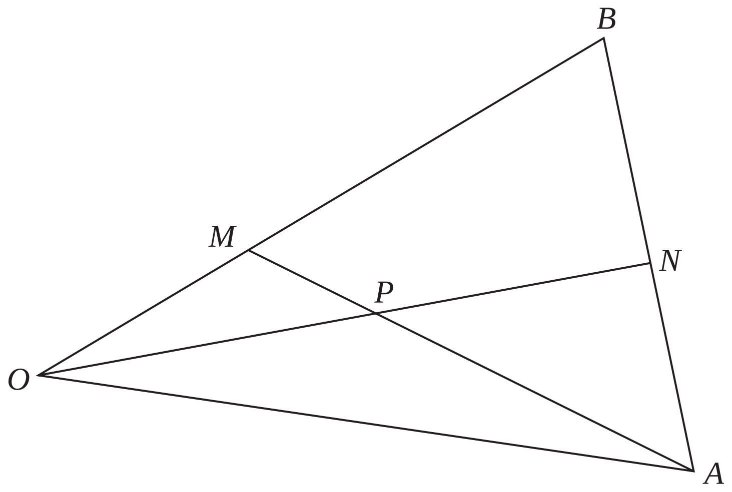


Diagram **NOT** accurately drawn

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

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 $\overrightarrow{OP}$ as a simplified expression in terms of **a** and **b**
Show your working clearly.

$\overrightarrow{BA} = \overrightarrow{BO} + \overrightarrow{OA}$
$= -6\underline{b} + 8\underline{a}$

$\overrightarrow{BN} = \frac{1}{2}(-6\underline{b} + 8\underline{a})$
$= -3\underline{b} + 4\underline{a}$

$\overrightarrow{ON} = \overrightarrow{OB} + \overrightarrow{BN}$
$= 6\underline{b} + (-3\underline{b} + 4\underline{a})$
$= 4\underline{a} + 3\underline{b}$ (1)

$\overrightarrow{OP} = \lambda(4\underline{a} + 3b)$ (1)

$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$
$= 8\underline{a} + x\overrightarrow{Am}$
$= 8\underline{a} + x(\overrightarrow{AB} + \overrightarrow{Bm})$
$= 8\underline{a} + x(6\underline{b} - 8\underline{a} - 4\underline{b})$
$= 8\underline{a} + x(2\underline{b} - 8\underline{a})$ (1)

$\underline{a}$ term : $4\lambda = 8 - 8x \quad -①$

$\underline{b}$ term : $3\lambda = 2x$

$\lambda = \frac{2}{3}x \quad -②$

subs ② into ① :

$4\left(\frac{2}{3}x\right) = 8 - 8x$

$\frac{8}{3}x = 8 - 8x$

$8x = 24 - 24x$

$32x = 24$

$x = \frac{24}{32} = \frac{3}{4}$ ①

$\lambda = \frac{2}{\cancel{3}}\left(\frac{\cancel{3}}{4}\right)$

$= \frac{1}{2}$

$\overrightarrow{OP} = \frac{1}{2}\left(4\underline{a} + 3\underline{b}\right)$

$= 2\underline{a} + \frac{3}{2}\underline{b}$ ①

$\overrightarrow{OP} =$ $2\underline{a} + \frac{3}{2}\underline{b}$

(Total for Question 10 is 5 marks)

11 The diagram shows triangle *OAB* with *OA* extended to *E*

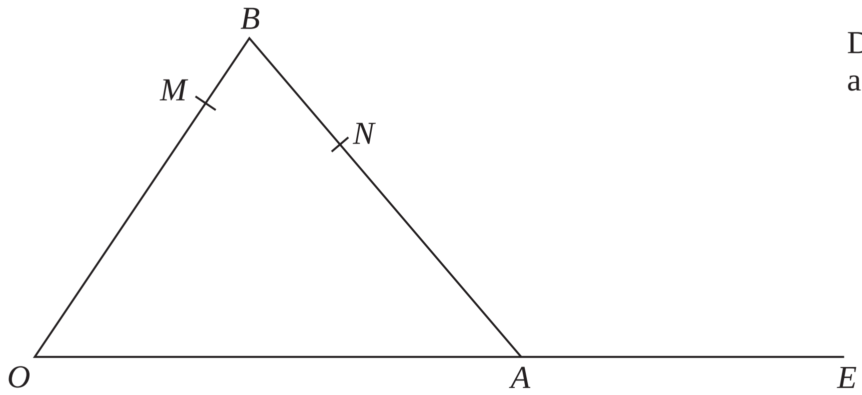


Diagram **NOT** accurately drawn

$\overrightarrow{OA} = \mathbf{a}$ $\overrightarrow{OB} = \mathbf{b}$

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 $\overrightarrow{ON}$ in terms of **a** and **b**
Give your answer in its simplest form.

$\overrightarrow{ON} = \overrightarrow{OB} + \overrightarrow{BN}$

$= \underline{b} + \frac{2}{5}\overrightarrow{BA}$ 1

$= \underline{b} + \frac{2}{5}(\overrightarrow{BO} + \overrightarrow{OA})$

$= \underline{b} + \frac{2}{5}(-\underline{b} + \underline{a})$

$= \frac{2}{5}\underline{a} + \frac{3}{5}\underline{b}$ 1

$\overrightarrow{ON} =$ $\frac{2}{5}\underline{a} + \frac{3}{5}\underline{b}$

(2)

(Total for Question 11 is 2 marks)

12 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.

$$\overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC}$$

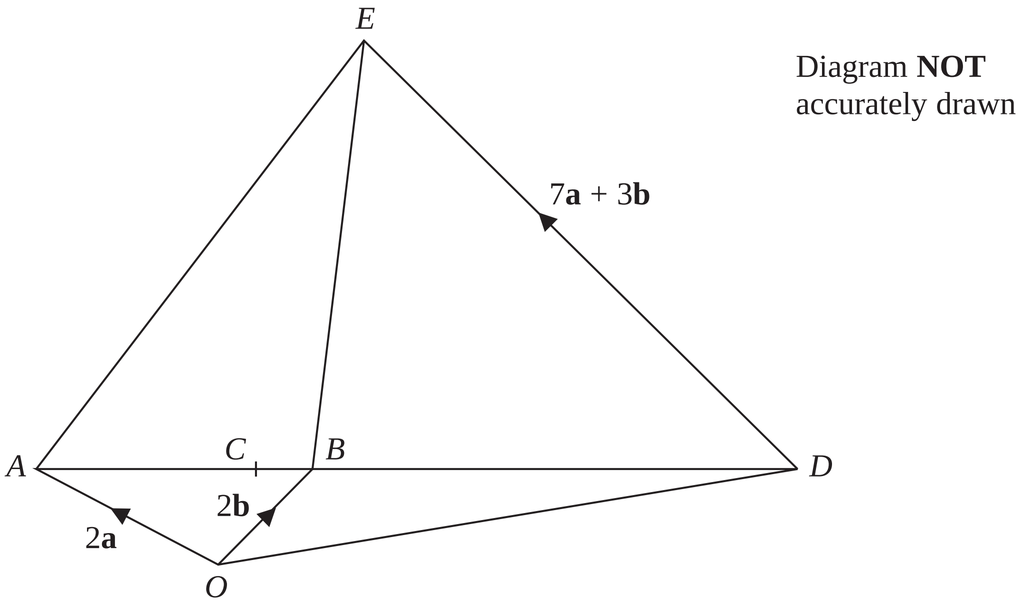
$$= \begin{bmatrix} 5 \\ -4 \end{bmatrix} + \begin{bmatrix} 9 \\ 1 \end{bmatrix} \quad 1$$

$$= \begin{bmatrix} 14 \\ -3 \end{bmatrix} \quad 1$$

$$\overrightarrow{AC} = \begin{pmatrix} 14 \\ -3 \end{pmatrix}$$

(Total for Question 12 is 2 marks)

13 *OAED* is a quadrilateral.



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

$AB : BD = 1 : 2$

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

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

$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB}$

$= -2\underline{a} + 2\underline{b}$ (1)

$\overrightarrow{AD} = \overrightarrow{AB} + \overrightarrow{BD}$

$= -2\underline{a} + 2\underline{b} + 2(-2\underline{a} + 2\underline{b})$

$= -2\underline{a} - 4\underline{a} + 2\underline{b} + 4\underline{b}$

$= -6\underline{a} + 6\underline{b}$

$\overrightarrow{OE} = \overrightarrow{OA} + \overrightarrow{AD} + \overrightarrow{DE}$

$= 2\underline{a} + (-6\underline{a} + 6\underline{b}) + 7\underline{a} + 3\underline{b}$

$= 2\underline{a} - 6\underline{a} + 7\underline{a} + 6\underline{b} + 3\underline{b}$

$= 3\underline{a} + 9\underline{b}$ (1)

$\overrightarrow{OC} = \overrightarrow{OA} + \overrightarrow{AC}$

$= 2\underline{a} + \lambda(-2\underline{a} + 2\underline{b})$

$= (2 - 2\lambda)\underline{a} + 2\lambda\underline{b}$ (1)

$\overrightarrow{OC} = \mu(\overrightarrow{OE})$

$= \mu(3\underline{a} + 9\underline{b})$

$\underline{a}$: $2 - 2\lambda = 3\mu$ — 1

$\underline{b}$: $2\lambda = 9\mu$

$\lambda = \frac{9}{2}\mu$ — 2

1

$2 - \cancel{2}\left(\frac{9}{\cancel{2}}\mu\right) = 3\mu$

$2 = 12\mu$

$\mu = \frac{1}{6}$

$\lambda = \frac{\cancel{9}3}{2}\left(\frac{1}{\cancel{6}2}\right)$

$\lambda = \frac{3}{4}$

OC : CE = 1:5

$\vec{OC} = \frac{1}{6}(\vec{OE})$ $\vec{CE} = \frac{5}{6}(\vec{OE})$

1

1 : 5 ....

(Total for Question 13 is 5 marks)

14

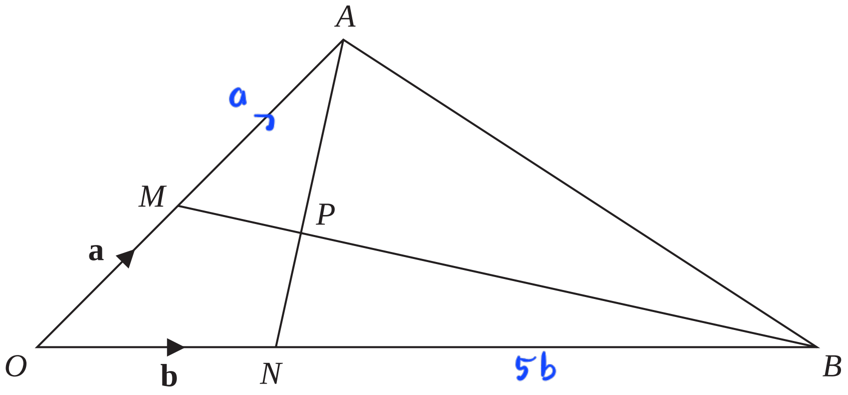


Diagram **NOT** accurately drawn

OMA, *ONB*, *MPB* and *NPA* are straight lines.

M is the midpoint of *OA*

$ON : NB = 1 : 5$

$\overrightarrow{OM} = \mathbf{a}$ $\overrightarrow{ON} = \mathbf{b}$

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

$\overrightarrow{AN} = \overrightarrow{AO} + \overrightarrow{ON}$

$= -2\underline{a} + \underline{b}$

$-2\underline{a} + \underline{b}$ (1)

(1)

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

$\overrightarrow{OP} = \overrightarrow{OM} + \overrightarrow{MP}$

$= \underline{a} + \lambda(\overrightarrow{MB})$ (1)

$= \underline{a} + \lambda(-\underline{a} + 6\underline{b})$

$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$

$= 2\underline{a} + \mu(\overrightarrow{AN})$ (1)

$= 2\underline{a} + \mu(-2\underline{a} + \underline{b})$

$\underline{a}: 1 - \lambda = 2 - 2\mu$ — (1)

$\underline{b}: 6\lambda = \mu$ — (2) (1)

substitute (2) into (1):

$1 - \lambda = 2 - 2(6\lambda)$

$1 - \lambda = 2 - 12\lambda$

$11\lambda = 1$

$\lambda = \frac{1}{11}$ $\mu = \frac{6}{11}$

$\overrightarrow{AP} = \frac{6}{11}\overrightarrow{AN}$

$\overrightarrow{AP} : \overrightarrow{PN} = 6 : 5$ (1)

$AP : PN =$ 6 : 5

(4)

(Total for Question 14 is 5 marks)