

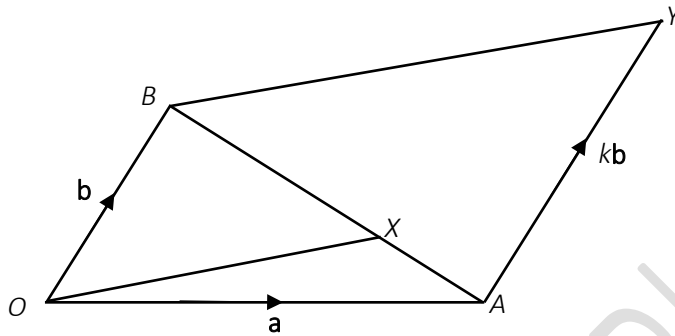
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LEARNING PLACE

Elementary Math Topical (Vector)

Question 1:

In the diagram, $\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OB} = \mathbf{b}$ and $\overrightarrow{AY} = k\mathbf{b}$. X lies on the line AB such that $\overrightarrow{AX} = \frac{1}{3}\overrightarrow{AB}$



Express the following vectors, as simply as possible, in terms of \mathbf{a} and \mathbf{b} , find

a) \overrightarrow{AX}

b) \overrightarrow{OX}

c) Express \overrightarrow{BY} in terms of k , \mathbf{a} and \mathbf{b}

d) Given that \overrightarrow{OX} is parallel to \overrightarrow{BY} , find the value of k .

e) The line OX when produced, meets AY at Z . Find ratio of $AZ : OB$.

f) $\frac{\text{area of } \triangle OAX}{\text{area of } \triangle OBX}$

g) $\frac{\text{area of } \triangle OAX}{\text{area of quadrilateral OAYB}}$

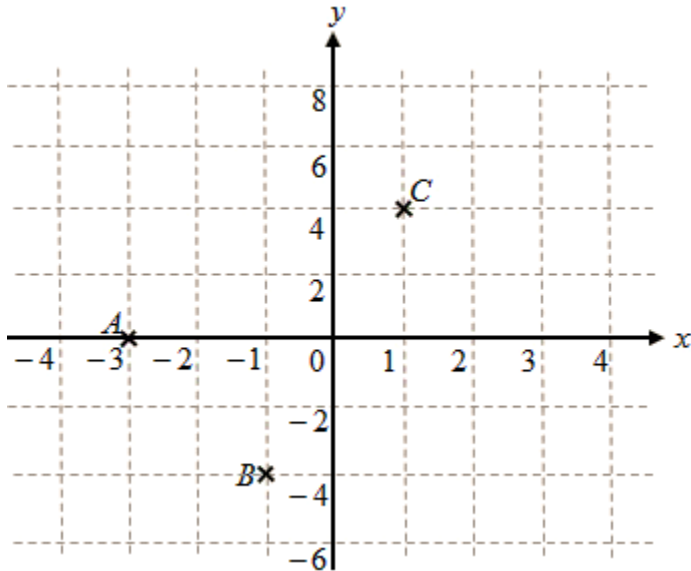
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Elementary Math Topical (Vector)

Question 2:

The diagram shows three points $A(-3,0)$, $B(-1,-4)$ and $C(1,4)$.



- Express \overrightarrow{AC} as column vector.
- Given that $\overrightarrow{OS} = \begin{pmatrix} 2 \\ a \end{pmatrix}$ is parallel to \overrightarrow{AC} , find the value of a .
- Find $|2\overrightarrow{AC}|$
- Find the position vector of point D given that $ABCD$ is a parallelogram

Question 3:

Given that $\overrightarrow{OM} = \begin{pmatrix} 3 \\ -5 \end{pmatrix}$, $\overrightarrow{ON} = \begin{pmatrix} -5 \\ -7 \end{pmatrix}$ where O is the origin and P is a point on the y -axis such that

$$\overrightarrow{MP} = \begin{pmatrix} -3 \\ 10 \end{pmatrix},$$

- express \overrightarrow{NM} as a column vector
- find the coordinates where the line MP crosses the x -axis.

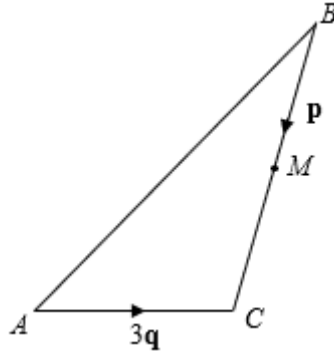
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Elementary Math Topical (Vector)

Question 4:

In triangle ABC below, M is the midpoint of BC . It is given that $\overrightarrow{BC} = \mathbf{p}$ and $\overrightarrow{AC} = 3\mathbf{q}$.



a) Find \overrightarrow{AM} in terms of \mathbf{p} and \mathbf{q} .

X is a point outside triangle ABC such that $\overrightarrow{BX} = k\mathbf{q}$, where k is a positive integer, and \overrightarrow{CX} is parallel to \overrightarrow{AM} .

b) Express \overrightarrow{CX} in terms of k , \mathbf{p} and \mathbf{q} .

c) Find the value of k .

Y is a point on AM such that $5AY = 2AM$. Z is a point on AB such that $AZ : AB = 1 : 4$. Express, in terms of \mathbf{p} and \mathbf{q} ,

d) \overrightarrow{CY}

e) \overrightarrow{CZ}

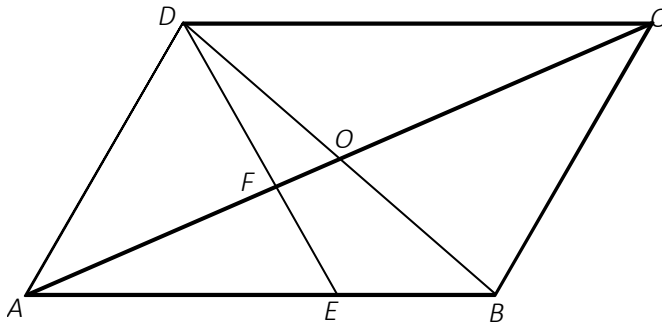
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Elementary Math Topical (Vector)

Question 5:

$ABCD$ is a parallelogram whose diagonals, AC and BD , intersect at O . E is a point on AB such that $AE = 2EB$. DE intersects AC at F .



Given that $\vec{OA} = \mathbf{a}$ and $\vec{OB} = \mathbf{b}$, express the following vectors in terms of \mathbf{a} and/or \mathbf{b} , giving each of your answers in its simplest form,

a) \vec{AC}

b) \vec{CD}

c) \vec{DA}

d) Show that $\vec{DE} = \frac{1}{3}(\mathbf{a} + 5\mathbf{b})$

e) Given that $\vec{FA} = \frac{4}{5}\vec{OA}$, show that D , E and F lie on the same straight line.

Find the numerical value of

f) $\frac{\text{Area of } \triangle AEF}{\text{Area of } \triangle CDF}$

g) $\frac{\text{Area of } \triangle DOF}{\text{Area of } \triangle AEF}$

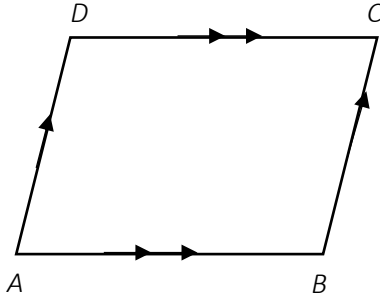
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Elementary Math Topical (Vector)

Question 6:

The position vectors of points A , B and C are $\vec{OA} = \begin{pmatrix} -2 \\ -3 \end{pmatrix}$, $\vec{OB} = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$ and $\vec{OC} = \begin{pmatrix} 3 \\ -3 \end{pmatrix}$ respectively. A point D is such that $ABCD$ is a parallelogram.



a) Find \vec{AB} .

b) Hence, find the coordinates of D .

The position of point E is $\vec{OE} = \begin{pmatrix} 9 \\ e \end{pmatrix}$.

c) Find $|\vec{CE}|$ in terms of e .

d) Given that $|\vec{CE}| = 2|\vec{AC}|$, find the possible values of e .

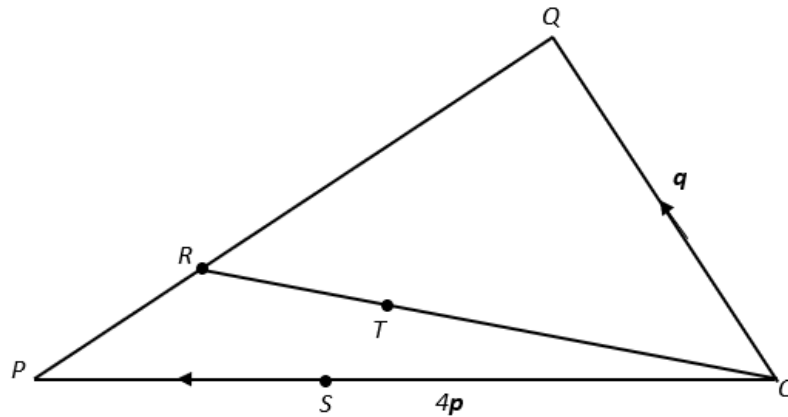
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Elementary Math Topical (Vector)

Question 7:

In the diagram, OPQ is a triangle and R , S and T are points on PQ , OP and OR respectively. It is given that $OS : OP = 4 : 7$, $OT : OR = 2 : 3$, $PR : PQ = 1 : 3$, $\vec{OS} = 4\mathbf{p}$ and $\vec{OQ} = \mathbf{q}$.



Express the following vectors in terms of \mathbf{p} and \mathbf{q} .

- \vec{QS}
- \vec{OR}
- \vec{OT}
- \vec{QT}
- State two facts about the vectors \vec{QT} and \vec{QS} .

Find the ratio of the areas of

- $\triangle OQT$ and $\triangle OQS$
- $\triangle OQS$ and $\triangle OQP$.

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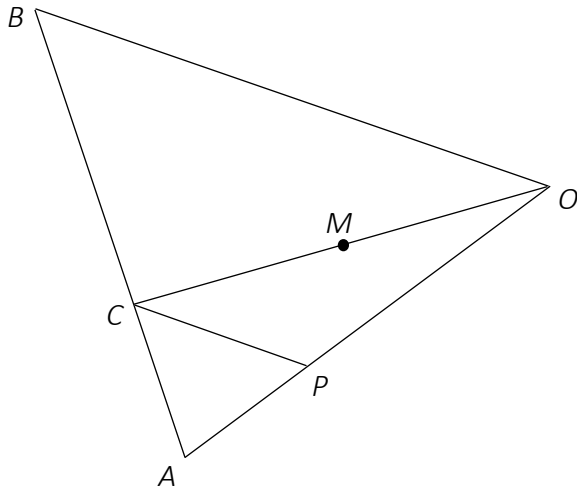
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Elementary Math Topical (Vector)

Question 8:

OAB is a triangle. $\overrightarrow{OA} = 3\mathbf{a}$ and $\overrightarrow{OB} = 2\mathbf{b}$. $\overrightarrow{OP} = \frac{2}{3}\overrightarrow{OA}$ and $\overrightarrow{AC} = \frac{1}{3}\overrightarrow{AB}$. M is a point on OC such that

$OM = MC$.



Express, as simply as possible, in terms of \mathbf{a} and/or \mathbf{b} ,

a) \overrightarrow{AB}

b) \overrightarrow{PC}

c) \overrightarrow{OC}

d) Explain why \overrightarrow{PC} is parallel to \overrightarrow{OB} .

e) Show that triangle ACP and ABO are similar.

f) Write down the ratio of the area of triangle ACP to the area of the quadrilateral CPOB.

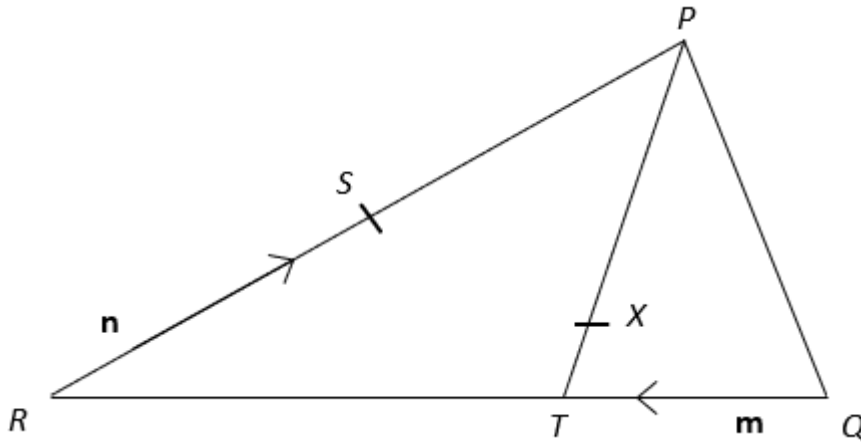
g) X is a point on OB such that $OB = 3OX$. Show that P, M and X are collinear.

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Elementary Math Topical (Vector)

Question 9:



In the diagram, $QR = 4QT$ and $TP = 5TX$. S is the midpoint of PR . $\vec{QT} = \mathbf{m}$ and $\vec{RS} = \mathbf{n}$.

Express, in terms of \mathbf{m} and/or \mathbf{n} ,

a) \vec{TR}

b) \vec{TP}

c) \vec{TX}

d) \vec{QS}

e) Show that $\vec{QX} = \frac{2}{5}(4\mathbf{m} + \mathbf{n})$.

f) Write down one fact you can deduce about the points Q , X and S .

Determine the value of

g) $\frac{QX}{QS}$,

h) $\frac{\text{Area of } \Delta PQX}{\text{Area of } \Delta PQT}$

i) $\frac{\text{Area of } \Delta PQX}{\text{Area of } \Delta PQR}$

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Elementary Math Topical (Vector)

Question 10:

$$\overrightarrow{AB} = \begin{pmatrix} 9 \\ -12 \end{pmatrix}$$

a) Find $|\overrightarrow{AB}|$.

b) D is the point $(-2, 5)$. $\overrightarrow{DC} = 2\overrightarrow{AB}$. Find the coordinates of C .

c) What type of quadrilateral is $ABCD$?

Question 11:

XYZ is a triangle.

$$\overrightarrow{XY} = \begin{pmatrix} 2 \\ 2 \end{pmatrix}, \overrightarrow{XZ} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$$

a) Calculate the length YZ .

b) Coordinates of Y is $(3, 4)$. Find the coordinates of X .

Question 12:

Given that $\overrightarrow{OP} = \begin{pmatrix} 7 \\ -2 \end{pmatrix}$, $\overrightarrow{OQ} = \begin{pmatrix} 4 \\ 6 \end{pmatrix}$ and $\overrightarrow{OR} = \begin{pmatrix} -2 \\ k \end{pmatrix}$. Find

a) $|\overrightarrow{PQ}|$

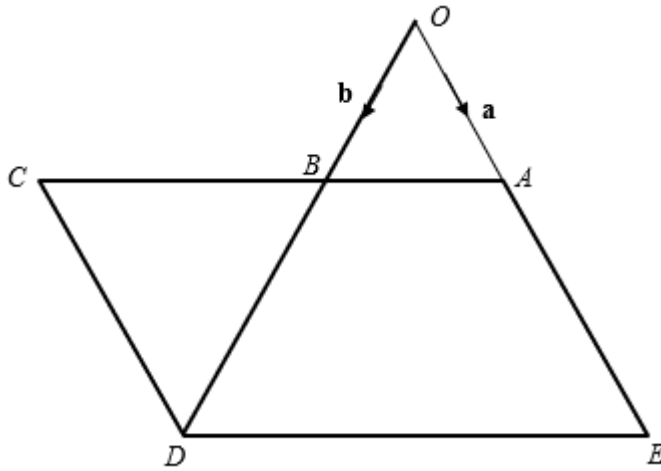
b) the value of k if O, P and R lie on the same straight line.

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Elementary Math Topical (Vector)

Question 13:



$ACDE$ is a parallelogram. The point B lie on CA . The line DB produced meets EA produced at the point

O such that $\frac{OB}{BD} = \frac{OA}{AE} = \frac{2}{3}$. It is given that $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$

Express, as simply as possible in terms of \mathbf{a} and/or \mathbf{b}

a) \overrightarrow{BA}

b) \overrightarrow{DE}

c) \overrightarrow{EC}

d) Show that triangle AOB and triangle CDB are similar.

Find, in its simplest form,

e) $\frac{\text{Area of triangle } OAB}{\text{Area of triangle } OED}$

f) $\frac{\text{Area of triangle } OAB}{\text{Area of triangle } OBE}$

g) $\frac{\text{Area of triangle } BCD}{\text{Area of quadrilateral } ABDE}$

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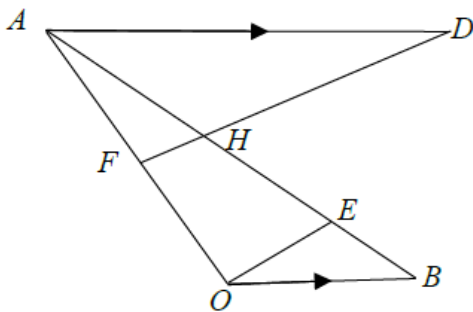
Elementary Math Topical (Vector)

Question 14:

The position vectors A and B , relative to O , are \mathbf{a} and \mathbf{b} respectively.

AD is parallel to OB such that $2AD = 3OB$ and E is a point on AB such that $AE : EB = 3 : 1$.

F is the midpoint of OA .



Express, as simply as possible, in terms of \mathbf{a} and/ or \mathbf{b} ,

- \overrightarrow{OE}
- \overrightarrow{FD}
- Write down 2 facts about OE and FD .
- If FD meets AB at a point H , and the area of OBE is 20 units², find the area of AFH .

Question 15:

It is given that $\overrightarrow{AC} = \begin{pmatrix} 8 \\ -3 \end{pmatrix}$ and $\overrightarrow{OC} = \begin{pmatrix} -10 \\ 5 \end{pmatrix}$. B is a point on OC such that $OB : BC = 2:3$. A , B and C are three points on level ground.

- Find the coordinates of A .
- Find \overrightarrow{OB}
- Evaluate $|\overrightarrow{AB}|$
- Given that $\begin{pmatrix} 2 \\ p \end{pmatrix}$ is parallel to \overrightarrow{AC} , find the value of p .

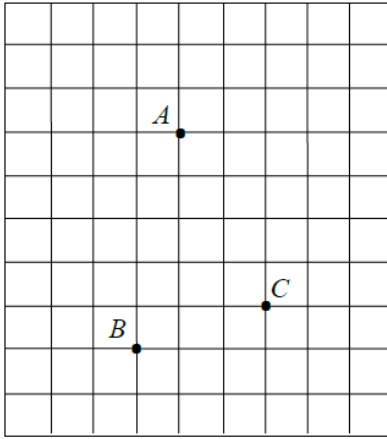
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Elementary Math Topical (Vector)

Question 16:

The grid below shows the positions of the points A, B and C where $\overrightarrow{BC} = \begin{pmatrix} 9 \\ 3 \end{pmatrix}$



- Express \overrightarrow{AC} as a column vector.
- D is a point such that $ABCD$ is a parallelogram. Find the value of $|\overrightarrow{CD}|$.

Question 17:

$OPQR$ is a parallelogram such that $\overrightarrow{PQ} = \begin{pmatrix} 2 \\ 4 \end{pmatrix}$ and P is the point $(3, 2)$.

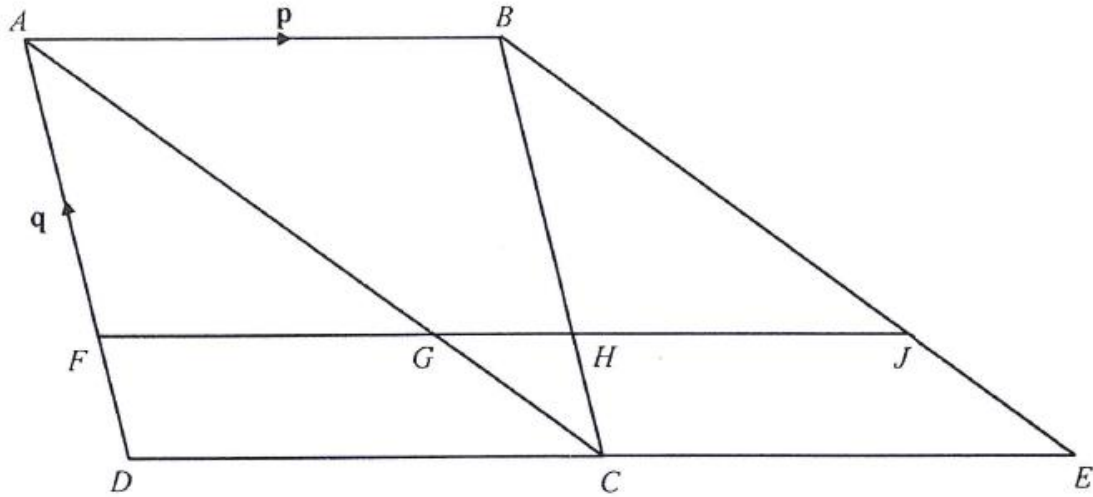
- Express \overrightarrow{RP} as a column vector
- The point J lies on \overrightarrow{RP} produced such that $\overrightarrow{PJ} = m\overrightarrow{RP}$. Show that $\overrightarrow{OJ} = \begin{pmatrix} 3+m \\ 2-2m \end{pmatrix}$

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Elementary Math Topical (Vector)

Question 18:



$ABCD$ is a rhombus. $ABEC$ is a parallelogram. FJ is parallel to AB and DC . F, G, H and J are points on AD, AC, BC and BE respectively.

$\overrightarrow{AB} = \mathbf{p}$ and $\overrightarrow{DA} = \mathbf{q}$. $FG : DC = 8 : 11$.

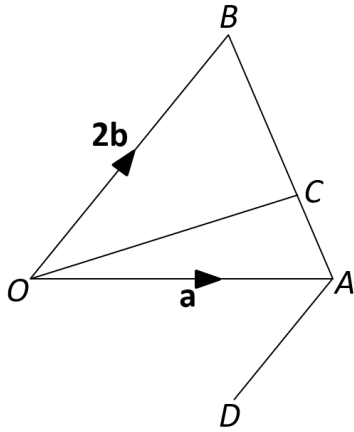
- a) Show that triangle ABC and JHB are similar. Give a reason for each statement you make.
- b) Express \overrightarrow{CG} , as simply as possible, in terms of \mathbf{p} and \mathbf{q} .
- c) X is a point on BE . Triangle BCX is congruent to triangle ECX . Find \overrightarrow{CX} , as simply as possible in terms of \mathbf{p} and \mathbf{q} .
- d) Find the ratio $BJ : JE$.
- e) Find the ratio of area triangle BHJ : area quadrilateral $ABHG$.

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Elementary Math Topical (Vector)

Question 19:



The position vectors of A and B, relative to O, are \mathbf{a} and $2\mathbf{b}$ respectively. $\overline{BC} = \frac{3}{4}\overline{BA}$ and

$$\overline{AD} = \frac{1}{2}\overline{BO}.$$

Find, in terms of \mathbf{a} and \mathbf{b} ,

a) \overline{AB}

b) \overline{OC}

c) the position vector of P, such that $\overline{BP} = 3\overline{OA}$.

d) What can you deduce about O, C and P? Explain your answer.

Find the ratio of

e) the area of triangle OCB to the area of triangle OCA,

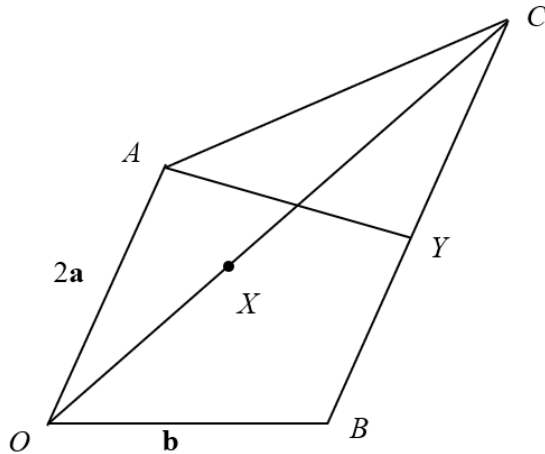
f) the area of triangle OAC to the area of triangle OAD.

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Elementary Math Topical (Vector)

Question 20:



In the diagram, $\vec{OA} = 2\mathbf{a}$, $\vec{OB} = \mathbf{b}$. BC is parallel to OA and $BC = \frac{3}{2}OA$. X is a point on OC such that $OX = \frac{2}{3}OC$. Y is the midpoint of BC . Express in terms of \mathbf{a} and/or \mathbf{b} , as simply as possible,

- a) \vec{AB}
- b) \vec{OC}
- c) \vec{OX}
- d) \vec{AX}

e) What can you deduce about the points A , X and B ? Justify your answer.

f) AY produced meets OB produced at a point Z . Given that $\vec{AZ} = h\vec{AY}$, express \vec{AZ} in terms of \mathbf{a} , \mathbf{b} and h .

g) Given also that $\vec{OZ} = k\vec{OB}$, express \vec{AZ} in terms of \mathbf{a} , \mathbf{b} , and k .

h) Hence, show that $h = 4$ and $k = 4$.

Find the value of

- i) $\frac{\text{area of } \triangle OAX}{\text{area of } \triangle OAC}$
- j) $\frac{\text{area of } \triangle OBX}{\text{area of } \triangle ABC}$

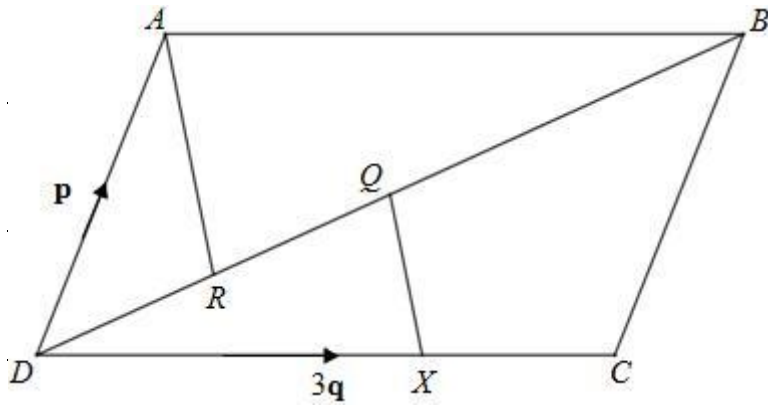
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Elementary Math Topical (Vector)

Question 21:

In the diagram, $ABCD$ is a parallelogram, Q is the midpoint of DB , R is the midpoint of DQ and X is the point on DC such that $DX = 2XC$.



a) Given that $\overrightarrow{DA} = \mathbf{p}$ and $\overrightarrow{DC} = 3\mathbf{q}$, show that $\overrightarrow{DB} = \mathbf{p} + 3\mathbf{q}$.

b) \overrightarrow{DR}

c) \overrightarrow{AR} ,

d) \overrightarrow{QX} .

e) Write down two facts about your answers to (b) and (c).

f) What is the special name given to the quadrilateral $AQXR$?

Write down the value of

g) $\frac{\text{area of } \triangle ABR}{\text{area of } \triangle DQX}$

h) $\frac{\text{area of } \triangle DAR}{\text{area of parallelogram } ABCD}$