19. Three points A, B and C lie on a straight line and their coordinates are $(-4, -6)$, $(-1, 0)$ and $(w + 1, 4w - 2)$ respectively.

(a) Find the value of w.

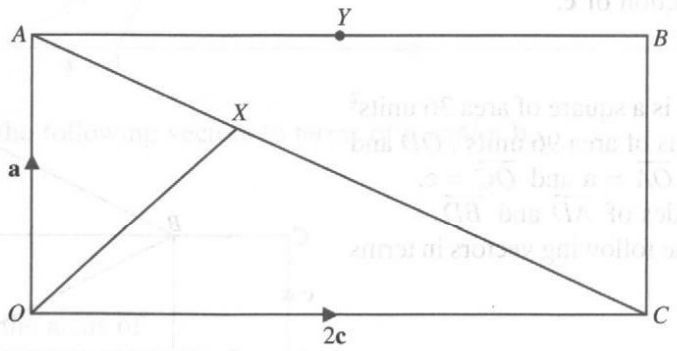
(b) Hence, express $\overrightarrow{AC}$ and $\overrightarrow{BC}$ as column vectors.

(c) **(i)** Find the position vector of the point D if $\overrightarrow{CD} = \begin{pmatrix} 0 \\ -22 \end{pmatrix}$.

(ii) Write down the coordinates of D.

(d) Hence, find the position vector of the point E if $ACED$ is a parallelogram.

20. In the diagram, $OABC$ is a rectangle and Y is the midpoint of AB. It is given that $AX : AC = 1 : 3$, $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = 2\mathbf{c}$.



(a) Express following vectors in terms of **a** and **c**.

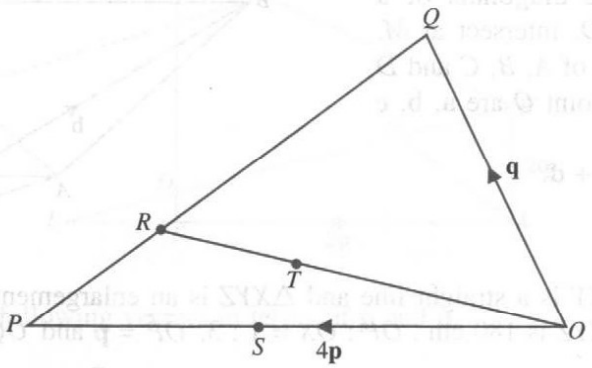
(i) $\overrightarrow{OX}$

(ii) $\overrightarrow{OY}$

(b) Do the points O, X and Y lie on the same straight line? Explain your answer.

(c) Suppose OY and CB produced intersect at Z. Show that $\overrightarrow{OB} = \overrightarrow{AZ}$.

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



(a) Express the following vectors in terms of **p** and **q**.

(i) $\overrightarrow{QS}$

(ii) $\overrightarrow{OR}$

(iii) $\overrightarrow{OT}$

(iv) $\overrightarrow{QT}$

(b) State two facts about the vectors $\overrightarrow{QT}$ and $\overrightarrow{QS}$.

(c) Find the ratio of the areas of

(i) $\triangle OQT$ and $\triangle OQS$,

(ii) $\triangle OQS$ and $\triangle OQP$,

(iii) $\triangle OQT$ and $\triangle OQP$.