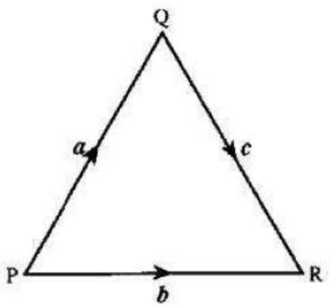
1 PQRS is a parallelogram with vertices $P(1,3,3)$, $Q(4,-2,-2)$ and $R(3,1,1)$.
Find the coordinates of S. **3**

2 ABCD is a quadrilateral with vertices $A(4,-1,3)$, $B(8,3,-1)$, $C(0,4,4)$ and $D(-4,0,8)$.

(*a*) Find the coordinates of M, the midpoint of AB. **1**

(*b*) Find the coordinates of the point T, which divides CM in the ratio 2 : 1. **3**

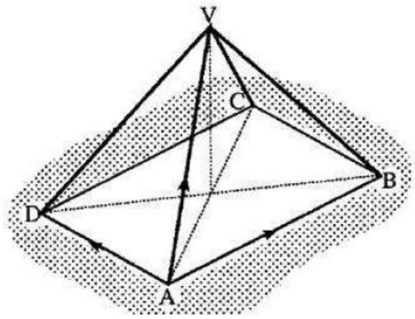
3 PQR is an equilateral triangle of side 2 units.



$\overrightarrow{PQ} = \boldsymbol{a}$, $\overrightarrow{PR} = \boldsymbol{b}$ and $\overrightarrow{QR} = \boldsymbol{c}$

Evaluate $\boldsymbol{a}.(\boldsymbol{b}+\boldsymbol{c})$ and hence identify two vectors which are perpendicular. **4**

4 VABCD is a pyramid with rectangular base ABCD.



The vectors $\overrightarrow{AB}, \overrightarrow{AD}$ and $\overrightarrow{AV}$ are given by

$\overrightarrow{AB} = 8\boldsymbol{i} + 2\boldsymbol{j} + 2\boldsymbol{k}$

$\overrightarrow{AD} = -2\boldsymbol{i} + 10\boldsymbol{j} - 2\boldsymbol{k}$

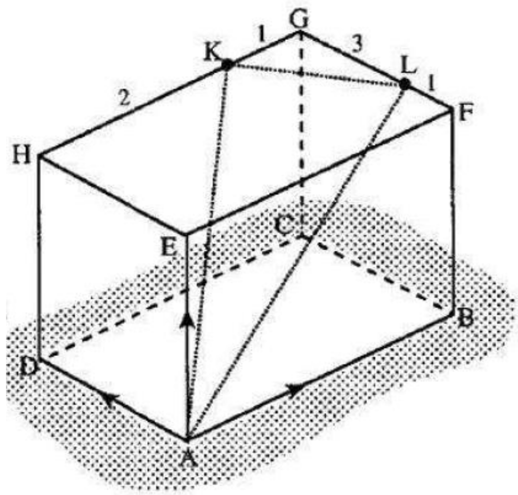
$\overrightarrow{AV} = \boldsymbol{i} + 7\boldsymbol{j} + 7\boldsymbol{k}$

Express $\overrightarrow{CV}$ in component form.

3

5 ABCDEFGH is a cuboid.

K lies two thirds of the way along HG. (i.e. HK:KG = 2:1).
L lies one quarter of the way along FG. (i.e. FL:LG = 1:3).



$\overrightarrow{AB}, \overrightarrow{AD}$ and $\overrightarrow{AE}$ can be represented by the vectors

$\begin{pmatrix}3\\6\\3\end{pmatrix}, \begin{pmatrix}-8\\4\\4\end{pmatrix}$ and $\begin{pmatrix}1\\-3\\5\end{pmatrix}$ respectively.

(a) Calculate the components of $\overrightarrow{AK}$. **2**

(b) Calculate the components of $\overrightarrow{AL}$. **2**

(c) Calculate the size of angle KAL. **5**

23 Marks