Write your name, centre number and candidate number in the boxes below.

| Surname | Other names |
|---|---|
| | |

Centre number | | | | | |

Candidate number | | | | |

**STEM** | Exam Builder

# Vector geometry

Time allowed: 1 hour 5 minutes

**Subject code** **0580**

# Mathematics

## Questions from Paper 1, Paper 2 and Paper 4

**You must have:** a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.
**You may use a calculator.**

Total marks

**/ 54**

### Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.
- Unless a question says otherwise, give answers that are not exact to 3 significant figures, and angles in degrees to 1 decimal place.

### Information

- This paper has 10 questions worth 54 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

### Advice

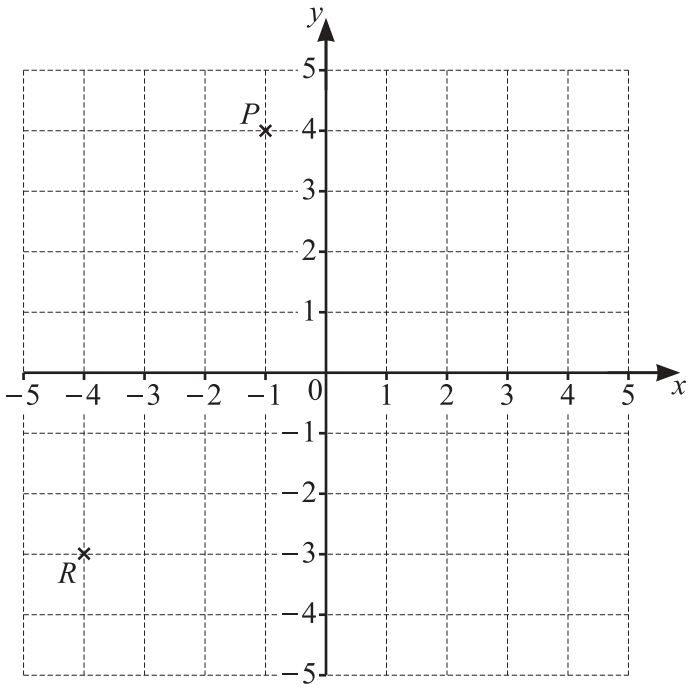
- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

STEM | Exam Builder



Print at 100% (Actual size) so diagrams keep their real measurements.

**1** The grid shows point $P$ and point $R$.




**(a)** Write down the coordinates of point $P$.

(..... , .....) [1]

**(b)** $\overrightarrow{PQ} = \begin{pmatrix} 3 \\ -2 \end{pmatrix}$

Mark point $Q$ on the grid. [1]

**(c)** Find $\overrightarrow{QR}$.

$\overrightarrow{QR} = \begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

**(d)** Complete this statement.

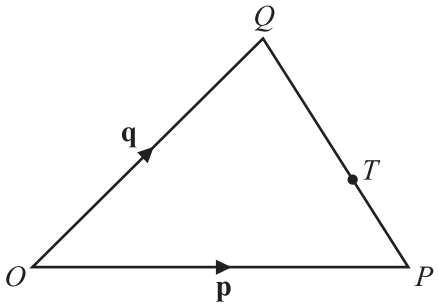
$\overrightarrow{PQ} + \overrightarrow{QR} =$ ..... [1]

(a) Coordinates (b) Vectors as diagrams (c) Position and displacement vectors (d) Position and displacement vectors Click for more variations

| | | | |
|---|---|---|---|
| **1**(a) | (−1, 4) | **1** | |
| **1**(b) | $Q$ marked at (2, 2) | **1** | |
| **1**(c) | $\begin{pmatrix} -6 \\ -5 \end{pmatrix}$ | **1** | **FT** *their* point $Q$ |
| **1**(d) | $PR$ | **1** | |

STEM | Exam Builder

**2**




NOT TO SCALE

$O$ is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.
$QT : TP = 2 : 1$

Find the position vector of $T$.
Give your answer in terms of **p** and **q**, in its simplest form.

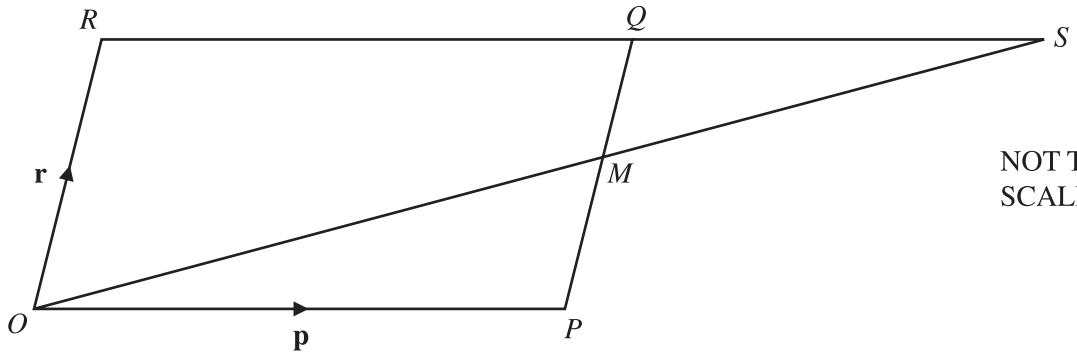
..... [2]

Position and displacement vectors Click for more variations

| | | | |
|---|---|---|---|
| **2** | $\frac{2}{3}\mathbf{p} + \frac{1}{3}\mathbf{q}$ | **2** | **M1** for correct route e.g. $\overrightarrow{OT}$ or $\overrightarrow{OQ} + \overrightarrow{QT}$<br>or for $\overrightarrow{QT} = \frac{2}{3}(-\mathbf{q} + \mathbf{p})$ oe or for $\overrightarrow{PT} = \frac{1}{3}(-\mathbf{p} + \mathbf{q})$ oe |

STEM | Exam Builder

**3**




*OPQR* is a parallelogram, with *O* the origin.
*M* is the midpoint of *PQ*.
*OM* and *RQ* are extended to meet at *S*.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OR} = \mathbf{r}$.

**(a)** Find, in terms of **p** and **r**, in its simplest form,

**(i)** $\overrightarrow{OM}$,

*Answer(a)*(i) $\overrightarrow{OM} =$ ..... [1]

**(ii)** the position vector of *S*.

*Answer(a)*(ii) ..... [1]

**(b)** When $\overrightarrow{PT} = -\frac{1}{2}\mathbf{p} + \mathbf{r}$, what can you write down about the position of *T*?

*Answer(b)* ..... [1]

(a)(i) Position and displacement vectors | (a)(ii) Finding vector paths | (b) Finding vector paths

Click for more variations

| | | | | |
|---|---|---|---|---|
| **3** | **(a)** **(i)** | $\mathbf{p} + \frac{1}{2}\mathbf{r}$ | **1** | |
| | **(ii)** | $2\mathbf{p} + \mathbf{r}$ | **1ft** | 2 × *their* (i) |
| | **(b)** | Midpoint of *R*Q | **1** | |

STEM | Exam Builder

**4** The position vector **r** is given by $\mathbf{r} = 2\mathbf{p} + t(\mathbf{p} + \mathbf{q})$.

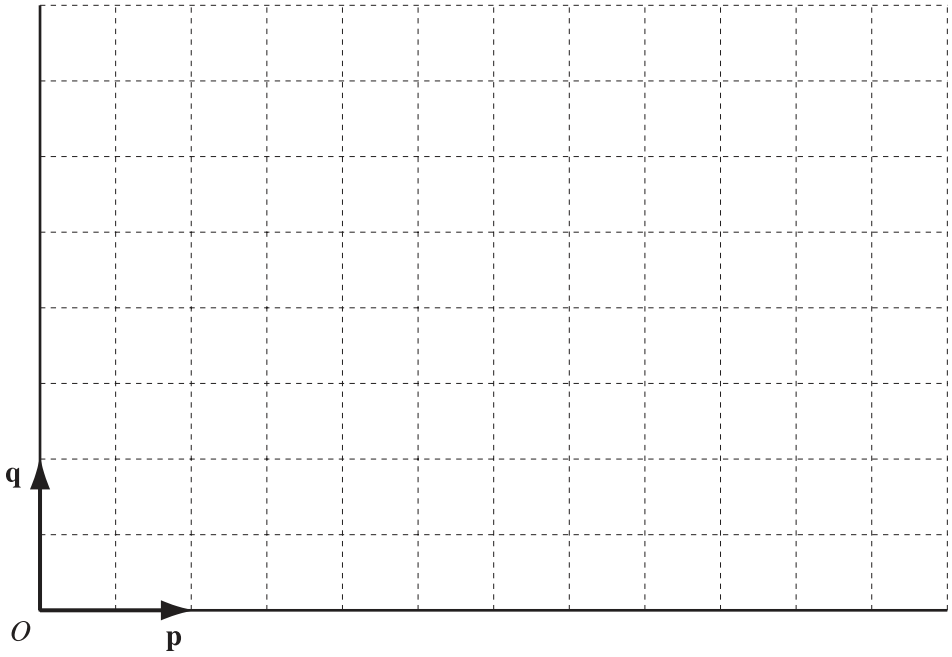
**(a)** Complete the table below for the given values of $t$.
Write each vector in its simplest form.
One result has been done for you.

| $t$ | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| **r** | | | $4\mathbf{p} + 2\mathbf{q}$ | |

[3]

**(b)** $O$ is the origin and **p** and **q** are shown on the diagram.

**(i)** Plot the 4 points given by the position vectors in the table.




[2]

**(ii)** What can you say about these four points?

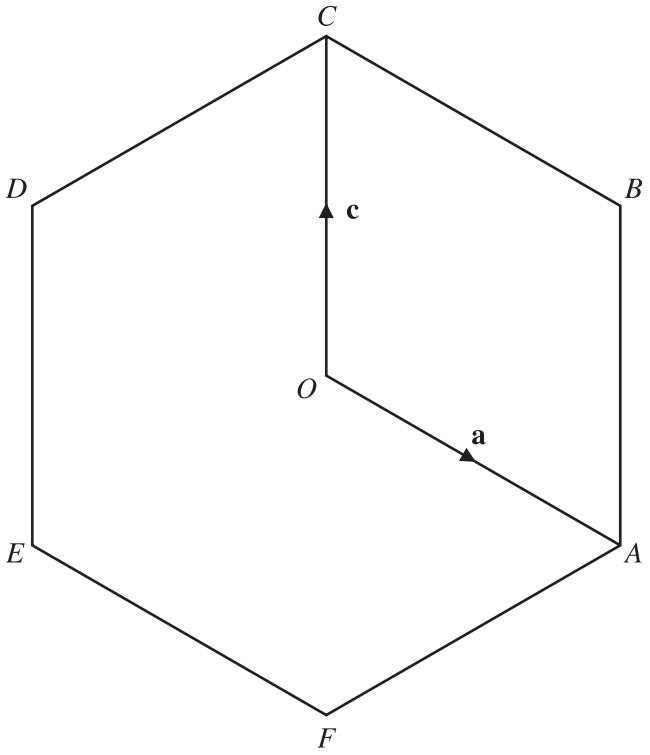
*Answer(b)*(ii) ..... [1]

(a) Position and displacement vectors (b)(i) Position and displacement vectors
(b)(ii) Position and displacement vectors Click for more variations

| | | | |
|---|---|---|---|
| **4** | **(a)** 2**p** 3**p** + **q** …….. 5**p** + 3**q** cao | 1, 1, 1 | |
| | **(b)** **(i)** all 4 plotted correctly ft | 2 | **B1** 2 or 3 correct |
| | **(ii)** a (straight) line | 1 | Allow linear, collinear |

STEM | Exam Builder

**5**




$O$ is the origin.
$ABCDEF$ is a regular hexagon and $O$ is the midpoint of $AD$.

$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = \mathbf{c}$.

Find, in terms of **a** and **c**, in their simplest form

**(a)** $\overrightarrow{BE}$,

*Answer(a)* $\overrightarrow{BE}$ = ..... [2]

**(b)** $\overrightarrow{DB}$,

*Answer(b)* $\overrightarrow{DB}$ = ..... [2]

**(c)** the position vector of $E$.

*Answer(c)* ..... [2]

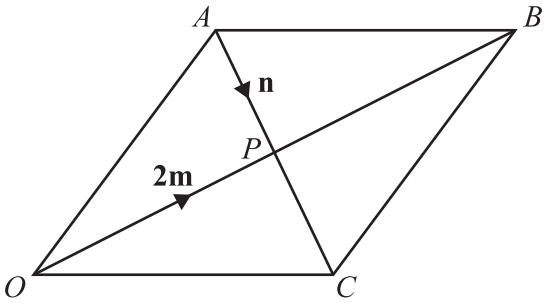
(a) Finding vector paths (b) Finding vector paths (c) Finding vector paths Click for more variations

STEM | Exam Builder

| | | | |
|---|---|---|---|
| **5** | **(a)** $-2\mathbf{a} - 2\mathbf{c}$ oe | **2** | **M1** for **BO** = **–a – c** or for any correct route or correct unsimplified expression |
| | **(b)** $2\mathbf{a} + \mathbf{c}$ | **2** | **M1** for any correct route or correct unsimplified expression |
| | **(c)** **–a – c** oe | **2FT** | FT *their* **(a)** or correct answer<br>Or **M1** for a correct non direct route from O to E or for correct unsimplified expression or for correct FT unsimplified |

STEM | Exam Builder

**6**




NOT TO SCALE

$OABC$ is a rhombus and $O$ is the origin.
The diagonals of the rhombus intersect at $P$.
$\overrightarrow{OP} = 2\,\mathbf{m}$ and $\overrightarrow{AP} = \mathbf{n}$.

**(a)** Find, in terms of **m** and **n**, in its simplest form

**(i)** $\overrightarrow{OA}$

$\overrightarrow{OA} =$ ..... [1]

**(ii)** $\overrightarrow{OC}$.

$\overrightarrow{OC} =$ ..... [1]

**(b)** $D$ is the point such that $\overrightarrow{AD} = 10\mathbf{m} - 3\mathbf{n}$.

Show that $OADC$ is a trapezium.

STEM | Exam Builder

[3]

(a)(i) Position and displacement vectors (a)(ii) Position and displacement vectors (b) Problem solving with vectors

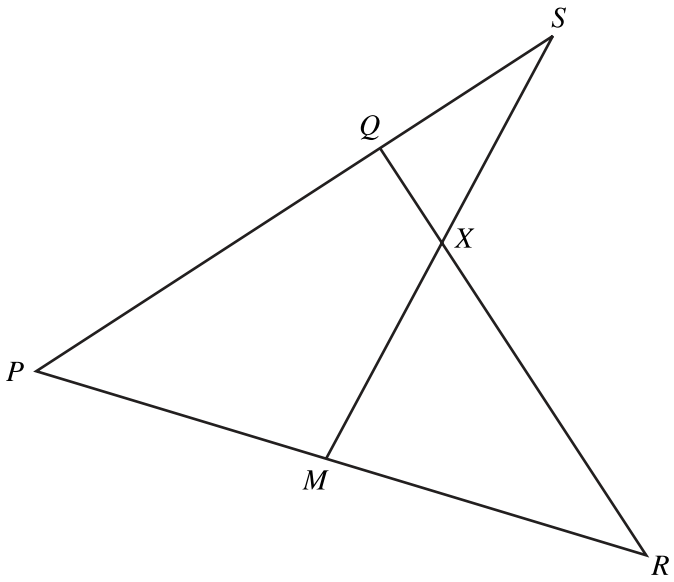
Click for more variations

| | | | |
|---|---|---|---|
| **6**(a)(i) | $2\mathbf{m} - \mathbf{n}$ | **1** | |
| **6**(a)(ii) | $2\mathbf{m} + \mathbf{n}$ | **1** | |

| | | | |
|---|---|---|---|
| **6**(b) | $\overrightarrow{CD} = 10\mathbf{m} - 5\mathbf{n}$ | **M2** | Allow **M2** for equivalents<br>$\overrightarrow{CD} = -2\mathbf{n} + 10\mathbf{m} - 3\mathbf{n}$<br>or $\overrightarrow{CD} = -(2\mathbf{m} + \mathbf{n}) + 2\mathbf{m} - \mathbf{n} + 10\mathbf{m} - 3\mathbf{n}$<br><br>For **M2**, FT *their* **(a)** e.g.<br>$\overrightarrow{CD} = \textit{their}\ \overrightarrow{CO} + \textit{their}\ \overrightarrow{OA} + 10\mathbf{m} - 3\mathbf{n}$<br><br>or **M1** for correct route for $\overrightarrow{CD}$ using the lines of the diagram with $\overrightarrow{AD}$<br>e.g. $\overrightarrow{CD} = \overrightarrow{CA} + \overrightarrow{AD}$ oe |
| | $\overrightarrow{CD} = 5\overrightarrow{OA}$<br>leading to $CD$ is parallel to $OA$<br>[$\therefore$ $OACD$ is a trapezium] | **A1** | Dependent on **M2** |

STEM | Exam Builder

**7**




NOT TO SCALE

In the diagram, $PQS$, $PMR$, $MXS$ and $QXR$ are straight lines.

$PQ = 2\,QS$.
$M$ is the midpoint of $PR$.
$QX : XR = 1 : 3$.

$\overrightarrow{PQ} = \mathbf{q}$ and $\overrightarrow{PR} = \mathbf{r}$.

**(a)** Find, in terms of **q** and **r**,

**(i)** $\overrightarrow{RQ}$,

*Answer(a)*(i) $\overrightarrow{RQ}$ = ..... [1]

**(ii)** $\overrightarrow{MS}$.

*Answer(a)*(ii) $\overrightarrow{MS}$ = ..... [1]

**(b)** By finding $\overrightarrow{MX}$, show that $X$ is the midpoint of $MS$.

*Answer (b)*

STEM | Exam Builder

[3]

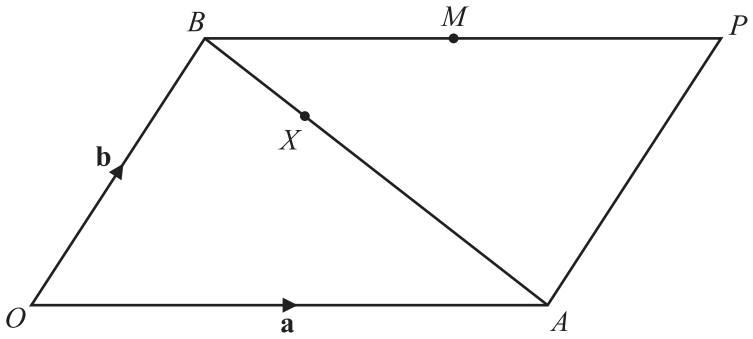
(a)(i) Position and displacement vectors | (a)(ii) Finding vector paths | (b) Problem solving with vectors

Click for more variations

| | | | |
|---|---|---|---|
| **7** | **(a) (i)** $-\mathbf{r} + \mathbf{q}$ or $\mathbf{q} - \mathbf{r}$<br>**(ii)** $\frac{1}{2}(3\mathbf{q} - \mathbf{r})$ oe<br><br>**(b)** correct working | **1**<br>**1**<br><br>**3** | <br>Must be simplified<br><br>**M1** for $\boldsymbol{MX} = \frac{1}{2}\,\mathbf{r} + \frac{3}{4}$ their $(-\mathbf{r} + \mathbf{q})$<br>**M1** using a different route for $\boldsymbol{XS}$ or $\frac{1}{2}\,\boldsymbol{MS}$<br>**E1** dep correct simplification and conclusion |

STEM | Exam Builder

**8**




NOT TO SCALE

*OAPB* is a parallelogram.
*O* is the origin, $\overrightarrow{OA}$ = **a** and $\overrightarrow{OB}$ = **b**.
*M* is the midpoint of *BP*.

**(a)** Find, in terms of **a** and **b**, giving your answer in its simplest form,

**(i)** $\overrightarrow{BA}$,

*Answer(a)*(i) $\overrightarrow{BA}$ = ..... [1]

**(ii)** the position vector of *M*.

*Answer(a)*(ii) ..... [1]

**(b)** *X* is on *BA* so that $BX : XA = 1 : 2$.

Show that *X* lies on *OM*.

*Answer(b)*

STEM | Exam Builder

[4]

(a)(i) Position and displacement vectors (a)(ii) Position and displacement vectors (b) Problem solving with vectors

Click for more variations

| | | | |
|---|---|---|---|
| **8 (a) (i)** | $-\mathbf{b} + \mathbf{a}$ | **1** | |
| **(ii)** | $\mathbf{b} + \frac{1}{2}\mathbf{a}$ | **1** | |
| **(b)** | $[\overrightarrow{OX} =]\ \mathbf{b} + \frac{1}{3}(-\mathbf{b} + \mathbf{a})$ oe | **M1** | |
| | $\frac{1}{3}\mathbf{a} + \frac{2}{3}\mathbf{b}$ oe | **A1** | |
| | 2 statements from:<br>$\overrightarrow{OM} = \mathbf{b} + \frac{1}{2}\mathbf{a}$ oe<br>or<br>$[\overrightarrow{OX} =]\ \frac{2}{3}(\mathbf{b} + \frac{1}{2}\mathbf{a})$ oe<br>or $\overrightarrow{OX} = \frac{2}{3}\overrightarrow{OM}$ oe | **B2** | **B1** for any one of these statements |

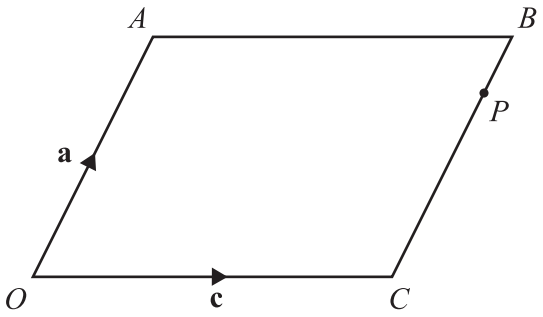
STEM | Exam Builder

**9** **(a)** $\left|\begin{pmatrix} 9m \\ 40m \end{pmatrix}\right| = \frac{205}{2}$

Find the two possible values of $m$.

$m =$ ..... or ..... [3]

**(b)**




NOT TO SCALE

$OABC$ is a parallelogram.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OC} = \mathbf{c}$.
$P$ is the point on $CB$ such that $CP : PB = 3 : 1$.

**(i)** Find, in terms of **a** and/or **c**, in their simplest form,

**(a)** $\overrightarrow{AC}$,

$\overrightarrow{AC} =$ ..... [1]

**(b)** $\overrightarrow{CP}$,

$\overrightarrow{CP} =$ ..... [1]

**(c)** $\overrightarrow{OP}$.

$\overrightarrow{OP} =$ ..... [1]

STEM | Exam Builder

**(ii)** $OP$ and $AB$ are extended to meet at $Q$.

Find the position vector of $Q$.

..... [2]

(a) Magnitude of a vector | (b)(i)(a) Position and displacement vectors | (b)(i)(b) Finding vector paths | (b)(i)(c) Finding vector paths | (b)(ii) Problem solving with vectors | Click for more variations

Reduced to 77% to fit the page (wider than A4).

| | | | |
|---|---|---|---|
| **9**(a) | 2.5 and – 2.5 oe | **3** | **M2** for $1681m^2 = \frac{42025}{4}$ oe<br>or **M1** for $(9m)^2 + (40m)^2$ oe |
| **9**(b)(i)(a) | **c** – **a** final answer | **1** | |
| **9**(b)(i)(b) | $\frac{3}{4}$ **a** final answer | **1** | |
| **9**(b)(i)(c) | **c** + $\frac{3}{4}$ **a** final answer | **1** | **FT c** + *their* **(b)(i)(b)**, must be a vector in terms of **a** and/or **c** in its simplest form |
| **9**(b)(ii) | **a** + $\frac{4}{3}$ **c** oe | **2** | **B1** for [ $\overrightarrow{BQ}$ = ] $\frac{1}{3}$ **c** or [ $\overrightarrow{AQ}$ = ] $\frac{4}{3}$ **c**<br>or<br>**M1** for a correct route<br>or for answer **a** + $k$**c** oe, where $k > 1$ |

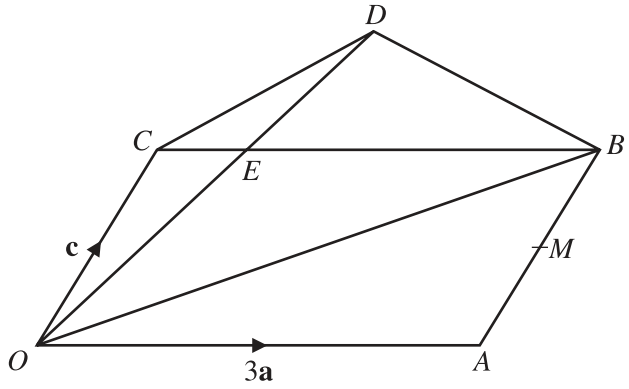
STEM | Exam Builder

**10** **(a)** $P$ is the point (2, 5) and $\overrightarrow{PQ} = \begin{pmatrix} 3 \\ -2 \end{pmatrix}$.

Write down the co-ordinates of $Q$.

*Answer(a)* ( ..... , ..... ) [1]

**(b)**




NOT TO SCALE

$O$ is the origin and $OABC$ is a parallelogram.
$M$ is the midpoint of $AB$.

$\overrightarrow{OC} = \mathbf{c}$, $\overrightarrow{OA} = 3\mathbf{a}$ and $CE = \frac{1}{3}CB$.

$OED$ is a straight line with $OE : ED = 2 : 1$.

Find in terms of **a** and **c**, in their simplest forms

**(i)** $\overrightarrow{OB}$,

*Answer(b)*(i) $\overrightarrow{OB}$ = ..... [1]

**(ii)** the position vector of $M$,

*Answer(b)*(ii) ..... [2]

**(iii)** $\overrightarrow{OE}$,

*Answer(b)*(iii) $\overrightarrow{OE}$ = ..... [1]

**(iv)** $\overrightarrow{CD}$.

*Answer(b)*(iv) $\overrightarrow{CD}$ = ..... [2]

**(c)** Write down two facts about the lines $CD$ and $OB$.

*Answer (c)* .....

..... [2]

(a) Position and displacement vectors | (b)(i) Finding vector paths | (b)(ii) Position and displacement vectors | (b)(iii) Finding vector paths | (b)(iv) Finding vector paths | (c) Problem solving with vectors

Click for more variations

STEM | Exam Builder

| | | | | |
|---|---|---|---|---|
| **10** | **(a)** | (5, 3) | **1** | |
| | **(b) (i)** | $3\mathbf{a} + \mathbf{c}$ | **1** | |
| | **(ii)** | $3\mathbf{a} + \frac{1}{2}\mathbf{c}$ **or** $\frac{1}{2}(6\mathbf{a} + \mathbf{c})$ | **2** | **M1** for $\overrightarrow{OM}$ oe e.g $OA+AM$ or correct unsimplified answer |
| | **(iii)** | $\mathbf{a} + \mathbf{c}$ | **1** | |
| | **(iv)** | $\frac{3}{2}\mathbf{a} + \frac{1}{2}\mathbf{c}$ or $\frac{1}{2}(3\mathbf{a} + \mathbf{c})$ | **2** | **M1** for $-\mathbf{c} + \frac{3}{2}\times$ their (iii) or $\mathbf{a} + \frac{1}{2}\times$ their (iii) or correct unsimplified answer or any correct route e.g. $CE + ED$ |
| | **(c)** | ($CD$) parallel (to $OB$) oe cao | **1dep** | Part (c) dependent on simplified (i) and (iv)<br>Dep on (i) = $k \times$ (iv) |
| | | $CD = \frac{1}{2}\ OB$ oe cao | **1dep** | Dep on (i) = 2 × (iv) must be scalars |

STEM | Exam Builder