



Physics. *You work it out.*

[Home](#) [Gameboard](#) [Maths](#) [Transformations of Graphs 3ii](#)

Transformations of Graphs 3ii

A Level

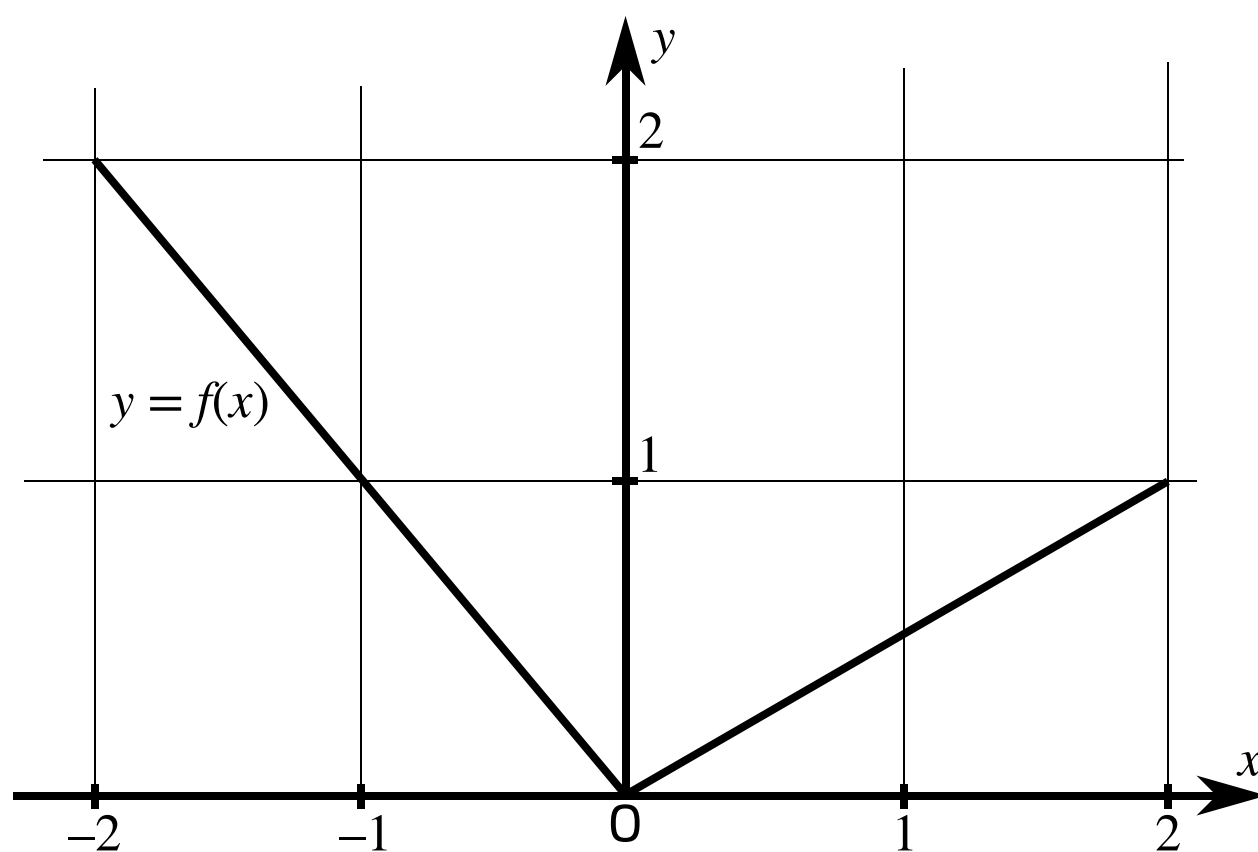


Figure 1: The graph of $y = f(x)$ for $-2 \leq x \leq 2$ is shown to the left.

Part A Sketch $y = f(-x)$

Sketch the curve $y = f(-x)$ for $-2 \leq x \leq 2$.

What is the y -value of the curve $y = f(-x)$ when $x = 1$?

The following symbols may be useful: y

Part B Sketch $y = f(-x) + 2$

Sketch the curve $y = f(-x) + 2$ for $-2 \leq x \leq 2$.

What is the y -value of the curve $y = f(-x) + 2$ when $x = -2$?

The following symbols may be useful: y

Part C Sketch $y = -\frac{1}{x^2}$

Sketch the curve $y = -\frac{1}{x^2}$.

For large negative values of x , the curve $y = -\frac{1}{x^2}$ becomes asymptotic to the horizontal line with which y -value?

The following symbols may be useful: y

Part D Sketch $y = 3 - \frac{1}{x^2}$

Sketch the curve $y = 3 - \frac{1}{x^2}$.

For large negative values of x , the curve $y = 3 - \frac{1}{x^2}$ becomes asymptotic to the horizontal line with which y -value?

The following symbols may be useful: y

Part E State the equation

The curve $y = -\frac{1}{x^2}$ is stretched parallel to the y -axis by scale factor 2. State the equation of the transformed curve.

The following symbols may be useful: x , y

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[Home](#) [Gameboard](#) [Maths](#) [Transformations of Graphs 1i](#)

Transformations of Graphs 1i

A Level



Part A Sketch y

Find the roots of the curve $y = x^2(3 - x)$ and sketch it. You can check your sketch after entering your answer.

Give the value of the root at which y has a minimum.

The following symbols may be useful: x

Part B Translate y

The curve $y = x^2(3 - x)$ is translated by two units in the positive direction parallel to the x axis.

State the equation of the curve after this transformation.

The following symbols may be useful: x , y

Part C Find transformation of y

Which of these describes the transformation of the curve $y = x^2(3 - x)$ to $y = \frac{1}{2}x^2(3 - x)$?

- ☐ A stretch of scale factor $\frac{1}{2}$ parallel to the y -axis.
- ☐ A stretch of scale factor 2 parallel to the y -axis.
- ☐ A stretch of scale factor 2 parallel to the x -axis.
- ☐ A stretch of scale factor $\frac{1}{2}$ parallel to the x -axis.
-

Part D Vertical translation of $f(x)$

The curve $y = f(x)$ passes through the point P with coordinates $(2, 5)$.

State the coordinates of the point corresponding to P on the curve $y = f(x) + 2$. Enter the x and y coordinates below.

Enter the x coordinate:

The following symbols may be useful: x

Enter the y coordinate:

The following symbols may be useful: y

Part E Lateral stretching of $f(x)$

The curve $y = f(x)$ passes through the point P with coordinates $(2, 5)$.

State the coordinates of the point corresponding to P on the curve $y = f(2x)$. Enter the x and y coordinates below.

Enter the x coordinate:

The following symbols may be useful: x

Enter the y coordinate:

The following symbols may be useful: y

Part F Find transformation of $f(x)$

Which of the following describes the single transformation that maps the curve $y = f(x)$ onto $y = f(x + 4)$?

- ☐ A translation of 4 units parallel to the x -axis.
 - ☐ A translation of 4 units parallel to the y -axis.
 - ☐ A translation of -4 units parallel to the y -axis.
 - ☐ A translation of -4 units parallel to the x -axis.
-

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[Home](#) [Gameboard](#) [Maths](#) [Functions](#) [General Functions](#) [Reflection and Symmetry](#)

Reflection and Symmetry

A Level



The following questions ask you to deduce the symmetry properties of a number of functions. There are three choices:

- even - a function for which $f(x) = f(-x)$ which is also described as being symmetric about the vertical axis,
- odd - a function for which $f(x) = -f(-x)$ which is also described as being antisymmetric about the vertical axis (or symmetric about zero),
- neither even nor odd.

For more details see the section on Symmetry in

[Graph interpreting - Level 2: More powers of \$x\$ and general polynomials](#)

Where relevant you may assume that a and b are non-zero constants.

Part A Even functions

In one of the following lists of functions all the functions are even. Pick the correct option from the choices below.

- ☐ $ax^2, ax^2 + b, ax^2 + bx^4, \frac{a}{x^2} + bx^2, (x - a)(x + a), a \cos x$
- ☐ $ax^2, a(x + b)^2, x^2(a + bx), \frac{a}{x^2} + bx^2, (x - a)(x + a), a \sin x$
- ☐ $ax^2, a(x + b)^2, ax^2 + bx^4, \frac{a}{x^2} + b, (x - a)(x + b) (a \neq b), a \sin x$
- ☐ $ax^2, ax^2 + b, x^2(a + bx), \frac{a}{x^2} + b, (x - a)(x + a), a \cos x$
- ☐ $ax^2, ax^2 + b, ax^2 + bx^4, \frac{a}{x^2} + b, (x - a)(x + b) (a \neq b), a \sin x$
- ☐ $ax^2, a(x + b)^2, x^2(a + bx), \frac{a}{x^2} + bx^2, (x - a)(x + b) (a \neq b), a \cos x$



Physics. *You work it out.*

[Home](#) [Gameboard](#) [Maths](#) [Circles 1ii](#)

Circles 1ii

A Level



The circle with equation $x^2 + y^2 - 6x - k = 0$ has radius 4.

The points $A(3, a)$ and $B(-1, 0)$ lie on the circumference of the circle, with $a > 0$.

Part A Centre

By completing the square for x and y find the coordinates of the centre of the circle. Enter the x and y coordinates below.

Enter the x -coordinate:

The following symbols may be useful: x

Enter the y coordinate:

The following symbols may be useful: y

Part B Value of k

Find the value of k .

The following symbols may be useful: k

Part C Length AB

Calculate the length of AB , giving your answer in simplified surd form.

Part D Equation

Find the equation of the line AB . Give your answer in the form $y = mx + c$.

The following symbols may be useful: x , y

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[Home](#) [Gameboard](#) [Maths](#) [Circles 3ii](#)

Circles 3ii

A Level



A circle has centre $(3, 1)$ and radius 5, and a line has equation $y = 2x$.

Part A Circle equation

Write down the equation of the circle.

The following symbols may be useful: x , y

Part B Intersection point

Find the coordinates of the point of intersection of the line and the circle with the largest x value.

Give the x -coordinate.

The following symbols may be useful: x

Give the y -coordinate.

The following symbols may be useful: y

Part C Point on the line

Find the coordinates of the point on the line which is closest to the centre of the circle.

Give the x -coordinate.

The following symbols may be useful: x

Give the y -coordinate.

The following symbols may be useful: y

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Circles 2i

A Level

P

P

P

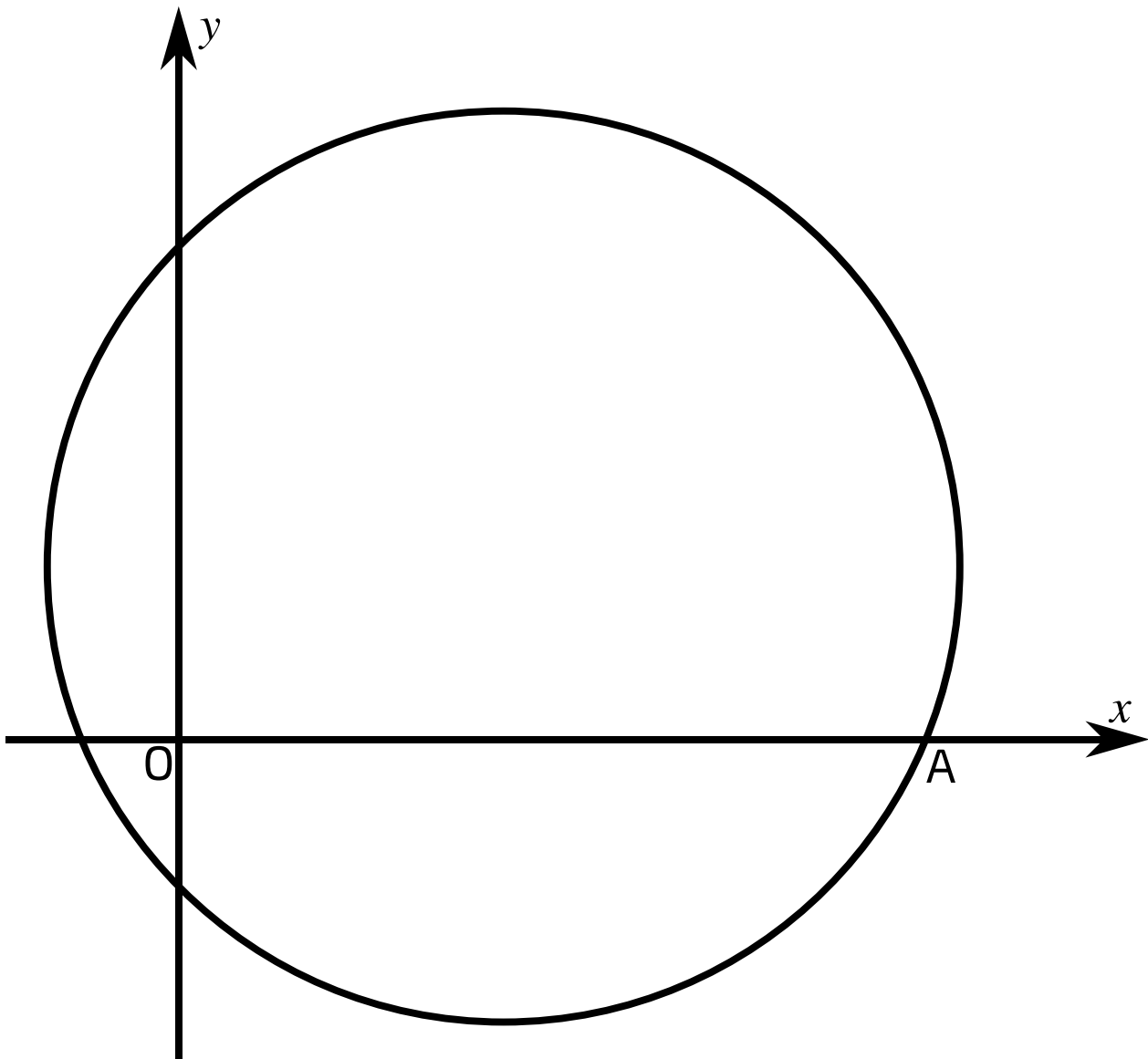


Figure 1: The circle with equation $x^2 + y^2 - 8x - 6y - 20 = 0$.

Figure 1 shows the circle with equation $x^2 + y^2 - 8x - 6y - 20 = 0$. The circle crosses the positive x axis at point A .

Part A Find C

By completing the square for x and y find the coordinates of the centre of the circle. Enter the x and y coordinates below.

Enter the x coordinate:

The following symbols may be useful: x

Enter the y coordinate:

The following symbols may be useful: y

Part B Find radius

Find the radius of the circle.

Part C Tangent to the circle 1

Find the equation of the tangent to the circle at A . Give your answer in the form $y = mx + c$.

The following symbols may be useful: x , y

Part D Tangent to the circle 2

A second tangent to the circle is parallel to the tangent at A . Find the equation of this second tangent in the form $y = mx + c$.

The following symbols may be useful: x , y

Part E Find a radius

Another circle has its centre at the origin O and radius r . This circle lies wholly inside the first circle. Find the set of possible values of r . Give your answer as an inequality.

The following symbols may be useful: $<$, \leq , $>$, \geq , r

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[Home](#) [Gameboard](#) [Maths](#) [Transformations and Area 2i](#)

Transformations and Area 2i

Further A



Part A *A*

The matrix **A** represents an enlargement, centre $(0, 0)$, with scale factor $\sqrt{2}$.

Give the first row of **A** in the form $x \ y$ with a space between x and y . x and y are in exact form. Write the square root of a number like this: `sqrt(5)`

Give the second row of **A** in the form $x \ y$ with a space between x and y . x and y are in exact form. Write the square root of a number like this: `sqrt(5)`

Part B *B*

The matrix **B** is given by $\mathbf{B} = \begin{pmatrix} \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} \\ -\frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} \end{pmatrix}$.

Which of the following transformations is represented by **B**?

- ☐ Enlargement, centre $(0, 0)$, scale factor $\frac{1}{\sqrt{2}}$.
 - ☐ Rotation, about the origin, 45° clockwise.
 - ☐ Reflection in the line $y = \frac{x}{\sqrt{2}}$
 - ☐ Stretch, scale factor $\frac{\sqrt{2}}{2}$ parallel to the y axis.
-

Part C *C*

C is given by **C** = **AB**.

Give the first row of **C** in the form *x y* with a space between *x* and *y*. *x* and *y* are in exact form.

Give the second row of **C** in the form *x y* with a space between *x* and *y*. *x* and *y* are in exact form.

Part D Transformed area

Find the area of the image of the unit square under transformation *C*.

Part E Unit square

Draw a diagram showing the unit square and its image under the transformation represented by **C**.

Easier question?

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[Home](#) [Gameboard](#) [Maths](#) [Transformations - Successive 3i](#)

Transformations - Successive 3i

Further A

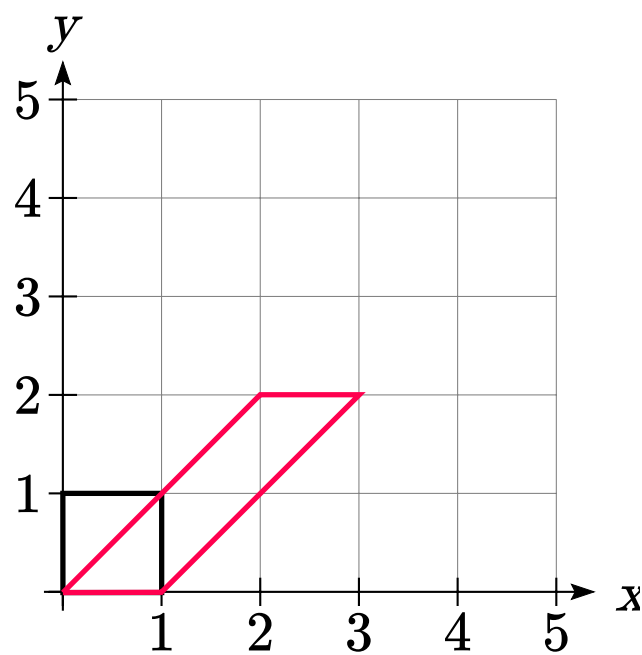


Figure 1: The unit square before and after transformation is shown in black and red respectively.

The matrix that represents this transformation is given by \mathbf{X} , which is also equivalent to a transformation \mathbf{P} followed by a transformation \mathbf{Q} .

Part A \mathbf{X}

The matrix that represents this transformation is given by \mathbf{X} .

Give the first row of \mathbf{X} in the form $x \ y$ with a space between x and y . x and y are in exact form.

Give the second row of \mathbf{X} in the form $x \ y$ with a space between x and y . x and y are in exact form.

Part B Transformation

Which of the following fully describe the transformation represented by **P** and **Q**?

- ☐ Enlargement, centre $(0, 0)$, scale factor 2 and rotation, about the origin, 45° clockwise.
- ☐ Stretch, scale factor 2 parallel to the y axis and shear, x axis invariant.
- ☐ Rotation, about the origin, 46.3° clockwise, and reflection in the y axis.
- ☐ Reflection in the line $y = \frac{x}{\sqrt{3}}$ and enlargement, centre $(0, 0)$, scale factor -2 .

Part C **P**

There are 2 possible matrices that represent **P**.

Give the first row of **P** in the form $x \ y$ with a space between x and y . x and y are in exact form.

Give the second row of **P** in the form $x \ y$ with a space between x and y . x and y are in exact form.

Part D **Q**

There are 2 possible matrices that represent **Q**.

Give the first row of **Q** in the form $x \ y$ with a space between x and y . x and y are in exact form.

Give the second row of **Q** in the form $x \ y$ with a space between x and y . x and y are in exact form.

Part E **PQ**

Give the first row of the matrix that represents transformation **Q** followed by transformation **P**. in the form $x \ y$ with a space between x and y . x and y are in exact form.

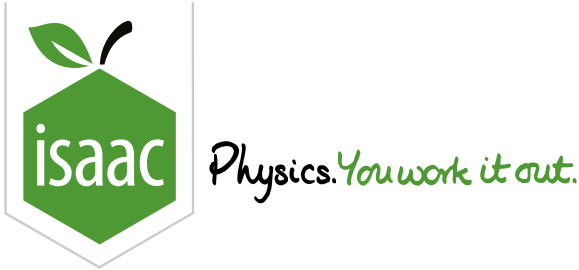
Give the second row of the matrix that represents transformation **Q** followed by transformation **P**. in the form $x \ y$ with a space between x and y . x and y are in exact form.

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Matrices - Transformations 1



P and **Q** are 3×3 matrices which carry out a reflection in the plane $y = 0$ and a rotation about the x -axis, respectively. The matrix **R** = **QP**.

Part A Reflection in the $y = 0$ plane

The 3×3 matrix **P** carries out a reflection in the plane $y = 0$. Write down the matrix **P**.

Give your answer by writing the elements in each row in brackets in the form (p_{m1}, p_{m2}, p_{m3}) where $m = 1, 2$ or 3 . Thus, if $p_{21} = 1$, $p_{22} = 2$ and $p_{23} = 0$, type: (1,2,0) with no spaces.

Give the elements in the top row ($m = 1$) of the matrix, writing them in the form indicated above.

Give the elements in the second row ($m = 2$) of the matrix, writing them in the form indicated above.

Give the elements in the bottom row ($m = 3$) of the matrix, writing them in the form indicated above.

Part B Rotation about the x -axis

The 3×3 matrix \mathbf{Q} carries out an anticlockwise rotation about the x -axis through an angle A . Write down the matrix \mathbf{Q} .

Give your answer by writing the elements in each row in brackets in the form (q_{m1},q_{m2},q_{m3}) where $m = 1, 2$ or 3 . Thus, if $q_{11} = 1$, $q_{12} = 2$ and $q_{13} = \sin A$, type: $(1,2,\sin A)$ with no spaces.

Give the elements in the top row ($m = 1$) of the matrix, writing them in the form indicated above.

Give the elements in the second row ($m = 2$) of the matrix, writing them in the form indicated above.

Give the elements in the bottom row ($m = 3$) of the matrix, writing them in the form indicated above.

Part C Reflection followed by rotation

Find the 3×3 matrix $\mathbf{R} = \mathbf{QP}$ which carries out a reflection in the plane $y = 0$ followed by a rotation anticlockwise about the x -axis through an angle A .

Give your answer by writing the elements in each row in brackets in the form (r_{m1},r_{m2},r_{m3}) where $m = 1, 2$ or 3 . Thus, if $r_{31} = 1$, $r_{32} = 2$ and $r_{33} = \cos A$, type: $(1,2,\cos A)$ with no spaces.

Give the elements in the top row ($m = 1$) of the matrix, writing them in the form indicated above.

Give the elements in the second row ($m = 2$) of the matrix, writing them in the form indicated above.

Give the elements in the bottom row ($m = 3$) of the matrix, writing them in the form indicated above.

Part D Reflection in the $z = 0$ plane

If the value of A is such that the 3×3 matrix \mathbf{R} matrix represents a reflection in the plane $z = 0$, find the angle A . Assume $0 \leq A < 2\pi$ and give your answer in radians.

The following symbols may be useful: A , π

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