

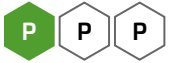


Physics. *You work it out.*

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Complex Numbers: Manipulations 3i

Further A



The complex number $2 + i$ is denoted by z , and the complex conjugate of z is denoted by z^* .

Part A z^2

Express z^2 in the form $x + iy$, where x and y are exact real numbers.

The following symbols may be useful: i

Part B $4z - z^2$

Express $4z - z^2$ in the form $x + iy$, where x and y are exact real numbers.

The following symbols may be useful: i

Part C zz^*

Express zz^* in the form $x + iy$, where x and y are exact real numbers.

The following symbols may be useful: i

Part D $\frac{z+1}{z-1}$

Express $\frac{z+1}{z-1}$ in the form $x + iy$, where x and y are exact real numbers.

The following symbols may be useful: i

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Complex Numbers: Manipulations 1i

Further A

The complex number z has modulus $2\sqrt{3}$ and argument $-\frac{\pi}{3}$.

Part A z

Find z in the form $z = x + iy$, where x and y are exact real numbers.

The following symbols may be useful: i , z

Part B $\frac{1}{(z^* - 5i)^2}$

Find $\frac{1}{(z^* - 5i)^2}$ in the form $x + iy$, where x and y are exact real numbers.

The following symbols may be useful: i

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Gameboard:

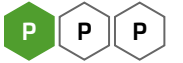
STEM SMART Double Maths 31 - Complex Numbers & Argand Diagrams

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Complex Numbers: $x+iy$ and Euler $3i$

Further A



The complex number z satisfies the equation

$$z + 2iz^* = 12 + 9i$$

Part A z

Find z in the form $z = x + iy$.

The following symbols may be useful: i , z

Part B Modulus-Argument

z can also be expressed in the form

$$z = r(\cos \theta + i \sin \theta)$$

Find r .

The following symbols may be useful: r

Find θ to 3 significant figures in radians.

Complex Numbers: Equations to Quartics 1ii

Further A

Part A Square roots

The square roots of the complex number $5 + 12i$ can be expressed in the form $x + iy$.

Give the square root with positive x and positive y .

The following symbols may be useful: i

Give the square root with negative x and negative y .

The following symbols may be useful: i

Part B $(3 - 2i)^2$

Find $(3 - 2i)^2$ in the form $x + iy$ where x and y are exact.

The following symbols may be useful: i

Part C Roots of quartic

The answers to the previous parts can be used to solve the quartic

$$z^4 - 10z^2 + 169 = 0$$

The roots to the quartic can be expressed in the form $x + iy$.

Give the root with positive x and positive y .

The following symbols may be useful: i

Give the root with positive x and negative y .

The following symbols may be useful: i

Give the root with negative x and positive y .

The following symbols may be useful: i

Give the root with negative x and negative y .

The following symbols may be useful: i

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Applying Complex Numbers 2ii

Further A

One root of the cubic equation $z^3 + bz^2 + cz - 15 = 0$, where b and c are real constants, is the complex number $2 + i$.

Part A Complex root

Find the other complex root in the form $x + iy$.

The following symbols may be useful: i

Part B Real root

Find the real root.

Part C b

Find b .

The following symbols may be useful: b

Part D c

Find c .

The following symbols may be useful: c

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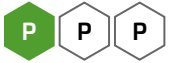


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Complex Numbers: Equations to Quartics 1i

Further A



One root of the quadratic equation $z^2 + az + b = 0$, where a and b are real, is $16 - 30i$.

Part A Other root

Give the other root in the form $x + iy$.

The following symbols may be useful: i

Part B a and b

Find the value of a

The following symbols may be useful: a

Find the value of b .

The following symbols may be useful: b

Part C Quartic

The quartic equation $z^4 + az^2 + b = 0$ has roots in the form $x + iy$.

Give the root with positive x and positive y .

The following symbols may be useful: i

Give the root with positive x and negative y .

The following symbols may be useful: i

Give the root with negative x and positive y .

The following symbols may be useful: i

Give the root with negative x and negative y .

The following symbols may be useful: i

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Argand Diagrams and Simple Loci 2i

Further A



The complex number a is denoted by $1 + i\sqrt{3}$.

Part A a

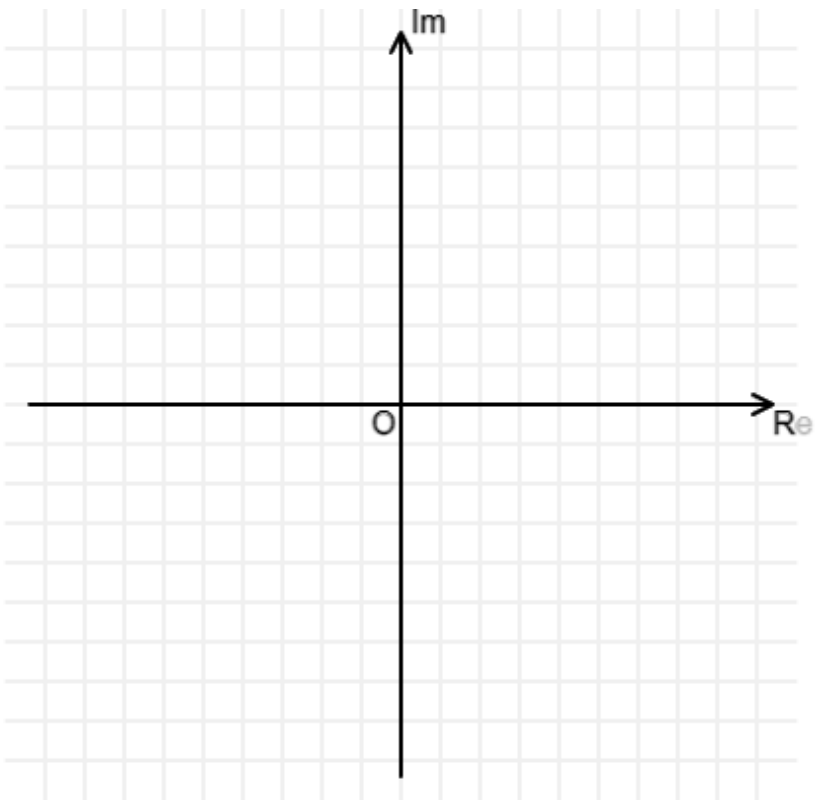
Find the value of $|a|$.

Find $\arg a$ in exact form.

The following symbols may be useful: π

Part B Loci

Sketch the loci given by $|z - a| = |a|$ and $\arg(z - a) = \frac{1}{2}\pi$ on a single Argand diagram.



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Argand Diagrams: Using Loci 2i

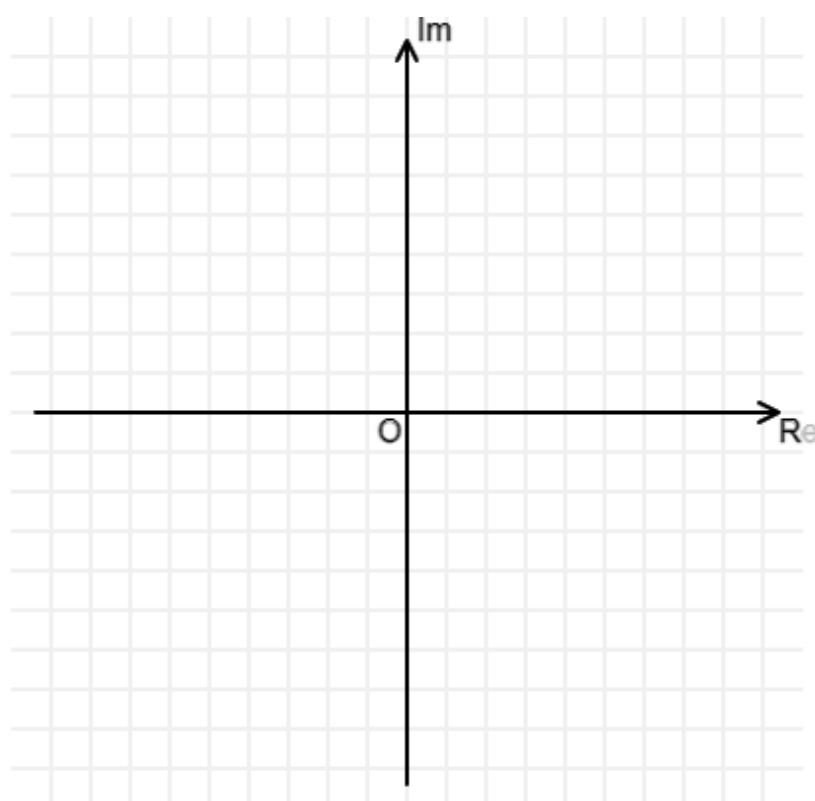
Further A



The loci C_1 and C_2 are given by $|z| = |z - 4i|$ and $\arg z = \frac{\pi}{6}$ respectively.

Part A Loci of C_1 and C_2

Sketch the loci C_1 and C_2 on a single Argand diagram.



Part B Intersection

Hence find, in the form $x + iy$, the complex number represented by the point of intersection of C_1 and C_2 .
Give your answer in exact form.

The following symbols may be useful: i



Argand Diagrams: Solving Inequalities 1ii

Further A



The loci L_1 and L_2 are given by $|z| = 2$ and $\arg(z - 3 - i) = \pi$ respectively.

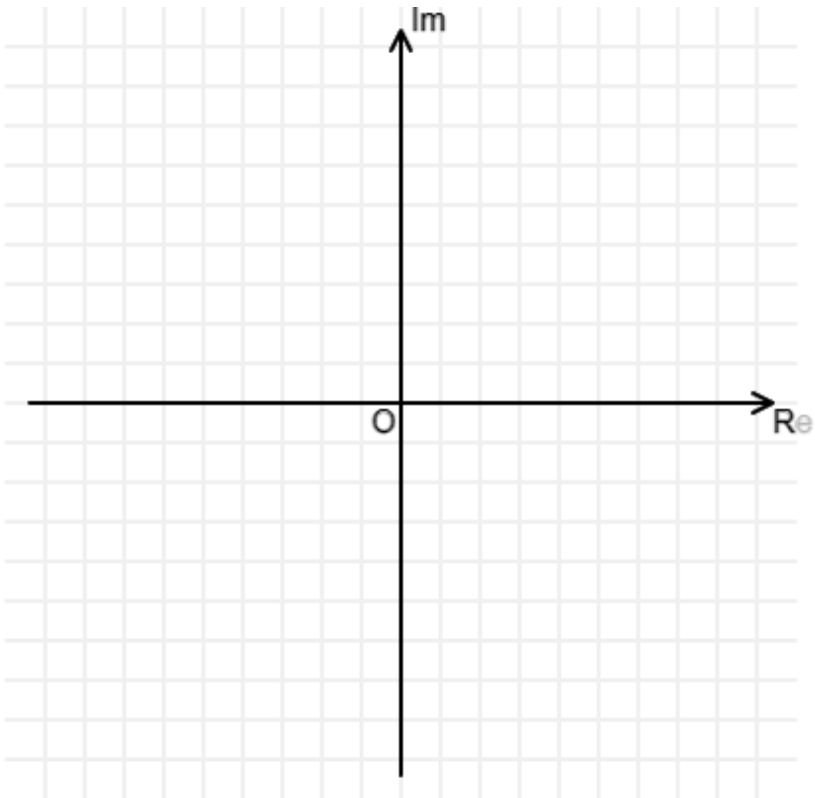
Part A Equation of L_1

By writing z in the form $x + iy$, express the equation for L_1 in Cartesian form, simplifying your answer as far as possible.

The following symbols may be useful: x , y

Part B Loci

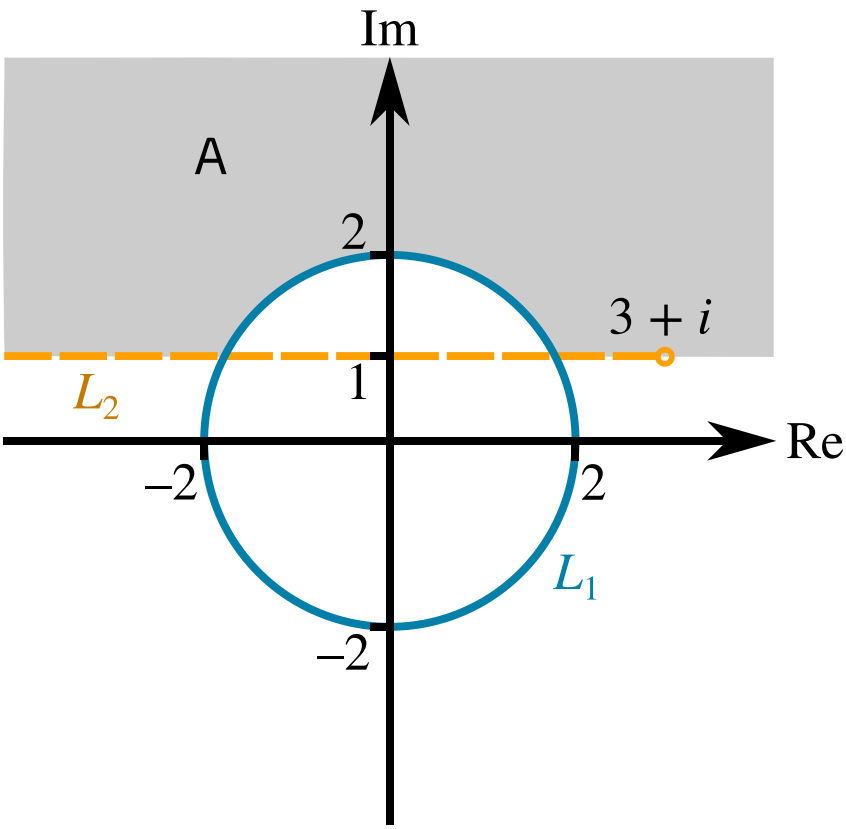
Sketch L_1 and L_2 on a single Argand diagram.



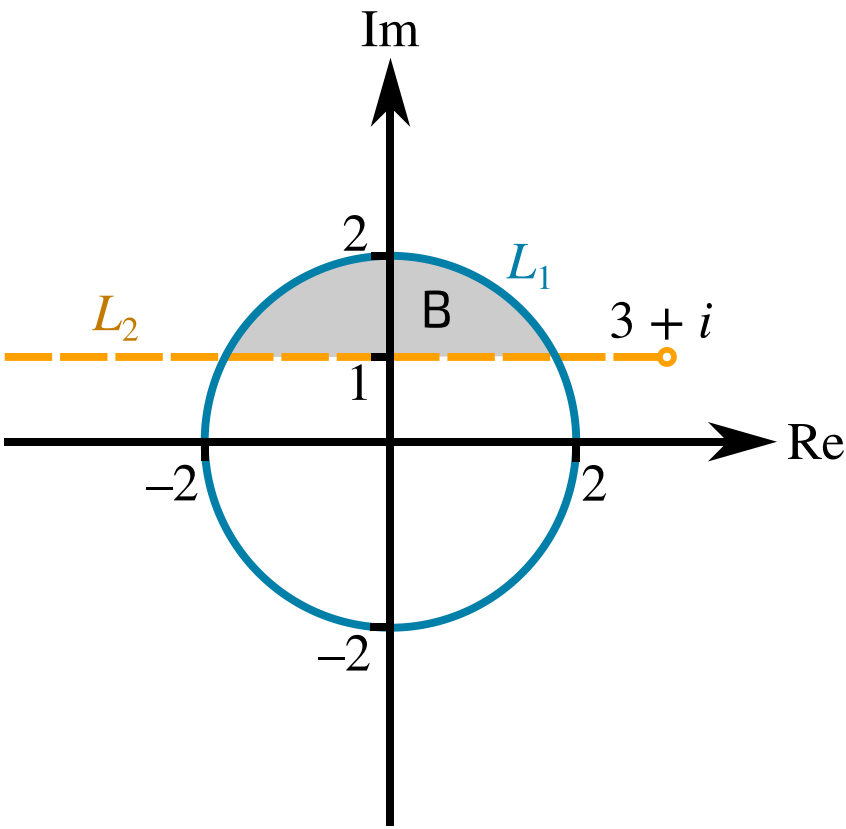
Part C Inequalities

Select from the images below the shaded region of the Argand diagram for which

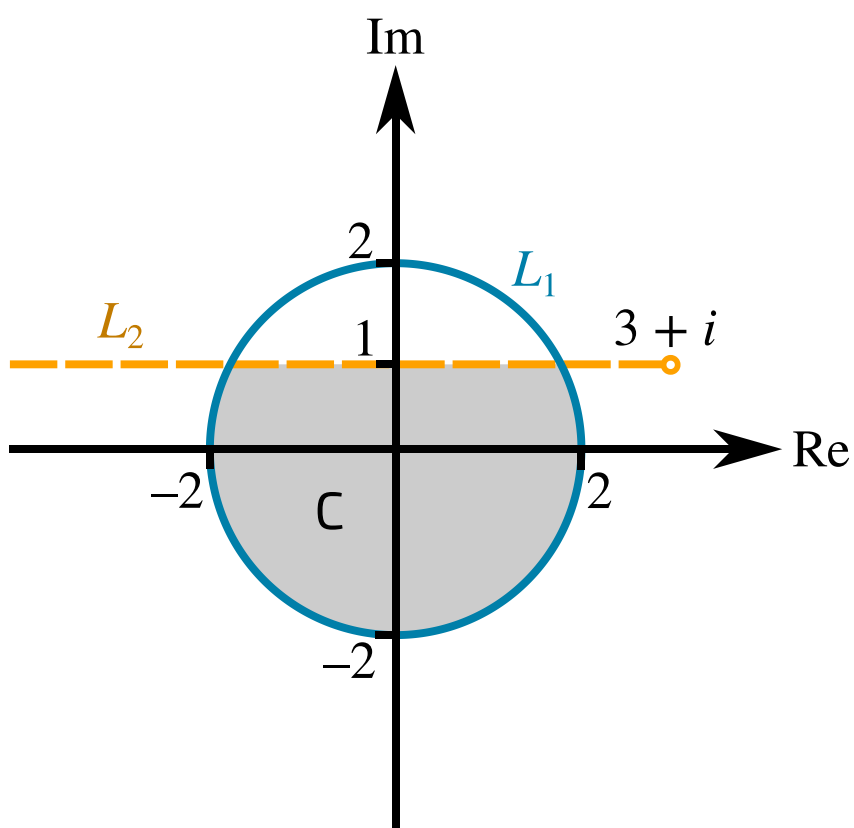
$$|z| \leq 2 \quad \text{and} \quad 0 \leq \arg(z - 3 - i) \leq \pi$$



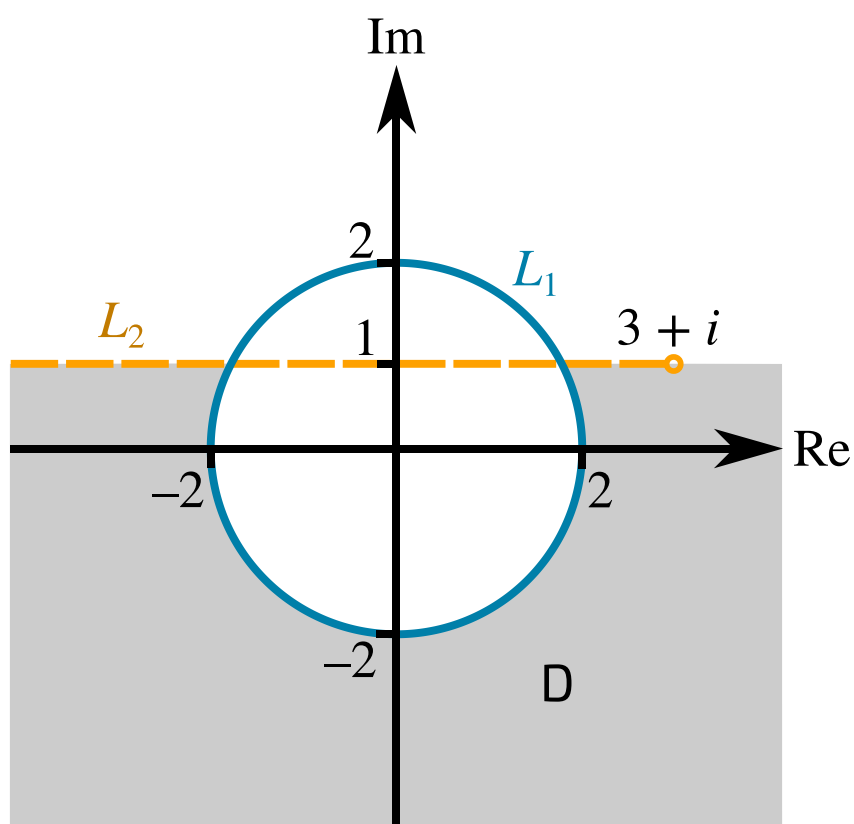
Region A.



Region B.



Region C.



Region D.

- ☐ Region A.
- ☐ Region B.
- ☐ Region C.
- ☐ Region D.

Argand Diagrams: Solving Inequalities 4ii

Further A

P

P

P

The loci L_1 and L_2 are given by $|z - 3 + 4i| = 5$ and $|z| = |z - 6|$ respectively.

Part A

Equation of L_1

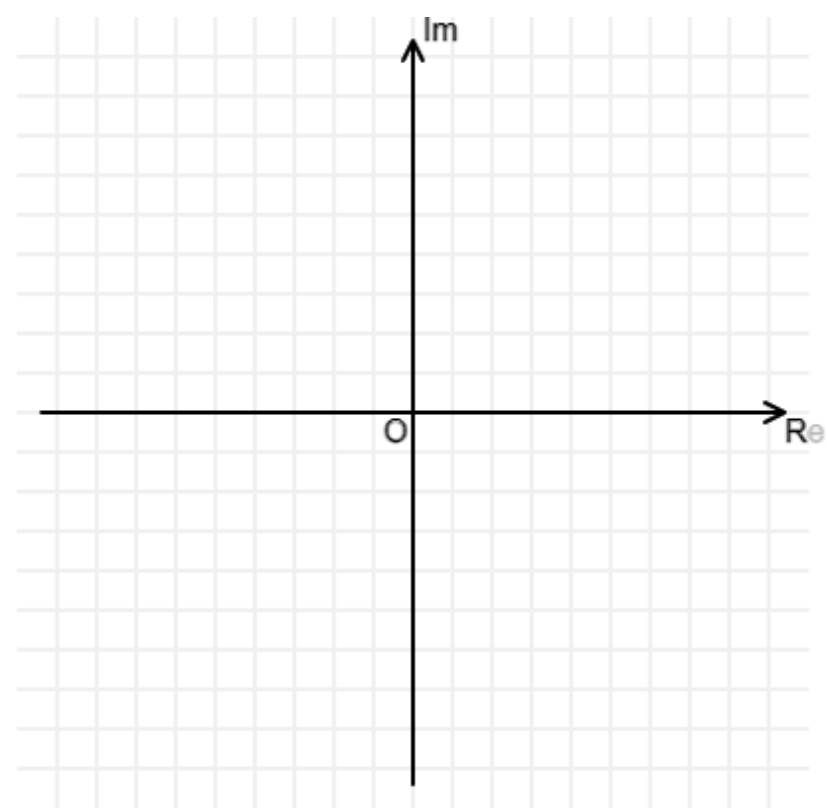
Give the equation of L_1 in the form $(x - a)^2 + (y - b)^2 = c^2$.

The following symbols may be useful: x , y

Part B

Loci

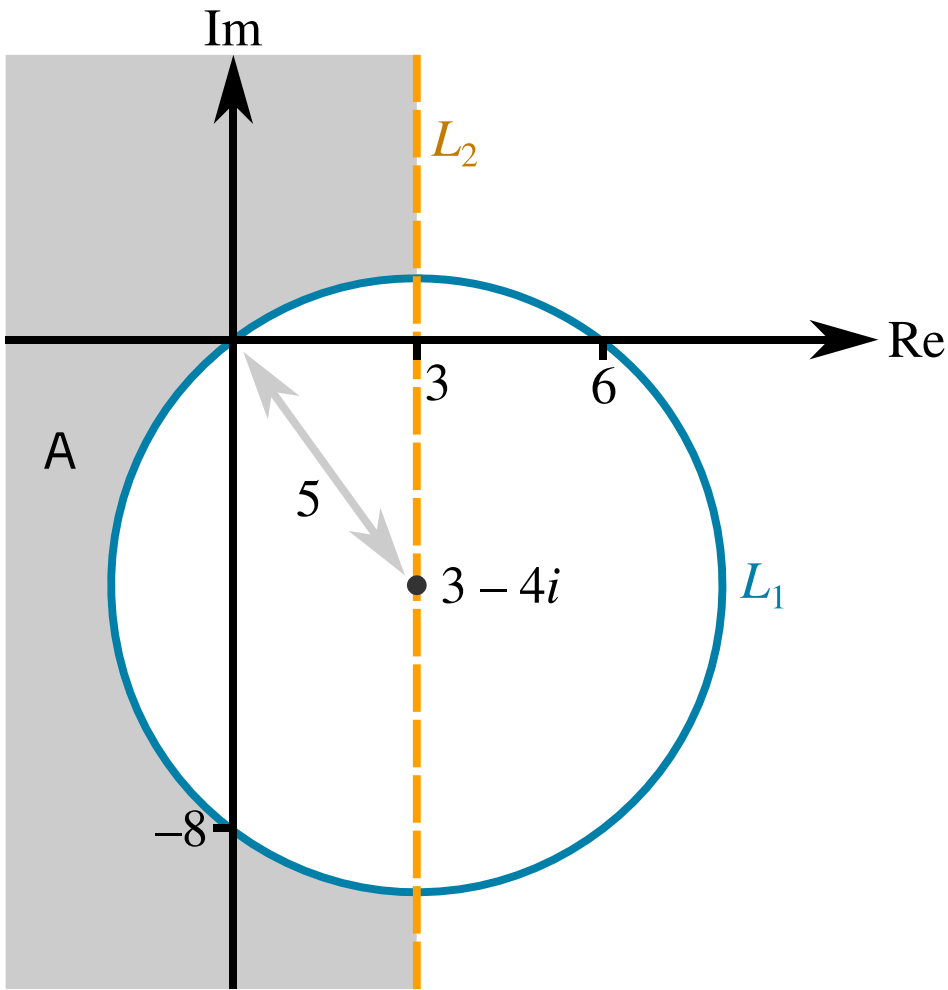
Sketch the loci L_1 and L_2 on a single Argand diagram.



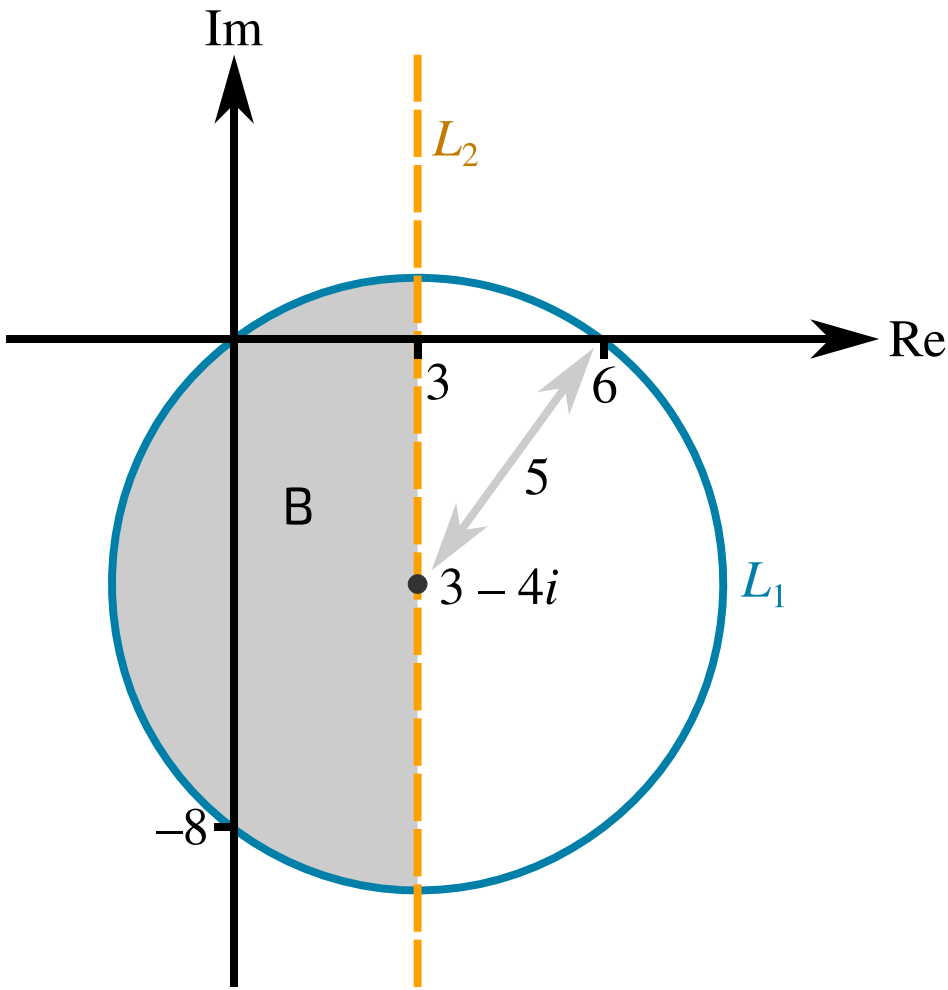
Part C Inequalities

Select from the images below the shaded region of the Argand diagram for which

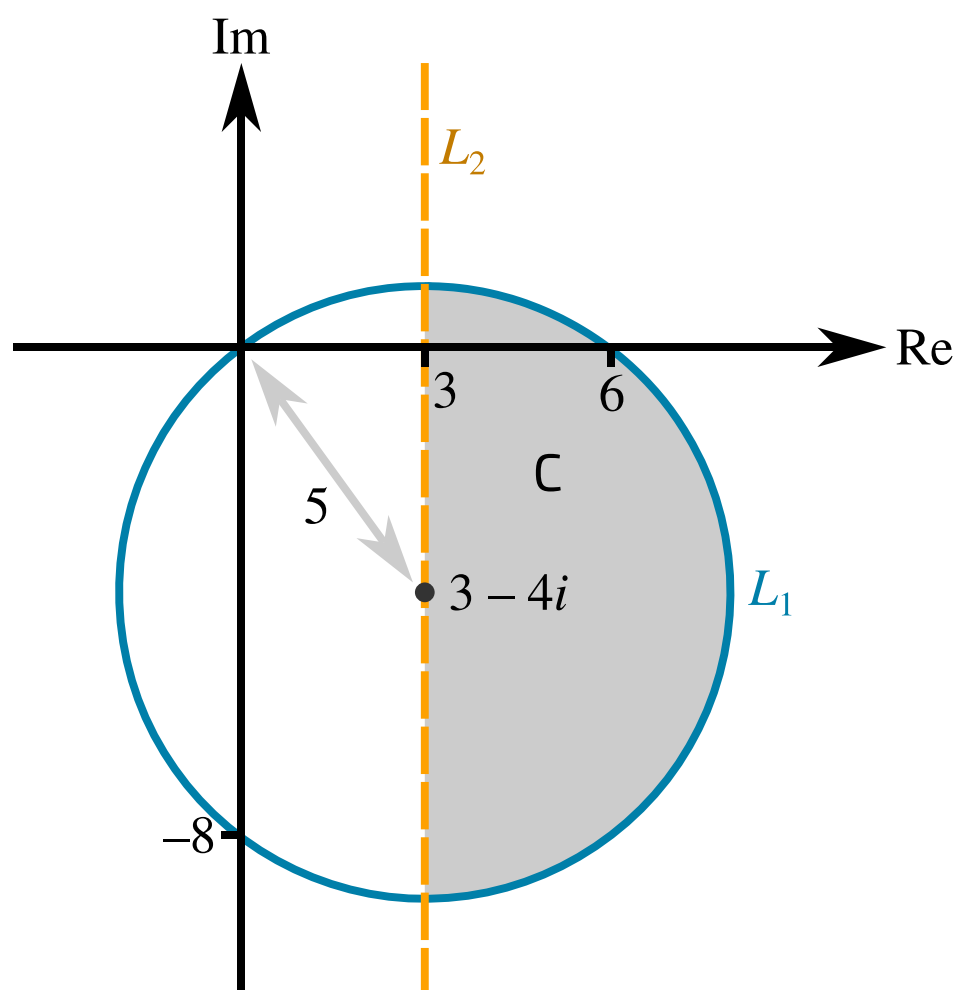
$$|z - 3 + 4i| \leq 5 \quad \text{and} \quad |z| \geq |z - 6|$$



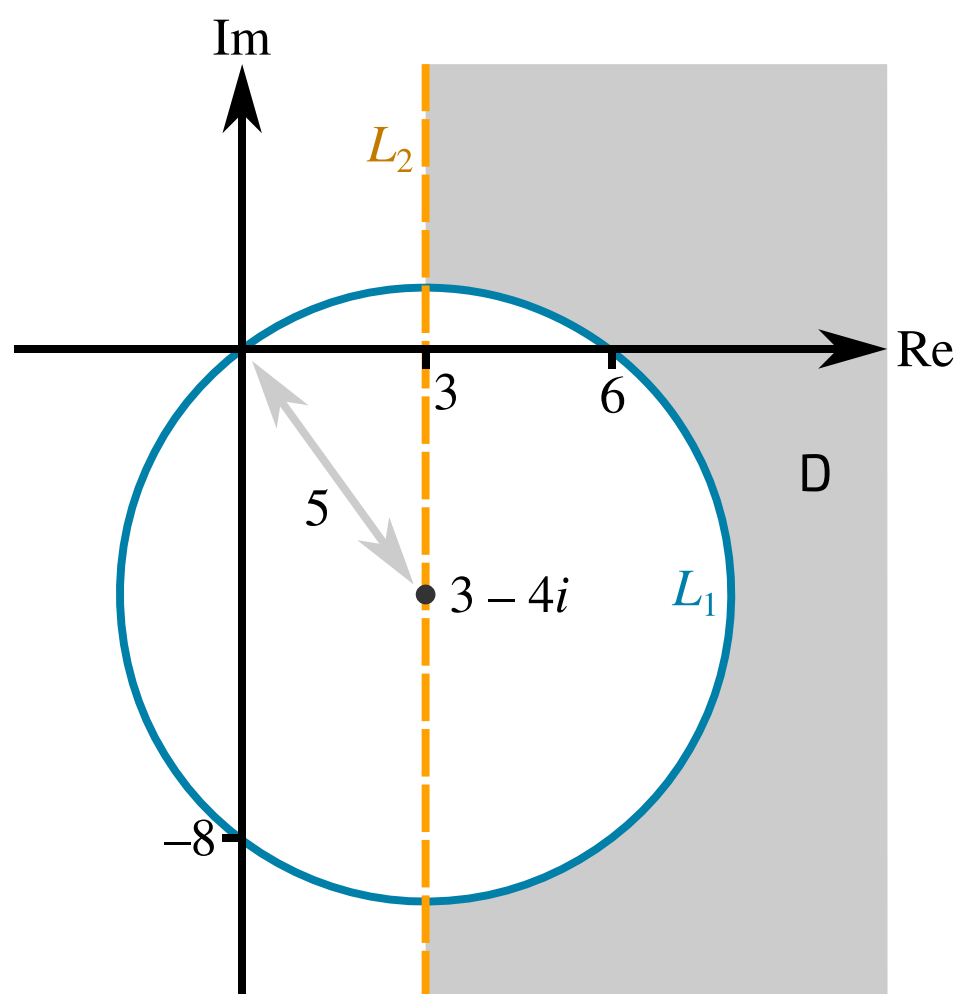
Region A.



Region B.



Region C.



Region D.

- ☐ Region A.
- ☐ Region B.
- ☐ Region C.
- ☐ Region D.