**Solve Quadratic Equations with Complex Roots**

When a quadratic equation cannot be solved by factorisation the following formula can be used

The equation *ax*2 + *bx* + *c* = 0 has the roots given by

$x=\frac{-b\pm \sqrt{b^{2}-4ac}}{2a}$

**Note:** The whole of the top of the right hand side, including –b, is divided by 2a. It is also called the quadratic or –b formula. If *b*2 – 4*ac* < 0, then the number under the square root sign will be negative, and so the solutions will be complex numbers.

### Example

Solve the equation *x*2 – 4*x* + 13

 *ax*2 + *bx* + *c* = 0 => *a* = 1, *b* = $-$4, *c* = 13

$x=\frac{-(-4)\pm \sqrt{(-4)^{2}-4(1)(13)}}{2(1)}$ = $\frac{4\pm \sqrt{16-52}}{2}$ = $\frac{4\pm \sqrt{-36}}{2} $= $\frac{4\pm 6i}{2}$

*x* = 2 ± 3*i*

Therefore, the roots are 2 + 3*i* and 2 – 3*i*

**Note:** Notice the roots occur in conjugate pairs. If one root of a quadratic equation is a complex number then the other root must also be complex and the conjugate of the first: i.e., if 3 – 4*i* is a root, then 3 + 4*i* is also a root,

 if –2 –5*i* is a root, then –2 + 5*i* is also a root

 if a + *bi* is a root, then *a* – *bi* is also a root

##### Questions

Solve for each of the following equations:

1. *x*2 – 6*x* + 13 = 0
2. *z*2 – 2*z* + 10 = 0
3. *x*2 + 16 = 0
4. *x*2 + 41 = 10*x*
5. 5 = 2*x* – *x*2