

## 2.3: Operations in the Number Systems

### 1. Sum and Product Properties:

- What happens when we add two rational numbers together?
- What happens when we add a rational number with an irrational number?
- What happens when we add two irrational numbers together?
- What happens when we multiply two rational numbers together?
- What happens when we multiply a rational number with an irrational number?
- What happens when we multiply two irrational numbers?

Let's explore ... Rational:  $1, 2, \frac{1}{2}, -5$

Irrational:  $\pi, \sqrt{2}, -\sqrt{2}, \sqrt{3}$

Rational Vs. Rational		Rational Vs. Irrational	
Add	Multiply	Add	Multiply
$1 + 2 = 3$ <b>Rational</b>	$1 \cdot 2 = 2$ <b>Rational</b>	$2 + \pi = 5.14159\dots$ <b>Irrational</b>	$2 \cdot \sqrt{2} = 2\sqrt{2}$ <b>Irrational</b>

* Irrational Vs. Irrational		Complex Vs. Real	
Add	Multiply	Add	Multiply
$\sqrt{2} + \sqrt{3}$ <b>Irrational</b>	$\sqrt{2} \cdot \sqrt{3} = \sqrt{6}$ <b>Irrational</b>	$3 + 2i$ <b>Complex</b>	$3 \cdot 2i = 6i$ <b>Complex</b>
$-\sqrt{2} + \sqrt{2} = 0$ <b>Rational</b>	$\sqrt{3} \cdot \sqrt{3} = \sqrt{9} = 3$ <b>Rational</b>		

\* When dealing with two irrational numbers, your result can be rational or irrational

We can add and subtract complex numbers just like we do polynomials (Day 1)

Example 4: Add or Subtract each set of complex numbers:

a)  $(-3 - 9i) + (11 - 7i)$

Combine like terms

b)  $(-1 - 3i) - (3 - 6i)$

$(-1) - 3i - (3) + 6i$

$-4 + 3i$

c)  $(6 - 11i) - (11 - 6i)$

$(6) - 11i - (11) + 6i$

$-5 - 5i$

We can also multiply complex numbers like we do polynomials. There is one major difference however. We know that  $i^2 = -1$  and can make that substitution to simplify our expression.

Example 5: Multiply:

$i = \sqrt{-1}$ , so  $i^2 = -1$

a)  $(-7 + 2i)(-7 - 4i)$

$49 + 28i - 14i - 8i^2$

$49 - 14i - 8(-1)$

$49 - 14i + 8$

$57 - 14i$

b)  $(6 + 8i)(-6 - 2i)$

$-36 - 12i - 48i - 16i^2$

$-36 - 60i - 16(-1)$

$-36 - 60i + 16$

$-20 - 60i$

c)  $(4 - 2i)^2 = (4 - 2i)(4 - 2i)$

$16 - 8i - 8i + 4i^2$

$16 - 16i + 4(-1)$

$16 - 16i - 4$

$12 - 16i$

d)  $(5 + 2i)(5 - 2i)$

e)  $(-4 + 5i)(4 + 5i)$

f)  $(-1 + 6i)(-5 + 4i)$

g)  $5(2 - 3i) + 4(2i)$

$10 - 15i + 8i$

$10 - 7i$

h)  $(3 + 9i) - 5(2 - i)$

$(3) + 9i - (10) + 5i$

$-7 + 14i$