Practice

1. $\sqrt{81x^2y^4z^6}$

2. $\sqrt{6xy} \cdot \sqrt{10x^2y^5}$

3. $3\sqrt{15a^2} \cdot 5\sqrt{12a}$

4. $16\sqrt[4]{25xy} - 9\sqrt[4]{25xy}$

5. $\sqrt[3]{375} - \sqrt[3]{24}$

6. $(6+\sqrt{7})(5-\sqrt{2})$

Practice

① (+) $\sqrt{81x^2y^4z^6} = \sqrt{3\cdot3\;3\cdot3\;xx\;yy\;yy\;zz\;zz\;zz}$

9 9

3 3 3 3

$3\cdot3\;x\;y\;y\;z\;z\;z$

$9|x|y^2|z^3|$ $\quad 9|x|\,y^2\,|z^3|$

② $\sqrt{6xy}\cdot\sqrt{10x^2y^5}$

$\sqrt{6\cdot10\,x^3y^6} = \sqrt{2\cdot2\;3\cdot5\;xx\,x\;yy\,yy\,yy}$

2 3 2 5

$= 2x\,yyy\sqrt{3\cdot5x}$

$2|xy^3|\sqrt{15x}$

③ $3\sqrt{15a^2}\cdot5\sqrt{12a}$

$3\cdot5\sqrt{15\cdot12\,a^3} = 15\sqrt{2\cdot2\;3\cdot3\cdot5\;aa\,a}$

3 5 4 3

2 2

$15\cdot2\cdot3\cdot a\sqrt{5a}$

$90|a|\sqrt{5a}$

④ $\boxed{16\sqrt[4]{25xy}} - \boxed{9\sqrt[4]{25xy}}$

$(16-9)\sqrt[4]{25xy} = 7\sqrt[4]{25xy}$

⑤ $\sqrt[3]{375} - \sqrt[3]{24} = \sqrt[3]{3\;5\cdot5\cdot5} - \sqrt[3]{2\cdot2\cdot2\;3}$

5 75 2 12

5 15 2 6

5 3 2 3

$5\sqrt[3]{3} - 2\sqrt[3]{3}$

$(5-2)\sqrt[3]{3} = 3\sqrt[3]{3}$

⑥ $(6+\sqrt{7})(5-\sqrt{2})$

F: $6\cdot5 = 30$

O: $6(-\sqrt{2}) = -6\sqrt{2}$

I: $(\sqrt{7})(5) = 5\sqrt{7}$

L: $(\sqrt{7})(-\sqrt{2}) = -\sqrt{14}$

$-\sqrt{7\cdot2}$

$30-6\sqrt{2}+5\sqrt{7}-\sqrt{14}$

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Lesson 4.8 Complex Numbers

i^3
i^4
i^5
i^6

imaginary unit

Def:	F/C:
$\boxed{*i = \sqrt{-1}}$ the complex number whose square is -1.	$\boxed{i^2 = *-1}$ $\sqrt{-a}$ $(\sqrt{-3})^2$
Ex:	**Non-ex.**
$\sqrt{-9} = \sqrt{-1}\cdot\sqrt{9} = i\cdot 3 = 3i$ $\sqrt{-3} = \sqrt{-1}\cdot\sqrt{3} = i\sqrt{3}$	$\sqrt[3]{-8}$ $\sqrt[4]{-1}$

imaginary unit

$\sqrt{-24} = 2i\sqrt{6}$

-1, 24

2, 12

2, 6

2, 3

$i^2 = (\cancel{\sqrt{-1}})^{\cancel{2}} = (\sqrt{-1}\cdot\sqrt{-1})$

$i^2 = -1$

$= \sqrt{-1\cdot -1}$

$= -1$

$\sqrt{-18} = 3i\sqrt{2}$

$\cancel{-1}$, 18

2, 9

3, 3

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Practice

① $\sqrt{\frac{25x^4}{36}} = \frac{\sqrt{5\cdot 5xxxx}}{\sqrt{6\cdot 6}} = \frac{5x^2}{6}$

② $\frac{\sqrt{32xy}}{\sqrt{2y}} = \sqrt{\frac{32x\cancel{y}}{2\cancel{y}}} = \sqrt{16x} = 4\sqrt{x}$

$\cancel{2}\ 8$

$\cancel{2}\ 4$

$\cancel{22}$

③ $\frac{3}{\sqrt{5x}} \cdot \frac{\sqrt{5x}}{\sqrt{5x}} = \frac{3\sqrt{5x}}{\sqrt{5\cdot 5xx}} = \frac{3\sqrt{5x}}{5x}$

④ $\frac{10}{\sqrt[3]{2}} \cdot \frac{\sqrt[3]{2\cdot 2}}{\sqrt[3]{2\cdot 2}} = \frac{10\sqrt[3]{4}}{2} \longrightarrow 5\sqrt[3]{4}$

$\sqrt[3]{2\cdot 2\cdot 2}$

⑤ $\frac{5}{(4+\sqrt{5})} \cdot \frac{(4-\sqrt{5})}{(4-\sqrt{5})} = \frac{5\cdot 4 - 5\sqrt{5}}{16-5} = \frac{20-5\sqrt{5}}{11}$

F : $4\cdot 4$ 16

O : $4(-\sqrt{5})$ $\boxed{\cancel{-4\sqrt{5}}}$

I : $\sqrt{5}\cdot 4$ $\boxed{\cancel{4\sqrt{5}}}$

L : $\sqrt{5}(-\sqrt{5})$ -5

$-\sqrt{5\cdot 5}$ 11

$4(4-\sqrt{5}) + \sqrt{5}(4-\sqrt{5})$

$16\ \boxed{\cancel{-4\sqrt{5} + 4\sqrt{5}}}\ -5$

11

$(a+b)(a-b) = a^2 - b^2$

$a\cdot a$ a^2

$a\cdot -b$ $\boxed{\cancel{-ab}}$

$b\cdot a$ $\boxed{\cancel{+ab}}$ 0

$b\cdot -b$ $-b^2$

Complex Numbers $(a+bi)$ → standard form

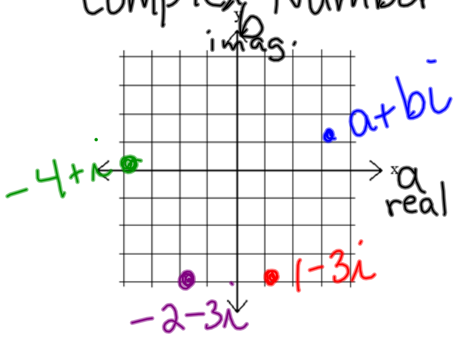
Real Numbers $a+bi$, $b=0$	Imaginary Numbers $a+bi$, $b\neq 0$ Pure Imaginary Number $0+bi$, $b\neq0$

*a, b → real numbers

$a \to$ "real"

$bi \to$ "imaginary"

Complex Number Plane

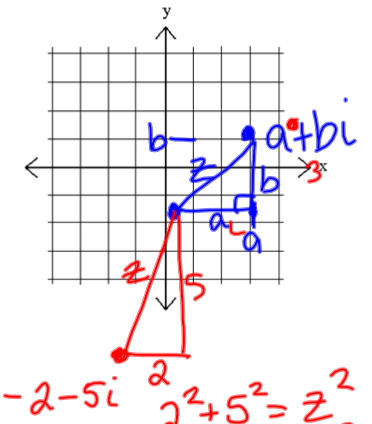


$(a,b) \to a+bi$

Graph $1-3i \to (1,-3)$

$-4+i$

$-2-3i \to (-2,-3)$



absolute value: distance from the origin

$a^2+b^2=c^2$

$\sqrt{a^2+b^2}=\sqrt{z^2}$

$\sqrt{a^2+b^2}=z=|a+bi|$

$2^2+5^2=z^2$

$4+25=z^2$

$\sqrt{29}=\sqrt{z^2}$

$\sqrt{29}=z$

$|4+3i| = \sqrt{4^2+3^2} = \sqrt{16+9} = \sqrt{25} = 5$

Plot $-2-5i$.

Find $|-2-5i|. = \sqrt{(-2)^2+(-5)^2} = \sqrt{4+25} = \sqrt{29}$

Find $|6| = \sqrt{6^2+0^2} = \sqrt{36} = 6$

Add	Subtract
Multiply	Divide

① $(2+i)+(-3+3i)$ $2+(-3)+i+3i$ $-1+4i$ ② $(5+i)+(5-i)$ $5+5+i-i=10$	① $(-6-2i)-1(4+2i)$ $-6-2i-4-2i$ * Distribute -1 to second ( ). $-6-4-2i-2i$ $-10-4i$ ② $(1+5i)-(3-2i)$
① $(4i)(2i)$ $-8i^2=8(-1)=-8$ ② $-i(4-8i)$ $-4i+8i^2=-4i+8(-1)$	$1+5i-3+2i=-2+7i$ ① $\frac{3}{7+2i}$ $\frac{(3)}{(7+2i)}\cdot\frac{(7-2i)}{(7-2i)}=\frac{21-6i}{53}$ $49\ \boxed{-14i+14i}-4i^2 \to -4(-1)$ $+4$ ② $\frac{(5+2i)}{(3-2i)}\cdot\frac{(3+2i)}{(3+2i)}=\frac{11+16i}{13}$

$=-4i-8=-8-4i$

$a+$ $\frac{21}{53}-$ $\frac{11}{13}+$

③ $(5-7i)(-4-3i)$

F $5\cdot(-4)$ -20
O $5(-3i)$ $-15i$
I $-7i(-4)$ $28i$
L $-7i(-3i)$ $-21i^2$

F $5\cdot3 \to 15$
O $5\cdot2i$ $10i$
I $2i\cdot3$ $6i$
L $2i\cdot2i$ $4i^2=-4$

$\frac{11+16i}{13}$

F $3\cdot3$ 9
O $3\cdot2i$ $\boxed{\cancel{6i}}$
I $-2i\cdot3$ $\boxed{\cancel{-6i}}$
L $-2i\cdot2i$ $-4i^2=+4$

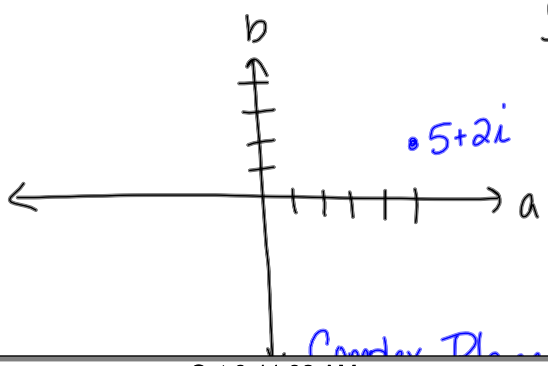
④ $(3+2i)(-4+\cancel{1}3i)$

$-12-15i-8i-10i^2$
$+10$

$-2-23i$

$5+2i$

$(5,2)$



Complex Plane

Warm-up – Work with your groups

① $\frac{3}{7+2i}$ $\qquad \sqrt{x}\,\sqrt{x} = x$

$\sqrt{3}\cdot\sqrt{3} = 3$

② $x^{\frac{1}{2}} \cdot x^{\frac{1}{2}} = x^{\frac{1}{2}+\frac{1}{2}} = x^{\frac{2}{2}} = x$

③ $\left(x^{\frac{1}{3}}\right)^3 = x^{\frac{1}{3}\cdot\frac{3}{1}} = x^1 = x$

$x^{\frac{1}{3}} \cdot x^{\frac{1}{3}} \cdot x^{\frac{1}{3}} = x^{\frac{1}{3}+\frac{1}{3}+\frac{1}{3}} = x^{\frac{3}{3}} = x$

$$x^{\frac{m}{n}} = \sqrt[n]{x^m} \text{ or } \left(\sqrt[n]{x}\right)^m$$

$x^{\frac{1}{2}} = \sqrt[2]{x}$ $\qquad x^{\frac{3}{5}} = \sqrt[5]{x^3}$

$m \rightarrow m$ $\qquad x^{\frac{1}{m}} = \sqrt[m]{x}$

11. $\sqrt[3]{250} - \sqrt[3]{54}$

$250 \to 25 \cdot 10$ $\qquad$ $54 \to 9 \cdot 6$

$\cancel{5 \cdot 5 \cdot 5} \cdot 2$ $\qquad$ $\cancel{3 \cdot 3 \cdot 3} \cdot 2$

$5\boxed{\sqrt[3]{2}} - 3\boxed{\sqrt[3]{2}}$

$2\sqrt[3]{2}$

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4. $\sqrt[3]{\dfrac{64x^9}{343}}$

$\dfrac{\sqrt[3]{64x^9}}{\sqrt{343}}$

$\sqrt[3]{\dfrac{27x^9}{343}}$

$\dfrac{\sqrt[3]{27x^9}}{\sqrt[3]{343}}$

3^9 3 3

7 49 7 7

28
63

$\dfrac{3x^3}{7}$

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