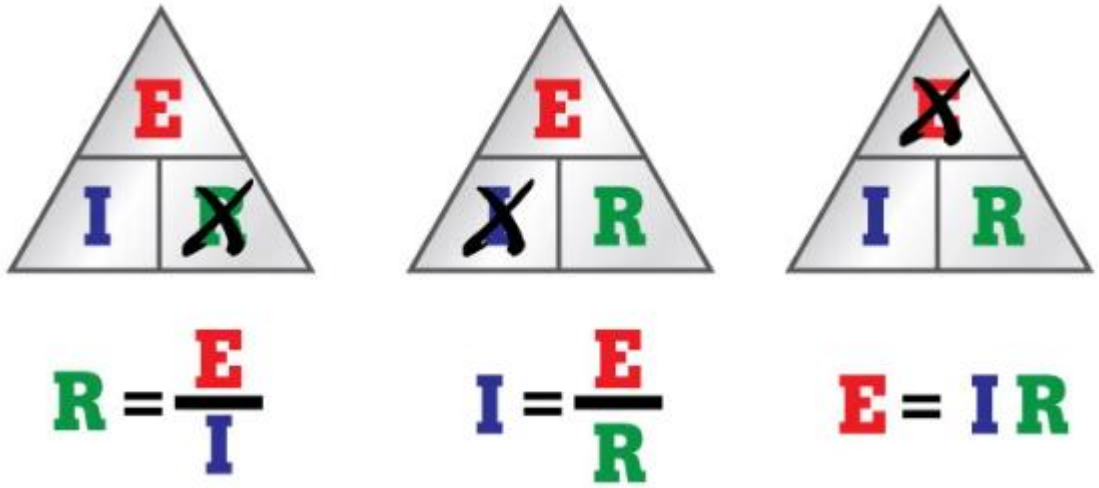
4. ELECTRICAL PRINCIPLES

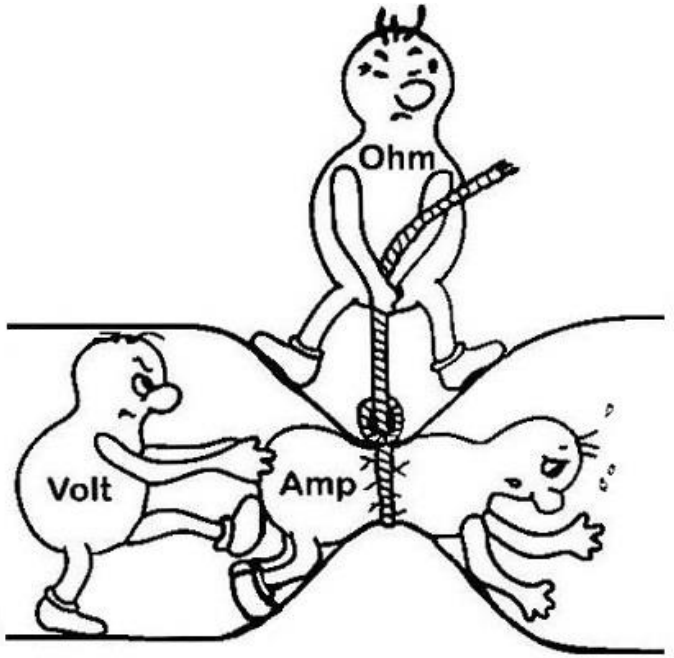
Chapter 4.1
Radio Mathematics

ARRL Amateur Extra Class

Ohms Law : Current, Voltage, Resistance

Easy for Direct Current





REACTANCE (X) : AC resistance

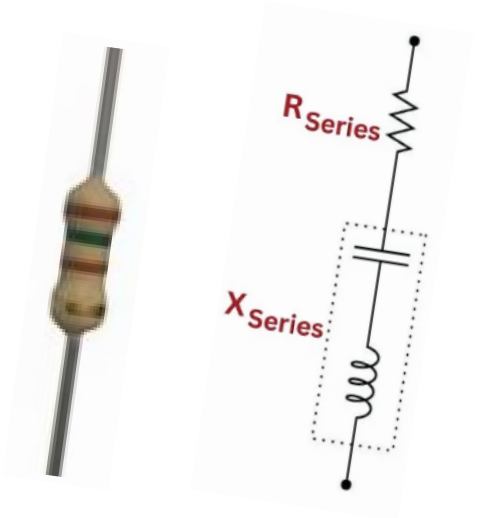
Reactance depends on frequency

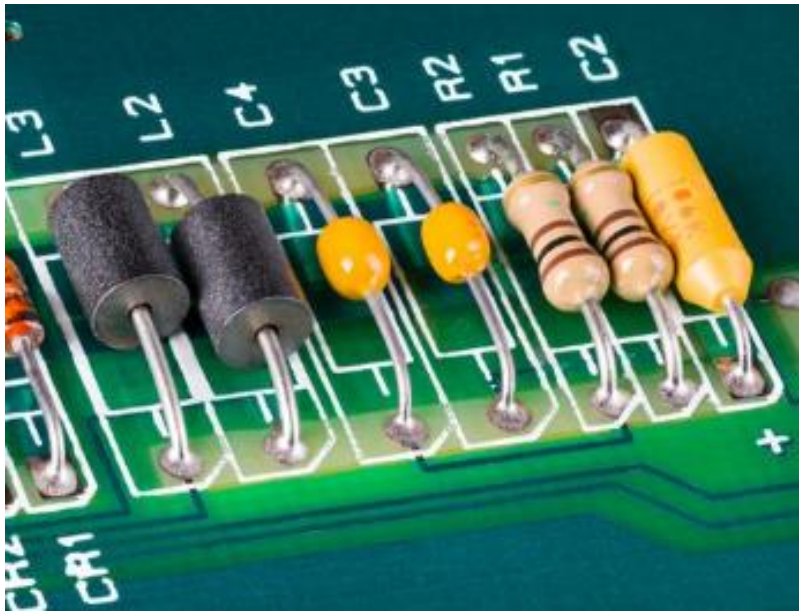
Capacitor: AC resistance decrease with higher frequency

Inductor: AC resistance increase with higher frequency

Any real circuit/component has both resistance AND reactance

Written as X





IMPEDANCE (Z)

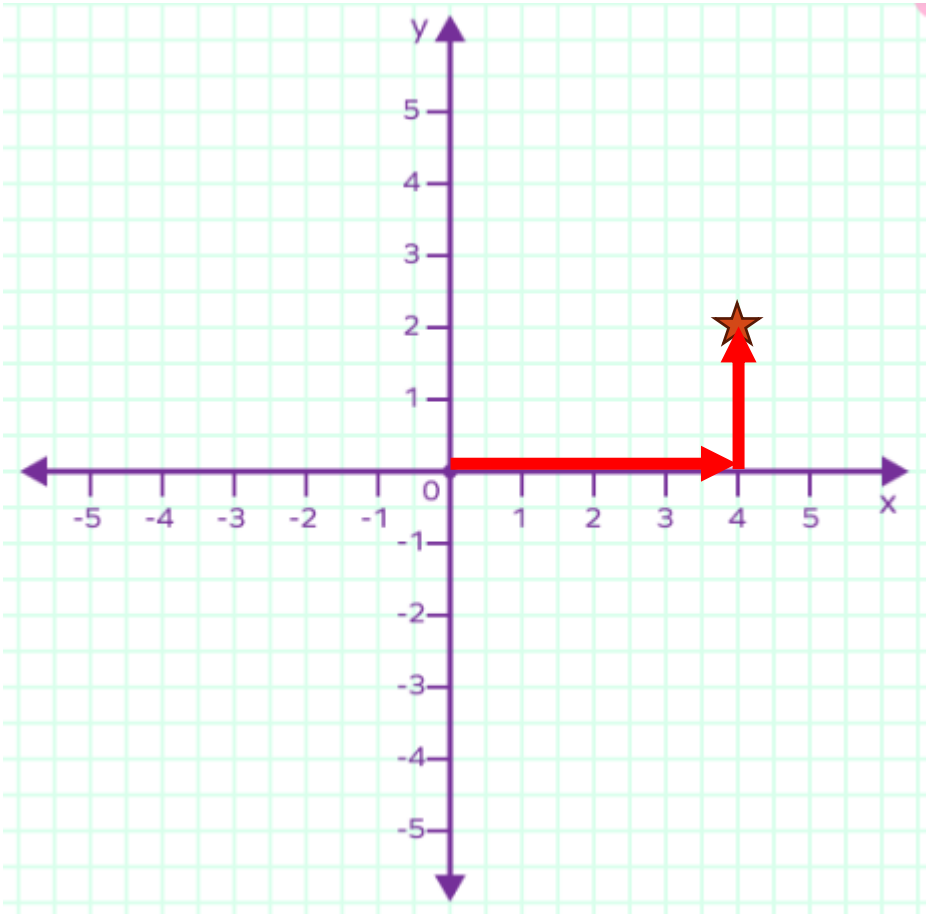
The combination of Resistance and Reactance

Written as Z

Two ‘dimensions’ – we can draw it !

x-axis = resistance, R

y-axis = reactance, X



Coordinate systems

Rectangular coordinates (Cartesian)

In our example: x=4, y=2

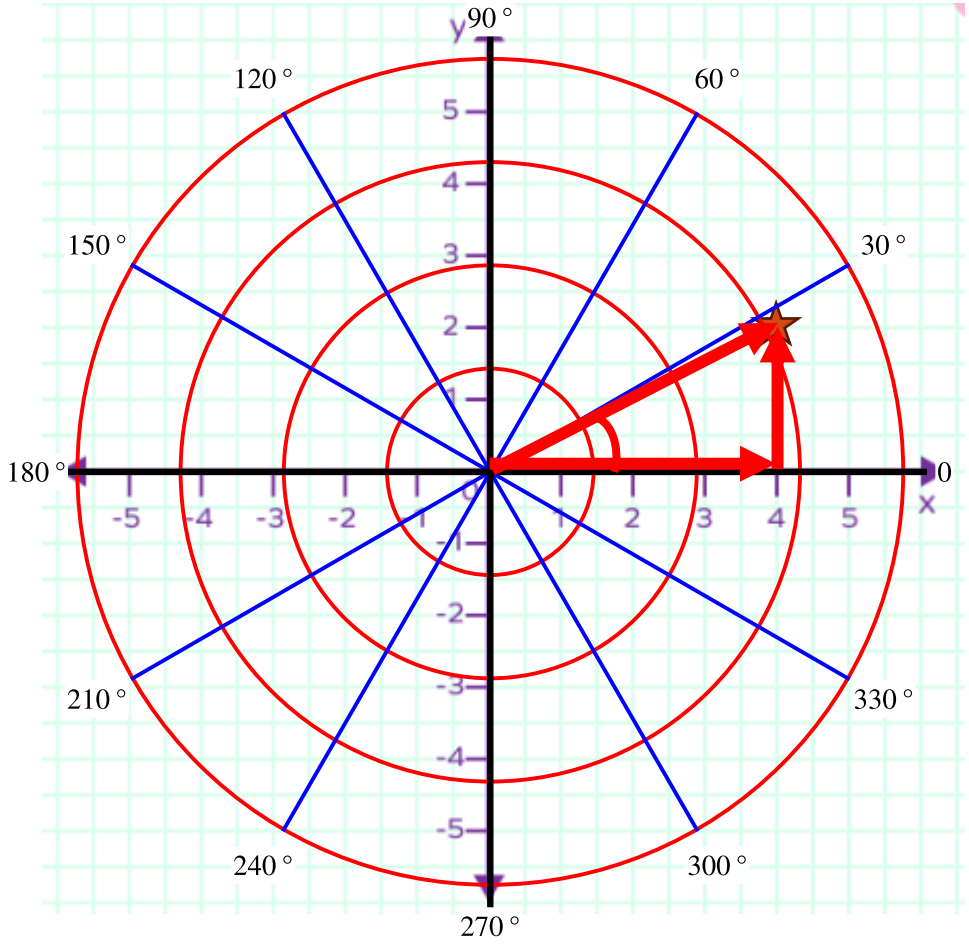
Simply: (4,2)

Polar coordinates

Distance from center (radius, r)

Angle (theta, θ)

(r $\angle$ θ)



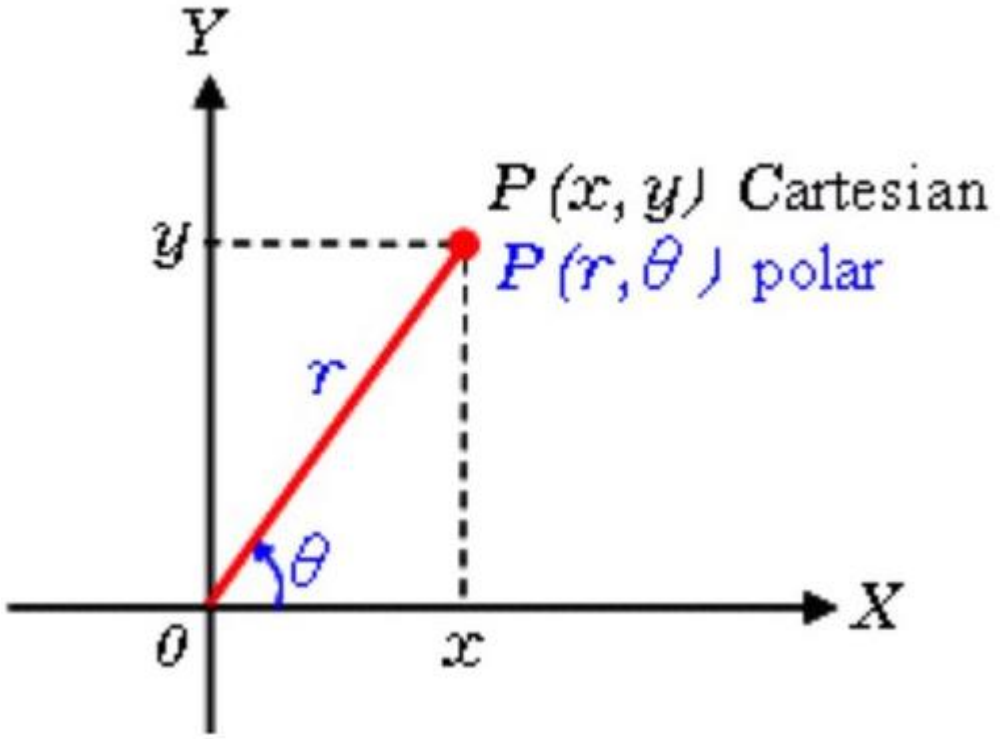
Coordinate systems

Convert from Rectangular to Polar

Pythagoras : $r^2 = x^2 + y^2$

$$r = \sqrt{x^2 + y^2}$$

$$\theta = \tan^{-1}\frac{y}{x}$$



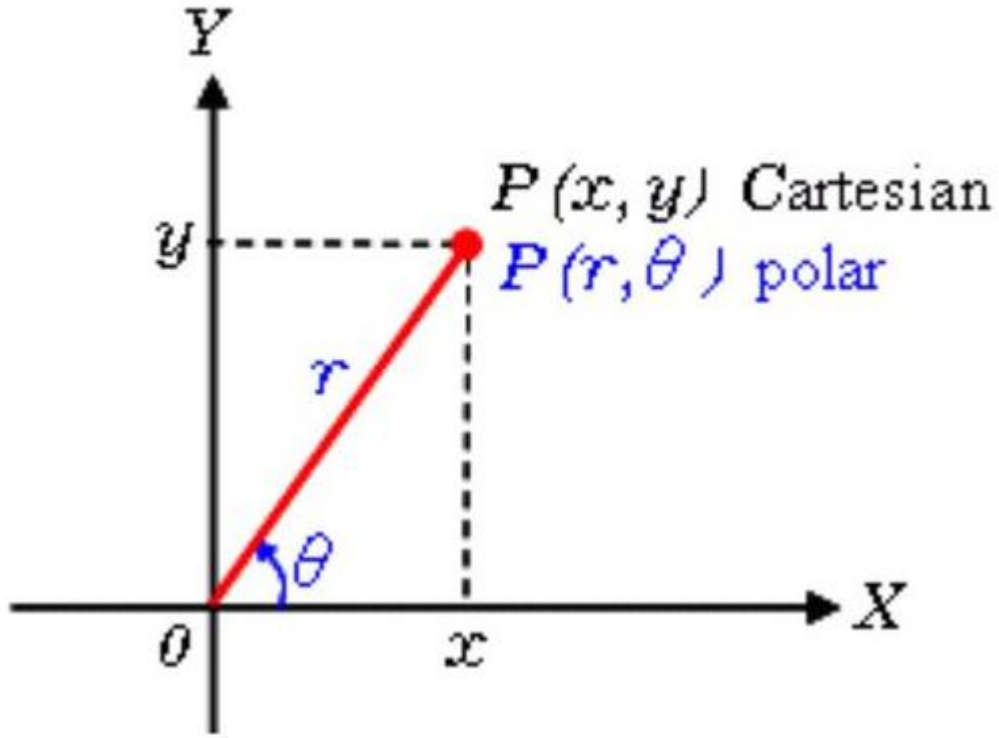
Polar coordinates are easier to MULTIPLY

Coordinate systems

Convert from Polar to Rectangular

$$x = r\cos\theta$$

$$y = r\sin\theta$$



Rectangular coordinates are easier to ADD

Imaginary numbers

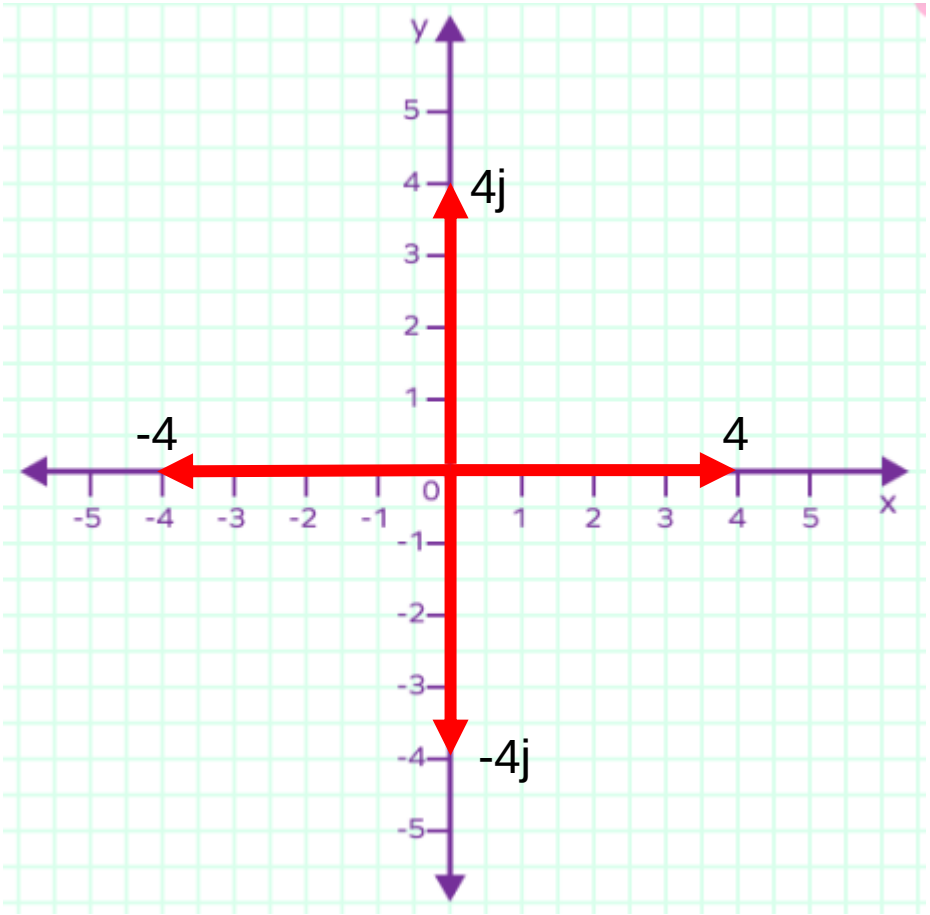
Have 2 rocks. Remove 3.
= -1 rock. *Impossible before 1700's!*

Imagine a number that multiplied with itself is equal to -1...

$j \cdot j = -1$

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

Think of j as the 'imaginary dimension'.

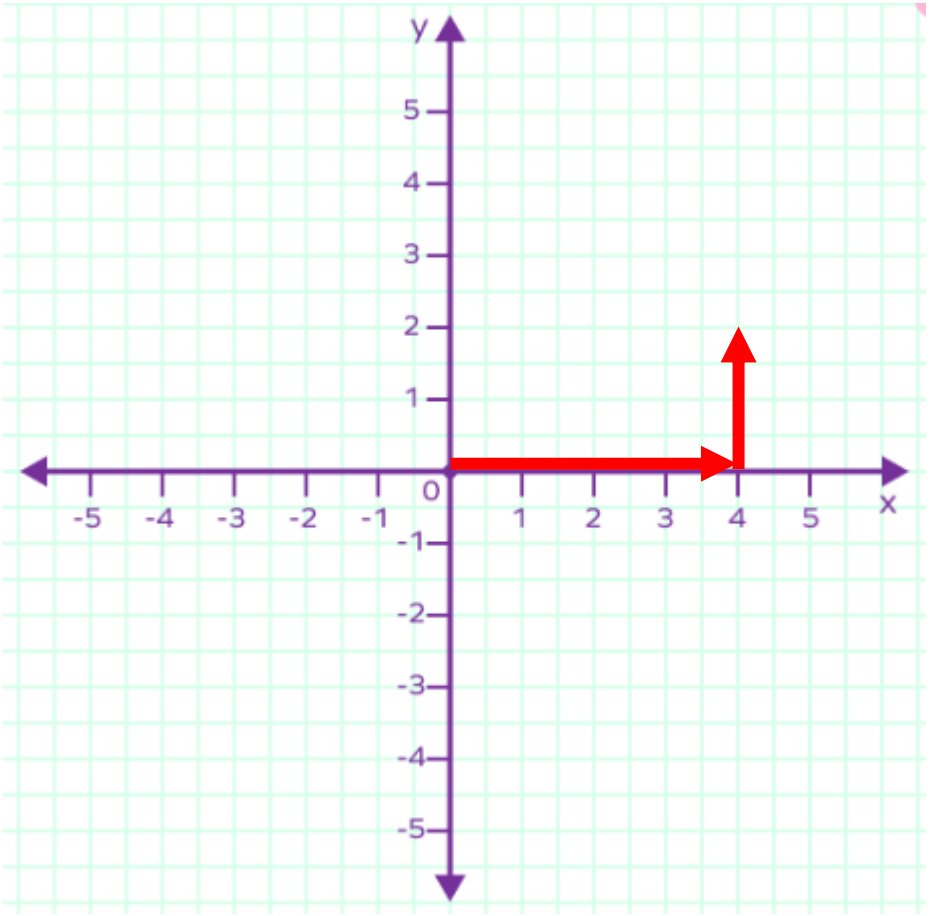


Complex numbers

Combining real numbers with imaginary..

4 + 2j

Can be expressed as either rectangular or polar coordinates



Why?

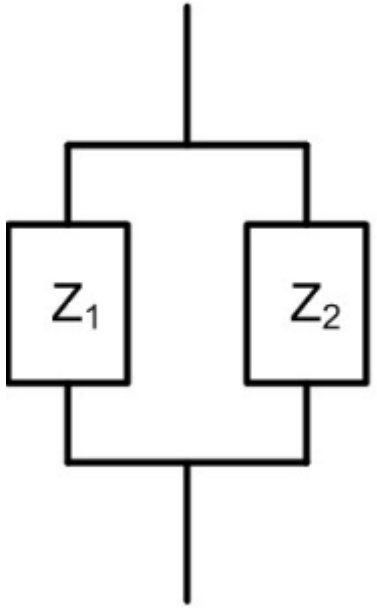
Impedances are described as complex numbers

Z = (resistive part) + j·(reactive part)

120 + j40Ω

Formula for parallel impedances:

$$Z_{eq} = \frac{Z_1 Z_2}{Z_1 + Z_2}$$



QUESTIONS?

ONLINE EXAM REVIEW AND PRACTICE QUESTIONS:

http://www.arrl.org/examreview