Newton's 1st Law (Inertia)

- An object's velocity remains constant unless acted upon by an external, unbalanced force.

“unbalanced” means net force is non-zero.
“external” means the force comes from outside the object considered.

Newton's 2nd Law

- acceleration of an object varies directly as the net force applied to the object
- $\vec{a} \propto \vec{F}_{net}$
- acceleration of an object varies inversely as the mass of the object
- $\vec{a} \propto \frac{1}{m}$
- Often we must add force vectors to find net force BEFORE we find acceleration

- Combining these relationships,

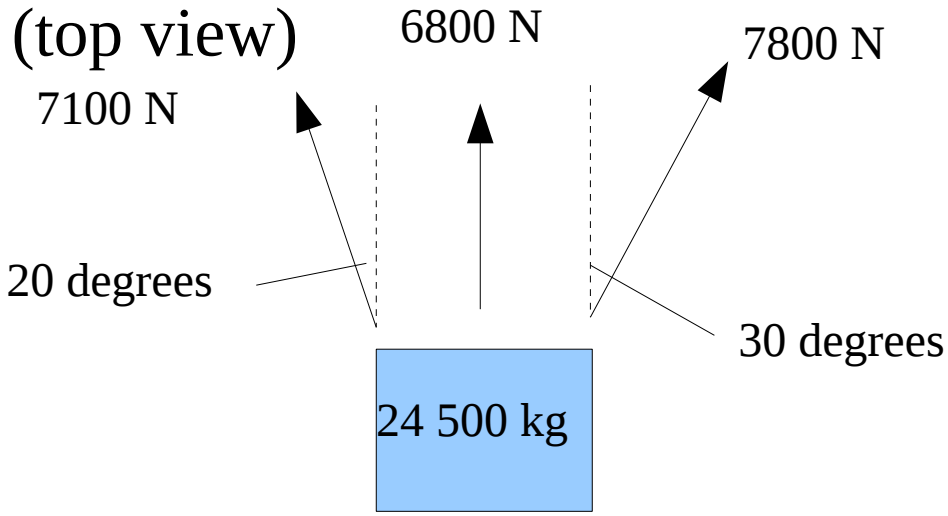
$$\vec{a} = \frac{\vec{F}_{net}}{m}$$

- in this case, we

1. Draw an FBD
2. Add all force vectors to find net force
3. Use $\vec{a} = \frac{\vec{F}_{net}}{m}$ to find acceleration

Example: A 24 500 kg barge is acted upon by forces from three tugboats: 6800 N [N], 7800 N [N 30º E] and 7100 N [N 20º W]. Determine the acceleration of the barge.

FBD (top view)



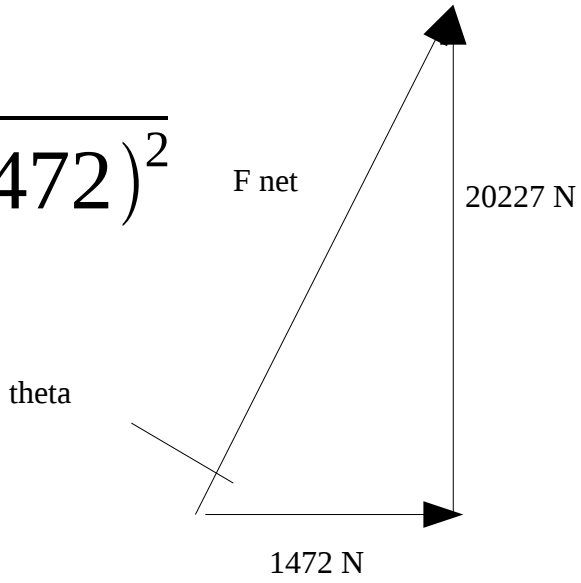
$$\Sigma \vec{F}_x = 7800\sin 30^o - 7100\sin 20^o$$

= 1472 N

$$\Sigma \vec{F}_y = 7800\cos 30^o + 7100\cos 20^o + 6800$$

= 20227 N

F net = $\sqrt{(20227)^2+(1472)^2}$



= 20280

Tan θ = 20227/1472

θ = 86º

$$\vec{a} = \frac{\vec{F}_{net}}{m} \text{ --> } \vec{a} = \frac{20280}{24500}$$

= 0.83 m/s^2

so acceleration = 0.83 m/s^2 [E 86º N]