Forces – Dynamics

I. Laws of Motion: 1 & 2
- inertia, force, mass
- **weight**

II. Law 3
- interaction & nature of force
- types of force: normal, friction
- air resistance, terminal velocity

III. Applications/Problem Solving
- components, inclines

	The student will be able to:	HW:
1	State Newton's 1st and 2nd Laws of Motion and apply these laws to physical situations in order to determine what forces act on an object and to explain the object's resulting behavior.	1 – 5
2	Recognize and state the proper SI unit of force and give its equivalence in fundamental units and use the relation $\mathbf{F}_{net} = m\mathbf{a}$ to solve problems.	6 – 10
3	Recognize the difference between weight and mass and convert from one to the other.	11 – 18
4	State and utilize Newton's 3rd Law to solve related problems.	19 – 21
5	Understand and utilize the concept of the normal force to solve related problems.	22 – 25
6	Understand and utilize the relation between friction force, normal force, and coefficient of friction for both cases: static and kinetic.	26 – 32
7	State the factors that influence air resistance and describe qualitatively the effect of each factor on the magnitude of the frictional force. And explain what is meant by "terminal velocity".	33 – 35
8	Resolve forces into components using trigonometry and use the results to solve related force problems.	36 – 40
9	Apply the concept of force components to objects on an incline and solve related problems.	41 – 47

Weight

Weight is the amount that gravity pulls an object. (*i.e.* the magnitude of the force of gravity)

Weight is often confused with *mass* because the more massive an object the more it weighs – a proportional relationship. However, the two concepts are not at all the same!

If there were no gravity would you be able to judge the mass of an object?

Weight Equation

If gravity is the sole force on an object it has an acceleration of *g*, therefore by Newton's 2nd Law:

$$F_G = mg$$

or

$$W = mg$$

This equation works for *any* situation – the object does *<u>not</u>* have to be in freefall.

Weight vs. Mass

- Weight depends on location because the strength of gravity can vary depending on location. Mass does not depend on location.
- Weight is measured in units of newtons; mass is measured in units of kilograms.
- Mass is purely a scalar; weight is the *magnitude* of a vector.

The next nine pages are intended to compare and contrast the concepts weight and mass.

Try flipping back and forth from page to page, noting the differences and similarities…

As the *mass* doubles …
(twice as much material)

… the *weight* doubles
(twice the pull of gravity).

(*i.e.* If the amount of matter is doubled then the force of gravity is also doubled.)

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In a location where $g = 9.80\ m/s^2$ (like Knoxville)

mass = 0.500 kg

weight = 4.90 N

A **scale** responds to *force* compressing a spring – most properly a device for measuring weight.

image credit "Knoxville TN skyline" by Nathan C. Fortner

In a location where $g = 9.80\ m/s^2$ (like Knoxville)

mass = 1.00 kg

weight = 9.80 N

A **scale** responds to *force* compressing a spring – most properly a device for measuring weight.

image credit "Knoxville TN skyline" by Nathan C. Fortner

In a location where $g = 9.82\ \mathrm{m/s^2}$ (like Oslo)

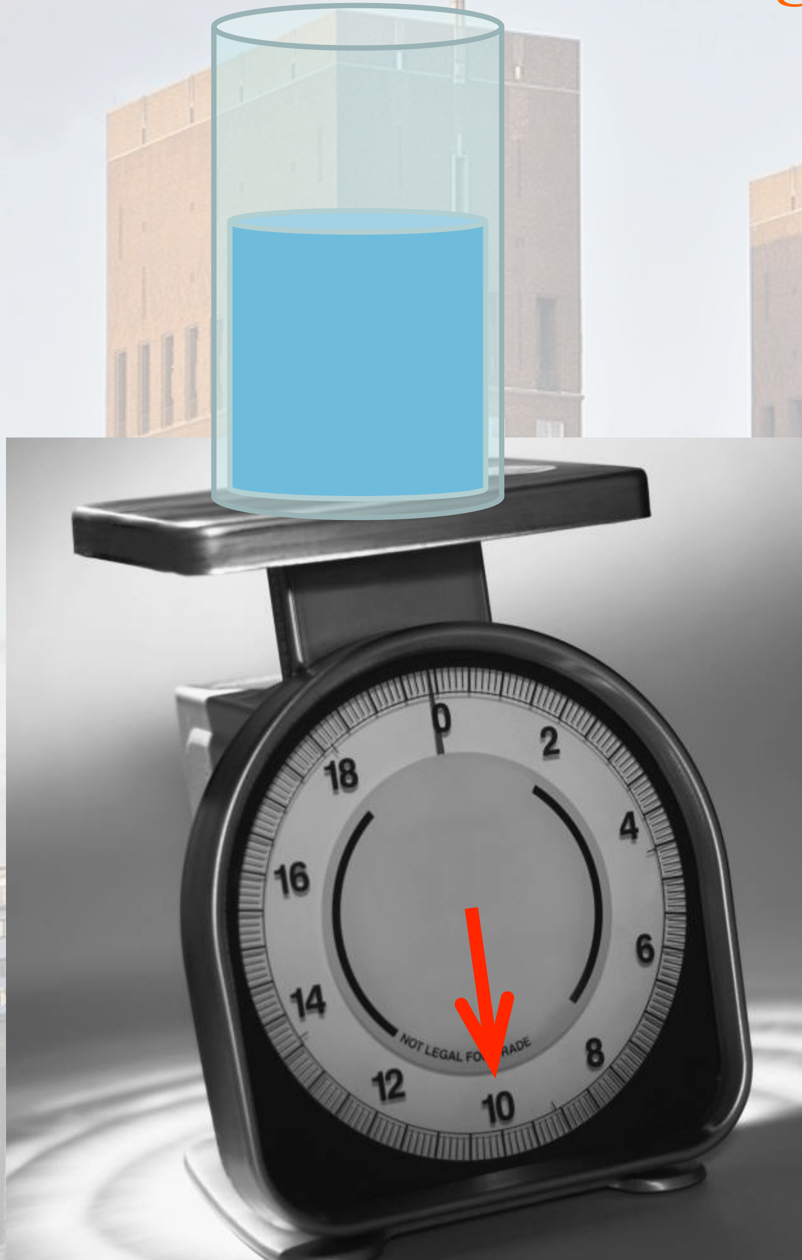
mass = 0.500 kg

weight = 4.91 N

The **scale** indicates a different value if gravity is different (even though the mass is the same).

image credit: "Oslo rådhus (by alexao)" by Alexander Ottesen

In a location where $g = 9.82\ \text{m/s}^2$ (like Oslo)



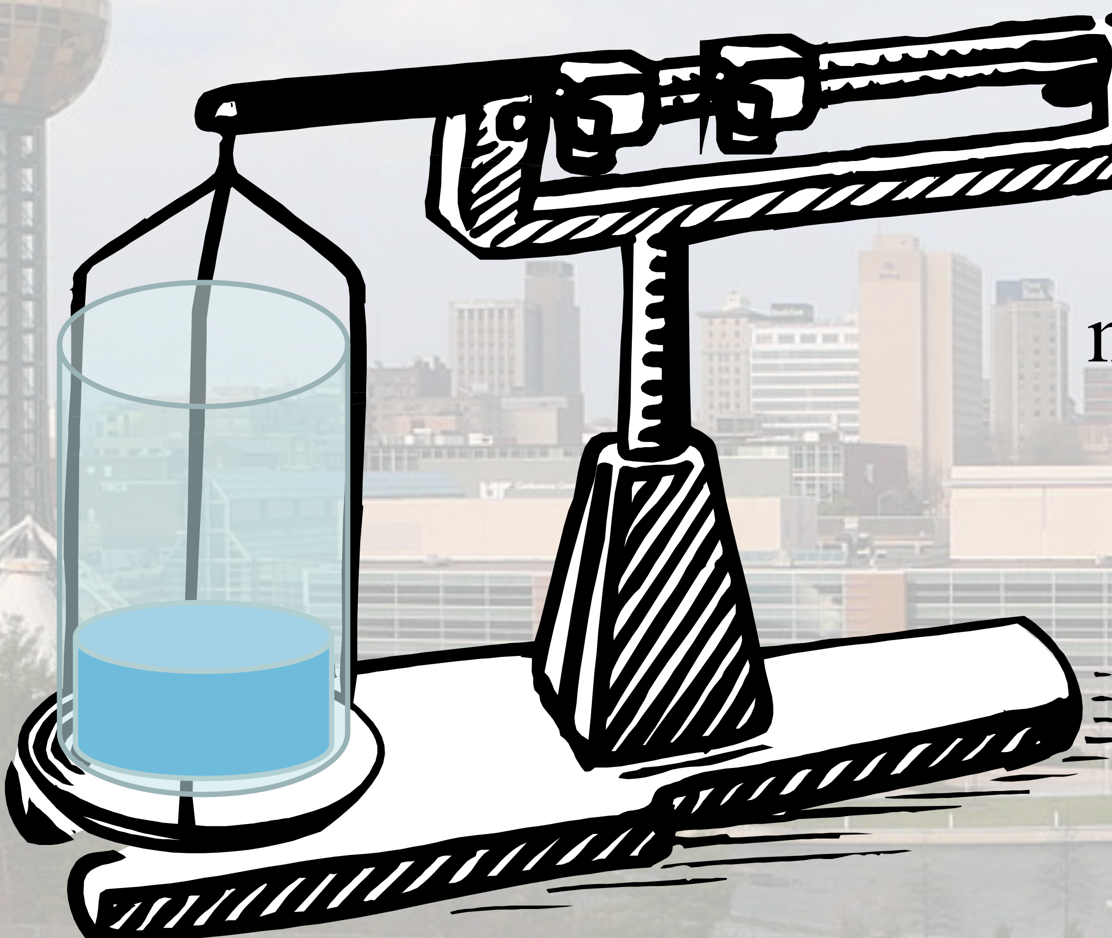
mass = 1.00 kg

weight = 9.82 N

The **scale** indicates a different value if gravity is different (even though the mass is the same).

image credit: "Oslo rådhus (by alexao)" by Alexander Ottesen

In a location where $g = 9.80\ m/s^2$ (like Knoxville)

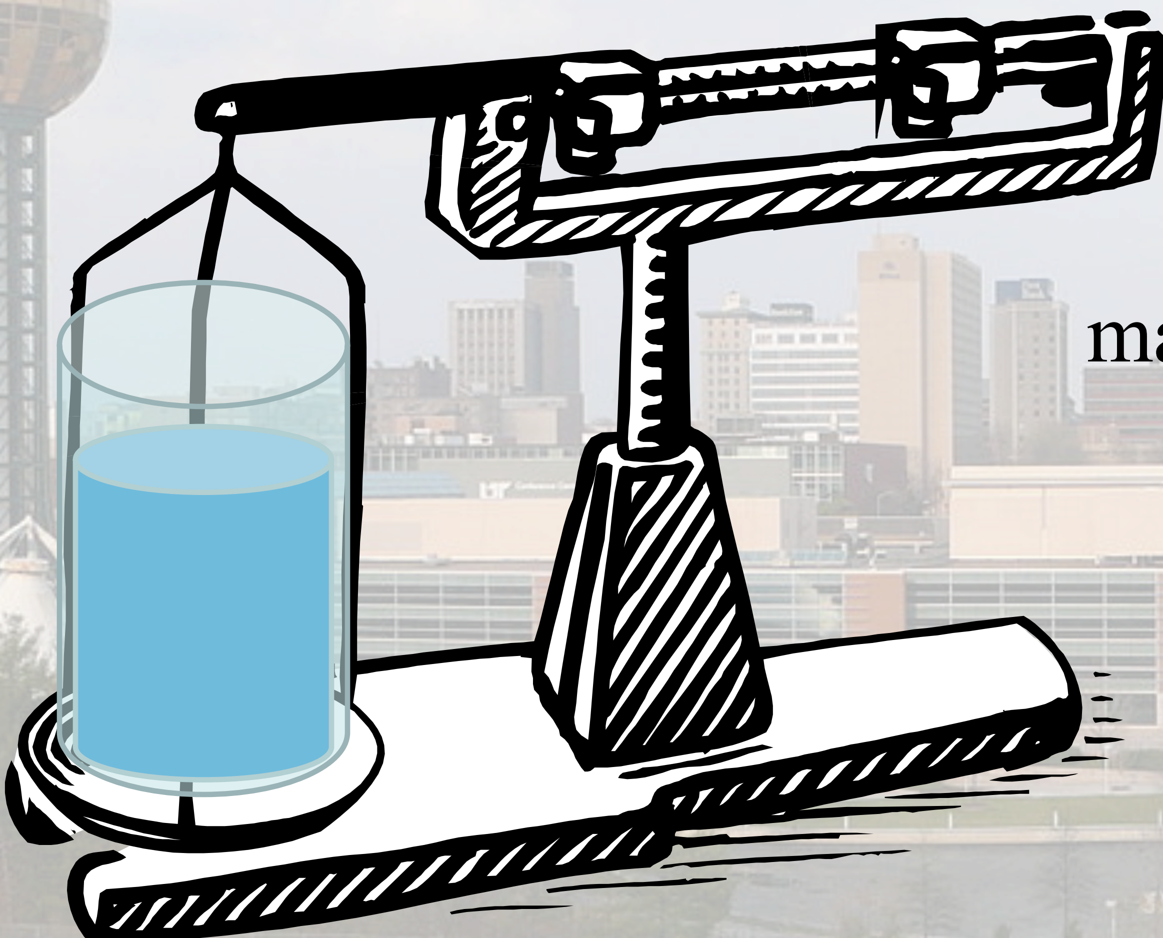


mass = 0.500 kg

A **balance** compares an unknown mass with known masses.

image credit "Knoxville TN skyline" by Nathan C. Fortner

In a location where $g = 9.80\ m/s^2$ (like Knoxville)



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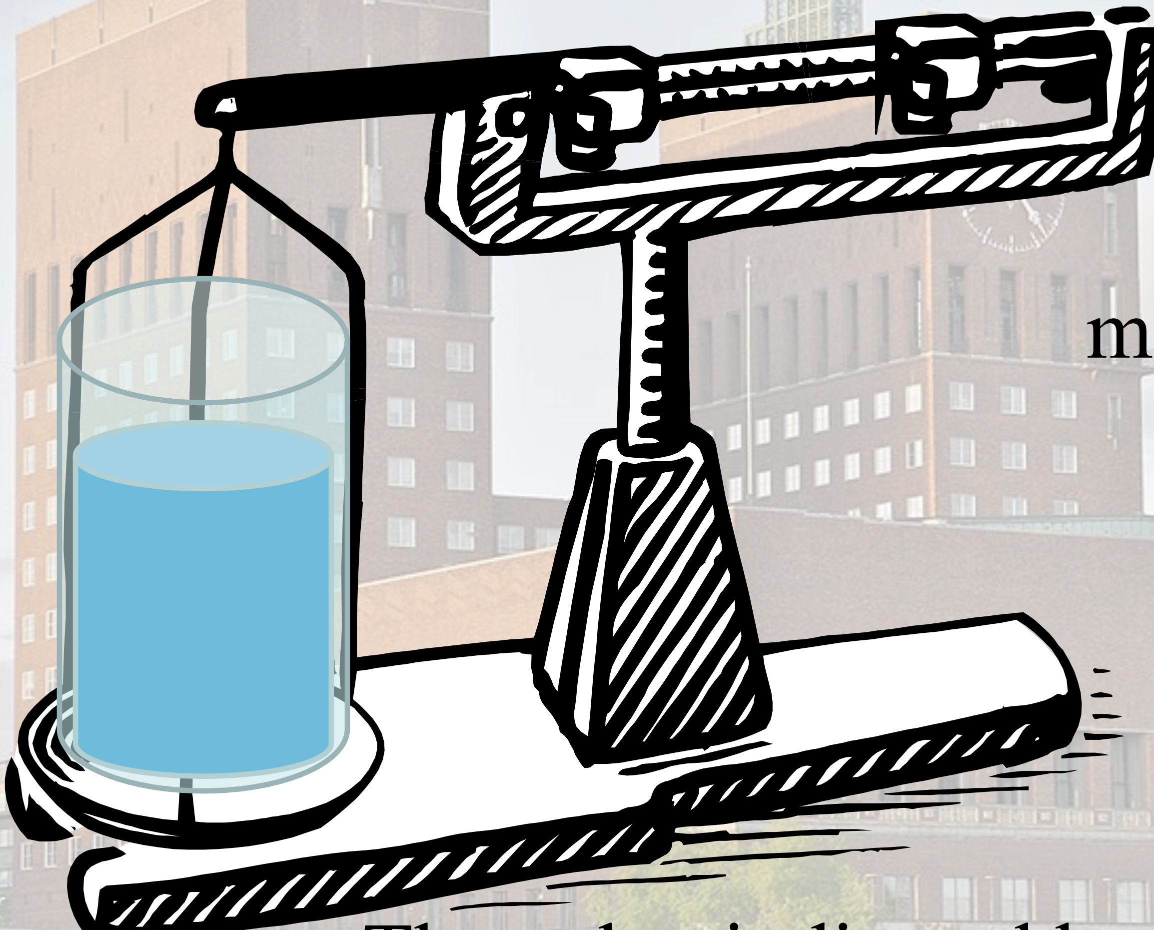

mass = 1.00 kg

The value indicated by a **balance** is <u>not</u> affected by the *strength* of gravity. It is most appropriate for measuring mass.

image credit: "Oslo rådhus (by alexao)" by Alexander Ottesen