Terminology,modeling ,and measurement

- **Even though physicists believe that the physical world obeys the laws of physics, they are also aware that the mathematical descriptions of some physical situations are too complex to permit solutions.**

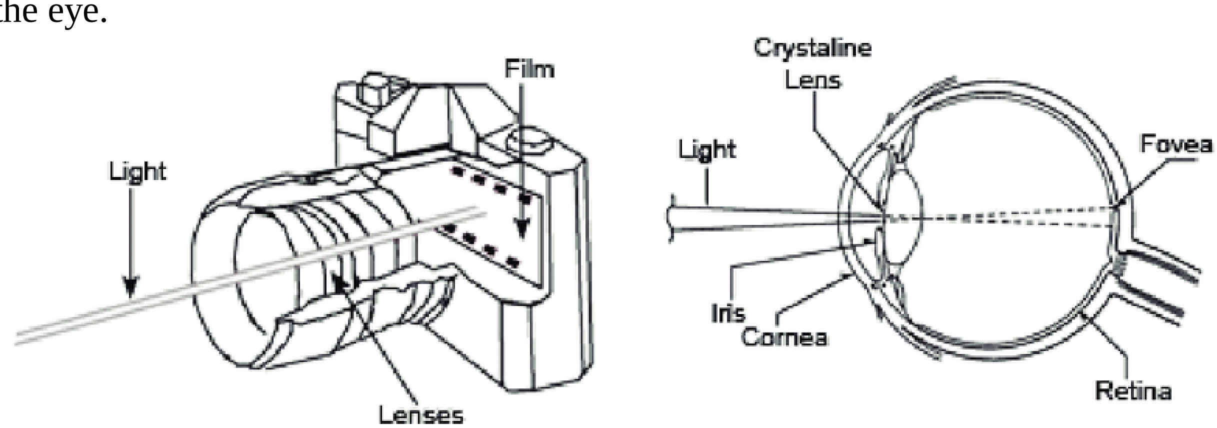
For Example: -

If you tore a small corner off this page and let it fall to the floor, it would go through various gyrations. Its path would be determined by the laws of physics, but it would be almost impossible to write the equation describing this path. Physicists would agree that the force of gravity would cause it to go in the general direction of the floor if some other force did not interfere. Air currents and static electricity would affect its path.

- **In trying to understand the physical aspects of the body, we often resort to analogies; physicists often teach and think by analogy. Keep in mind that analogies are never perfect.**

For Example: -

In many ways the eye is analogous to a camera; however, the analogy is poor when the film, which must be developed and replaced, is compared to the retina, the light detector of the eye.

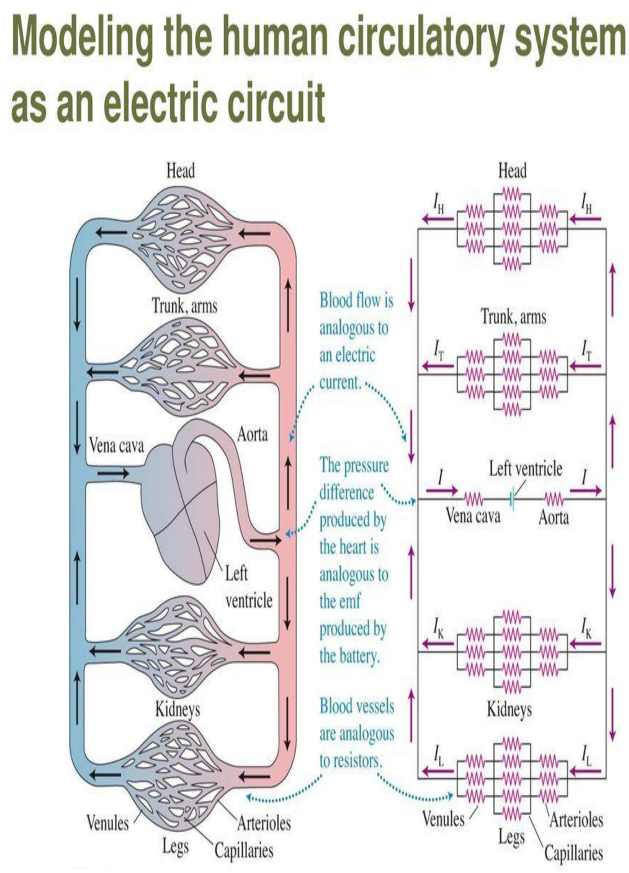


❖ **Some models involve physical phenomena that appear to be completely unrelated to the subject being studied.**

<u>For Example: -</u>

A model in which the flow of blood is represented by the flow of electricity is often used in the study of the body's circulatory system. This electrical model can simulate very well many phenomena of the cardiovascular system. Of course, if you do not understand electrical phenomena the model does not help much. Also, as mentioned before, all analogies have their limitations.

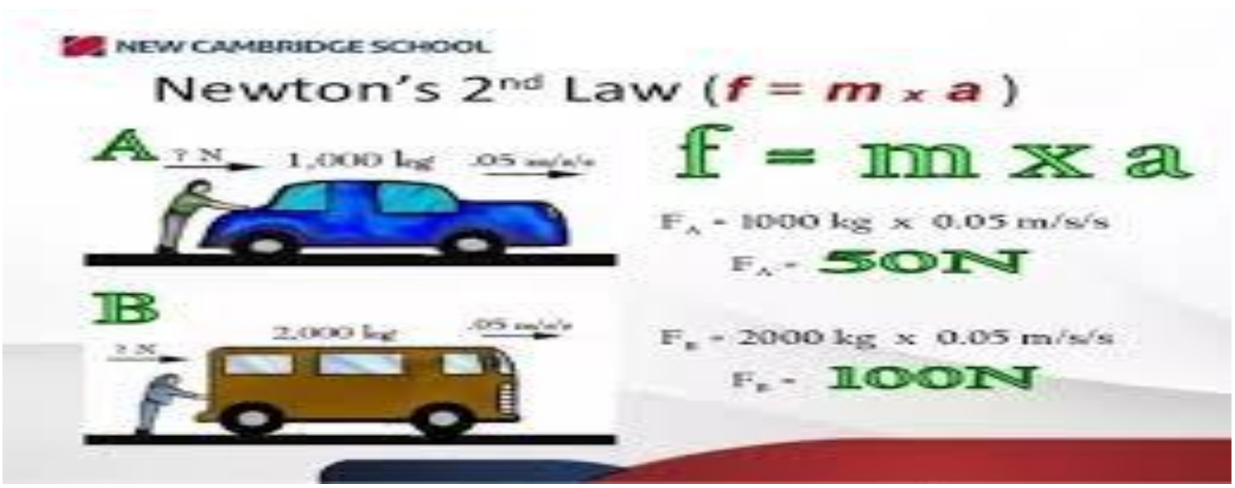
Blood is made up of red blood cells and plasma, and the percentage of the blood occupied by the red blood cells (**the hematocrit**) changes as the blood flows toward the extremities. This phenomenon is difficult to simulate with the electrical model.

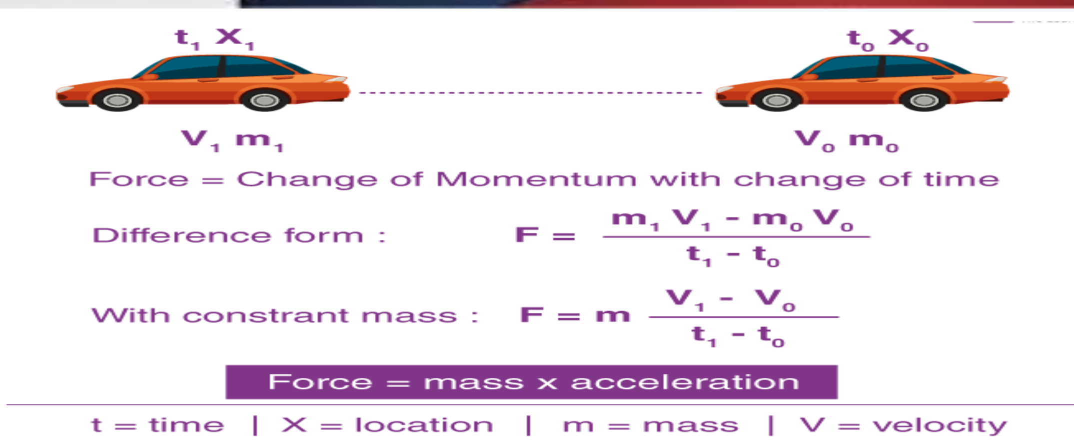


- **Other models are mathematical; equations are mathematical models that can be used to describe and predict the physical behavior of some systems. In the everyday world of physics we have many such equations. Some are of such general use that they are referred to as laws.**

<u>For Example: -</u>

The relationship between force ***F***, mass ***m***, and acceleration ***a***, usually written as ***F=ma***, is known as **Newton's second law**. There are other mathematical expressions of this law that may look quite different to a lay person but are recognized by a physicist as other ways of saying the same thing. **Newton's second law** is used in the form ***F*=Δ*mv*/Δ*t***, where ***v*** is the velocity, ***t*** is the time, and Δ indicates a small change of the quantity. The quantity ***mv*** is the momentum, and the part of the equation ***P*/Δ*t*** means rate of the change (**of momentum**) with time.





Measurement

Physiological measurements have also been used to monitor and measure various physiological parameters. Many physiological measurement techniques are non-invasive and invasive methods.

Measurements are central to clinical practice and medical and health research. They form the basis of diagnosis, and evaluation of the results of medical interventions.

*There are many other physical measurements involving the body and time. We can divide them into **two** groups: -*

1- Measurements of **repetitive** processes. It usually involves the number of repetitions per second, minute, hour, and so forth.

For Example: -

- The pulse rate is about 70/min.
- The breathing rate is about 15/min.

2-Measurements of **nonrepetitive** processes, **Nonrepetitive** time processes in the body range from the action potential of a nerve cell (**1msec**) to the lifespan of an individual.

For Example: -

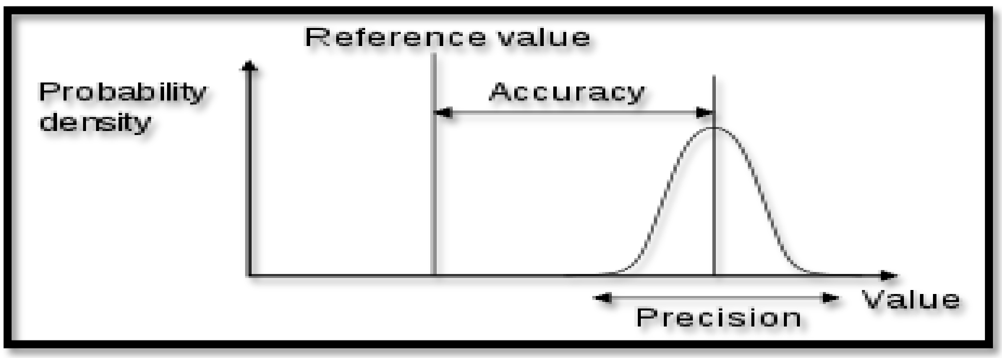
Such as how long it takes the kidneys to remove a foreign substance from the blood

Measurement accuracy: is the closeness of agreement between a measured quantity value and a true quantity value of the measured. A measurement is said to be more accurate when it offers a smaller measurement error.

For example

One may wish to measure a certain chemical's volume in the experiment.

If the actual volume was **60 ml** but the measurement was **75 ml**, it would not be a very accurate value due to the fact that it is not close to the 'true' value of 60 ml.



Measurement precision: is the closeness of agreement between measured quantity values obtained by replicate measurements on the same or similar objects under specified conditions.

Example 1 –

When you are measuring the value of resistance using a digital multimeter.
(A multimeter or a multitester, also known as a VOM (volt-ohm-milliammeter))

The value of resistance is actually 35 Ohms, but multimeter is showing 33 Ohms consistently 10 times. **So, Multimeter is Precise but not Accurate.**

<u>Example 2 –</u>

Let’s say the temperature of an object is 60-degree Celsius. And thermometer is showing 60 degrees for all readings. That means thermometer is **Accurate and precise.**

<u>The following are the common measurements used in the practice of medicine. Some of these measurements are more reproducible than others:</u>

- **Weight.**
- **Pulse.**
- **Temperature.**
- **Blood pressure.**
- **X-ray.**
- **Blood analysis.**

***When a physician must decide if the patient is ill or not, and what the illness is?**

After a physician has reviewed a patient's: -

1. Medical history.
2. The findings of the physical examination.
3. The results of the clinical laboratory measurements.

Measurements of physiological, biochemical, physical, and other patient-related variables produce results; these results from such measurements also provide essential information for critical decision-making in clinical practice, as well as for research and technology development.

Erroneous measurements can jeopardize patient safety and can expose the most critically ill patients to severe hazards.

The decisions are two types: -

1. Right decisions.
2. Wrong decisions.

It is not surprising that sometimes **wrong decisions** are made. These wrong decisions are of **two** types: -

1. False Positives.
2. False Negatives.

A **false positive** error occurs when a patient is diagnosed to have a particular disease when he or she does not have it.

A **false negative** error occurs when a patient is diagnosed to be free of a particular disease when he or she does have it.

Note: -

In some situations a diagnostic error can have a great impact on a patient's life.

For Example: -

A young woman was thought to have a rheumatic heart condition and spent several years in complete bed rest before it was discovered that a **false positive diagnosis** had been made-she really had arthritis, a disease in which activity should be maintained to avoid joint stiffening.

In the early stages of many types of cancer it is easy to make a **false negative diagnostic** error because the tumor is small. Since the probability of cure depends on early detection of the cancer, a false negative diagnosis can greatly reduce the patient's chance of survival.

<u>Diagnostic errors (false positives and false negatives) can be reduced by: -</u>

1-Research into the causes of misleading laboratory test values.

2-Development of new clinical tests and better instrumentation.

3-Using care in taking the measurement.

4-Repeating measurements.

5-Using reliable instruments.

6-Properly calibrating the instruments.