Terminology, Modeling, and Measurement

Physics is divided into several types:
1. Motor mechanics 2. Physics of waves and sound 3. Nuclear physics 4. Physics of the universe and astronomy 5. Physics of high energies 6. Physics of electronics 7. Physics of engineering optics 8. Quantum mechanics 9. Theory of relativity 10. Thermodynamics 11. Nano science 12. *Medical and Biological Physics* 13. Laser Physics 14. Elementary Particle Physics 15. Atomic Physics 16. Plasma Physics 17. Electromagnetic Theory 18. Statistical Physics 19. Solid State Physics 20. Chemical Physics

1.1 Terminology:

Medical physics: is the term of a science that overlaps with the two fields of medicine and physics and it refers to the applications of physics to the function of the human body in health and disease , is the application of the concept of physics in medicine.

Aims of the Medical physics Application of the concepts and methods of physics to understanding the function of human body in health and disease .

1 .**Physics of** the **body** is to understanding physical aspect of the body such as ; forces on and in the body , work , energy ,power of the body, heat ,blood flow , respiration , electricity , ,circulation, and hearing

2.Application of physics in medicine

Medical physics Techniques are used for

A. Diagnostic :

Stethoscope ,Manometer (blood pressure),Sphygmomanometer ,Electrocardiograph(ECG),X- Ray, Electroencephalograph(EEG), Electromyography (EMG) , thyroid function using I^{131} ,Computer tomography (CT scan) , Ultrasound , tuning Fork, Imaging Magnetic Resonance (IMR), Flow meter , Spirometer to study the function lungs, Audiometer, Optics, Laser, Gamma camera to study the function of kidney ,liver ,and lungs .

Radiotherapy

Cobalt sixty(Co sixty) ,High voltage ,Ultrasound ,infrared ,Radio frequency ,Heating ,Laser

B. Therapy

c. Patient monitoring

ECG , spirometer , blood pressure ,and thermometer

physics of physiology

. Application of physics in the practice of medicine: physics of the stethoscope ,etc.

Physical medicine and physical therapy
Biophysics
Health physics
Medical engineering or biomedical engineering
Bioengineering.

1.2 Modeling

- Modeling

1. Simplification: selection of main features 2. Qualitative or quantitative expression 3. Analysis 4. Verification 5. Interpretation
6. Application

- Analogy

1. Mechanical model 2. Electrical circuit model

- Mathematics

1. Equation 2. Function

- Feedback control or

1. Negative feedback: homeostasis 2. Positive feedback

1.3 Measurement

- General structure

1. Measured 2. Sensor or transducer 3. Signal processing 4. Output display

Units:

1. SI units(SI units: Two types of SI units)

1.Physical unit

a. MKS system: (M = mass ,K = Kilogram ,S = Second)
b. CGS system: (C = centimeter,G = gram,S = second)
Force in MKS *Newton*…..in CGS *dyne*
Energy Joule ,erg

2 .Physiological unit

In medicine it is often convenient to measure quantities in nonstandard units. ..For example :the physical units of pressure is newtons per square meter ,blood pressure is expressed in millimeter of mercury (Hg)
2. English units 3. Nonstandard units

Non Standard Unit

(Pressure = mm Hg ,Time = minute,Energy = calorie ,Heart rate = pulse / minute)… Another example ; pulse rate measure in pulse per min
*There are two groups of physics measurement in the body which are *repetitive* and *nonrepetitive*, the *repetitive* is the number of repetition per second, minute … e.g. pulse rate (70/minute) breathing rate (16/minute men and 20/minute women) and frequencies in the electrical signals from the brain.
The *nonrepetitive* means ……. Such as the time of the function of the kid eyes remove a foreign substance from the blood, food digestion in the body, time intervals of nerve signal.

The measurement in medicine should be very accurate and the percentage of error should be as low as possible.
The diagnostic error is not result of measuring instruments only, because the error can happened due to a cycological reasons e.g. the blood and pressure pusse rate can be affected during the measurement by several rejoins the diagnostic errors can lead to wrong dictions which are of two types which are:
i. a false negative error occurred when a point is diagnosed to be free of particular disease when he does have it.

ii. a false positive error occurs when patient is diagnosed to have a particular disease when he does not have it.
Diagnostic positive and negative errors can be reduced by:

i. research in the causes of misleading laboratory test values.

ii. devalgment of new clinical tests.

iii. better instrumentation .
All the measurement are uncertain and inaccurate. The uncertainties and from measurement can be reduced by using:
1.care in taking the measurement. 2.Repeating measurement.

3.Using reliable instruments. 4.Calibration of the instruments.

- Static characteristics:
1. Accuracy 2. Precision 3. Resolution 4. Reproducibility
- Sources of error
1. Inherent variability 2. Sensor or transducer 3. Signal processing
4. Output display 5. Interconnection and feedback control: known or unknown 6. Psychological effects 7. Physical environment 8. Human factors: sensation, interpretation, mistake, etc
- Things to remember:
1. All measurements are uncertain and inaccurate
2. We can reduce the error and the uncertainty with special effort
3. In many cases, there is no need to improve the measurement.

(H.W)// The following systolic blood pressures (in millimeters of mercury)were recorded for one individual over a period of several days.

112	128	110	117	133
127	118	117	124	112
123	127	114	115	125
132	133	132	126	136
123	119	132	134	131

a. Find the mean pressure $\overline{P} = \sum P_i / n$,where $\sum P_i$ is the sum of all ,(n= 25) values of pressure.

b. Find the standard deviation .

$$\sigma = \sqrt{\frac{\sum (P_i - \overline{P})^2}{n-1}}$$

Ans.// a) $\overline{P} = 124 mmHg$,

b)

$$\sigma = 8 mmHg$$

Ref….. Medical physics By: John R .Cameron