General Physics

Radiology Techniques Department

1st Class

Al-Mustaqbal University college

Lecture 3: Mechanics

2020/2021

Mechanics

Mechanics is a segment of physics that deals with objects at rest (statics) and objects in motion (dynamics).

Velocity

Velocity, sometimes called speed, is a measure of how fast something is moving or, more precisely, the rate of change of its position with time.

$$V = \frac{d}{t}$$

where d represents the distance traveled in time t.

Question: What is the velocity of a ball that travels 60 m in 4 s?

Answer: $V = \frac{d}{t}$

$$V = \frac{60\ m}{4\ s} = 15\ m/s$$

Often, the velocity of an object changes as its position changes.

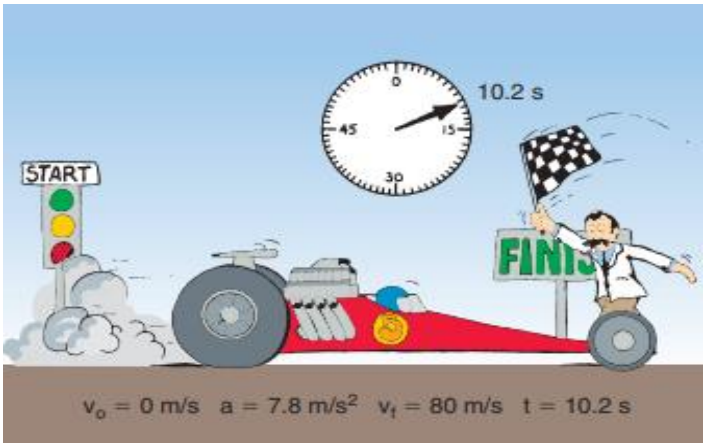
- The average velocity can be calculated from the following expression:

$$\bar{V} = \frac{V_0 + V_f}{2}$$

The initial velocity (v_o) and The final velocity (v_f)

Question: What is the average velocity of the dragster?

$$\bar{V} = \frac{0\frac{m}{s} + 80\frac{m}{s}}{2} = 40\frac{m}{s}$$



Acceleration

The rate of change of velocity with time is acceleration. It is how "quickly or slowly" the velocity is changing.

$$a = \frac{V_f - V_o}{t}$$

Question: What is the acceleration of the dragster?

Answer: $\bar{V} = \frac{80\frac{m}{s} - 0\frac{m}{s}}{10.2\ s} = 7.8\frac{m}{s^2}$

Work

The work done on an object is the force applied times the distance over which it is applied.

$$W = Fd$$

Question: Find the work done in lifting an infant patient weighing 90 N (20 lb) to a height of 1.5 m.

Answer: Work = Fd = (90 N) (1.5 m) = 135 J

Power

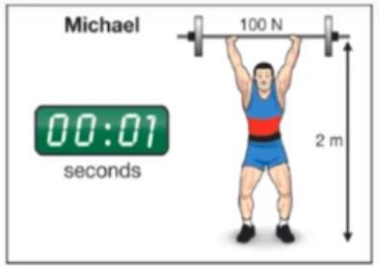
Power is the rate of doing work. It define as the time rate of energy transfer.

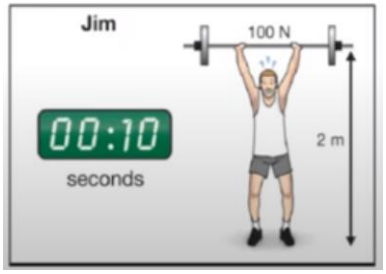
- Power gives us a way to include the time required to perform the work.

$$P = Work/t = Fd/t$$

- The SI unit of power is the joule/second (J/s)

1 horsepower (hp) = 746 W , 1000 = 1 kilowatt (kW)





Example: A radiographer lifts a 0.8 kg cassette from the floor to the top of a 1.5 m table with an acceleration of 3 m/s^2 .
What is the power exerted if it takes 1.0 s?

Solution:

F = ma
= (0.8 kg) (3 m/s^2)
= 2.4 N

Next, find work:

Work = Fd
= (2.4 N) (1.5 m)

= 3.6 J

Now, P can be determined:

P = Work/t

= 3.6 J/1.0 s

= 3.6 W

Energy

- Energy is the ability to do work.
- Energy may be transformed from one form to another, but it cannot be created or destroyed

Types of energy

- Mechanical energy
- Chemical energy
- Electrical energy
- Thermal energy (heat)
- Nuclear energy
- Electromagnetic energy

Two forms of mechanical energy often are used in radiologic science: kinetic energy and potential energy.

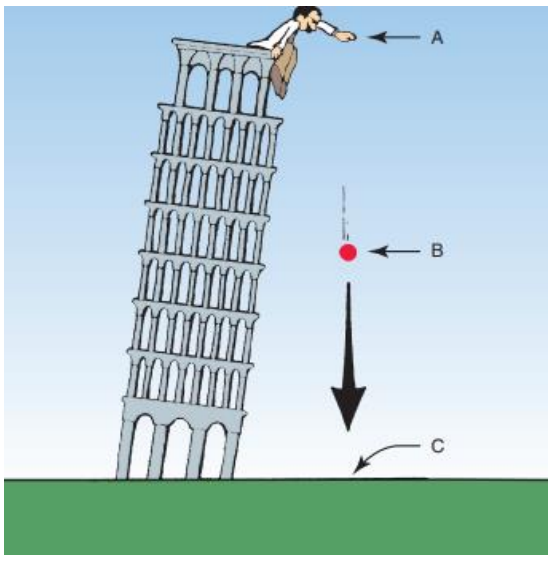
Kinetic Energy: is the energy associated with the motion of an object as expressed by the following:

$$K.E = \frac{1}{2} mv^2$$

A, Maximum potential energy, no kinetic energy.

B, Potential energy and kinetic energy.

C, Maximum kinetic energy, no potential energy



Example : Consider two rodeo chuck wagons, A and B, with the same mass. If B has twice the velocity of A, verify that the kinetic energy of chuck wagon B is four times that of chuck wagon A.

Answer:

$$\text{Chuck wagon A: } KE_A = \frac{1}{2}mv_A^2$$

$$\text{Chuck wagon B: } KE_B = \frac{1}{2}mv_B^2$$

$$\text{However, } m_A = m_B,\ v_B = 2v_A$$

$$\text{therefore, } KE_B = \frac{1}{2}m_A(2v_A^2)$$

$$= \frac{1}{2}m_A(4v_A^2)$$

$$KE_B = 2mv_A^2$$

$$= 4\left(\frac{1}{2}mv_A^2\right)$$

$$= 4\,KE_A$$

Potential energy is the stored energy of position or configuration.

- Examples of potential energy
  1. Gravitational potential energy
  2. Elastic potential energy

Example: the man lifts a 10 kg package 2 meters above the ground. What is the potential energy given to the package by the man?

P.E = mgh
= (10) (9.8) (2)
= 196 J