Physics Chapter 2

Speed\Velocity

Speed = distance/time
Scalar quantity requiring magnitude only to describe how fast a body is.

- **Instantaneous speed** The speed at any instant of time.
- **Average speed** = distance/time

Velocity = distance/time
Vector quantity requiring magnitude and direction
It describe how fast and in what direction.

- **Constant velocity** Means motion in straight line at a constant speed.
- **Changing velocity** If either the speed of the direction Or both changes, then the velocity changes.

Acceleration

is the change in velocity per unit time.

Type of acceleration

- (+a) **positive acceleration.** — when the speed increases
- (-a) **negative acceleration** (deceleration). — when the speed decreases

* when the speed is constant, the acceleration is zero.

Average acceleration = change in velocity/time

Dimension: Length/time^2

Units: m/s^2, km/h^2.

Fall

Free fall

a = g = 9.8 m/s^2

Air resistance is negligible.

Depends on — weight, inertia

Dropped meand (Vi = 0)

Up ward means (Vf = 0)

Non free fall

a < g < 9.8 m/s^2.

Air resistance is NOT negligible.

Depends on — speed, FSA Frontal Surface Area.

Terminal speed

Occur when acceleration terminates when air resistance equals wight and net force.

Accelerated motion

Equestions

1. $v_{avg} = \frac{v_f + v_i}{2}$
2. $a = \frac{v_f - v_i}{t}$
3. $v_f = v_i + at$
4. $s = v_i t + \frac{1}{2} a t^2$
5. $s = \frac{1}{2}(v_f + v_i)t$
6. $2as = v_f^2 - v_i^2$

where
s = displacement
v_f = final velocity
v_i = initial velocity
v_{avg} = average velocity
a = constant acceleration
t = time

Newton's laws

Newton's 1st law

a body at state of rest (speed = 0) or motion with constant velocity (constant speed in straight line) tends to remain at this state unless acted upon by an unbalanced force.

Newton's 2nd law

$F = m\,a$

$F \equiv$ the total force.
$m \equiv$ mass.
$a \equiv$ acceleration.

The law of acceleration

Newton's 3rd law

To every action there is always an opposed equal reaction.

Force

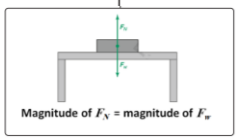
F = ma

Fw = mg
w means weight.

$$F_w = mg$$

where F_w = weight
m = mass
g = acceleration due to gravity
g = 9.80 m/s^2 (earth, metric)
g = 32.2 ft/s^2 (earth, U.S.)

FN = mg
N means normal



Friction force

The characteristics of friction can be described by the following equation:

$$F_f = \mu F_N$$

where F_f = frictional force
F_N = normal force (force perpendicular to the contact surface)
μ = coefficient of friction

Higher μ ⇒ two rough surfaces; smaller μ ⇒ two smooth surfaces (*not too smooth*)

Net force
the resultant of the forces

- Same direction (add)
- Opposite direction (subtract)

Static friction

The two surfaces are at rest relative to each other.

$= \mu_s F_N$

Kinetic friction

The two surfaces are in relative motion.
*** Static friction > Kinetic friction**

$= \mu_k F_N$

To reduce kinetic friction:

1- Use smoother surfaces.

2- Use lubrication.

3- Use Teflon.

Work

Work is the product of the force in the direction of the motion and the displacement.

$$W = Fs$$

where W = work
F = force applied *in the direction of the motion*
s = displacement

Work = 0 .. when

- F = 0
- s = 0
- Subtopic

Work units are

- 1 N m = 1 joule = 1J (SI system).
- 1 feet x pounds = 1 ft lb (British system).

Power

Power is *the rate of doing work*;

$$P = \frac{W}{t}$$

P = power
W = work
t = time

Power units are

- Joule/second = J/s = Watt (SI system)
- feet/second = ft/s = hp (British system).

Energy

Potential energy
is the stored energy of a body due to its internal characteristic or its position.

Gravitational potential energy

$$E_p = m\,g\,h$$

where E_p = potential energy
m = mass
g = 9.80 m/s^2 or 32.2 ft/s^2
h = height above reference level

Kinetic energy
energy of motion of a body due to the mass and velocity of a moving object.

If object speed is doubled the kinetic energy is quadrupled.

$$E_k = \frac{1}{2}\,m\,v^2$$

where E_k = kinetic energy
m = mass of moving object
v = velocity of moving object

If all the work is transferred into kinetic energy

$$F\,s = \frac{1}{2}\,m\,v^2$$

where E_k = kinetic energy
m = mass of moving object
v = velocity of moving object
F = net force of work
s = displacement

Conservation of mechanical energy

$$\max E_p = \max E_k$$
$$mgh = \tfrac{1}{2}mv^2$$

Solving for the velocity

$$v = \sqrt{2\,g\,h}$$

Energy units are

1 N m = 1 joule = 1J (SI system).

1 feet x pounds = 1 ft lb (British system).

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