Chapter 5 – Force and Motion I

I. Newton's first law.

II. Newton's second law.

III. Particular forces:

- Gravitational
- Weight
- Normal
- Friction
- Tension

IV. Newton's third law.

Newton mechanics laws cannot be applied when:

1) The speed of the interacting bodies are a fraction of the speed of light → Einstein's special theory of relativity.

2) The interacting bodies are on the scale of the atomic structure → Quantum mechanics

I. Newton's first law: If no *net force* acts on a body, then the body's velocity cannot change; the body cannot accelerate → $\vec{v}$ = constant in magnitude and direction.

- Principle of superposition: when two or more forces act on a body, the net force can be obtained by adding the individual forces vectorially.

- Inertial reference frame: where Newton's laws hold.

II. Newton's second law: The net force on a body is equal to the product of the body's mass and its acceleration.

$$\vec{F}_{net} = m\vec{a} \qquad (5.1)$$

$$F_{net,x} = ma_x, \quad F_{net,y} = ma_y, \quad F_{net,z} = ma_z \qquad (5.2)$$

- The acceleration component along a given axis is caused only by the sum of the force components along the same axis, and not by force components along any other axis.

- System: collection of bodies.

- External force: any force on the bodies inside the system.

III. Particular forces:

-Gravitational: pull directed towards a second body, normally the Earth →

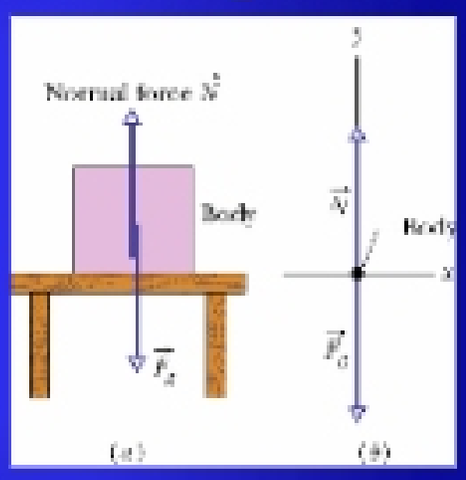
$$\vec{F}_g = m\vec{g} \qquad (5.3)$$

- Weight: magnitude of the upward force needed to balance the gravitational force on the body due to an astronomical body →

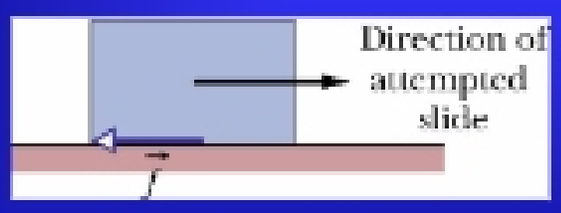
$$W = mg \qquad (5.4)$$

- Normal force: perpendicular force on a body from a surface against which the body presses.

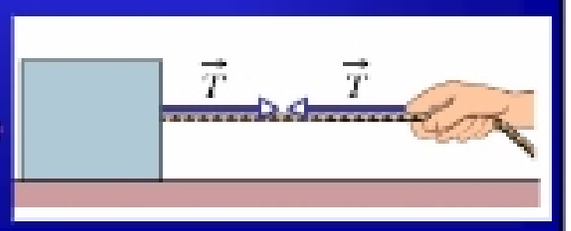
$$N = mg \qquad (5.5)$$



- Frictional force: force on a body when the body attempts to slide along a surface. It is parallel to the surface and opposite to the motion.

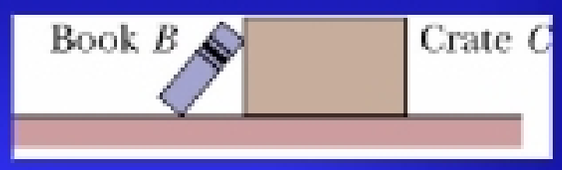


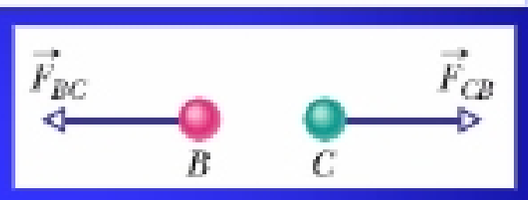
-Tension: pull on a body directed away from the body along a massless cord.



IV. Newton's third law: When two bodies interact, the forces on the bodies from each other are always equal in magnitude and opposite in direction.

$$\vec{F}_{BC} = -\vec{F}_{CB} \qquad (5.6)$$





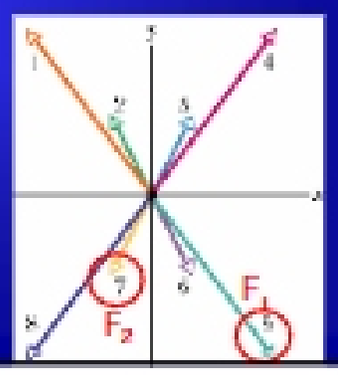
QUESTIONS

Q2. Two horizontal forces $\vec{F}_1$, $\vec{F}_2$ pull a banana split across a frictionless counter. Without using a calculator, determine which of the vectors in the free body diagram below best represent: a) F_1, b)F_2. What is the net force component along (c) the x-axis, (d) the y-axis? Into which quadrant do (e) the net-force vector and (f) the split's acceleration vector point?

$$\vec{F}_1 = (3N)\hat{i} - (4N)\hat{j}$$
$$\vec{F}_2 = -(1N)\hat{i} - (2N)\hat{j}$$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 = (2N)\hat{i} - (6N)\hat{j}$$

Same quadrant, 4



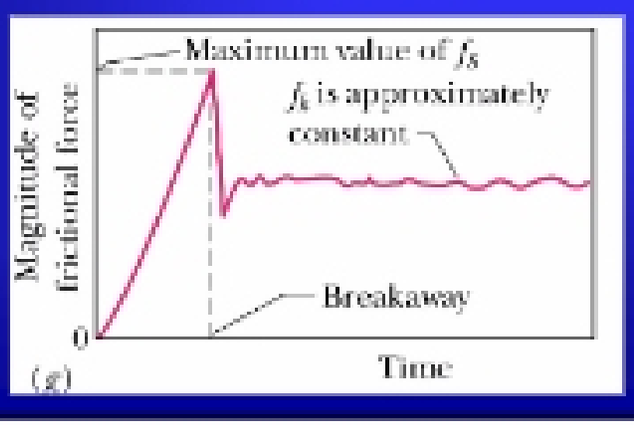
I. Frictional force

Counter force that appears when an external force tends to slide a body along a surface. It is directed parallel to the surface and opposite to the sliding motion.

-**Static**: (f_s) compensates the applied force, the body does not move.

$$\vec{f}_s = -\vec{F}_{II}$$

-**Kinetic**: (f_k) appears after a large enough external force is applied and the body loses its intimate contact with the surface, sliding along it.



$\vec{F}$ (applied force)