مدونة المناهج السعودية

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الموقع التعليمي لجميع المراحل الدراسية

في المملكة العربية السعودية

PHYS 101

Ch. 4

Newton’s Laws of Motion

Chapter 4

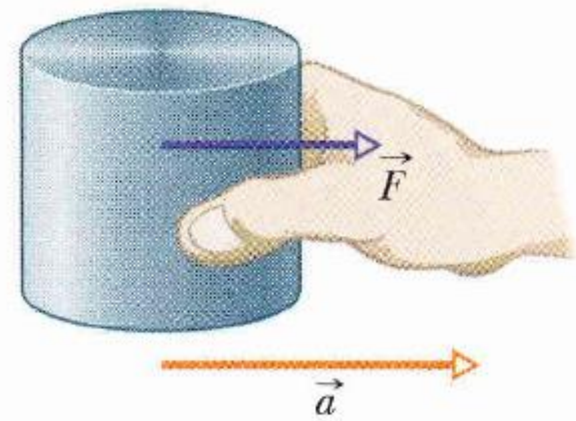
Chapter Four
Newton's Laws of Motion

- ***Force and Interactions***
- ***Newton's First Law***
- ***Newton's Second Law***
- ***Mass and Weight***
- ***Newton's Third Low***

Force and Interactions

Force

- Forces are vector quantities.
- The direction of a fore is the direction of the acceleration it causes.
- The net force on a body is the vector sum of all the forces acting on the body.



If no *net* force acts on a body ($\vec{F}_{net} = 0$), the body's velocity cannot change; that is, the body cannot accelerate.

Newton's First Law

Newton's First Law

Newton's First Law: If no force acts on a body, the body's velocity cannot change; that is, the body cannot accelerate.

F ⟶ ∇V ⟶ a

Newton's First Law

Example 1:

A car travels east at constant velocity. The net force on the car is:

Solution:

(C)

(A) greater than zero
(B) less than zero
(C) zero
(D) 9.8 N

Newton's First Law

Example 2:

A 3 kg box is moving with a constant speed. The net force on the box is:

Solution:

(D)

(A) 245.1 N
(B) 190.2 N
(C) 31.5 N
(D) zero

Newton's Second Law

Newton's Second Law

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

$$\vec{F}_{net} = m\vec{a} \quad \text{(Newton's second law)}$$

which may be written in the component versions

$$F_{net,x} = ma_x, \quad F_{net,y} = ma_y, \quad \text{and} \quad F_{net,z} = ma_z$$

- The second low indicates that in SI units

$$1\ N = (1\ kg)(1\ m/s^2) = 1\ kg \cdot m/s^2$$

Newton's Second Law

Example 3:

Two forces are applied to an object of mass 18.25 kg. One force is 27.5 N to the north and the other is 24.0 N to the west. The magnitude of the acceleration of the object is:

Solution:

(D)

(A) 5.0 m/s^2
(B) 4.0 m/s^2
(C) 3.0 m/s^2
(D) 2.0 m/s^2

Newton's Second Law

Example 4:

Three forces act on a particle in which it moves with constant speed, if $\overrightarrow{F_1} = (-8\hat{\imath})\text{N}$ and $\overrightarrow{F_2} = (-10\hat{\jmath})\text{N}$. Then $\overrightarrow{F_3}$ is:

Solution:

(A)

(A) $8\hat{\imath} + 10\hat{\jmath}$
(B) $8\hat{\imath}$
(C) $-8\hat{\imath} - 10\hat{\jmath}$
(D) $10\hat{\jmath}$

Mass and Weight

Mass

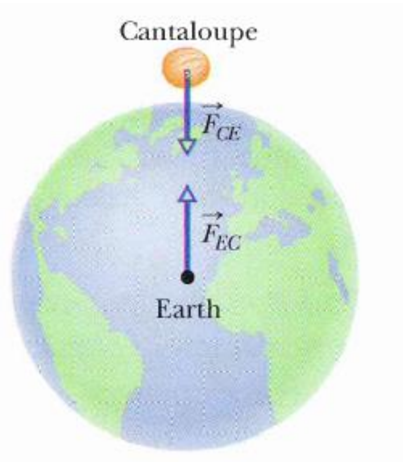
- Masses are scalar quantities.
- The mass of a body is the characteristic of that body.
- It relates the body's acceleration to the net force causing the acceleration.

Mass and Weight

Some Particular Forces

The Gravitational Force

$$F_g = mg.$$



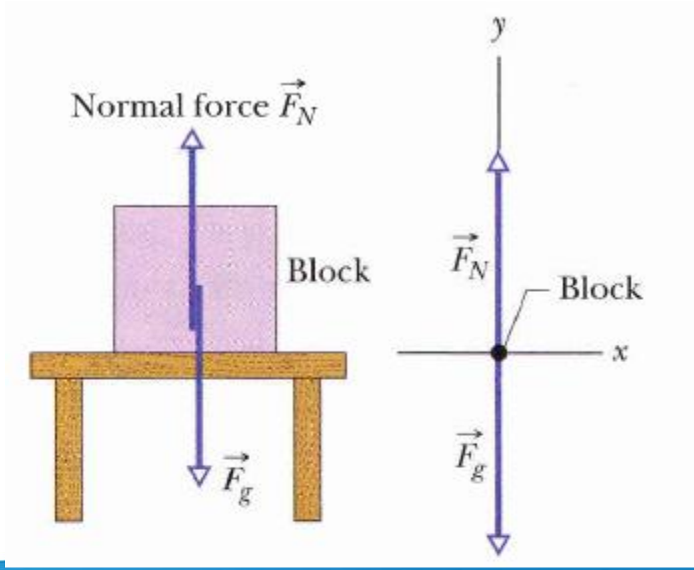
Weight

$$W = mg$$

The Normal Force

$$F_N - mg = ma_y.$$

$$F_N = mg.$$



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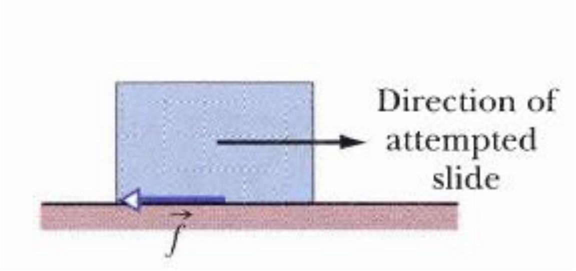
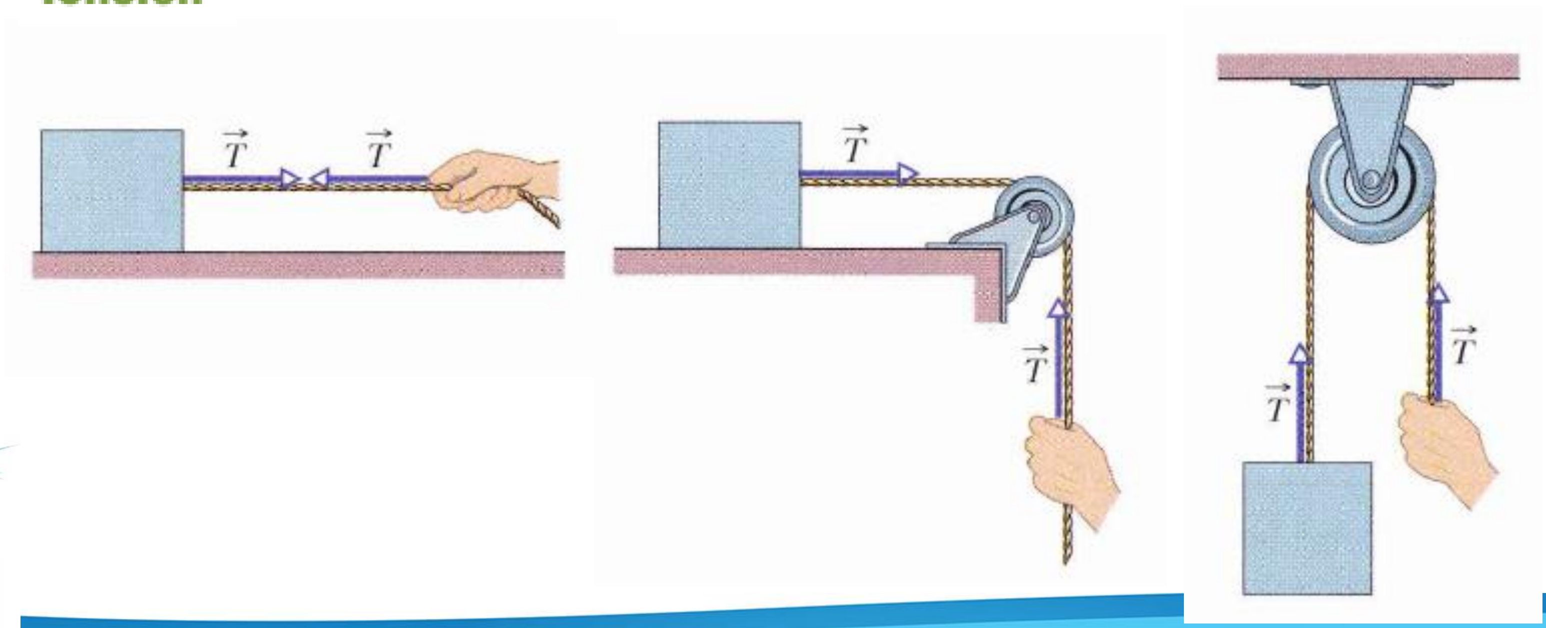
Mass and Weight

Friction



Tension



Mass and Weight

Example 5:

A 60 kg person weighs 100N on the moon. The acceleration of gravity on the moon is:

Solution:

(B)

(A) zero
(B) 1.67 m/s^2
(C) 4.9 m/s^2
(D) 9.8 m/s^2

Mass and Weight

Example 6:

A man of mass 50 kg. His weight is:

Solution:

(A)

(A) 490 N
(B) 98 N
(C) 50 N
(D) zero

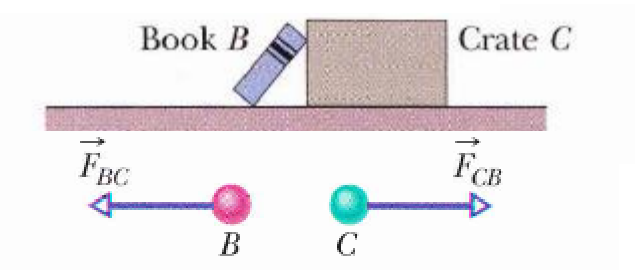
Newton’s Third Low

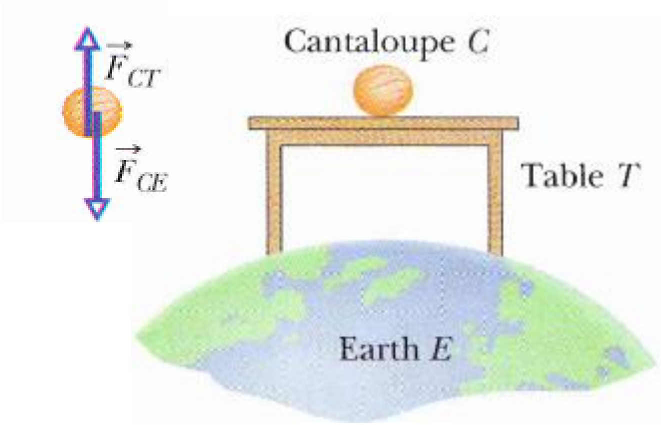
Newton’s Third Law

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.

$$F_{BC} = F_{CB} \quad \text{(equal magnitudes)}$$

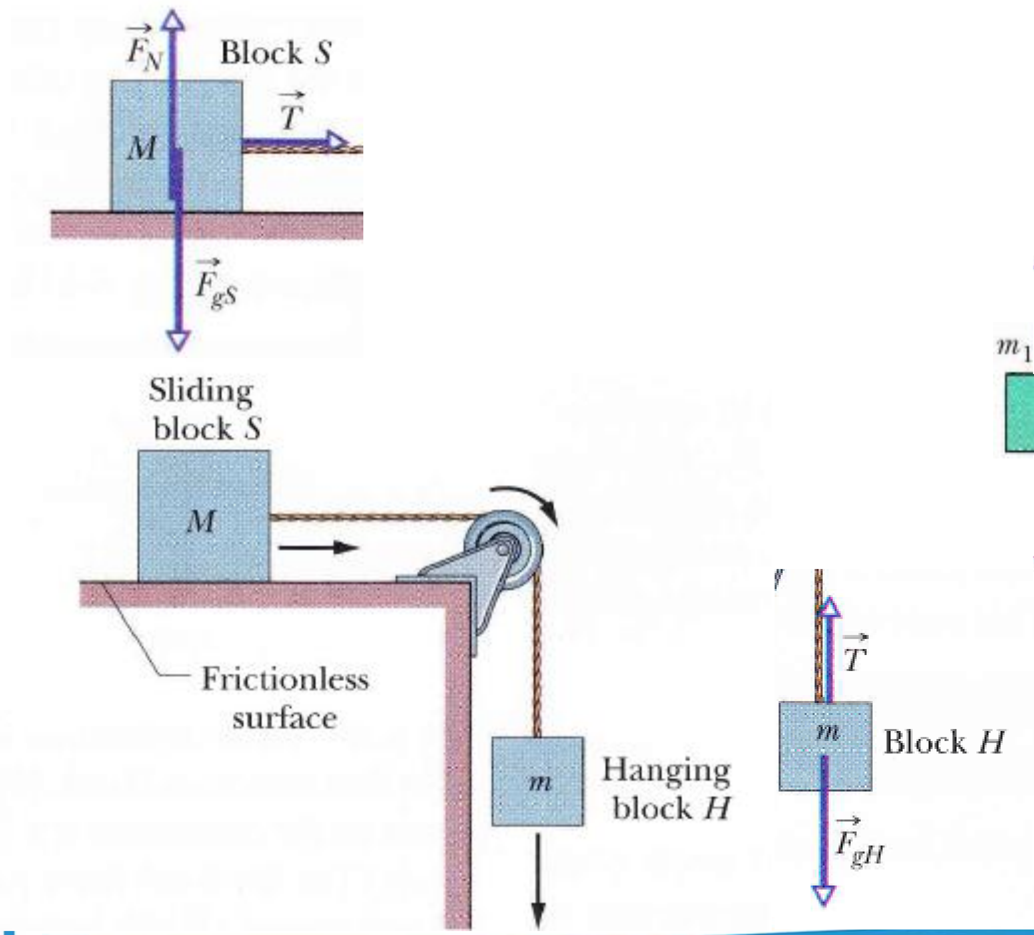
$$\vec{F}_{BC} = -\vec{F}_{CB} \quad \text{(equal magnitudes and opposite directions),}$$

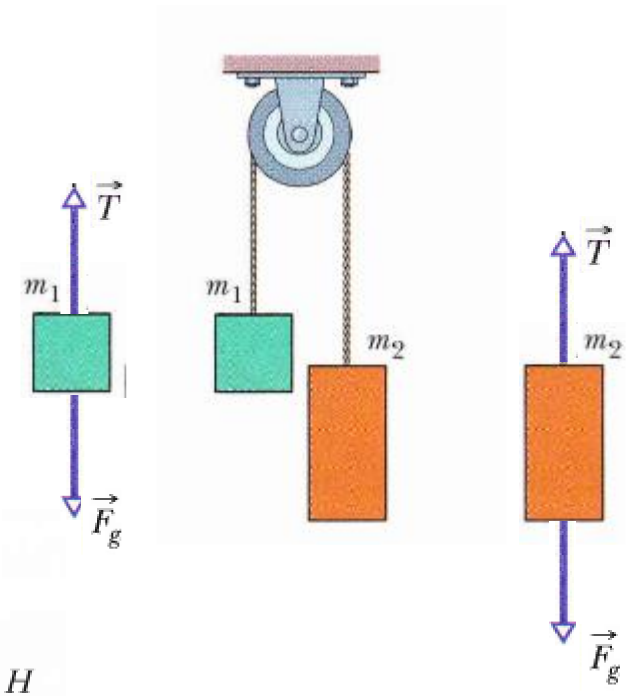




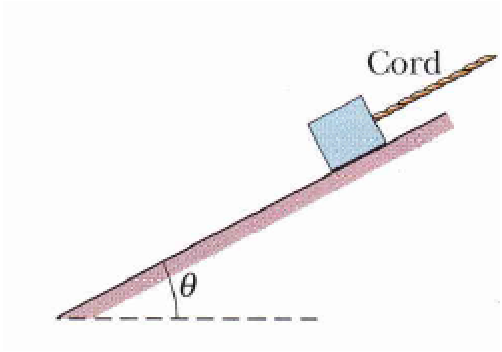
Newton’s Third Low

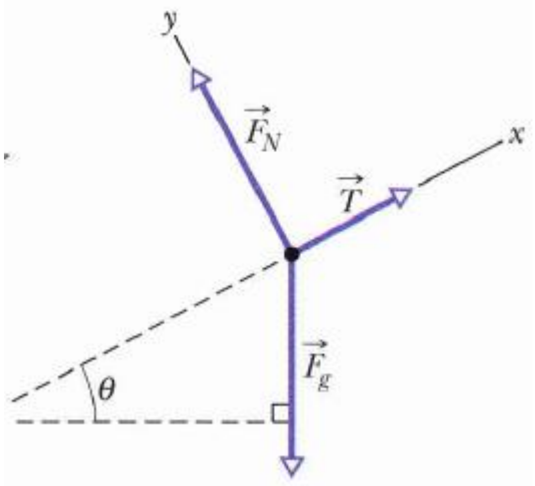
Applying Newton’s Laws

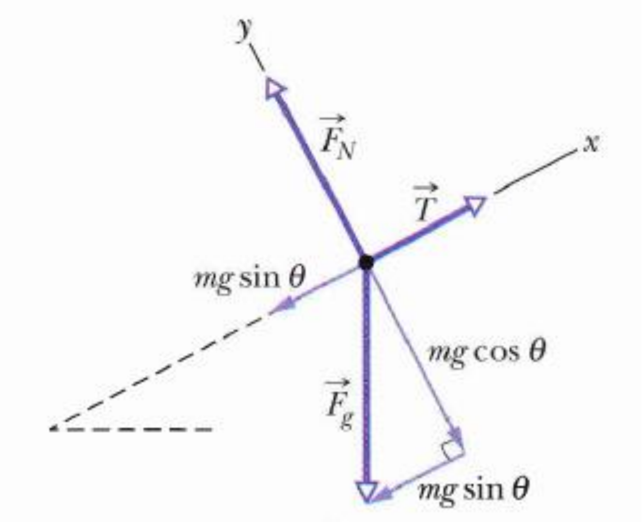




Newton's Third Low







Newton's Third Low