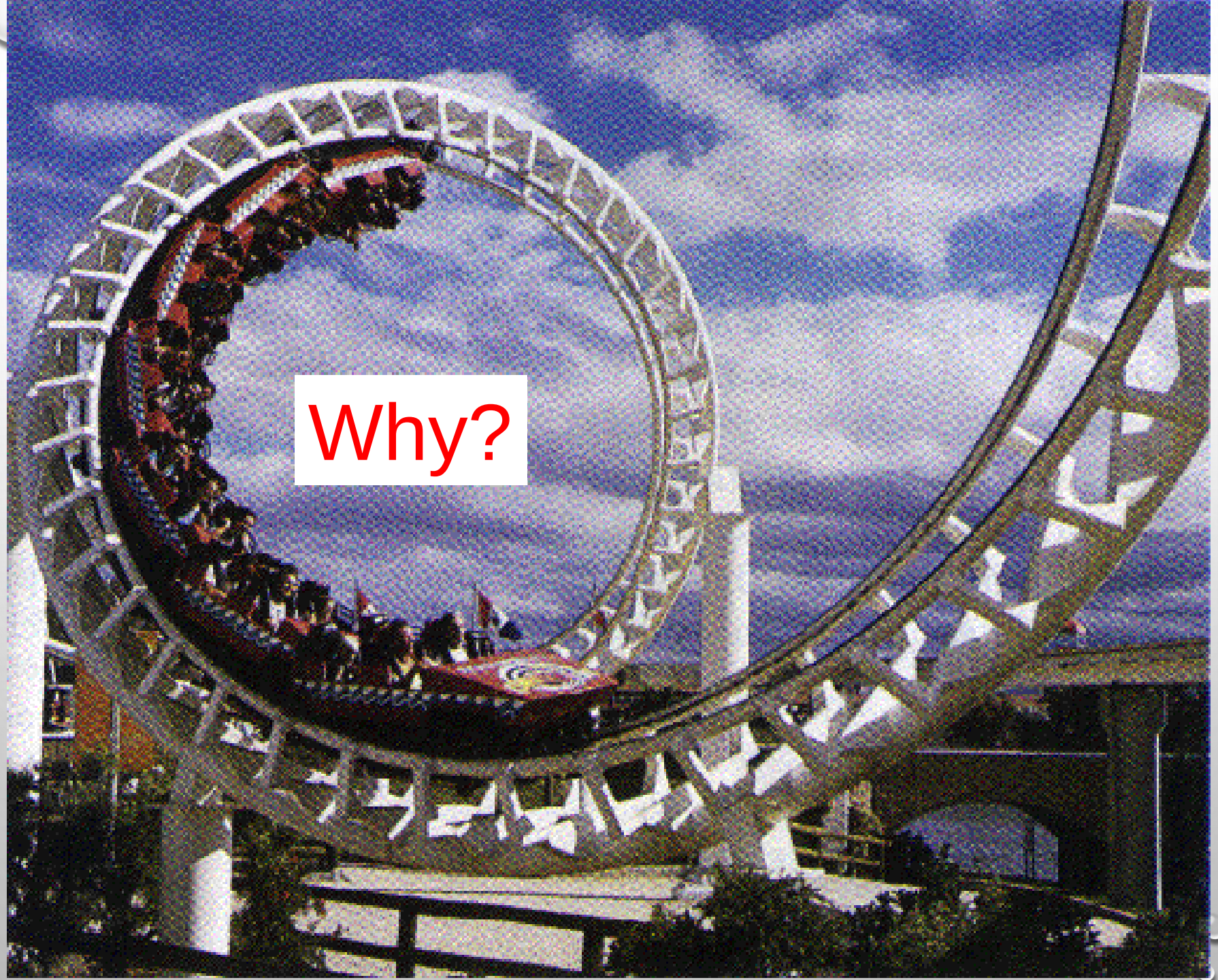
GENERAL PHYSICS 1

Dynamics of Motion:

The Newton's Laws of Motion

MARLON FLORES SACEDON


Why?


Why?


Why?

Objective

- To understand the three laws of Newton.
- To solve the total force acting on a moving particle.
- To calculate acceleration and velocity of this moving particle.

DYNAMICS OF MOTION: THE NEWTON'S LAWS OF MOTION

What is Dynamics of Motion?

Dynamics is a branch of **physics** (specifically classical mechanics) concerned with the study of forces and torques and their effect on motion, as opposed to kinematics, which studies the motion of objects without reference to its causes.

Force and Motion

Answer the question, Why object moves?

DYNAMICS OF MOTION

Force and interactions

- Force is a push or a pull exerted by our muscles.

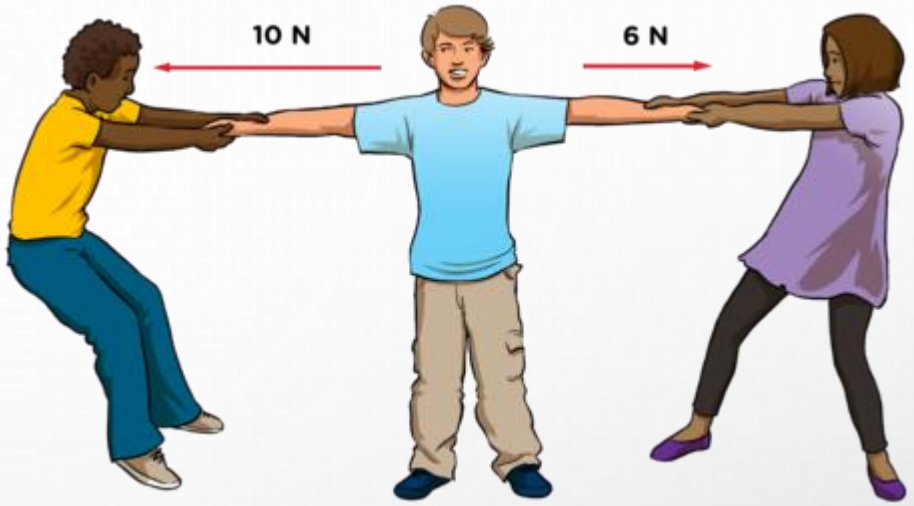
- Changes in the motion of bodies are caused by some kind of interaction between them called force. Therefore, force maybe regarded as an action of one body on another.

- If the interaction between bodies does not produce motion, it means that the forces neutralize each other. If forces are not neutralized a change in motion of the body or system will result.

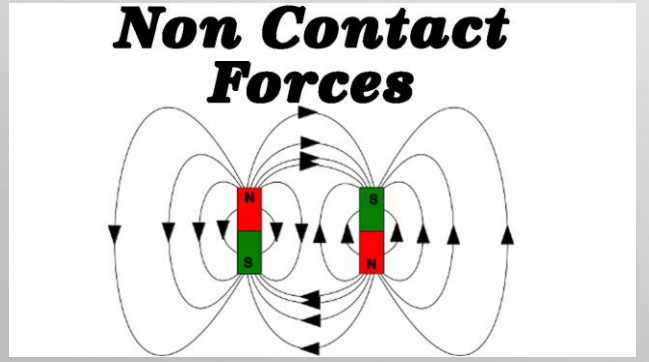
DYNAMICS OF MOTION

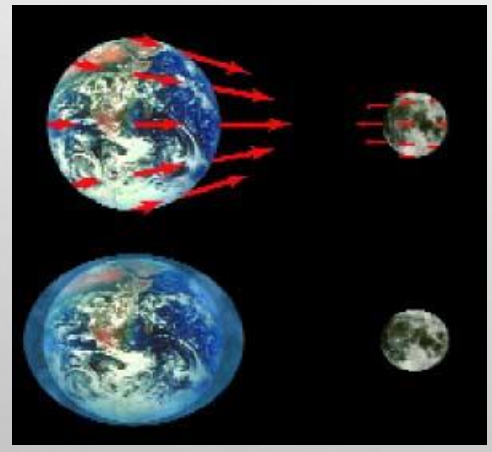
Force and interactions

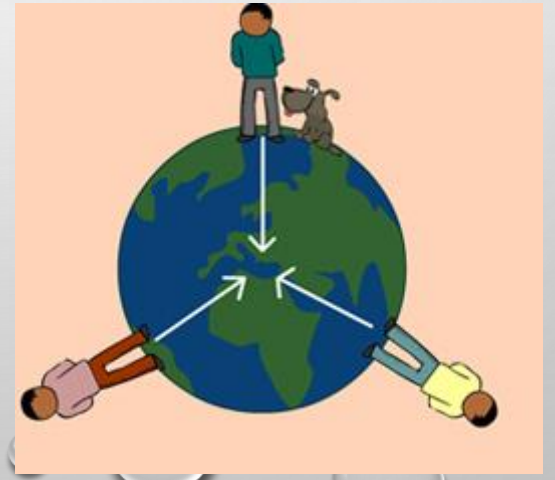
- When a force involves direct contact between two bodies, we call it a **contact force.**



- **Long-range forces** that act even when the bodies are separated by empty space.







DYNAMICS OF MOTION

Classification of Forces

Concurrent - forces that act at a point or whose line of action converges or intersects at a common point.

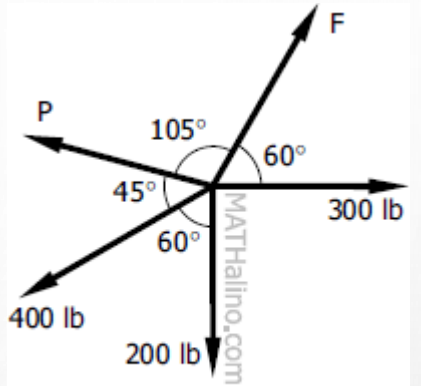
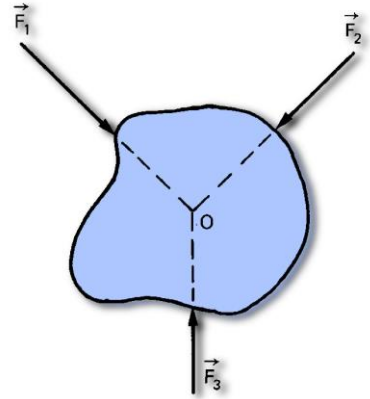
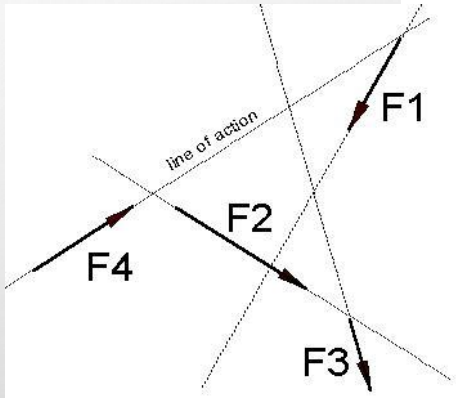


Figure P-313



Non-concurrent - forces whose line of action does not converge at a common point.



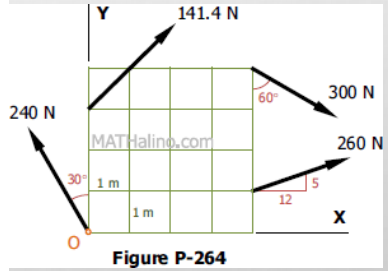
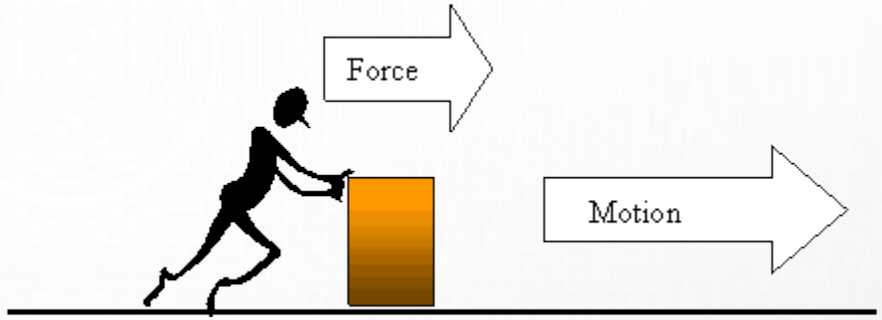


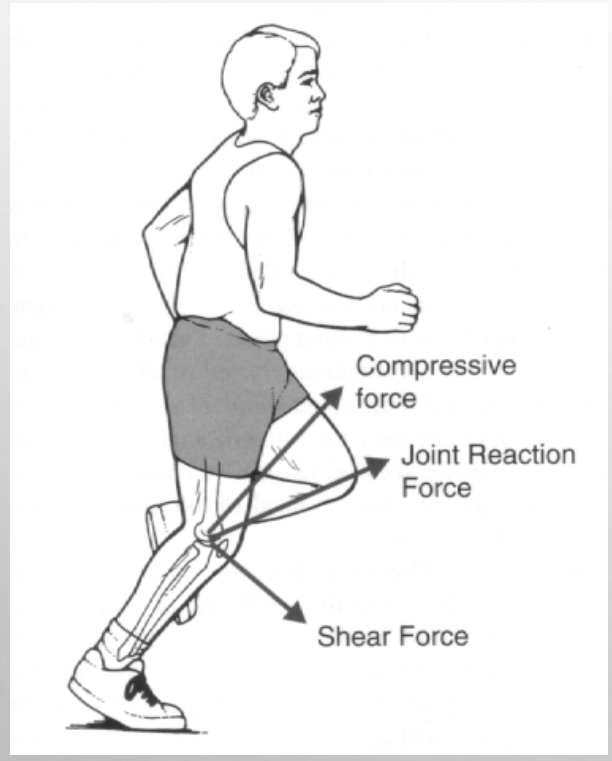
Figure P-264

DYNAMICS OF MOTION

Classification of Forces

External force – force that a body exerts on another body.





Internal force – forces exerted by one part of a body on other parts of same body.

DYNAMICS OF MOTION

Classification of Forces

Co-planar - forces acting on one plane.

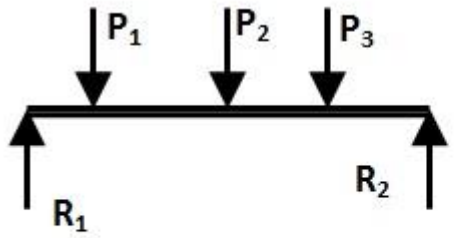
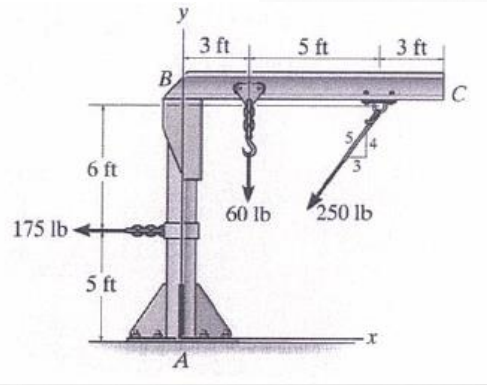
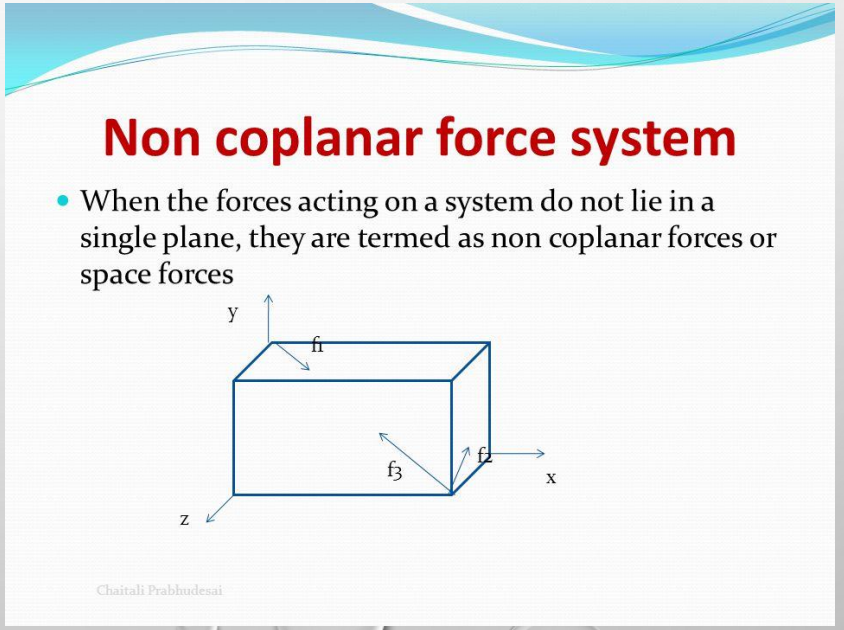


Figure 3: Parallel Coplanar



Non-coplanar - forces acting in more than one plane.



DYNAMICS OF MOTION

Unit of Force

- MKS: Newton = force that will give a mass of 1 kg an acceleration of 1 m/s^2.
- CGS : dyne = force that will give a mass of 1 g an acceleration of 1 cm/s^2.
- FPS : poundal = force that will give a mass of 1 slug an acceleration of 1 ft/s^2.

- 1 kg force = 9.81N
- 1 g force = 980 dynes

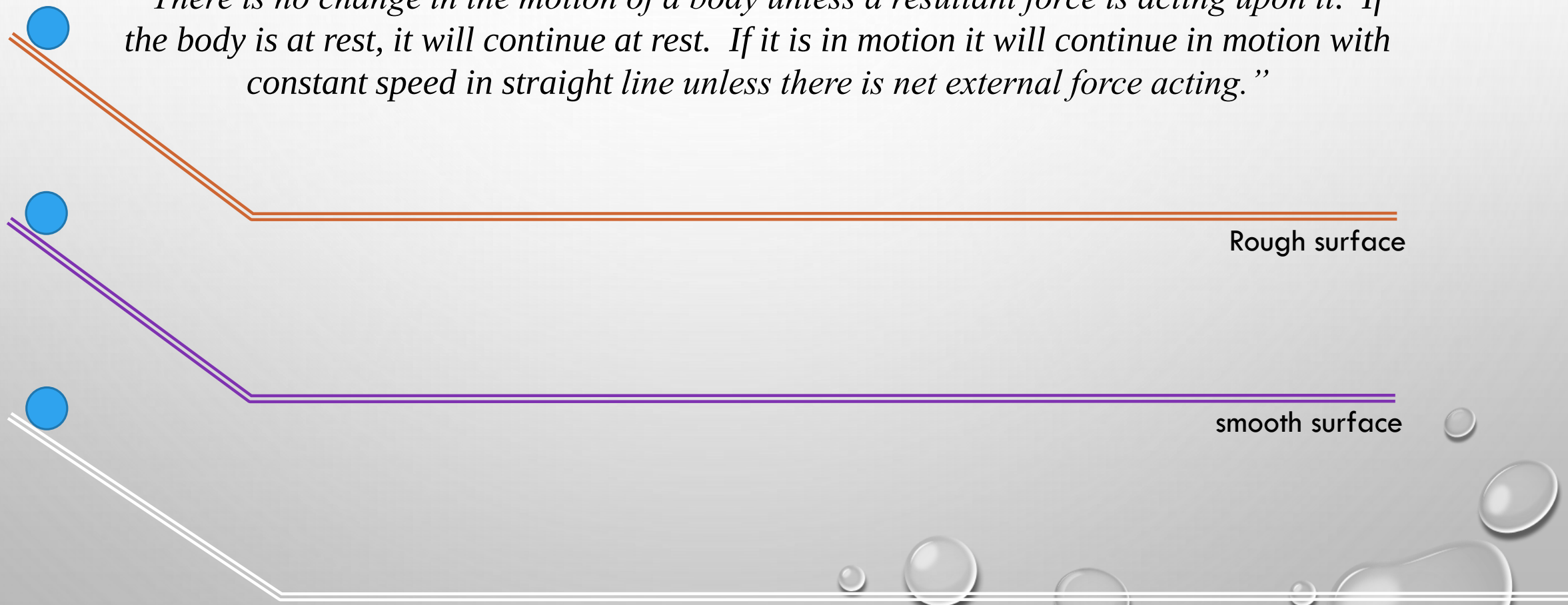
1 lb force = 32 poundal
1 slug mass = 32 lb

NEWTON'S LAWS OF MOTION

Newton's First Law

Law of Inertia

"There is no change in the motion of a body unless a resultant force is acting upon it. If the body is at rest, it will continue at rest. If it is in motion it will continue in motion with constant speed in straight line unless there is net external force acting."



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The car hits a cement road divider and is stopped. The driver, who is not wearing his seat belt, will continue to move at 60 mph.

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Moon rotates around the Earth every month, because it moves with constant velocity

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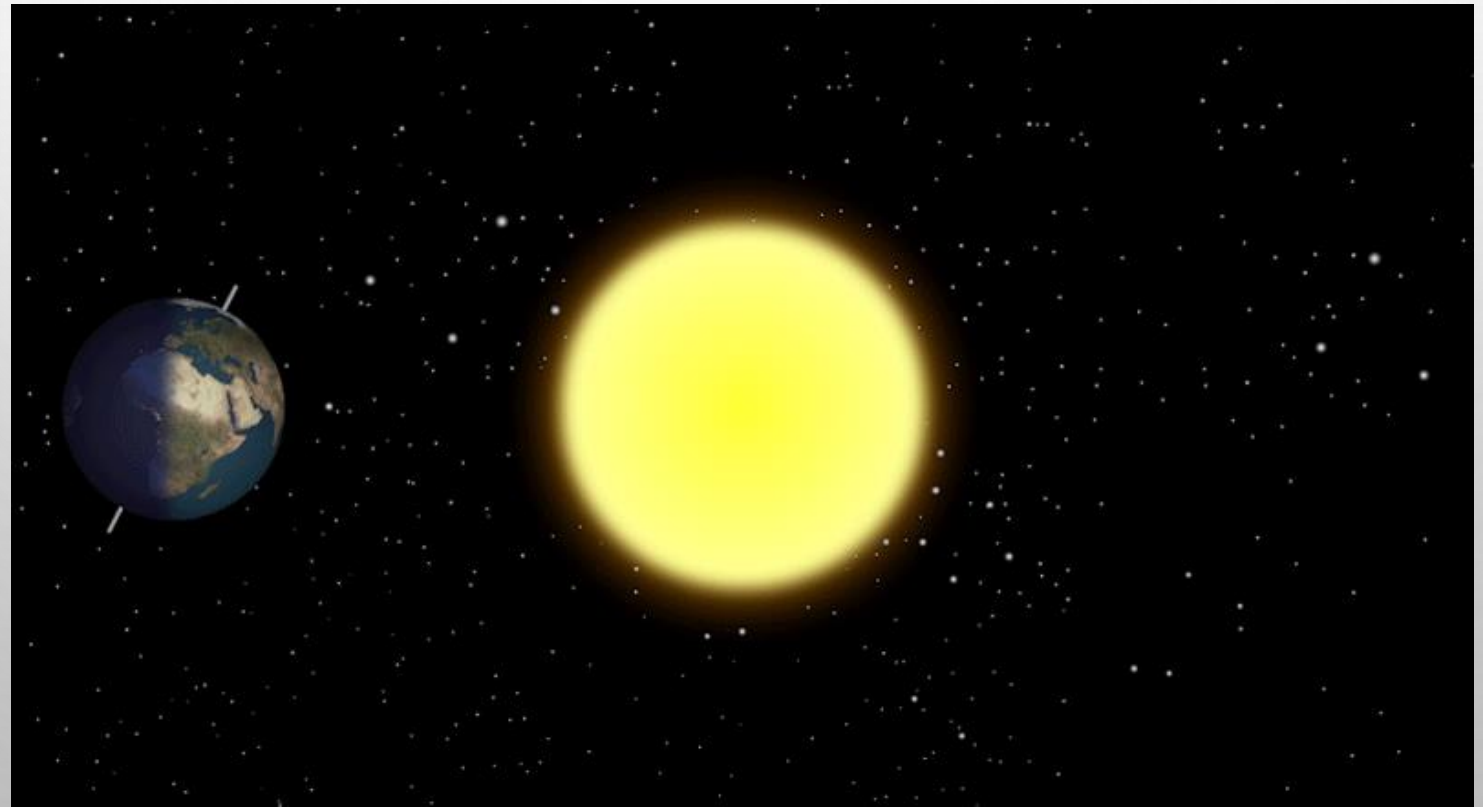
Earth rotates around the Sun every year, because it moves with constant velocity



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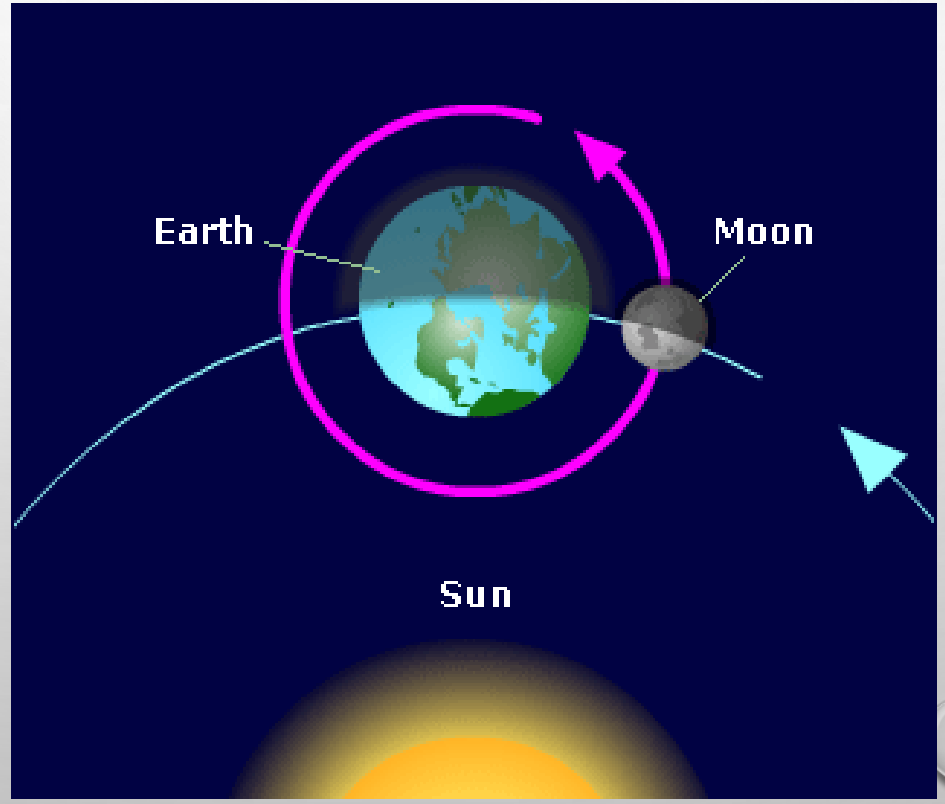
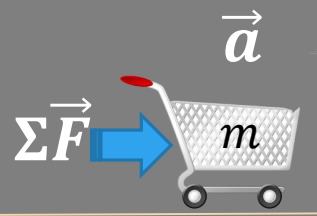


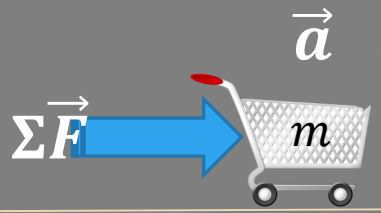
NEWTON'S LAWS OF MOTION

Newton's Second Law

Law of Acceleration

"If a net external force acts on a body, the body accelerates. The direction of acceleration is the same as the direction of the net force. Acceleration is inversely proportional to the mass of moving particle."





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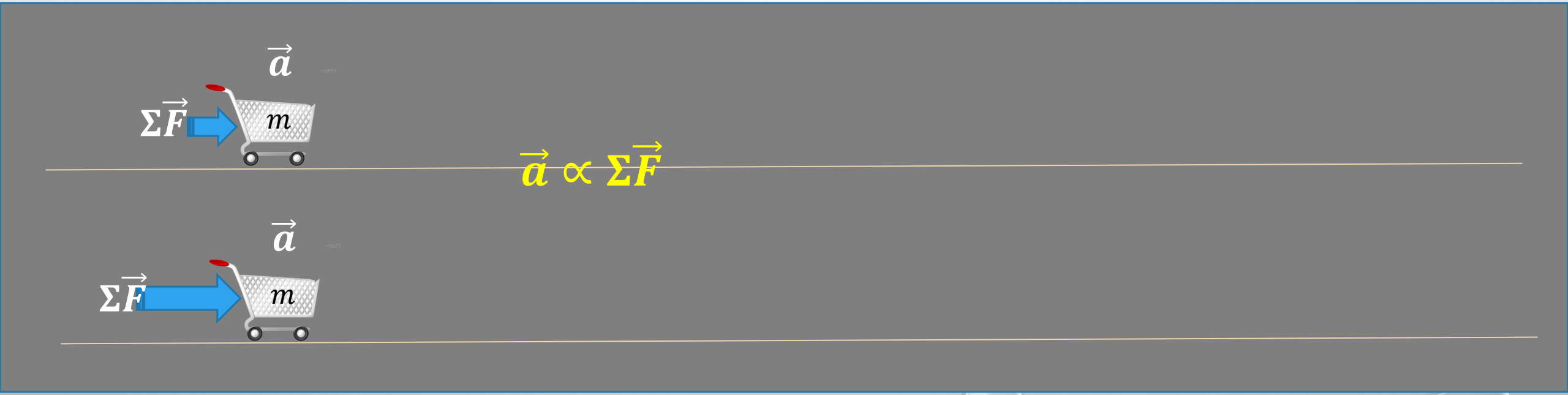

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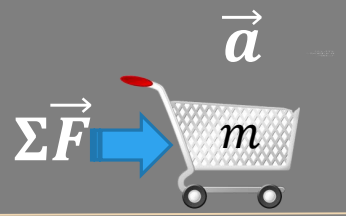
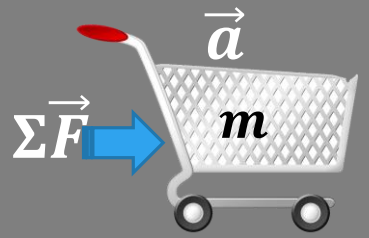


$$\vec{a} \propto \Sigma\vec{F}$$



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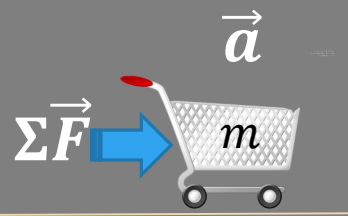

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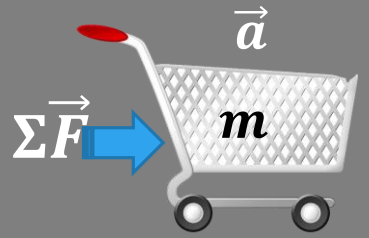

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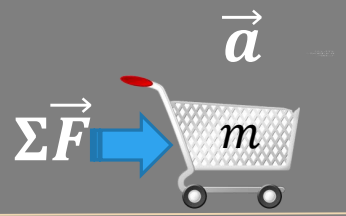
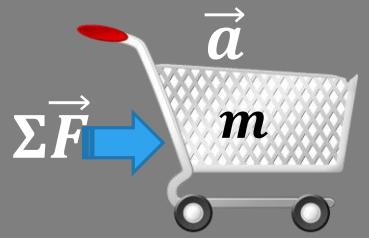


$$\vec{a} \propto \Sigma\vec{F} \qquad \vec{a} \propto \frac{1}{m} \qquad \vec{a} \propto \frac{\Sigma\vec{F}}{m}$$



$$\vec{a} = \frac{1}{k} \cdot \frac{\Sigma\vec{F}}{m} \qquad \Sigma\vec{F} = km\vec{a}$$

NEWTON'S LAWS OF MOTION

Newton's Second Law

Law of Acceleration

"If a net external force acts on a body, the body accelerates. The direction of acceleration is the same as the direction of the net force. Acceleration is inversely proportional to the mass of moving particle."

$$\Sigma\vec{F} = km\vec{a}$$

If $k = 1$ for unity

$$\Sigma\vec{F} = m\vec{a}$$

Second law of Newton Formula

Units

$1\ N = 1\ kg.m/s^2$

$1\ dyne = 1\ g.cm/s^2$

$1\ poundal = 1\ slug.ft/s^2$

Where:

$\Sigma\vec{F}$ = Unbalanced force or Net External Force

$\vec{a}$ = Acceleration of moving particle whose direction is always the same in $\Sigma\vec{F}$.

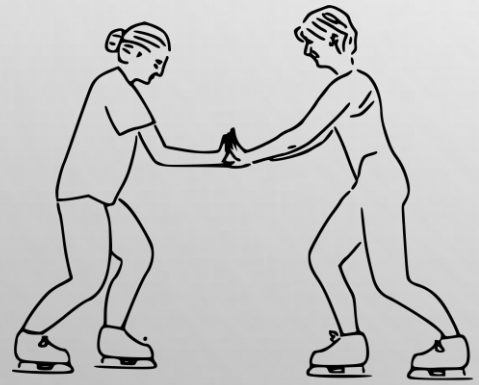
m = total mass of moving particle.

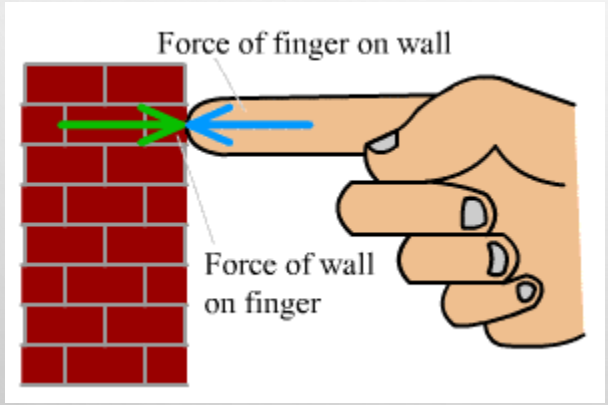
NEWTON'S LAWS OF MOTION

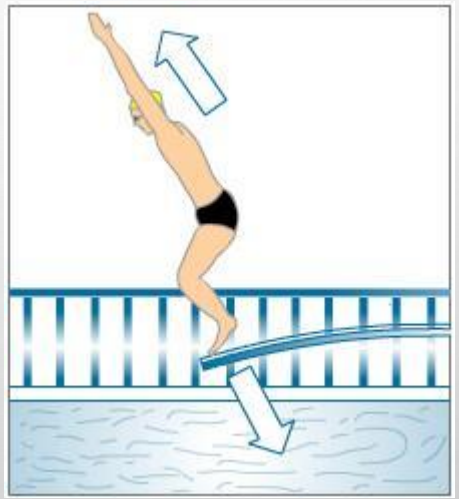
Newton's Third Law

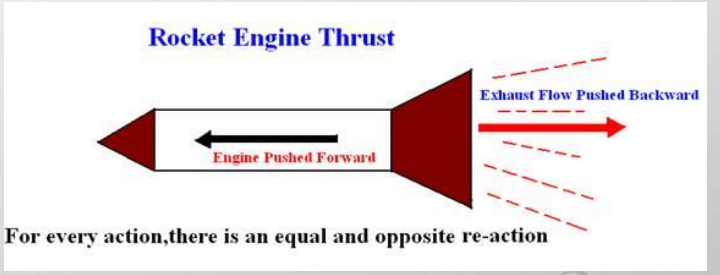
Law of Action - Reaction (Inter-Action)

"If body A exerts a force on body B (an "action"), then body B exerts a force on body A (a "reaction"). These two forces have the same magnitude but are opposite in direction. These two forces act on different bodies."





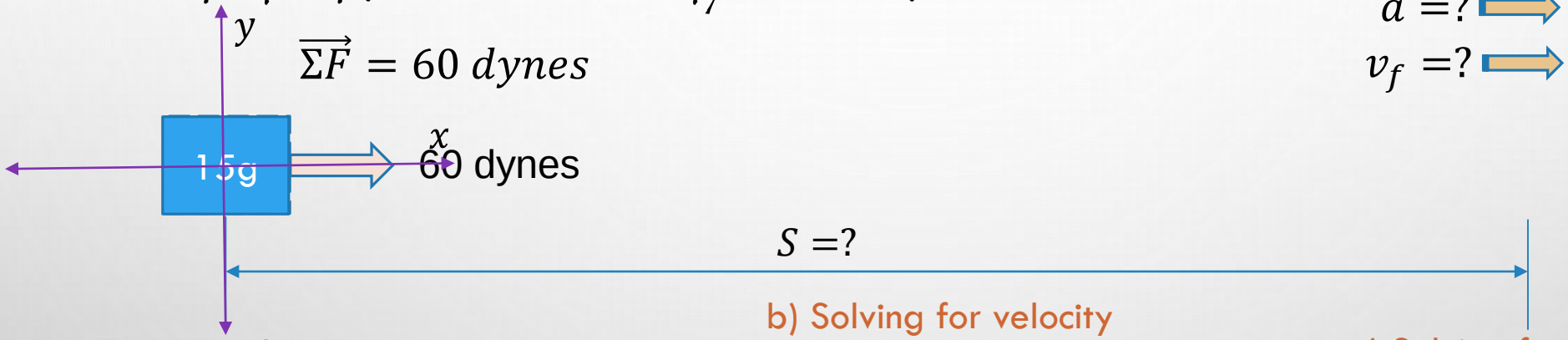




NEWTON'S LAWS OF MOTION

Problem: Newton's Second Law

1. A force of 60 dynes acts upon a mass of 15g a) What acceleration is imparted to the body, b) What velocity will the body acquire in 8s? c) What distance will the body cover in these 8s?



a) Solving for acceleration a

$\Sigma\vec{F} = ma$ Second Law of Newton

$60 dynes = (15g)a$

$a = 4cm/s^2$ ANSWER

b) Solving for velocity acquire in 8s v_f

$v_i = 0$

$t = 8s$

$a = 4cm/s^2$

Formula: $v_f = v_i + at$

$v_f = 0 + 4(8)$

$v_f = 32cm/s$ ANSWER

c) Solving for s

$v_i = 0$

$t = 8s$

$a = 4cm/s^2$

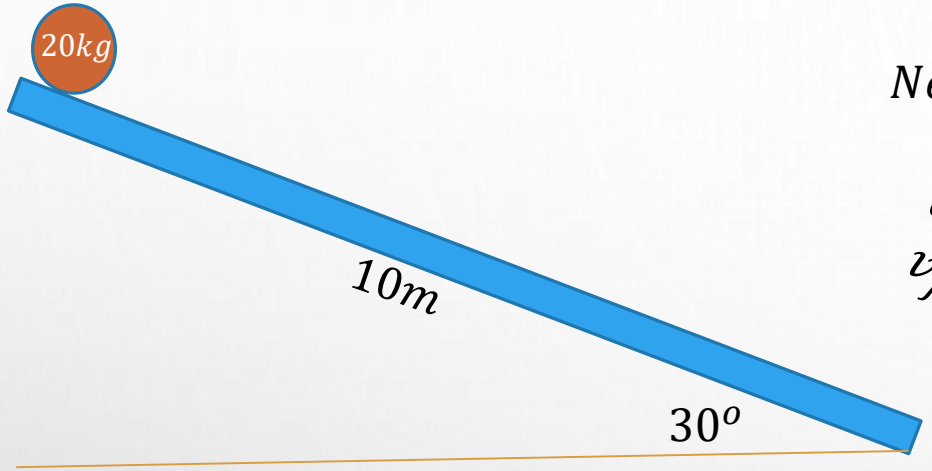
Formula: $s = v_i t + (\frac{1}{2})at^2$

$s = o(8) + \left(\frac{1}{2}\right)(4)8^2 = 128cm$

ANSWER

NEWTON'S LAWS OF MOTION

Problems: Newton's Second Law



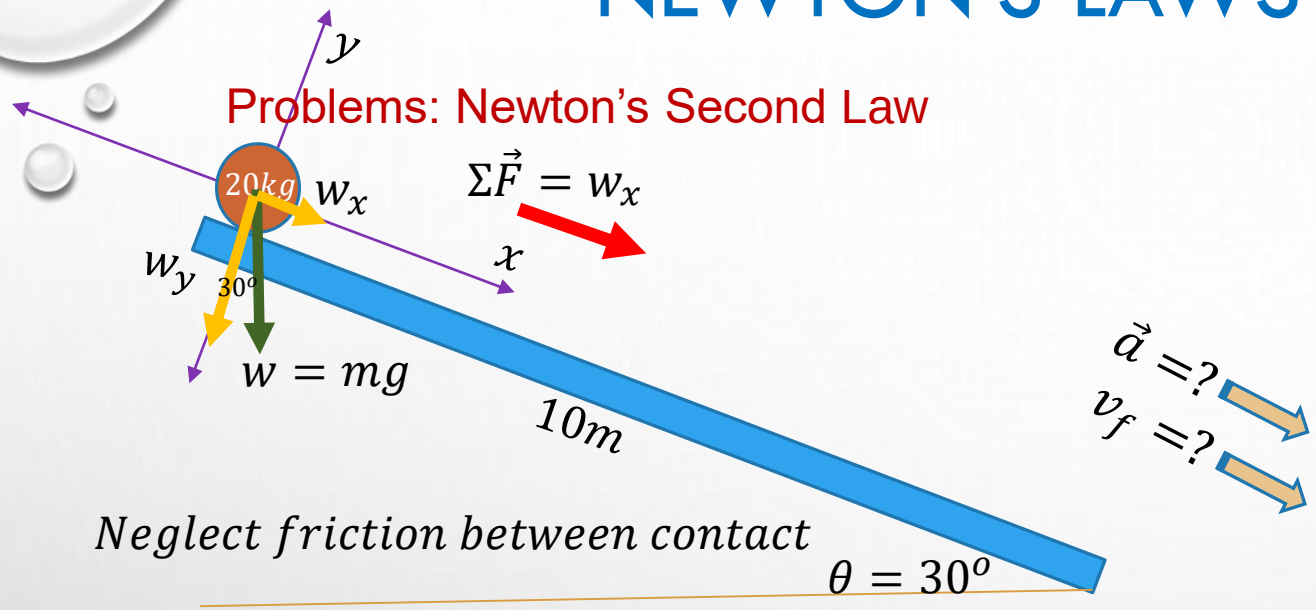
Neglect friction between contact

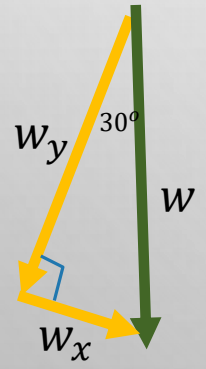
$\vec{a} = ?$

$v_f = ?$

NEWTON'S LAWS OF MOTION

Problems: Newton's Second Law





$w_y = w\cos\theta$

$w_x = w\sin\theta$

$\Sigma\vec{F} = ma$ Second Law of Newton

$w_x = ma$

$w\sin\theta = ma$

$mg\sin\theta = ma$

$$a = \frac{mg\sin\theta}{m}$$

$a = g\sin\theta$

$a = 9.81(sin30) = 4.91 m/s^2$ ANSWER

Solving for v_f

$v_i = 0$

$s = 10m$

$a = 4.91 m/s^2$

$v_f^2 = v_i^2 + 2as$

$v_f^2 = 0 + 2(4.91)(10)$

$v_f = 9.91\ m/s$ ANSWER

NEWTON'S LAWS OF MOTION

Assignment

1. A 10-kg box starting from rest is pulled by means of a rope which make an angle of 30° with the horizontal. If it travels a distance of 10m in 2s, what is the magnitude of the force exerted by the rope?

2. A horizontal cord is attached to a 6.0-kg body in a horizontal table. The cord passes over a pulley at the end of the table and to this end is hung a body of mass 8 kg. Find the distance the two bodies will travel after 2s, if they start from rest. What is the tension in the cord?

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