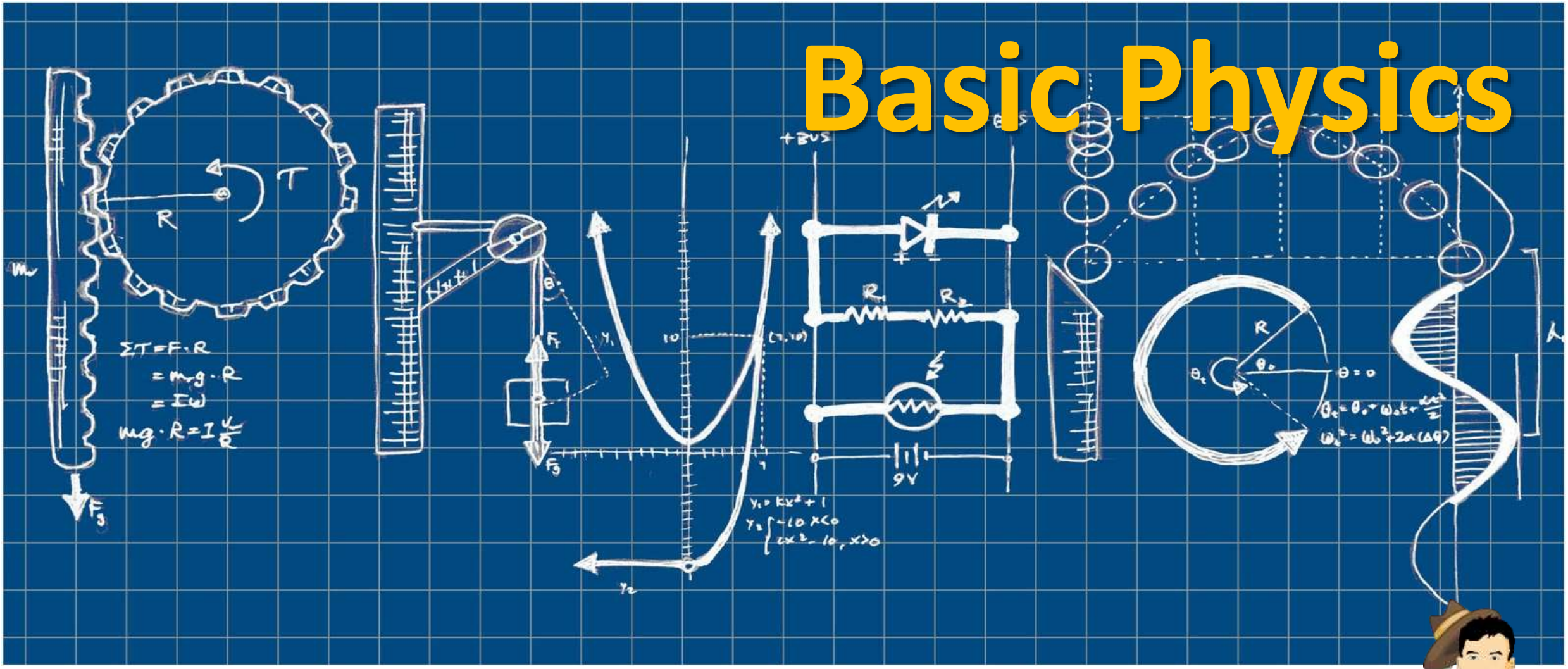
Basic Physics



Lecture 2: Mechanics

รวบรวมและเรียบเรียงโดย
อ. วรรณพงษ์ เตรียมโพธิ์
ภาควิชาฟิสิกส์ คณะวิทยาศาสตร์ ม. มหิดล

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09-88240430, 08-40004269

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Students are able to

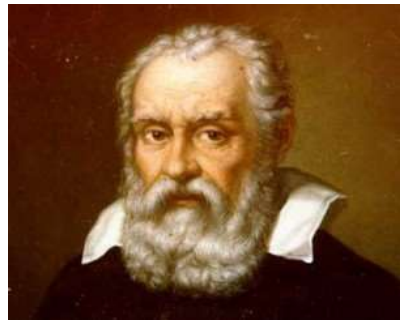
1. Explain some basic physics concepts, theories , and laws.

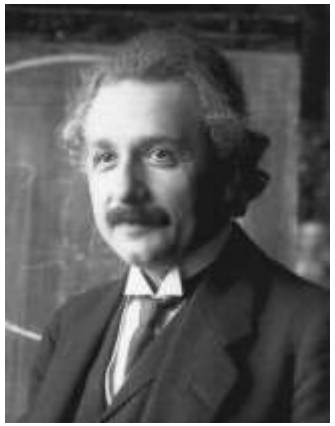
2. Apply physics knowledges for their learning and living.

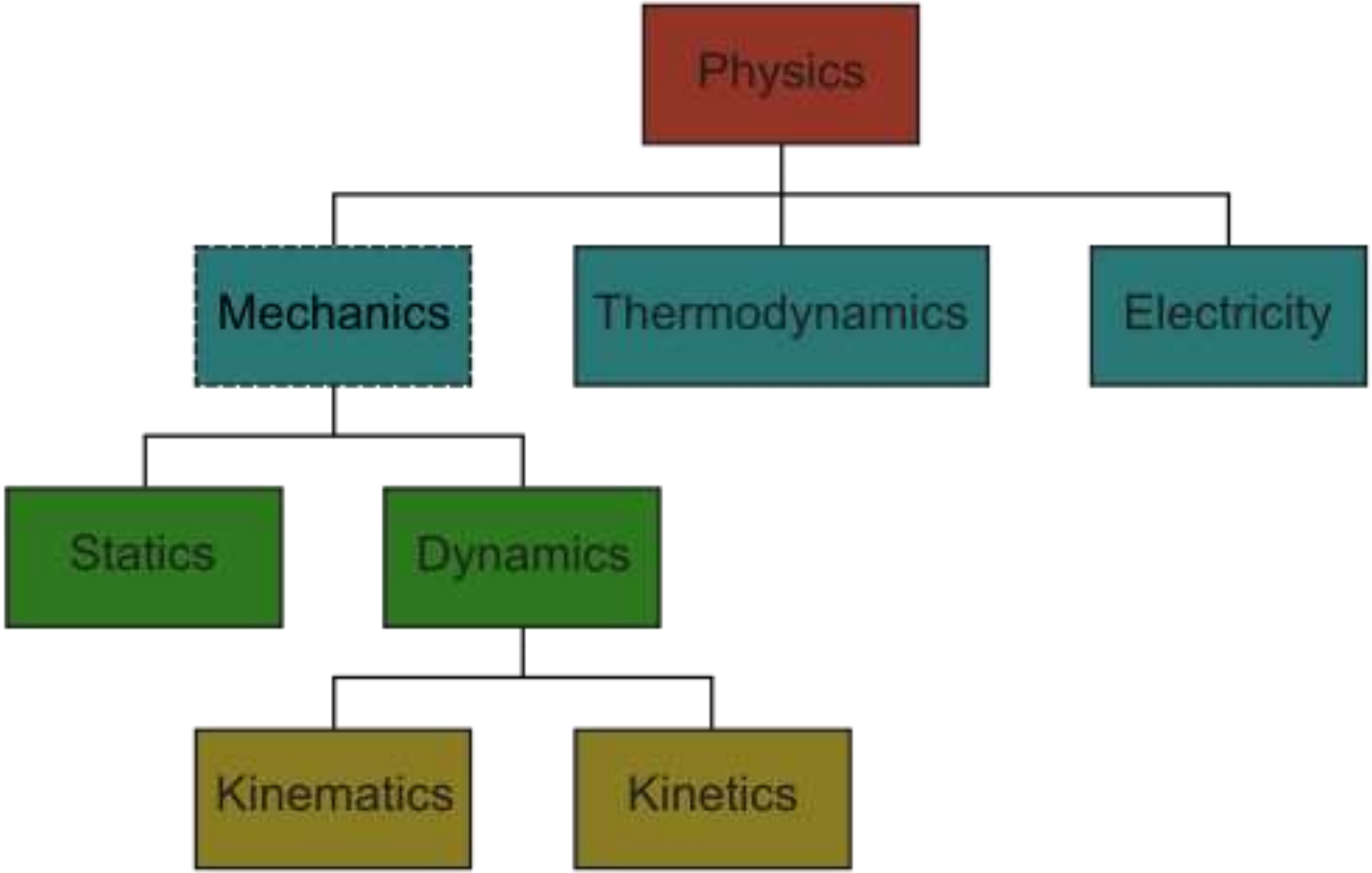
3. Change attitude toward physics, namely “physics is too difficult”

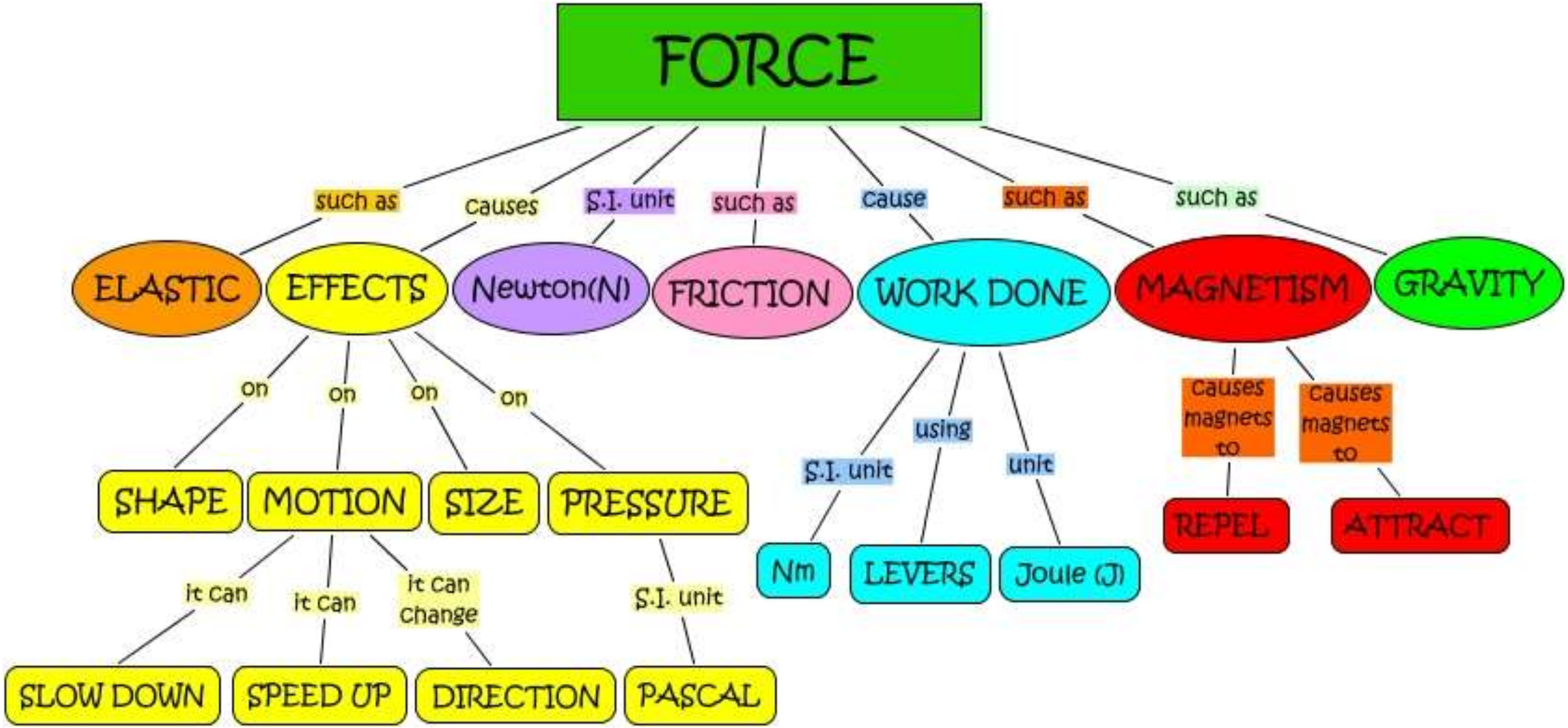
Topics

0. Nature of Science and physics
1. Mechanics
2. Temperature and Heat
3. Fluid
4. Waves
5. Sound and hearing
6. Optics and visualization
7. basic electromagnetism
8. basic quantum mechanics
9. atomic physics
10. basic nuclear physics and radioactivity

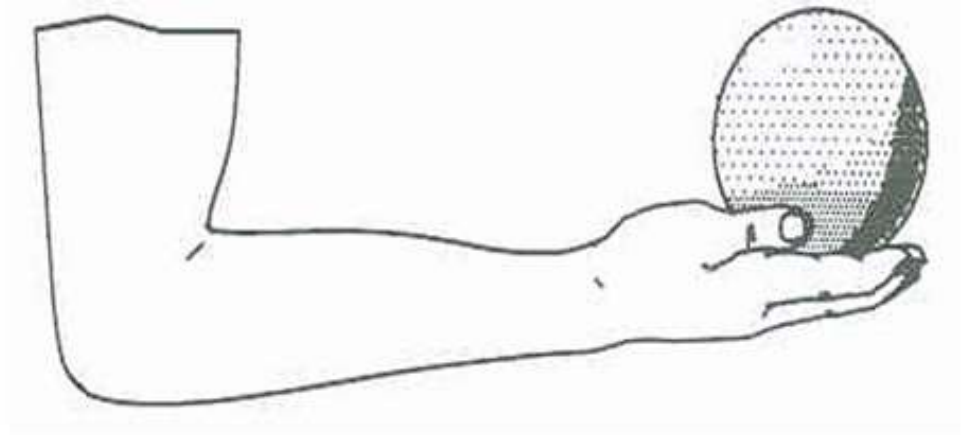


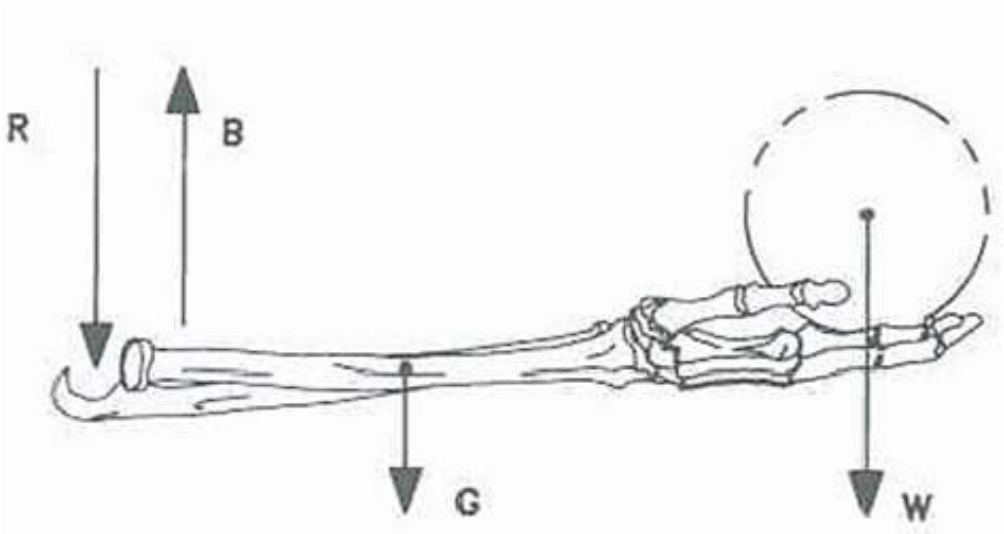



Physics
Mechanics
Thermodynamics
Electricity
Statics
Dynamics
Kinematics
Kinetics


FORCE
such as
causes
S.I. unit
such as
cause
such as
such as
ELASTIC
EFFECTS
Newton(N)
FRICTION
WORK DONE
MAGNETISM
GRAVITY
on
on
on
on
S.I. unit
using
unit
Causes magnets to
Causes magnets to
SHAPE
MOTION
SIZE
PRESSURE
Nm
LEVERS
Joule (J)
REPEL
ATTRACT
it can
it can
it can change
S.I. unit
SLOW DOWN
SPEED UP
DIRECTION
PASCAL

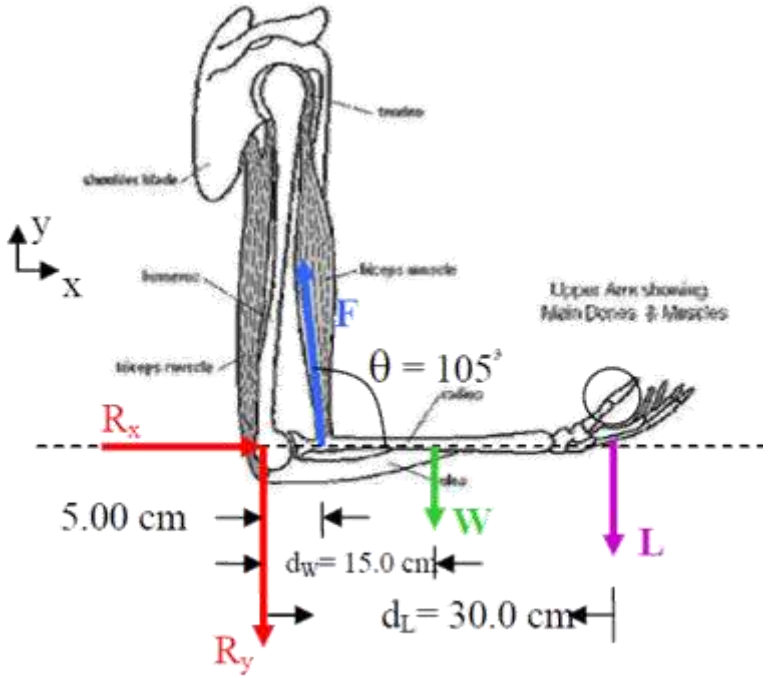
Statics



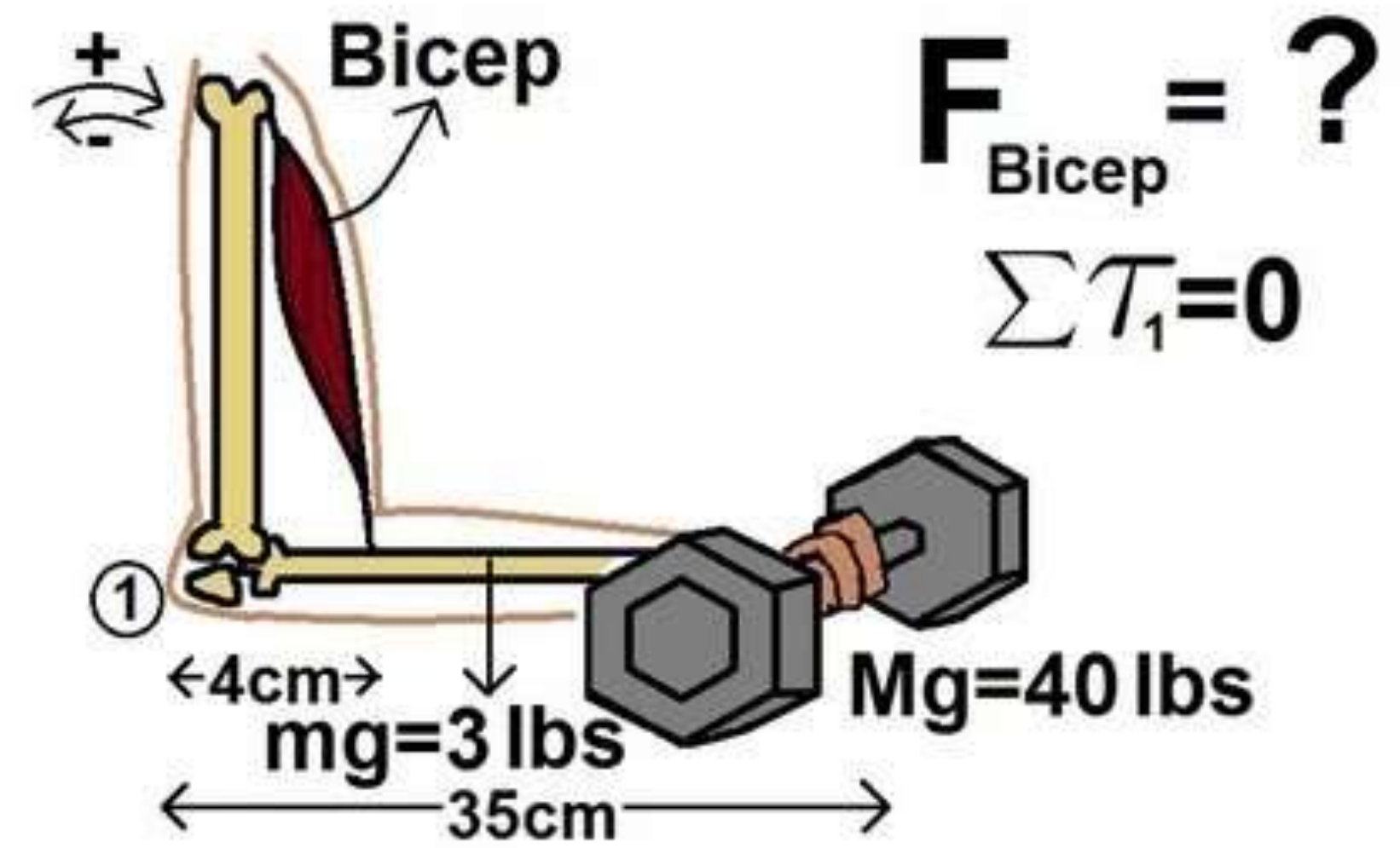


Free body diagram showing forearm holding a ball .
The biomechanical forces that act on the elbow joint

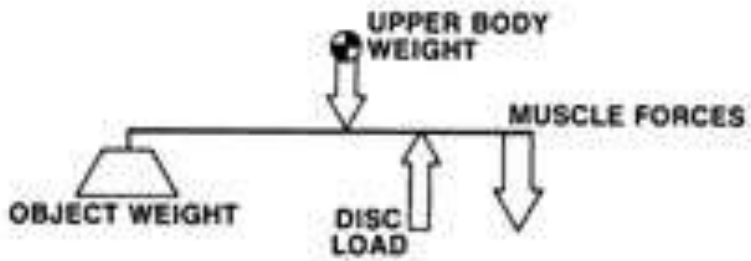
What is R?

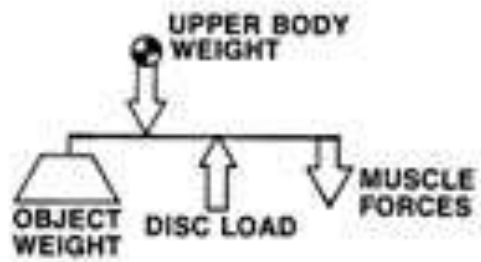


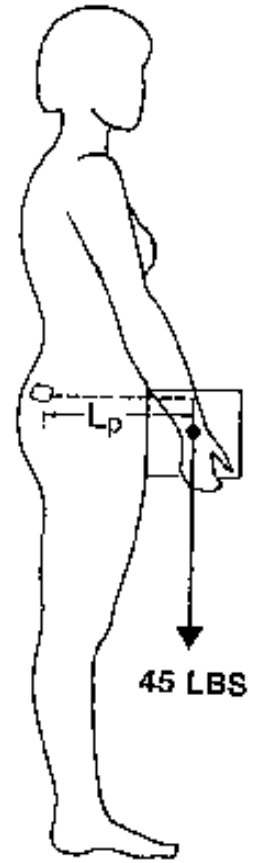
G is the weight of the forearm acting vertically downwards,
B is the biceps force,
R is the joint reaction force.


+
-
Bicep
$F_{Bicep} = ?$
$\sum \tau_1 = 0$
1
4cm
mg=3 lbs
Mg=40 lbs
35cm

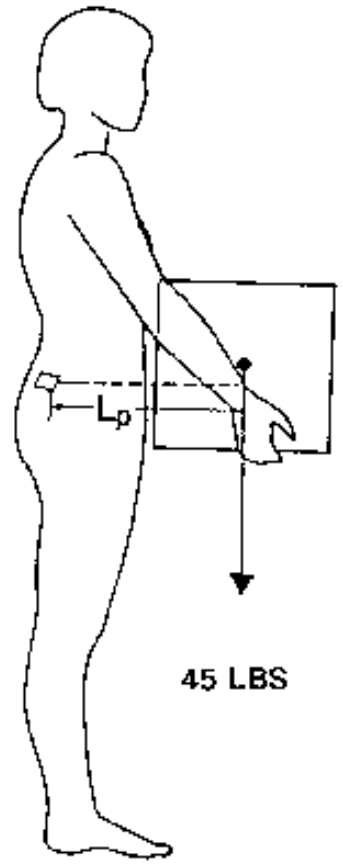
Biomechanics of Lifting



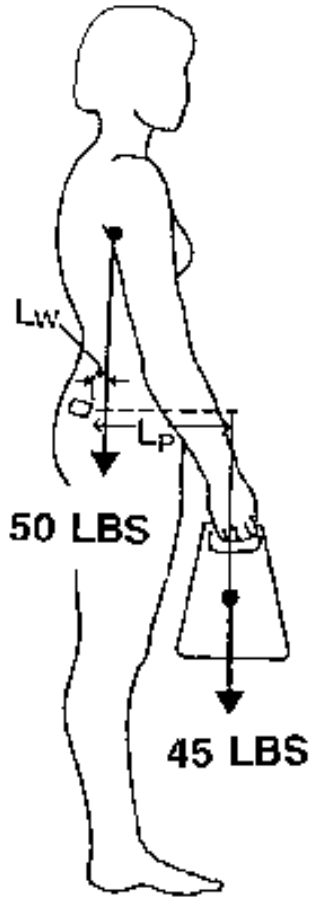




FLEXION MOMENT
45 LBS*8 IN.=360 IN*LBS

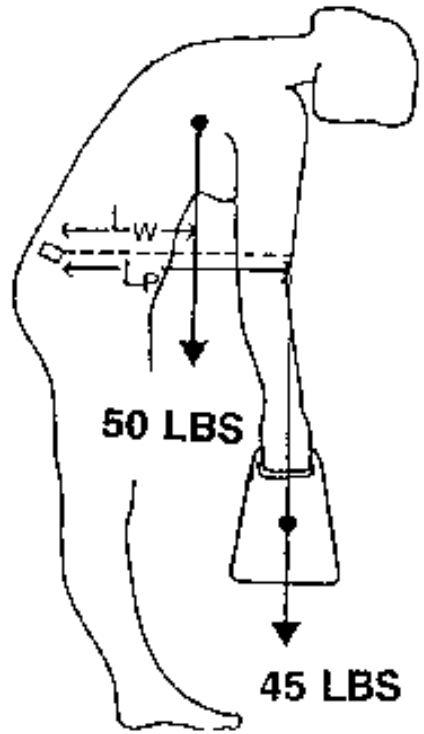


FLEXION MOMENT
45 LBS*16 IN=720 IN*LBS



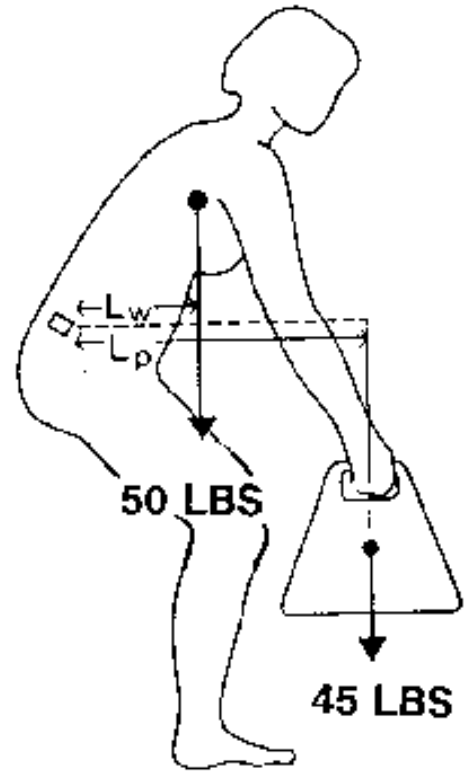
L_W = 1 IN
L_P = 12 IN

FLEXION MOMENT
= 590 IN*LBS



L_W = 10 IN
L_P = 16 IN

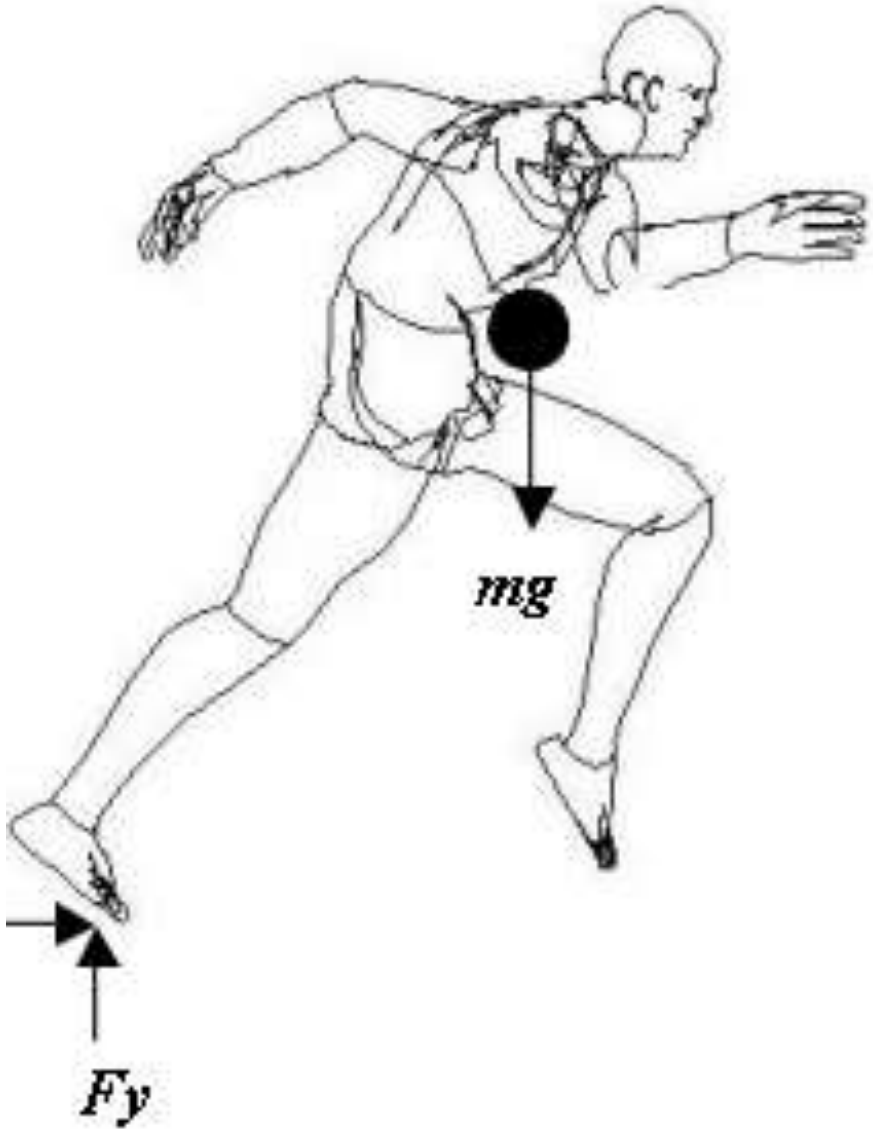
FLEXION MOMENT
= 1220 IN*LBS

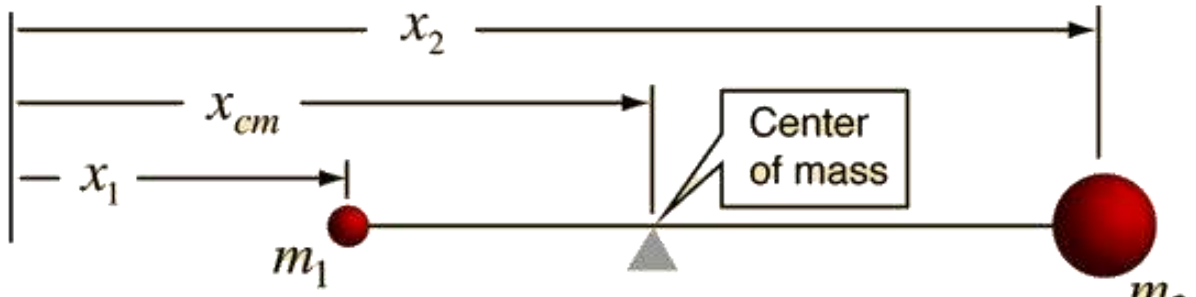


L_W = 7 IN
L_P = 14 IN

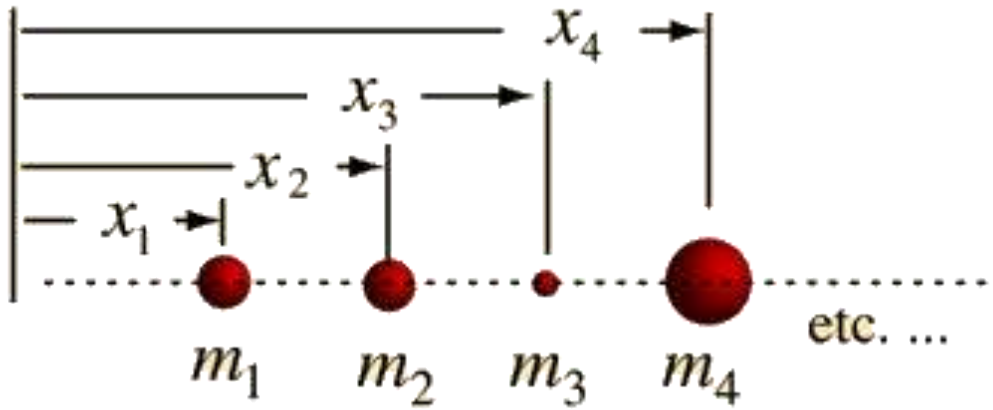
FLEXION MOMENT
= 980 IN*LBS

Dynamics

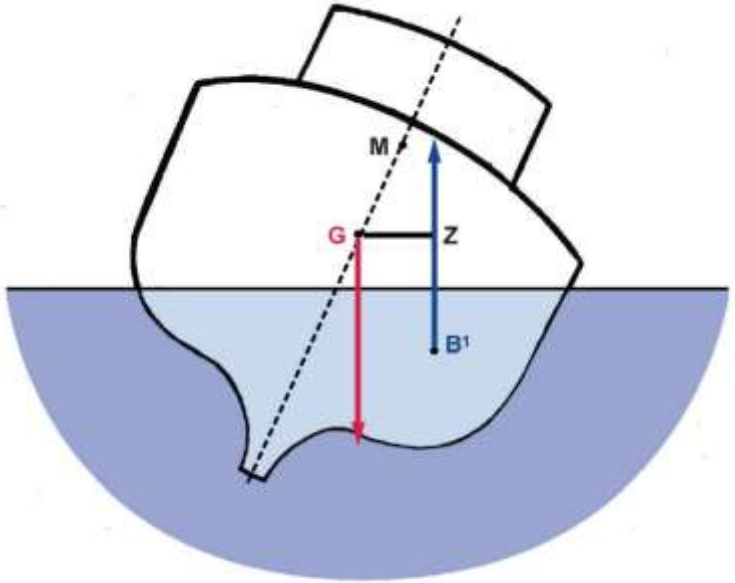


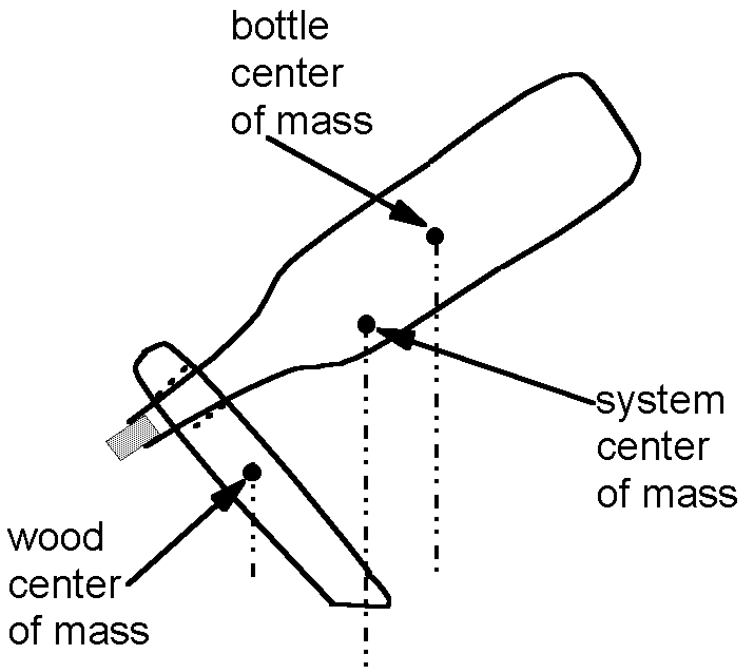


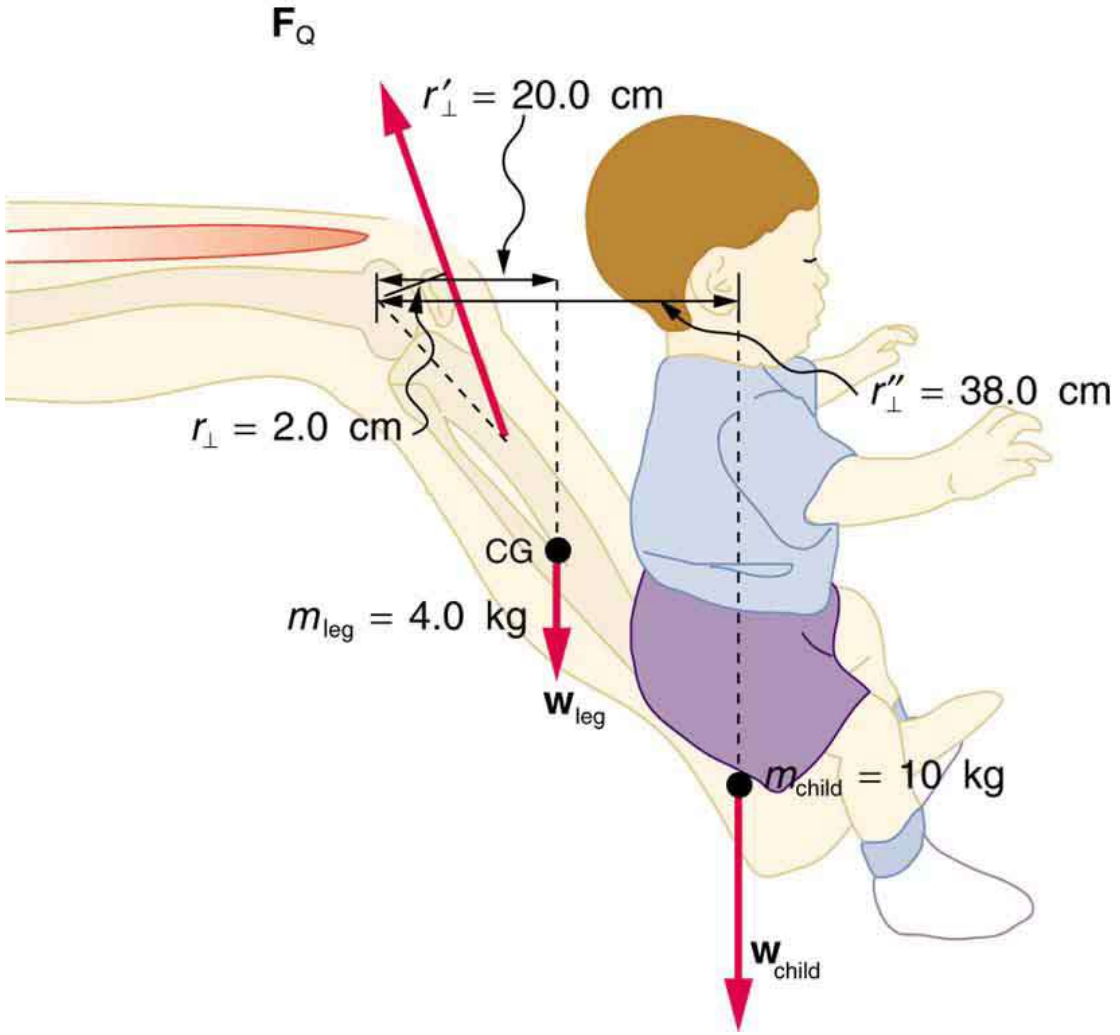
For two masses: $x_{cm} = \dfrac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$

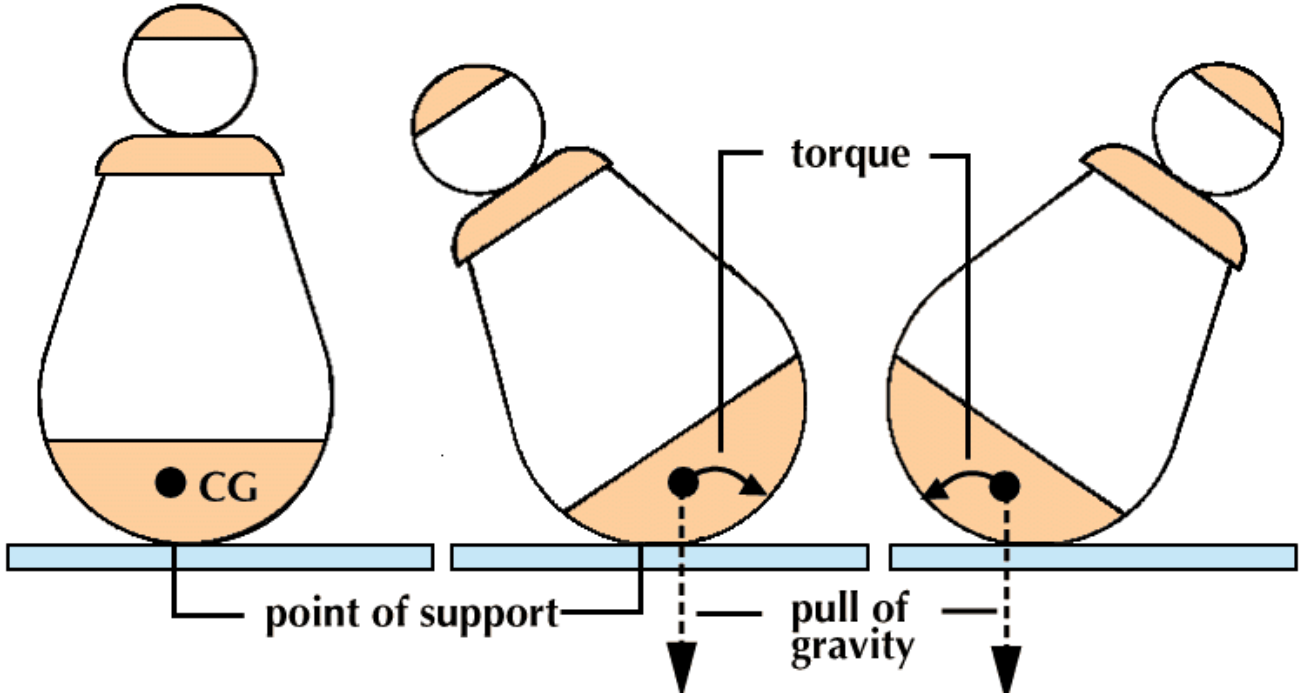


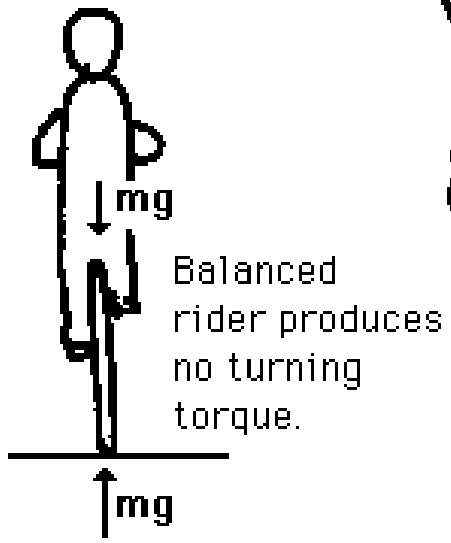
$$x_{cm} = \frac{\sum_{i=1}^{N} m_i x_i}{M}$$

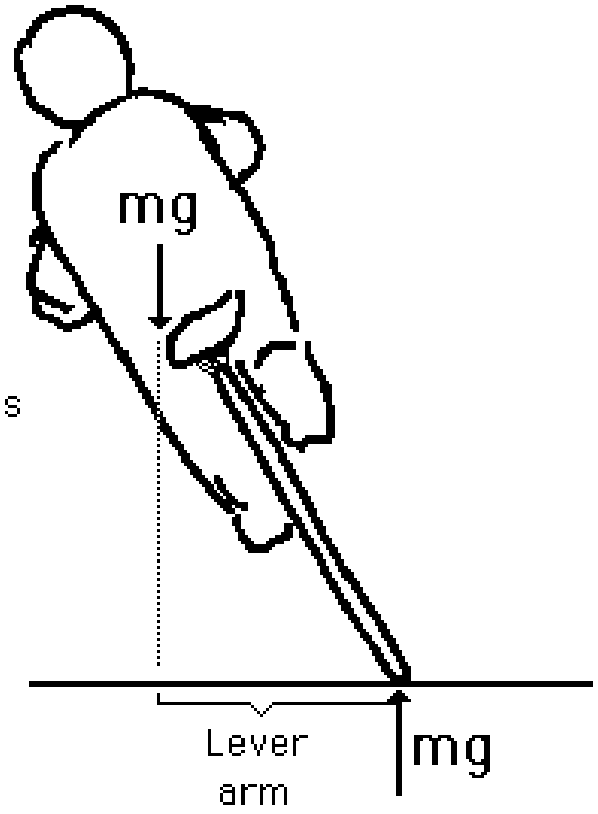

M
G
Z
B1


bottle
center
of mass
system
center
of mass
wood
center
of mass


F_Q
$r'_\perp$ = 20.0 cm
$r''_\perp$ = 38.0 cm
$r_\perp$ = 2.0 cm
CG
m_{leg} = 4.0 kg
w_{leg}
m_{child} = 10 kg
w_{child}


torque
CG
point of support
pull of
gravity


mg
Balanced
rider produces
no turning
torque.
mg


mg
Lever
arm
mg

Newton's Laws of Motion

Sir Isaac Newton

- 1642 – 1727
- Formulated basic laws of mechanics
  (صاغ قوانين الميكانيكا الاساسية)
- Discovered Law of Universal Gravitation
  (اكتشف قانون الجذب العام)
- Invented form of calculus
- Many observations dealing with light and optics

"Every object persists in its state of rest or uniform motion in a straight line unless it is compelled to change that state by forces impressed on it."

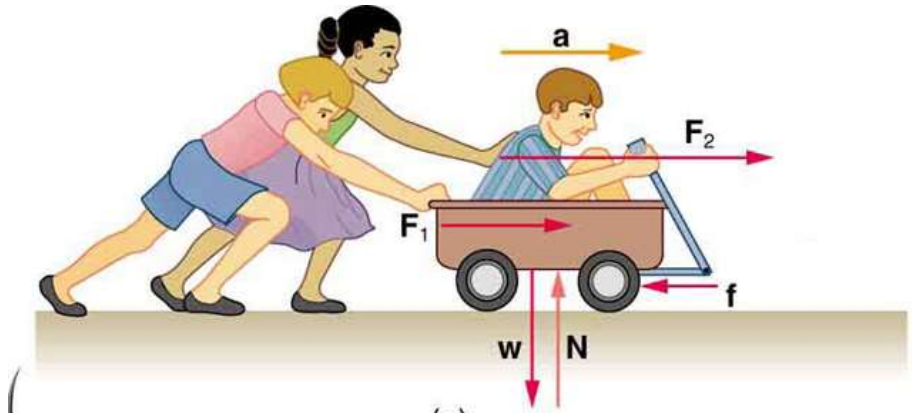
"Force is equal to the change in momentum (mV) per change in time. For a constant mass, force equals mass times acceleration."

$$F = m\ a$$

"For every action, there is an equal and opposite re-action."

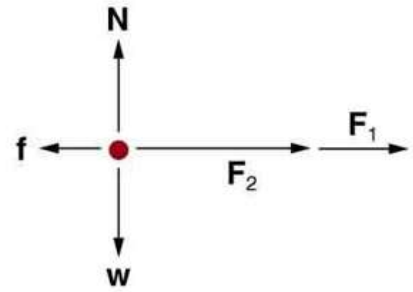
NEWTON'S FIRST LAW OF MOTION

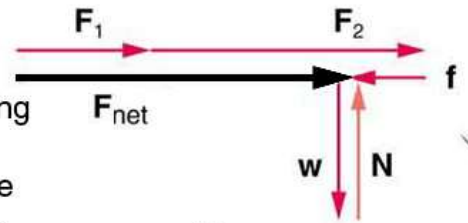
An object is at rest or in motion unless affected by an external force.



(a)

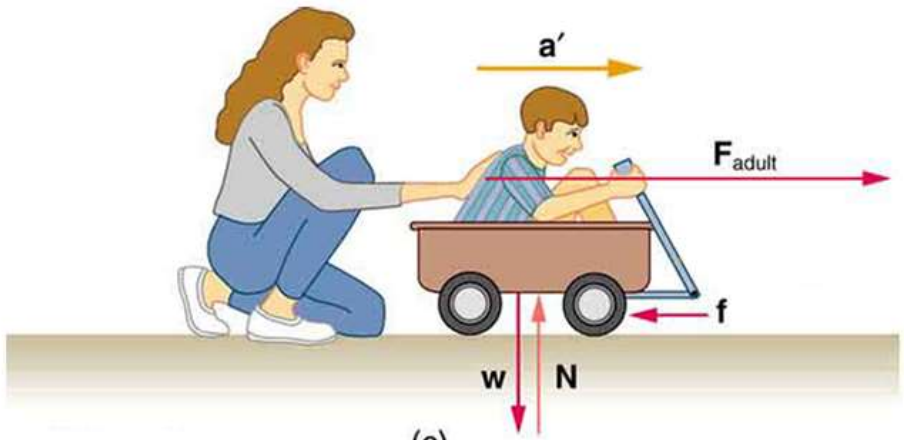
Free-body diagram





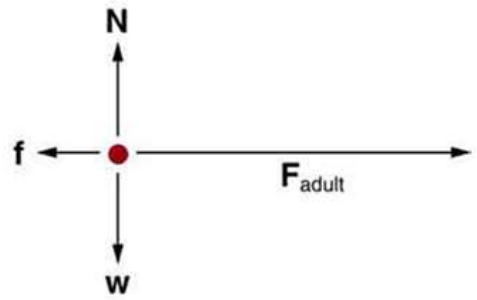
Each force acting on the system adds to produce a net force, F_{net}.

(b)

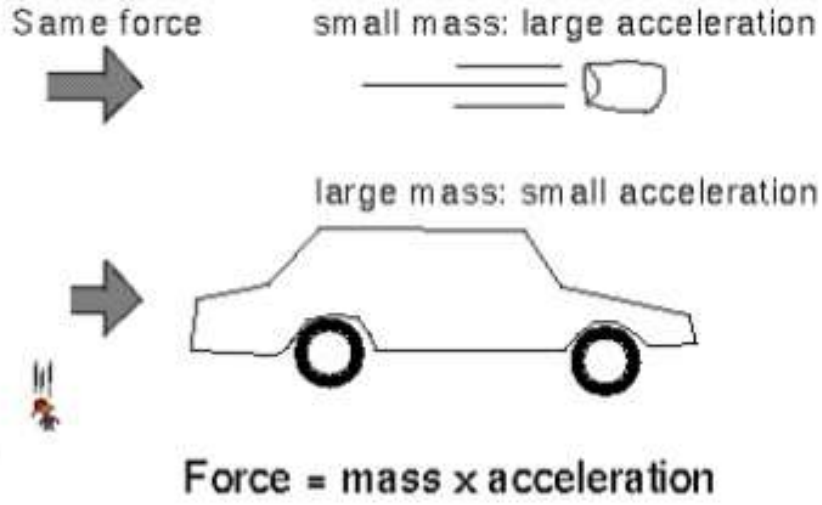


(c)

Free-body diagram



Newton's second law of motion



- Acceleration = $\frac{\text{net force}}{\text{mass}}$

$$a = \frac{F}{m}$$

$\frac{F}{m}$

F = force measured in Newtons
($1\ N = kg \cdot m/s^2$)

- If force acts on a small mass and a large mass, the small mass will accelerate more
- Ex: if you try to push an empty box across the floor, it will accelerate faster if the box is packed with books

Question 2

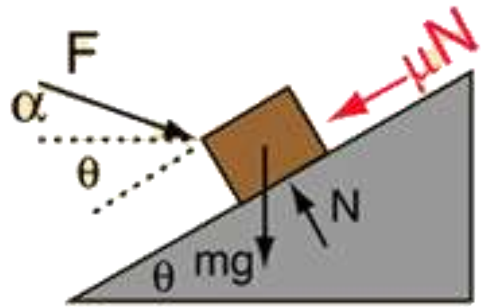
Two forces of 6 N and 3 N act upon an object in opposite directions. What would be the acceleration of this object if it has a mass of 100 kg?

A) 0.03 m/s²

B) 0.09 m/s²

C) 0.3 m/s²

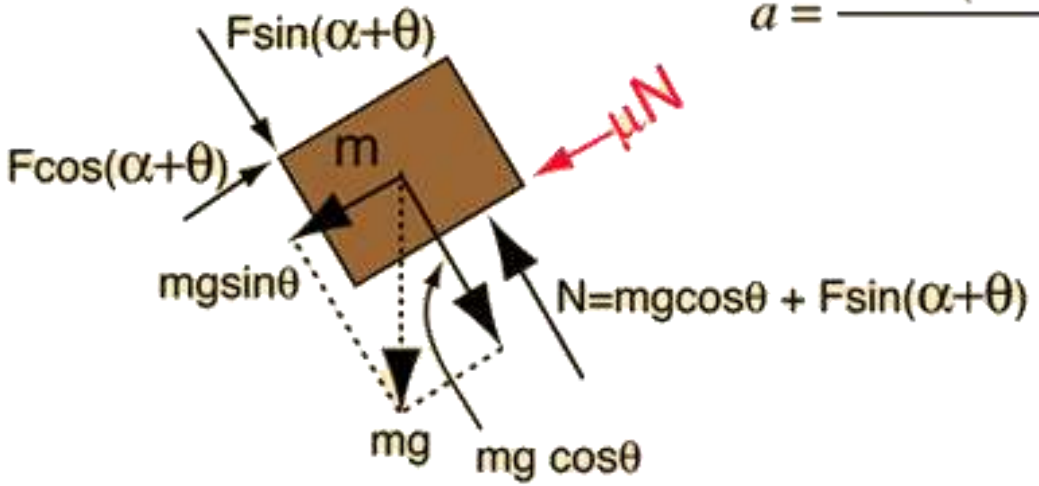
D) 0.9 m/s²



Applying Newton's Second Law involves the net force:

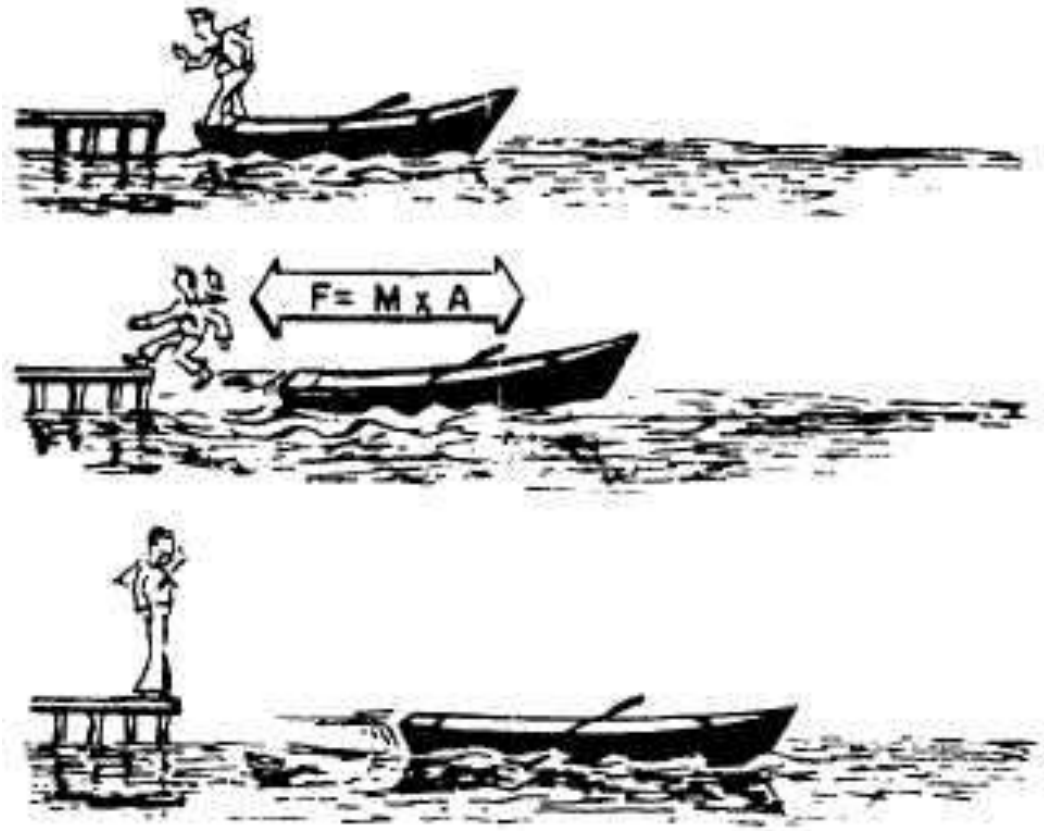
$$F_{net} = F\cos(\alpha+\theta) - mg\sin\theta - \mu N$$

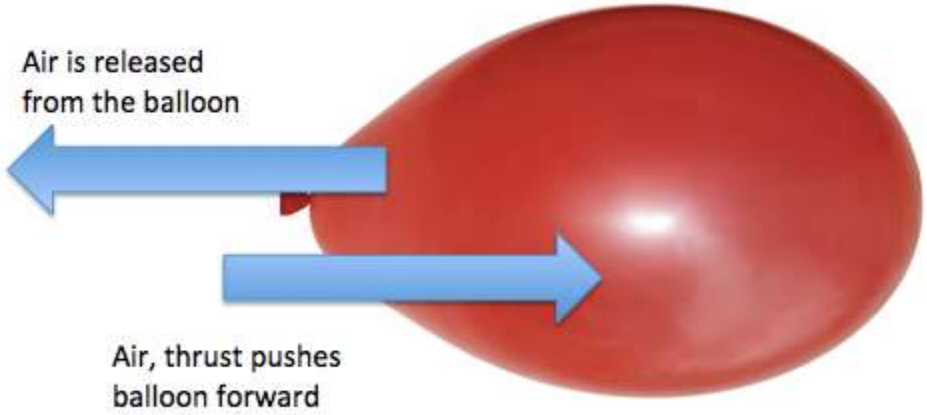
Free-body diagram



$$a = \frac{F\cos(\alpha+\theta) - mg\sin\theta - \mu N}{m}$$

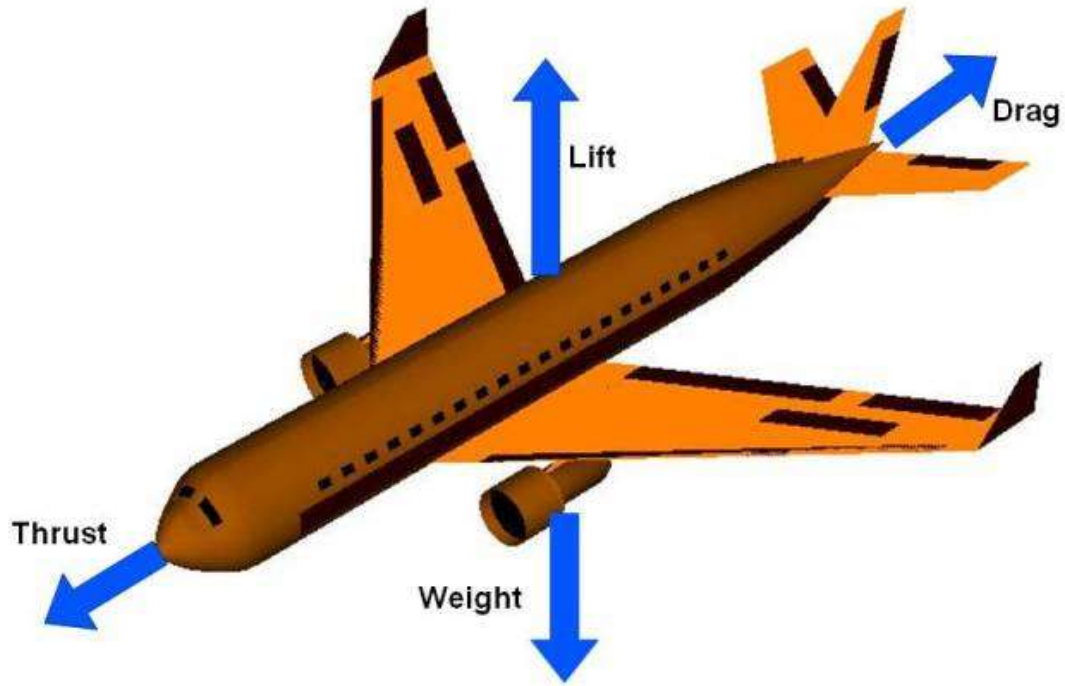
Figure 17–2 Opposite and Equal Reaction

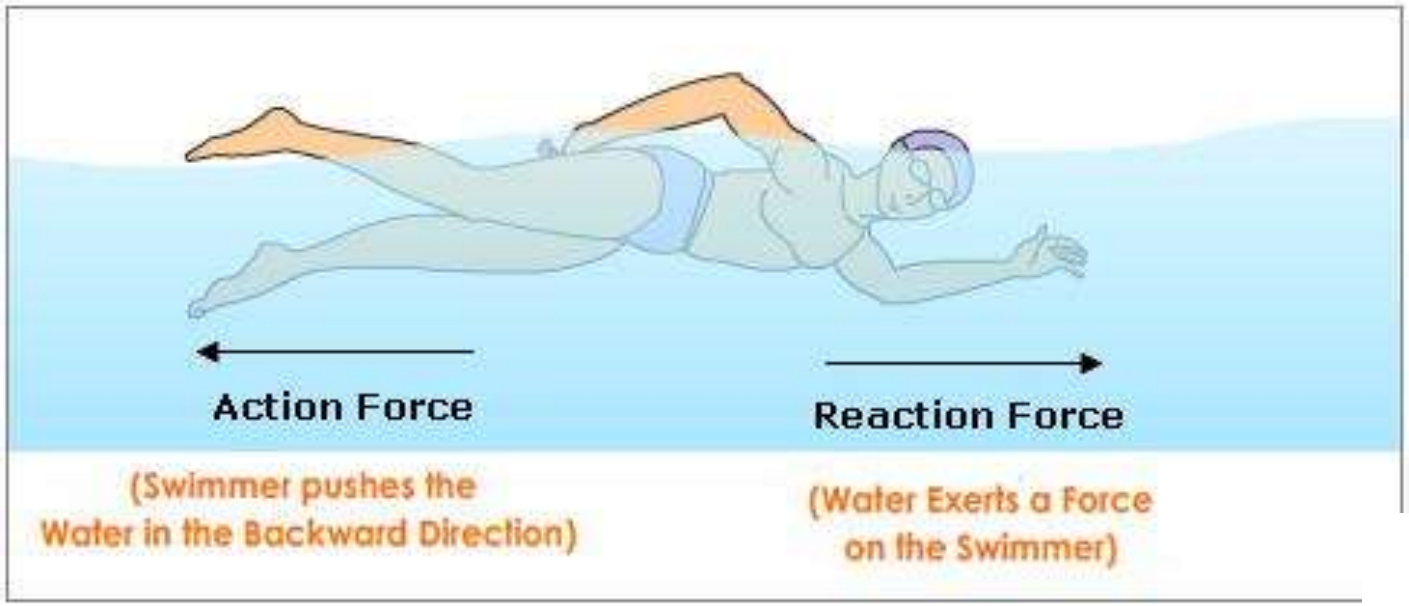




National Aeronautics and Space Administration

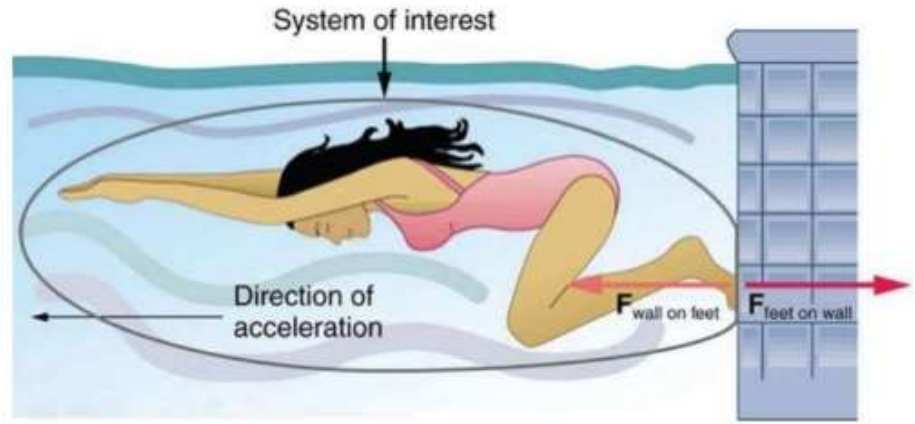
Four Forces on an Airplane



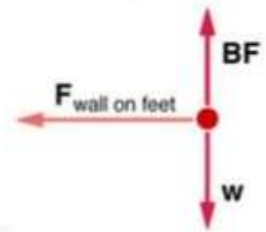


Example 1 – swimmer pushing on a wall

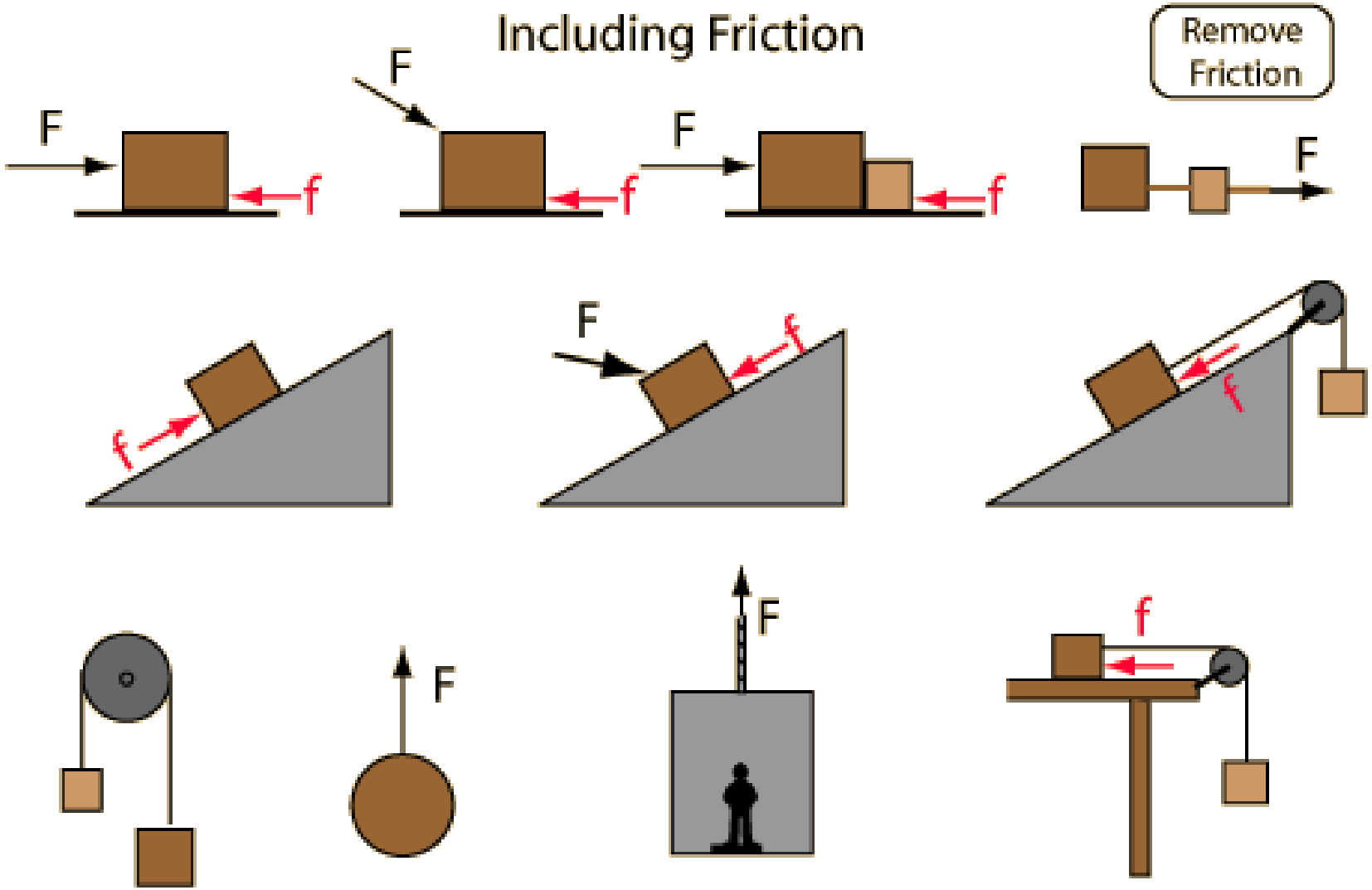
openstax COLLEGE

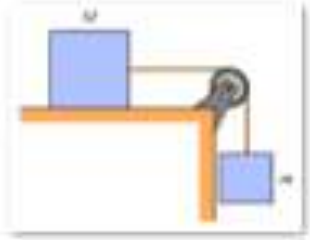


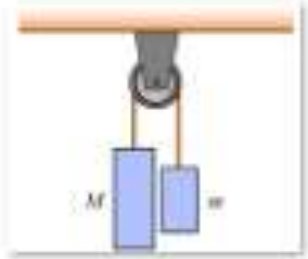
Free-body Diagram

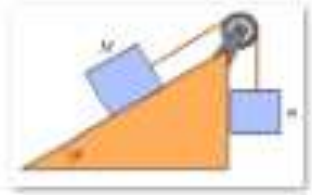


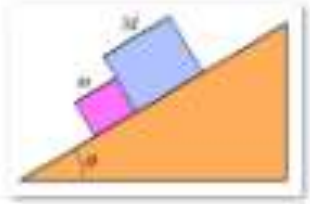
Standard Mechanics Problems

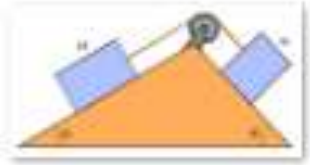


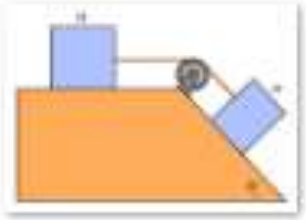


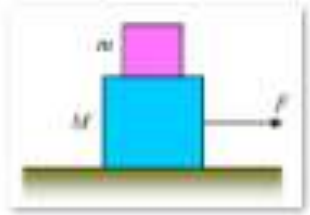


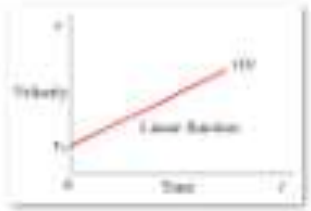


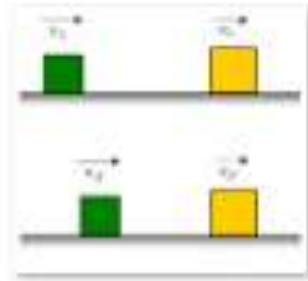


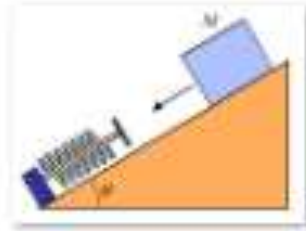


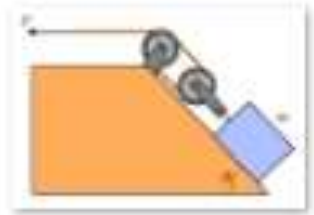




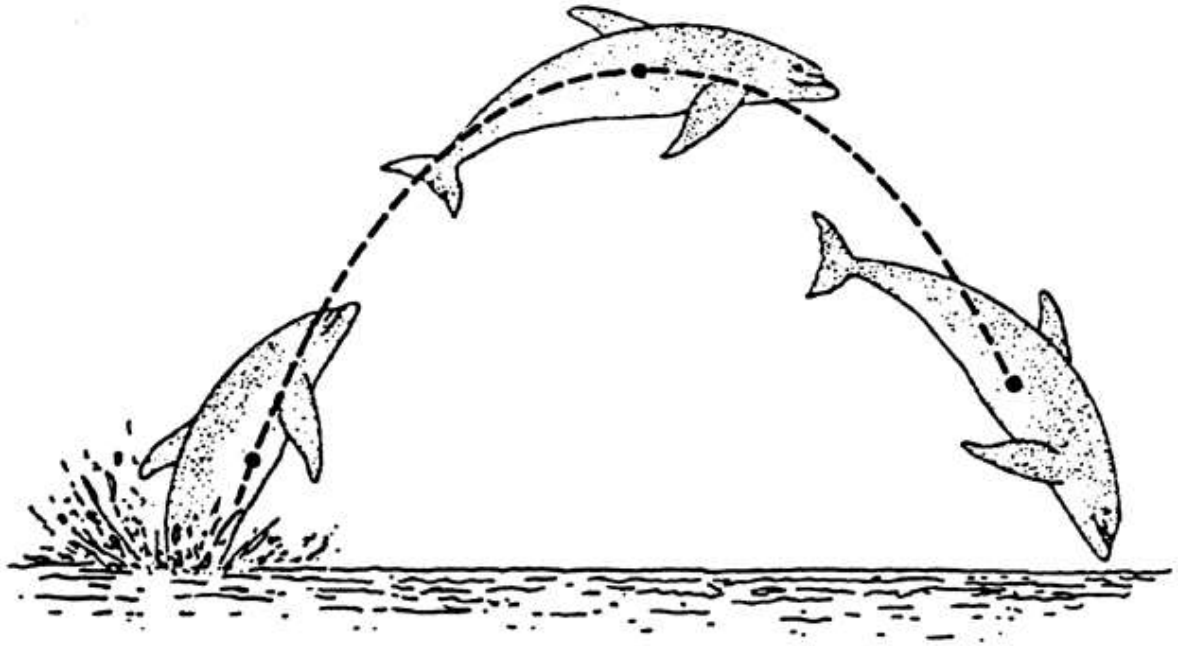




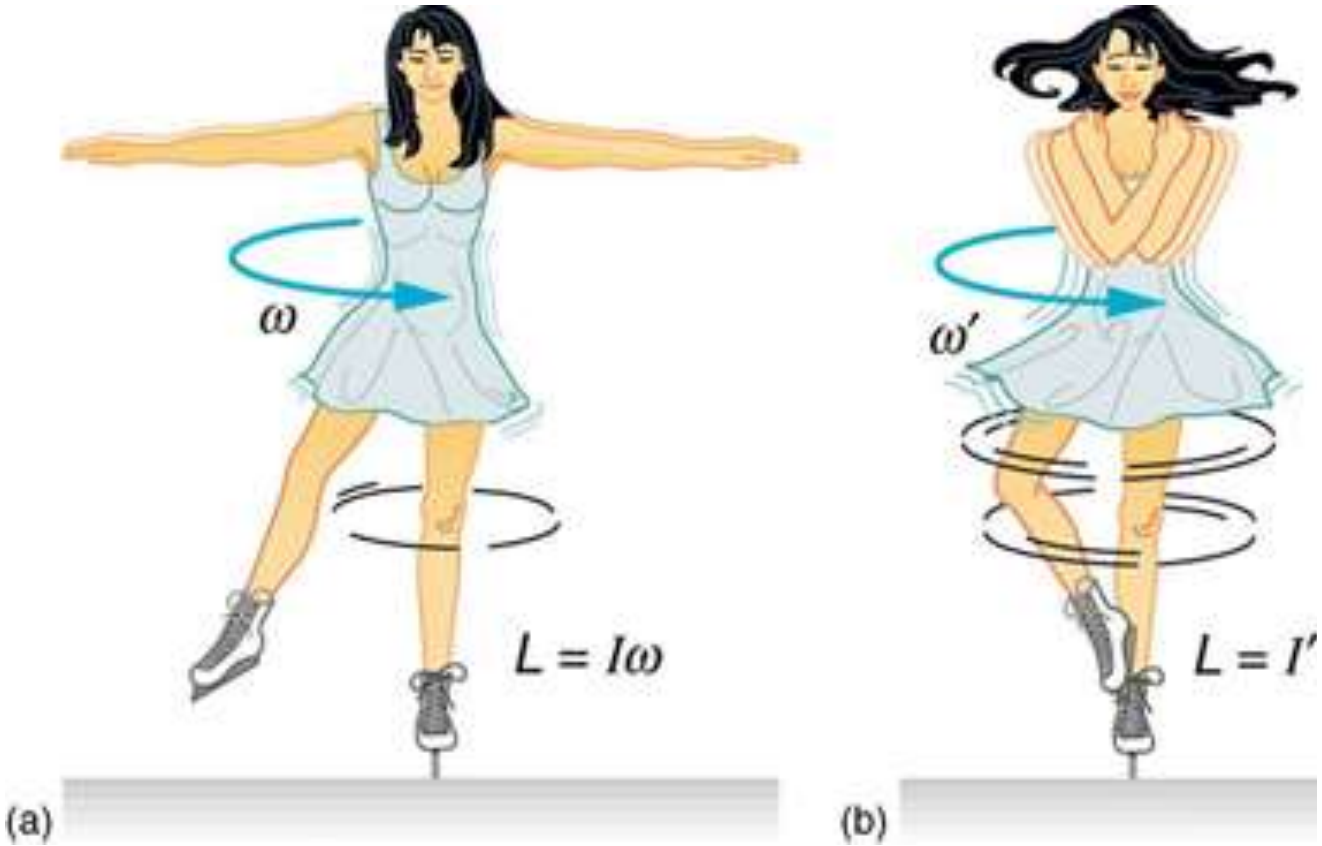


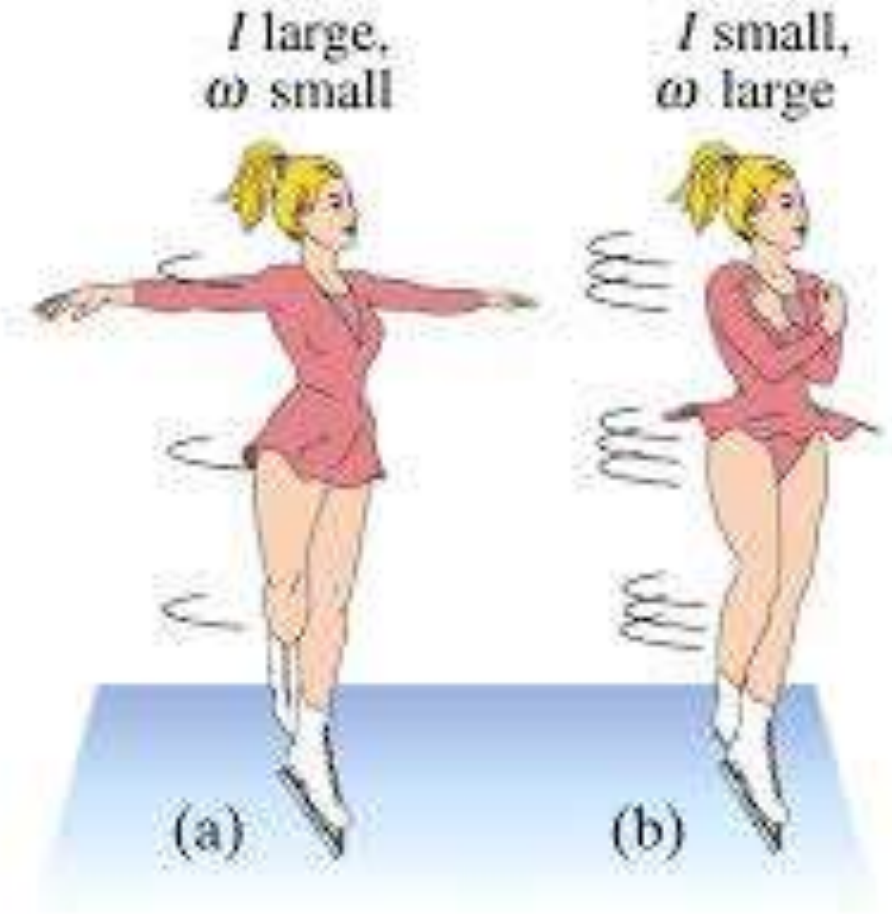


Real life projectile

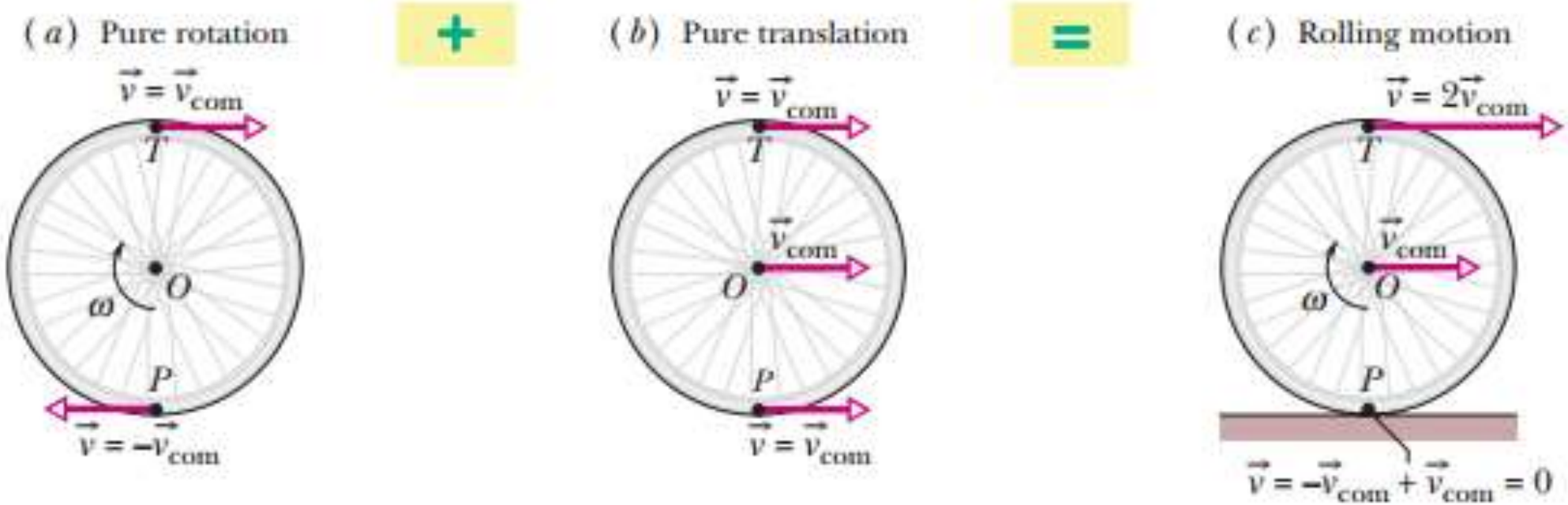


Conservation of Angular Momentum





Olympic Physics


(a) Pure rotation
+
(b) Pure translation
=
(c) Rolling motion
$\vec{v} = \vec{v}_{com}$
T
O
ω
P
$\vec{v} = -\vec{v}_{com}$
$\vec{v} = \vec{v}_{com}$
T
$\vec{v}_{com}$
O
P
$\vec{v} = \vec{v}_{com}$
$\vec{v} = 2\vec{v}_{com}$
T
$\vec{v}_{com}$
ω
O
P
$\vec{v} = -\vec{v}_{com} + \vec{v}_{com} = 0$

Plato is my friend,
Aristotle is my friend,
but my greatest friend
is truth.

Isaac Newton

"INSANITY IS DOING THE SAME THING OVER AND OVER AND EXPECTING A DIFFERENT RESULT."

--ALBERT EINSTEIN