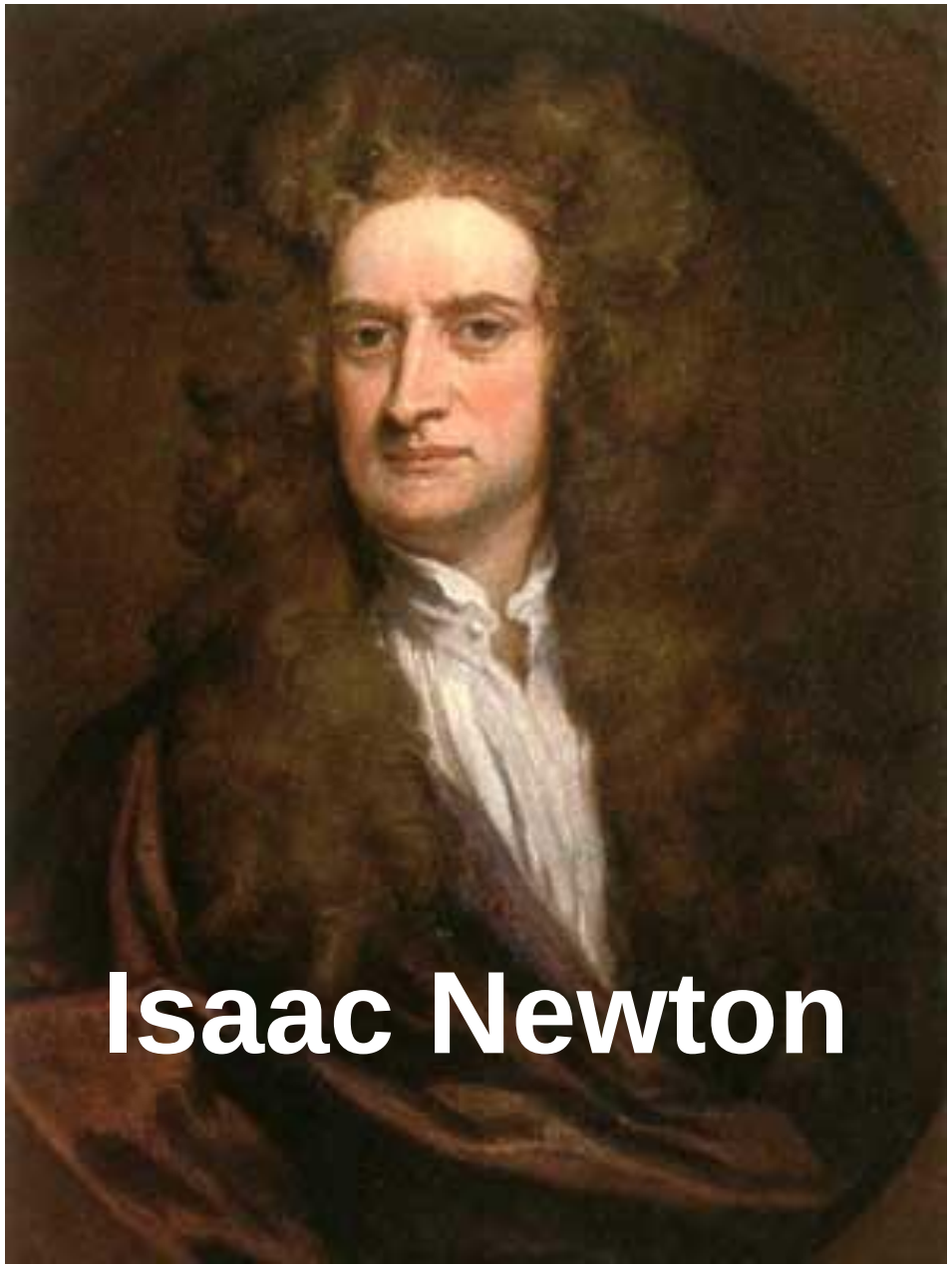
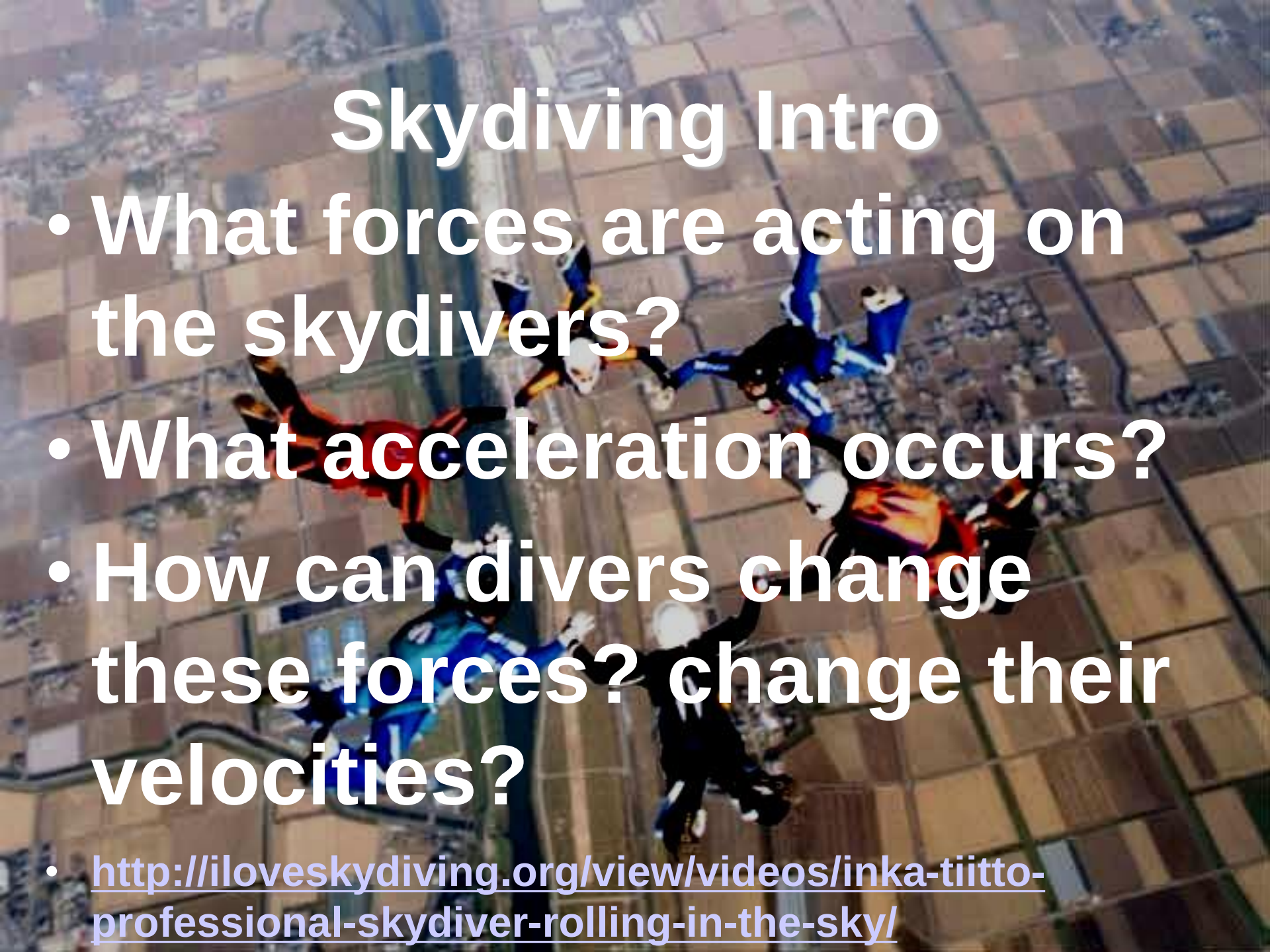


CH 4
FORCES



Skydiving Intro

- What forces are acting on the skydivers?
- What acceleration occurs?
- How can divers change these forces? change their velocities?
- http://iloveskydiving.org/view/videos/inka-tiitto-professional-skydiver-rolling-in-the-sky/

Introduction

- **Changing position is defined as _____.**
- **Changing velocity is defined as _____.**
- **What causes acceleration?**

_____

Force

- **Force** : A _____upon an object.
  - Forces are _____.
- **System**: The object that _____.
- **Environment/External World**: Everything around the object that is _____.
- **Agent**: Whatever is _____ _____.

Types of Forces:

_____ forces

_____forces

Contact Forces

Caused by _____ between objects.

- frictional forces
- normal forces
- applied forces
- tensional forces
- air resistance forces
- spring forces

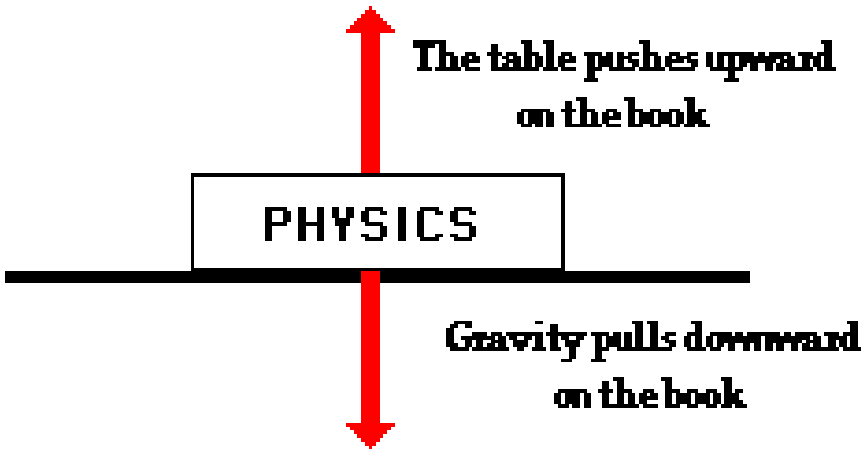
Friction Force _____

- Force exerted by a _____ as an object _____ or _____.
- _____ the motion of the object.
- Friction depends on _____ _____ and upon the degree to which they are _____.

As a book slides across a table from left to right, the force of friction acts on the book to slow it down and bring it to rest.

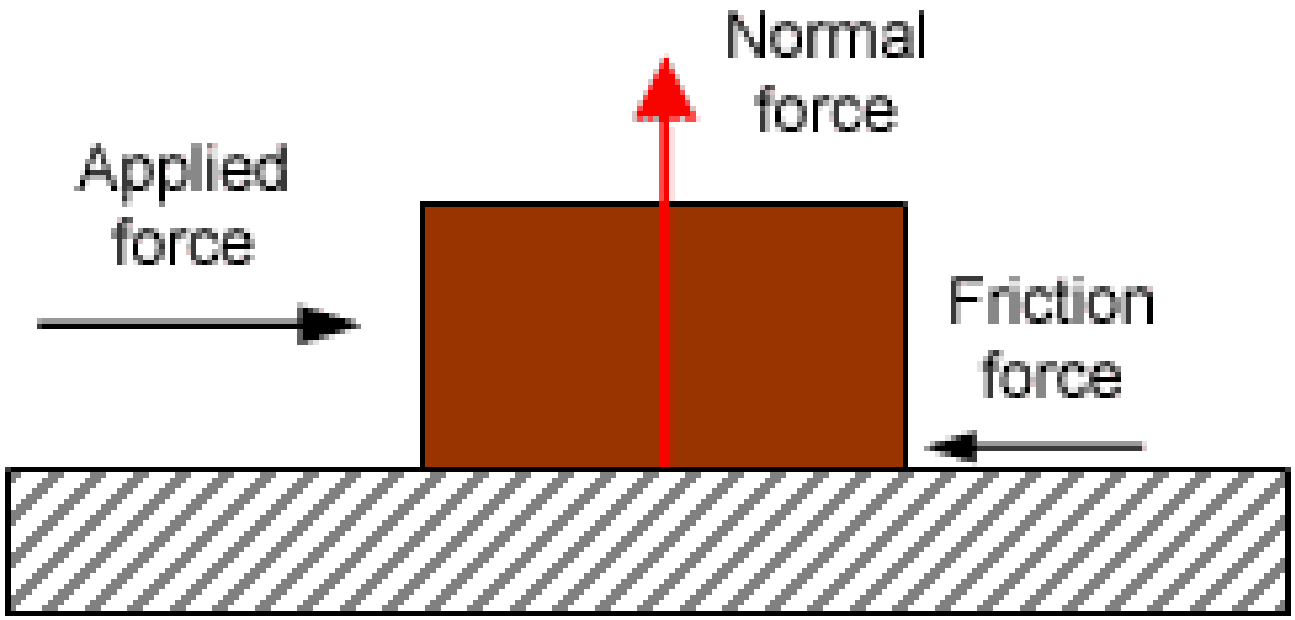
Normal Force _____

- The contact force exerted by a _____ that on an object is on.
- _____ to the surface.



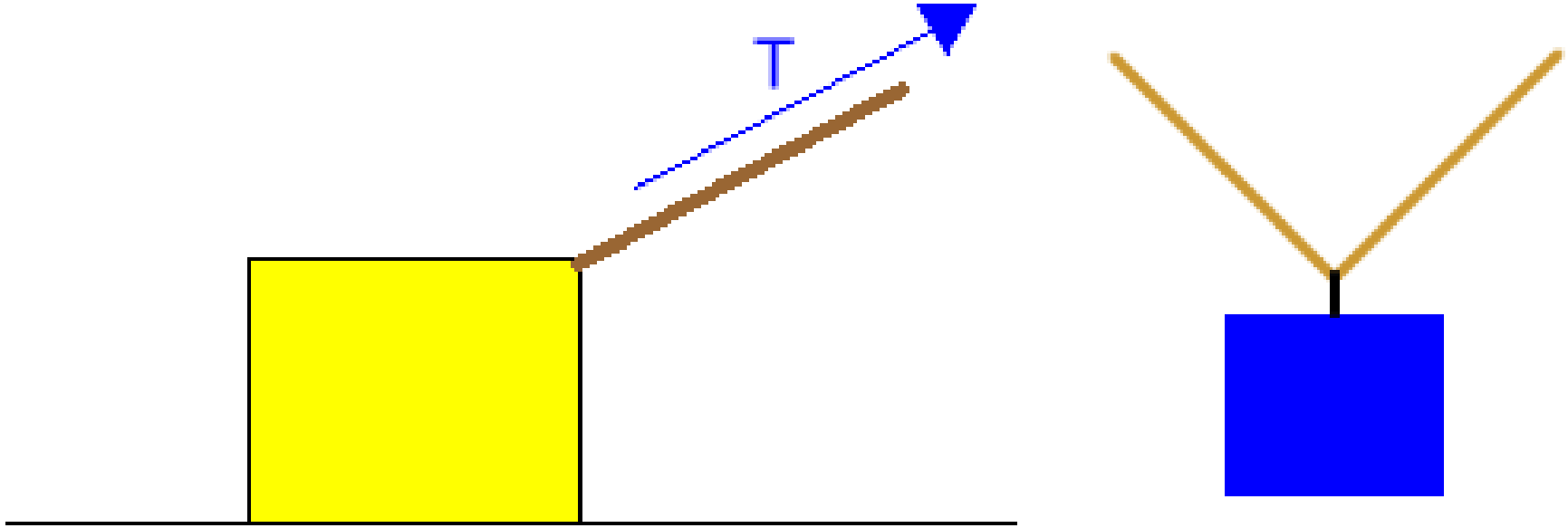
Applied Force _____

- A force which is _____ to an object by a _____.



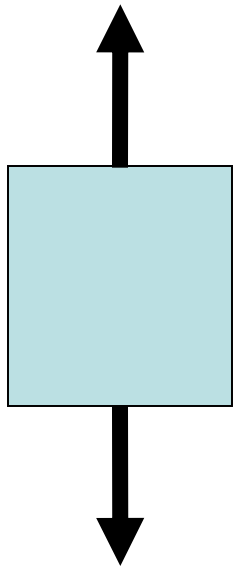
Tensional Force _____

- The force transmitted through a _____ _____ when it is pulled _____ by forces acting from each end.
- Force is _____to the rope and points _____ the object.



Air Resistance Force _____

- Type of _____ force
- _____ the motion of the object.
- Often neglected for objects that it _____.
- Noticeable for objects which travel at _____or for objects with _____.



Spring Force _____

- Force exerted by a _____ _____ spring.
- Force is _____ of the object.
- _____ force.

Force Due to Gravity (Weight)
F_g

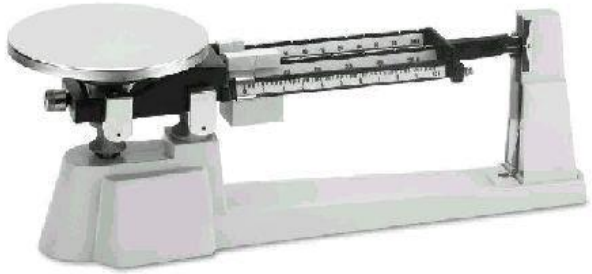
- Force from the _____ pulling on you.

- To find weight:
- **$F_g = m * g$**
  - g = 9.8 m/s^2 (on _____)
  - m = mass (in kg)

- **Do not confuse weight with_____.**

Mass & Weight

- Mass
  - Constant (at every location)
  - Balance
  - Kilograms

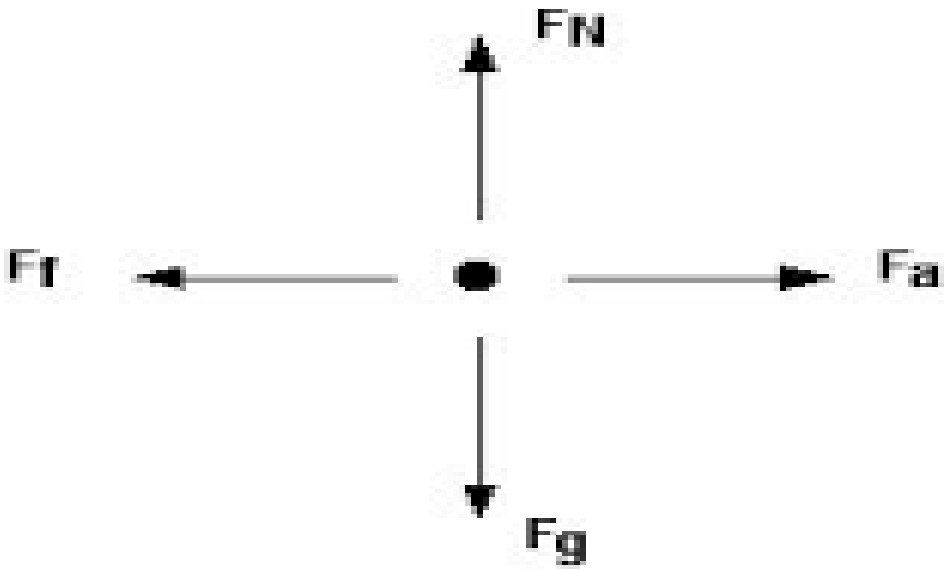


- Weight
  - Gravity dependent
  - Scale
  - Newtons

Free Body Diagram

- _____ representation of all _____ acting upon an object.
- Shows both _____ and _____ of all the forces.
- Determines _____.
  - The _____ of all the forces taking _____ into account.
  - **An object will _____ in the same direction as the _____ acting on it**.

- Always draw the tail of the vector on the object.
- Represent the object with a dot.



Free Body Diagram

- An egg is free-falling from a nest in a tree.
- Diagram the forces acting on the egg as it is falling.

Free Body Diagram

- A girl is suspended motionless from a trapeze hanging from the ceiling by ropes.
- Diagram the forces on the bar.

Free Body Diagram

- A skydiver is descending with a constant velocity.
- Diagram the forces on the sky diver.

Free Body Diagram

- A car is coasting to the right and slowing down.
- Diagram the forces on the car.

Free Body Diagram

- A rightward force is applied in order to move a book across a desk at constant velocity.
- Neglect air resistance.
- Diagram the forces.

Find Net Force

A construction crane applies a 1200N force to an 81.6 kg sign

Find Net Force

An 800N skydiver falls with 600N air resistance.

Newton's 2nd Law: _____

- _____ causes _____
- The acceleration depends on
  - –the net force acting on the object (_____ related)
  - –the mass of the object (_____ related)

FORCE UNITS - Newton

- One Newton is the amount of force required to give a 1-kg mass an acceleration of 1 m/s^2
- A Newton is abbreviated by a "N."

$$1\ \text{Newton} = 1\ \text{kg} * \frac{\text{m}}{\text{s}^2}$$

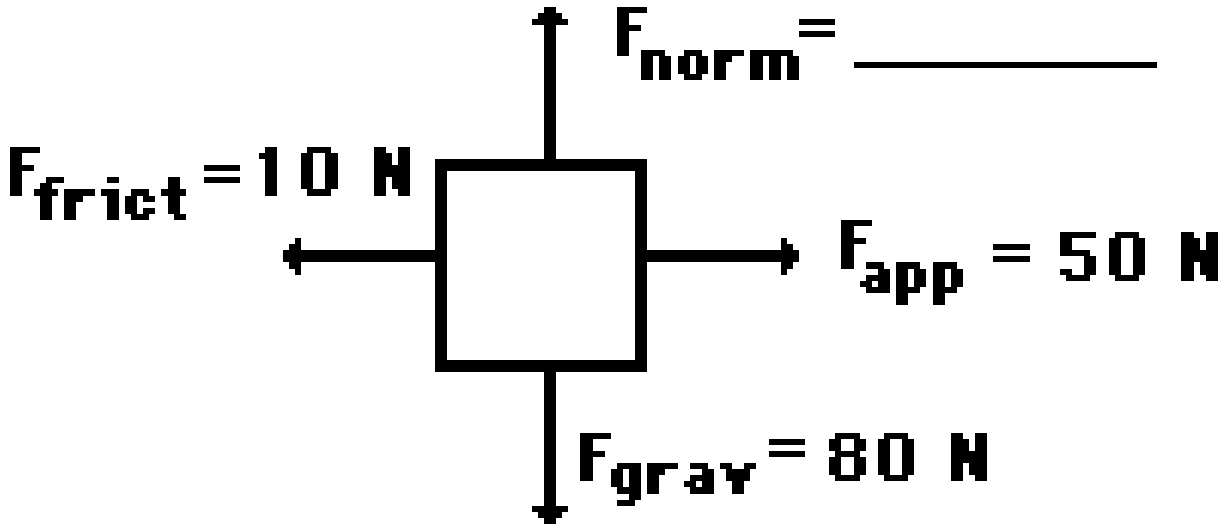
Important Summary:

- If the net force on an object is __, the object will have a _____ velocity or __ velocity.
  - It is in _____.
- If the net force on an object is not 0, the object will have an _____ in the _____ direction as the _____.
- When finding net force work separately with _____ and _____ forces.

EX:

- What acceleration will result when a 12-N net force is applied to a 3-kg object?

Try It: The diagram represents a pushed shopping cart.



m = _____

a = _____

F_{net} = _____

EX:

Arnold needs to lift a 35 kg rock. If he exerts an upward force of 502 N on the rock, what is the rock's acceleration?

EX:

A 50 kg bucket is being lifted by a rope. The rope will not break in the tension is 525 N or less. The bucket started at rest, and after being lifted 3 m, it is moving at 3 m/s. If the acceleration is constant, is the rope in danger of breaking?

Newton's 1st Law

An object at rest will _____,
and an object in motion will _____
_____, unless acted on by an
_____.

"Objects keep on doing what they're doing"

Also called the Law of _____

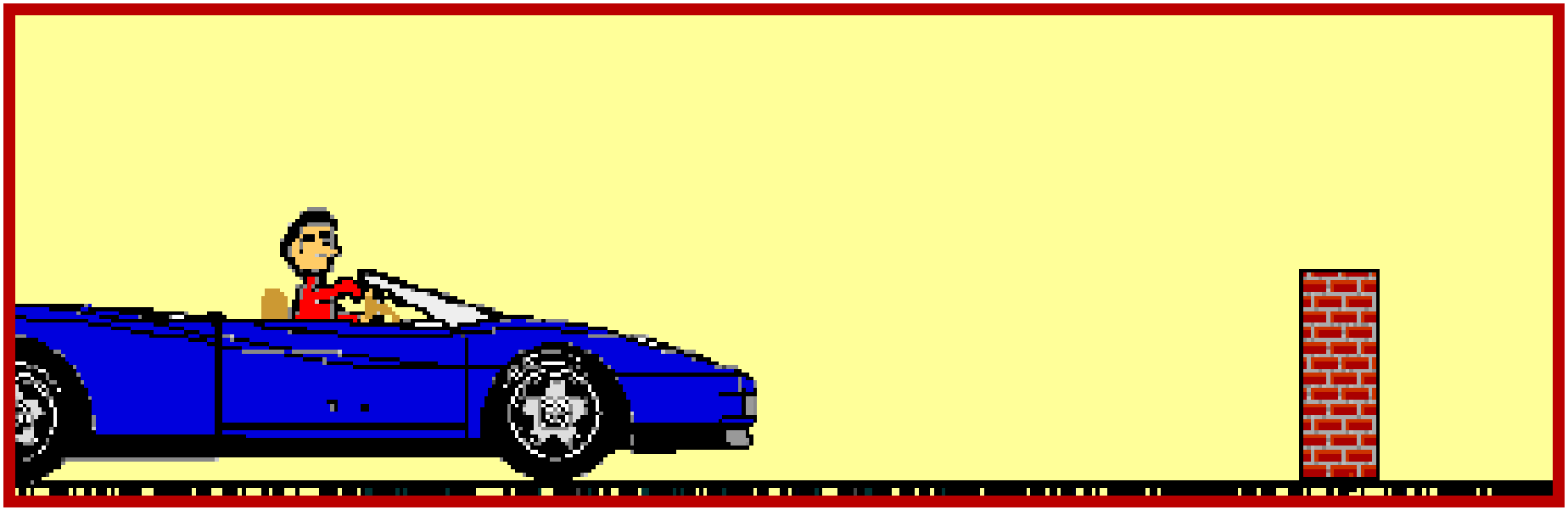
Inertia

- Inertia – the tendency of an object _____ _____.
- An object:
  - At _____wants to stay _____.
  - In _____ wants to stay _____ _____.

- Inertia is a _____ of the object that depends on its _____.

more _____ = more _____

Inertia



Inertia

1st Law Application

What will happen to a coffee cup filled to the rim while starting a car from rest or while bringing a car to rest from a state of motion? Why?

1st Law Application

- The head of a hammer can be tightened onto the wooden handle by banging the bottom of the handle against a hard surface. Why?

Explain how the 1st Law can apply to:

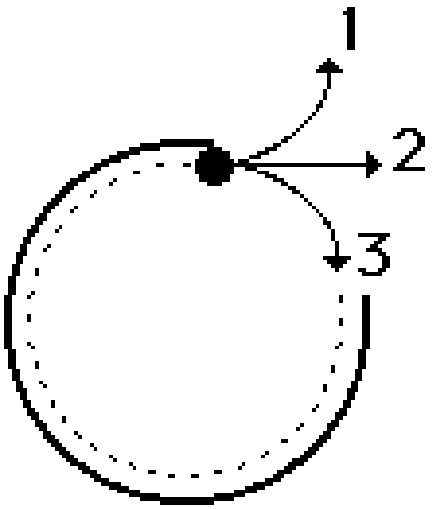
- Ketchup
- Skateboards
- Seatbelts

Check for Understanding

- Ben is being chased through the woods by a moose. If Ben makes a zigzag pattern through the woods, he is able to use the large mass of the moose to his own advantage.
- Explain this in terms of inertia and Newton's first law of motion.

Check for Understanding

- The 15th hole at the Putt-Putt Golf Course has a large metal rim which guides the ball towards the hole.
- A player hits their golf ball around the metal rim When the ball leaves the rim, which path (1, 2, or 3) will the golf ball follow? Explain.



Gravitational Force/Weight

- $F_g = mg$
- $g = 9.8\ m/s^2$
- You can use a _____ to measure weight.
  - When you are standing on a bathroom scale, the _____ equals the _____ _____.
  - In different locations or situations, the scale may read _____.

Apparent Weight

- Apparent weight – what your weight _____to be due to a _____ acting on you and giving you an _____.
- What your weight _____ like.
  - May be _____ or _____
  - EX:

Weightlessness

- Weightlessness – An object's apparent weight of _____that results when there are _____ pushing up on an object.
  - EX: If the cable of the elevator breaks and you and the scale are both in free fall.

Example:

- Suppose you are standing in an elevator that is accelerating upward. Is the magnitude of the normal force exerted on you by the floor of the elevator the same as, larger than, or smaller than the magnitude of your weight?

- You are riding in an elevator when you suspect the cable has broken. What can you do to quickly determine if this is the case or not?

EX:

Your mass is 65 kg and you are standing on a scale in an elevator. Starting from rest, the elevator accelerates upward at 3 m/s^2 for 4 seconds and then continues at a constant speed. Find the scale reading during both parts of the elevator ride.

Drag Force

- Drag force – the force exerted by a _____ on the object _____ _____.
- Depends on:
  - _____
  - _____
  - _____

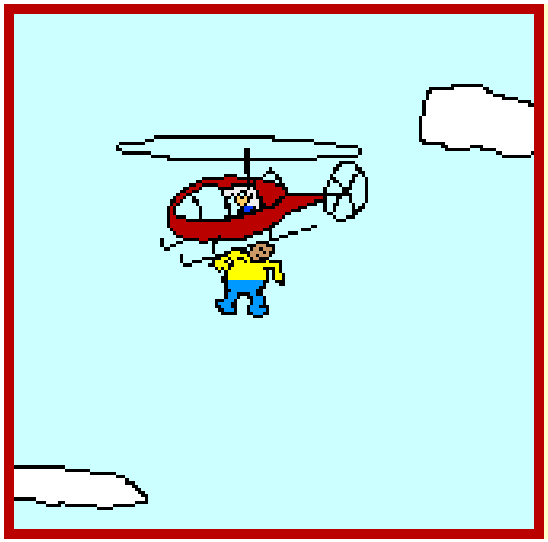
- When an object is falling, it experiences an _____ due to the _____ and a _____.
- Terminal Velocity - the _____ _____ that is reached when the _____ equals the _____.

Terminal Velocity

- As a falling object _____, it encounters an _____ amount of _____.
- Objects will continue to _____ until the _____ balances the _____.
- Once the two forces are _____, the object has reached its terminal velocity. The object will continue to fall to the ground with this _____ terminal velocity.

Which has a larger terminal velocity – a feather or elephant? Explain.

Skydiving



$$a = \frac{F_{net}}{m}$$

$$a = \frac{1000\ N}{100\ kg}$$

$$a = 10.0\ m/s^2$$

(down)

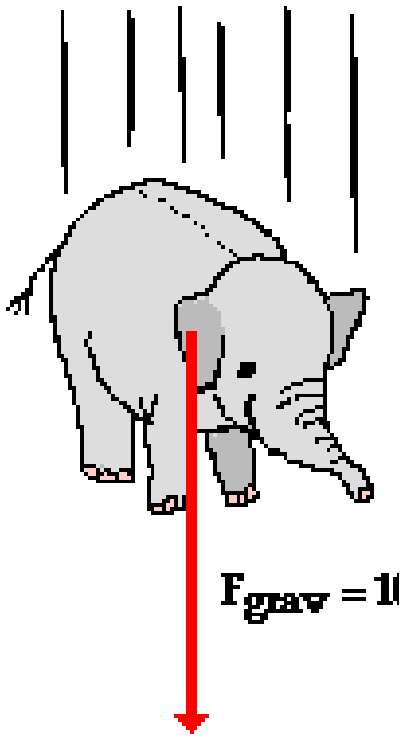
_____ air resistance, objects fall at different _____ because they have different _____.

_____ air resistance, _____ objects fall at the _____.

WHY:

Free Fall – NO Air Resistance

$m = 1000\ kg$



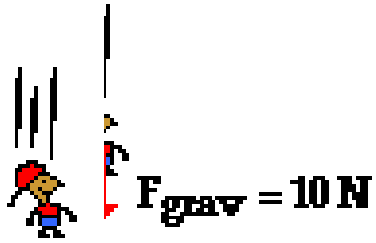
$F_{grav} = 1$

$$a = \frac{F_{net}}{m} = \frac{10\,000}{1000\ kg}$$

$a = 10\ m/s/s$

$$\frac{F}{m}$$

$m = 1\ kg$



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

$$a = \frac{et}{m} = \frac{10\ N}{1\ kg}$$

$a = 10\ m/s/s$

Newton's 3rd Law

- For every _____ there is an _____.

- Interactive Pair – two forces that are _____ in direction and _____ in magnitude.
  - These two forces _____ _____.
  - NOTE: These forces _____ because they _____.

When identifying interaction pairs, keep in mind that they will always occur in _____ _____.

Examples of 3rd Law Forces:

- When you sit in your chair, your body exerts a _____ _____ and the chair exerts an _____.
- When you sit in your chair, Earth exerts a _____ and you exert _____ _____.
- **"Press on a rock and the rock presses on you (with an equal, but opposite force)"**

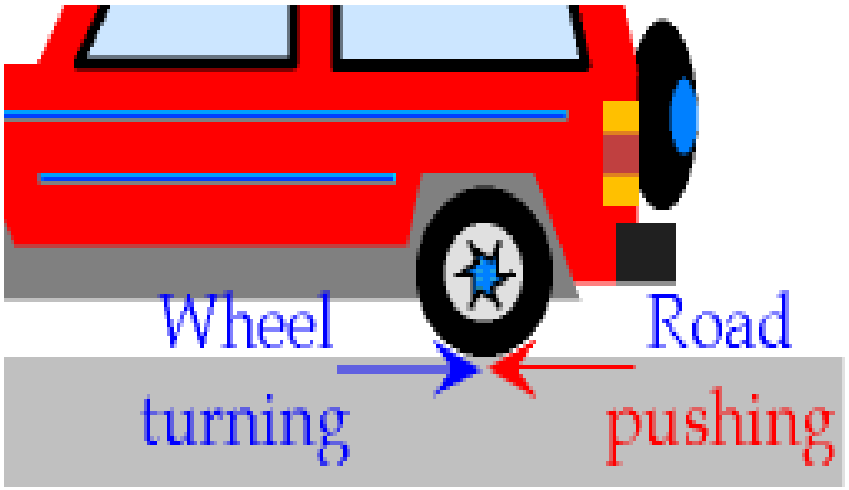
  - Newton

Bird

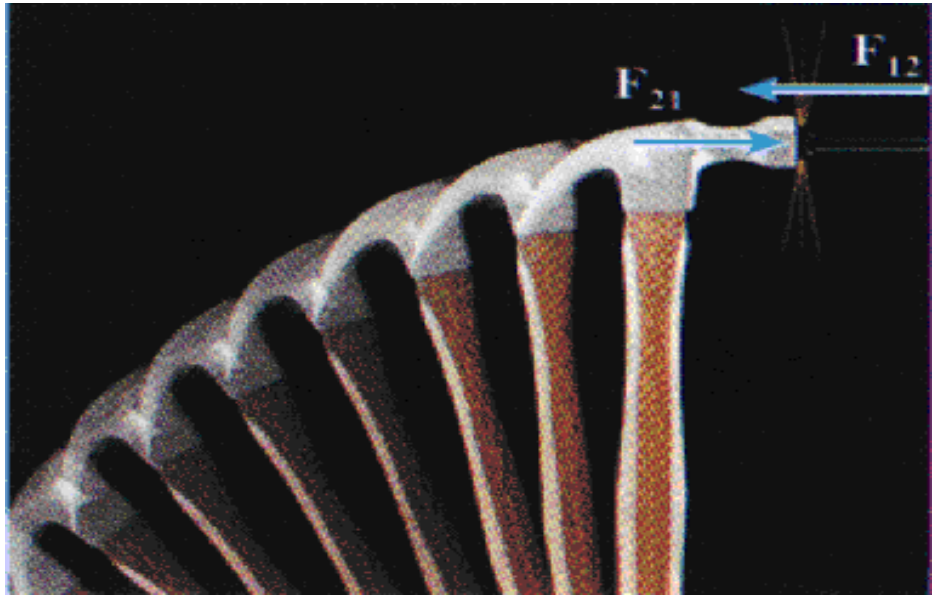
- The wings of a bird push air downwards. In turn, the air reacts by pushing the bird upwards.

Car

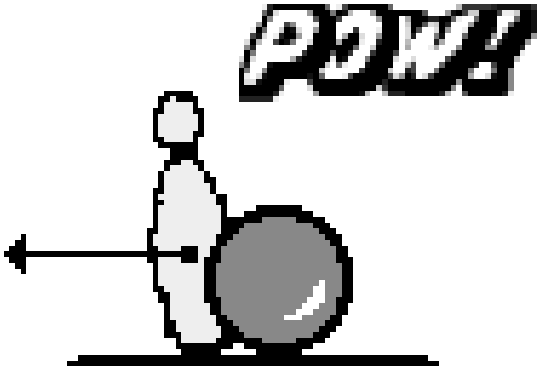
- A car is equipped with wheels which spin backwards. As the wheels spin backwards, they grip the road and push the road backwards. In turn, the road reacts by pushing the wheels forward.



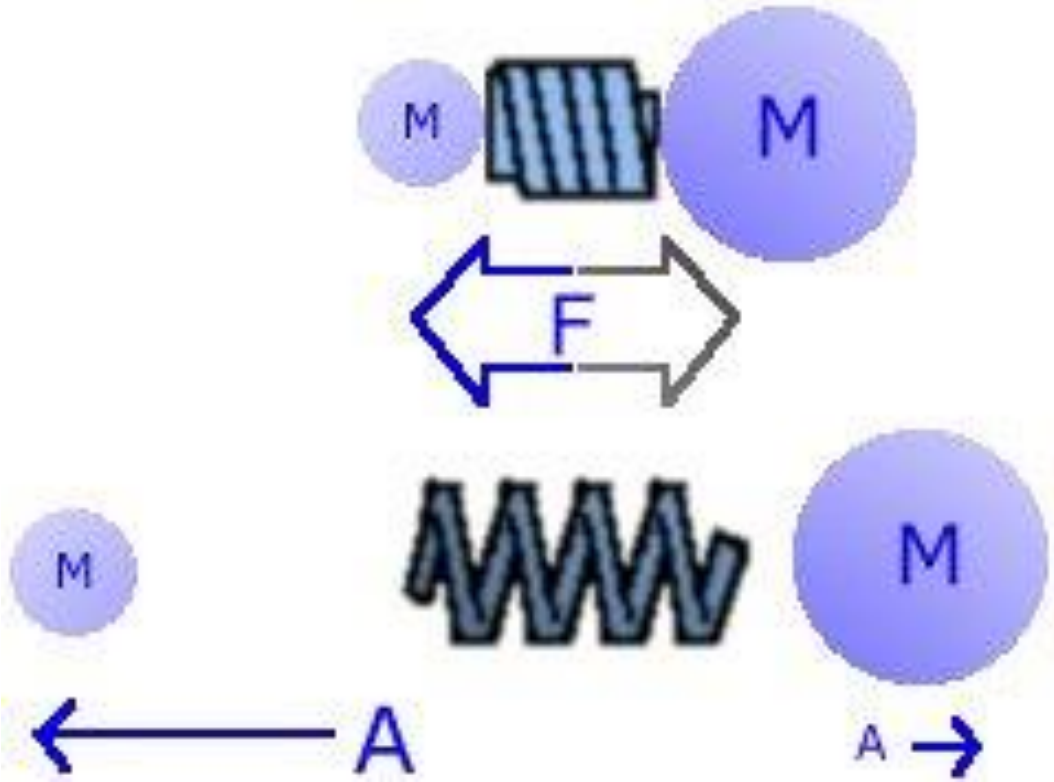
Equal and opposite



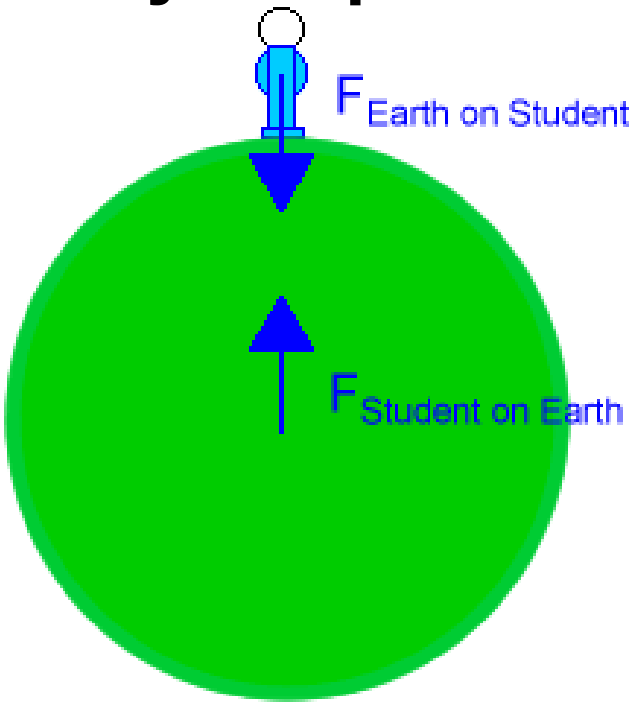
Equal and Opposite



- Bowling ball pushes pin leftwards.
- Pin pushes bowling ball rightwards


M
M
F
M
M
A
A

If the force on the Earth is equal to the force on you why doesn't the Earth rise up to meet you when you jump into the air?



EX:

When a softball with a mass of 0.18 kg is dropped, it acceleration toward Earth is equal to g, the acceleration due to gravity. What is the force on Earth due to the ball, and what is the Earth's resulting acceleration? Earth's mass is $6x10^{24}$ kg.