

Name _____ Block _____ Date _____

Ch 5 Newton's 2nd Law: Force and Acceleration

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Objectives:

State the relationship between acceleration and net force. Know the SI units and the other units.(5.1)

State the relationship between acceleration and mass. Know the SI units and the other units(5.2)

State Newton's 2nd Law of Motion and explain it using a "numeric" example. (5.3)

Describe the effect of friction on stationary and on moving objects. (5.4)

Distinguish between force and pressure. Know their SI & other units of measurement.(5.5)

Using the metric system, convert mass given in grams to kilograms and vice a versa. (4.6)

Vocabulary:

| | | | |
|-----------------|----------------|---------------------------|------------------|
| air resistance | pressure | Newton's 2nd Law | pascal |
| inversely | fluid | free-body diagram | rolling friction |
| static friction | fluid friction | kinetic/ sliding friction | |

| | symbol | SI unit | other unit(s) |
|--------------|--------|-------------------|-----------------------|
| force | F | N newton | kg m/ s ² |
| acceleration | a | m/ s ² | |
| friction | f | N newton | kg m / s ² |
| pressure | P | Pa pascal | N/ m ² |
| area | A | m ² | |

Formulas:

$$a = \frac{F}{m} \qquad F = ma \qquad w = mg \qquad F_f = \mu F_N \qquad A = \pi r^2 \qquad P = \frac{F}{A}$$

Newton's 1st law covered objects at rest or moving at a constant velocity

Newton's 2nd law covers objects that are changing their motion.....they are accelerating

acceleration is the change in velocity per time $a = \frac{\Delta v}{t}$

5.1 Force Causes Acceleration

apply a force to object at rest.....it velocity changes.....therefore, it has accelerated

if remove that force then object will continue its motion at a constant velocity

if add force again....it's velocity will change again....and it is accelerating

5.1 Force Causes Acceleration

acceleration depends on the net force.....to increase the acceleration of an object you must increase the net force acting on it.....double the force.....double the acceleration

object's force is directly proportional to the net force acting on it (not = to each other)

acceleration \sim net force

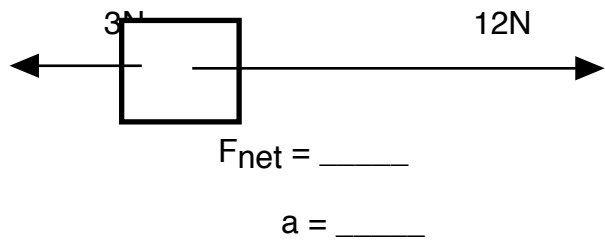
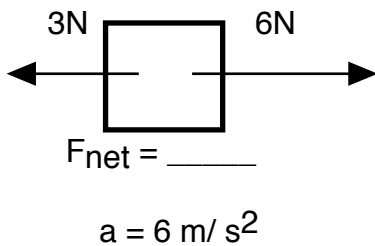
if net force increases.....so does acceleration

if double net force.....double acceleration

if halve net force.....halve acceleration

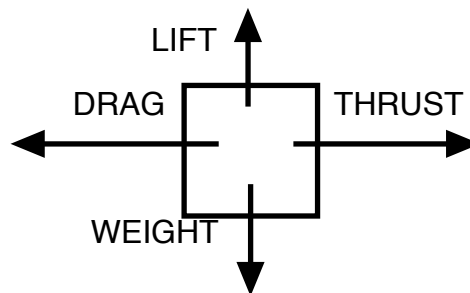
? The acceleration of a ball with a net force of 2N is 6 m/s². If the net force is doubled then what is the resulting acceleration? Draw free body diagrams to help solve.

? The acceleration of a box being pushed across a room with a net force of 3N is 6 m/ s². What is the resulting acceleration if the net force is tripled?



? A pilot announces that the plane is flying at a constant 900 km/ h and the thrust of the engines is constant 80,000 N. What is the acceleration of the airplane?

? what is the combined force of air resistance that acts on the plane's outside surface?



5.2 Mass Resists Acceleration

acceleration depends on the mass being pushed

the same force applied to twice as much mass results in only half the acceleration

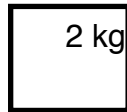
for a given force, the acceleration produced is inversely proportional to the mass

inversely- When two values change in opposite directions, so that if one is doubled the other is reduced to one half.

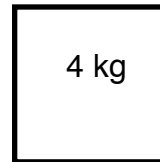
$$\text{acceleration} \sim \frac{1}{\text{mass}}$$

as mass increases.....acceleration decreases
if double mass.....halve acceleration
if halve mass.....double acceleration

? A bucket has a mass of 2 kg and has an acceleration of 4 m/s^2 . If 2 kg of stones are added to the bucket, then what is its new acceleration?



$$a = 4 \text{ m/s}^2$$



$$a = \underline{\hspace{2cm}}$$

5.3 Newton's Second Law

The acceleration produced by a net force on a body is directly proportional to the magnitude of the net force, is in the same direction as the net force, & is inversely proportional to the mass of body.

Newton's 2nd law equation

$$\text{acceleration} = \frac{\text{net force}}{\text{mass}}$$

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

doubling the net force acting on an object doubles its acceleration
doubling the mass of an object halves its acceleration

if both the net force & mass are double, the acceleration is unchanged

acceleration depends on net force on object & also depends on the mass of object

5.4 Friction

friction= force that acts to resist motion (or attempted motion)

F_f depends on 1. area of surfaces in contact increase Aincrease F_f

2. Types of materials in contact (irregularities in the surfaces)

use coefficient of friction to describe relationship b/w 2 materials in contact

Coefficient of Friction - ratio of force of sliding friction to normal force

high μ high F_f and object does not slide easily

low μ low F_f and object slides easily

(oils and lubricants strive for a low μ)

$$F_f = \mu F_n \qquad \mu \sim F_f$$

? A boy weighs 420N steps in a puddle on the floor. The coefficient of friction between the boy and the wet floor is 0.04. What is the force of sliding friction between the boy and the slippery floor?

fig. 5.5 tire and metal barrier have low μ therefore less friction force

tire and concrete barrier have a higher μ therefore more friction force...decrease acc (car s
barrier is wider on bottom...rubber tire hits barrier before metal part of car

fluid- anything that flows (liquid or gas)

fluid friction- resistant force of gas or liquid on a n object that passes through

ex. **air resistance**- friction or drag that acts on something moving through air

constant velocity.....only if $F_f = F_{app}$ $F_{net} = 0N$ and $a = 0 \text{ m/s}^2$

static friction- the resistance force that must be overcome to start an object in motion

kinetic or sliding friction- the resistance force between two surfaces already in motion

rolling friction- the resistance force between a surface and a rolling object

5.5 Applying Force- Pressure

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force- a push or a pull (measured in Newtons)

pressure- the amount of force per unit of area symbol - P SI Unit - Pascal (Pa)

$$\text{pressure} = \frac{\text{force}}{\text{area of application}} \quad \frac{\text{(newton)}}{(\text{m}^2)} = \text{Pascal}$$

$$P = F / A$$

square area = length x width

$$\text{circle area} = A = \pi r^2$$

fig 5.7 The force exerted by an object onto a surface is independent of which side of the object on the surface. The upright book exerts the same force, but greater pressure, against the supporting surface.

$$P = F / A$$

$$P \sim F$$

$$P \sim 1 / A$$

the smaller the area supporting a given force, the greater the pressure on that surface

eg: sharpened knives exert more force over less area

? a. What happens to the pressure you exert on the floor when you stand on 1 foot compared to when you were standing on 2 feet?

b. What happens to the force you exert on the floor when you stand on 1 foot compared to when you were standing on 2 feet?