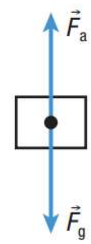
SPH3U: 3.1 Types of Forces

1. Measuring forces and force diagrams

Dynamics:	
force	
newton (N)	
measuring forces	
system diagrams	
free-body diagrams (FBDs)	



2. Everyday forces

Applied force:	
Tension:	
Normal force:	
Friction:	
Gravity:	

Draw both the system diagram and the FBD for each object in italics.

a. A *cup* is sitting at rest on a table.

b. A large *trunk* in the basement is pulled by a rope tied to the right side of the trunk by a person. The trunk does not move.

c. A *baseball player* is sliding to the left across the ground.

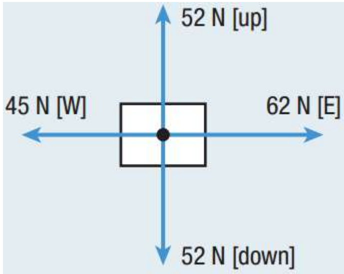
d. A *desk* is pushed to the left across the floor.

3. Calculating net forces

Net force:	

The floor exerts a normal force of 36 N [up] on a stationary chair. The force of gravity on the chair is 36 N [down]. Draw the FBD of the chair and use the FBD to determine the net force on the chair.

The figure to the right shows all the forces acting on an object. Use the FBD to calculate the net force.



4. Four fundamental forces

Gravitational:	
Electromagnetic:	
Strong nuclear:	
Weak nuclear:	

Type of force	Approximate relative strength	Range	Effect
gravitational			
electromagnetic			
strong nuclear			
weak nuclear			

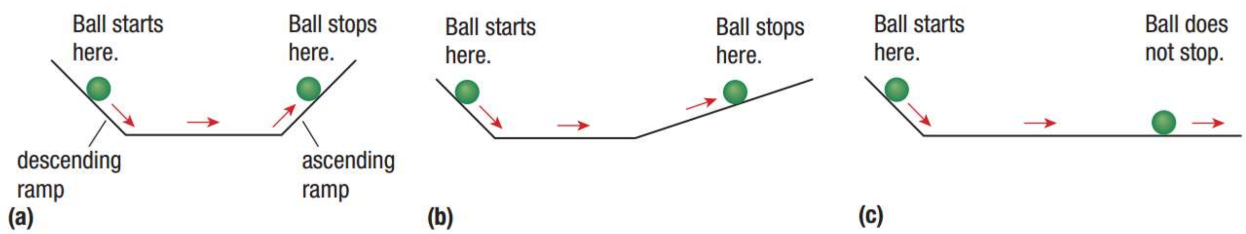
5. Summary

Homework: page 122: #1-3, 5, 7, 13, 15

SPH3U: 3.2 Newton's First Law of Motion

6. Inertia

Inertia:	
Newton's first law of motion	
Isaac Newton	
Galileo Galilei's thought experiment	



Use Newton's first law to explain each situation below:

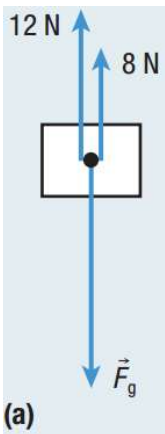
a. Why does a computer sitting on a desk remain at rest?

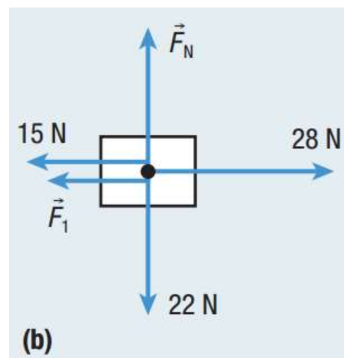
b. Why does a hockey puck moving across smooth ice move at a constant velocity?

c. Why does a wagon pulled across a rough surface by a child move at a constant velocity?

Older cards did not have headrests, but all new cars do. How do headrests help prevent injuries during a rear-end collision? Use Newton's first law to explain your answer.

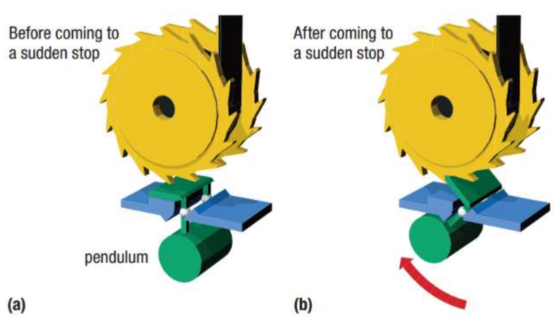
What is the missing force on each FBD shown below? Figure a) is an object at rest and Figure b) is an object moving left at a constant velocity.





7. Applications of Newton's first law

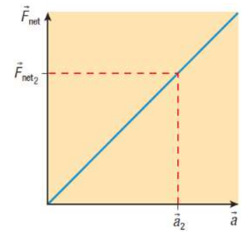
Seat belt:	

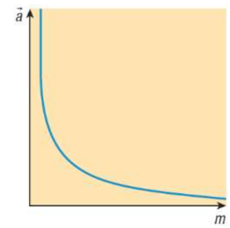


Homework: page 129: #1-4, 7, 10, 13

SPH3U: 3.3 Newton's Second Law of Motion

8. Newton's second law





Newton's second law:	
force vs. accel.	
accel. vs. mass	

A net force of 36 N [forward] is applied to a volleyball of mass 0.25 kg. Determine the acceleration of the volleyball.

A 64 kg runner starts walking at 3.0 m/s [E] and begins to speed up for 6.0 s, reaching a final velocity of 12.0 m/s [E]. Calculate the net force acting on the runner.

A 9100 kg jet moving slowly on the ground fires its engines, resulting in a force of 22 000 N [E] on the jet. The force of friction on the jet is 3800 N [W].

a. Draw the FBD for the jet.

b. Calculate the net force acting on the jet.

c. Calculate the acceleration of the jet.

9. Newton's second law and gravity

Force due to gravity:	

In an investigation, students place a 0.80 kg cart on a table. They tie one end of a light string to the front of the cart, run the string over a pulley, and then tie the other end to a 0.20 kg hanging object. Assume that no friction acts on either object.

a. Determine the magnitude of the acceleration of the cart and the hanging object.

b. Calculate the magnitude of the tension.

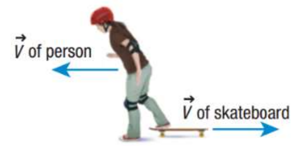
10. Summary

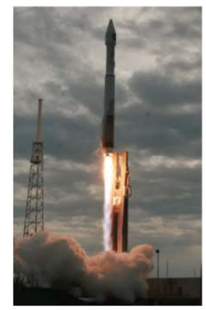
Homework: page 136: #1-4, 6, 10-11

SPH3U: 3.4 Newton's Third Law of Motion

11. Newton's third law

Newton's third law:	
stepping off skateboard	
rocket launch	





Explain each event in terms of Newton's third law:

a. A swimmer moves through the water.

b. A small balloon releases air and flies around the classroom.

c. You start walking across the floor.

12. Separate objects

Action and reaction force:	
two FBDs	

Two skaters are standing on ice facing each other. Skater 1 pushes on skater 2 with a force of 70 N [E]. Assume that no friction actos on either skater. The mass of skater 1 is 50 kg and the mass of skater 2 is 70 kg.

a. State the action and reaction forces.

b. Draw the FBD of each skater.

c. Describe what will happen to each skater.

d. Calculate the acceleration of each skater.

13. Summary

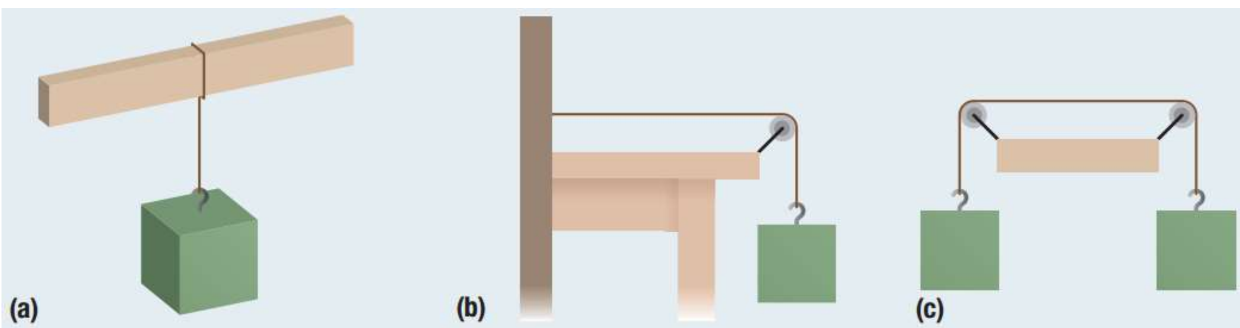
Homework: page 141: #2-3, 6-9

3.5 Using Newton's Laws

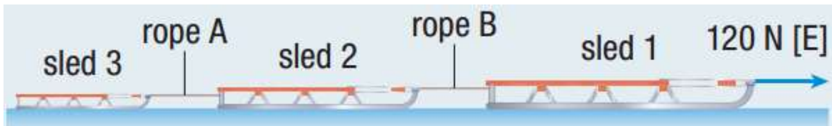
14. Tension and Newton's laws

Tension:	
Newton's third law	
ignoring tension	

Each object below has a force of gravity of 120 N [down] acting on it. Determine the tension in each string.



Three sleds are tied together and pulled east across an icy surface with an applied force of 120 N [E]. The mass of sled 1 is 12.0 kg, the mass of sled 2 is 11.0 kg, and the mass of sled 3 is 7.0 kg. Assume there is no friction.



a. Determine the acceleration of the sleds.

b. Calculate the magnitude of the tension in rope A.

c. Calculate the magnitude of the tension in rope B.

15. Kinematics and Newton's laws

Kinematics equations:	

Starting from rest, an ice skater (54.0 kg) pushes the boards with a force of 130.0 N [W] and moves 0.704 m. He then moves at a constant velocity for 4.00 s before he digs in his skates and starts to slow down. When he digs in his skates, he causes a net force of 38.0 N [W] to slow him down until he stops.

a. Determine the acceleration of the skater
   i. when he is pushing on the boards

   ii. just after he stops pushing on the boards

   iii. when he starts to slow down

b. How far does he move?

Homework: page 147: #1-2, 4-6