Title: Weight and Contact Force

Objectives: To learn the difference between weight and contact force and to observe the relationship between net force and acceleration when a person is standing on a scale in an elevator.

Grading: This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

Instructions: Check out a scale from the TA lab (N252 ESC). (Sometimes scales are already in the elevator.) Take the scale to the passenger elevator in the ESC or SWKT and stand on it. Record the contact force observed, deduce the weight by reasoning, and describe what you know about the direction of the acceleration in the following situations. Do the entire activity when the elevator is either moving up or down. Do not try and mix data taken up and down in your analysis. Hint: What does a scale measure, how much you weigh or how hard you push on it? (Text p. 38)

1. When the elevator is at rest.

   ______ contact force ______ weight
   ______ net force ______ acceleration
   (direction only)

2. Just as the elevator begins to move.

   ______ contact force ______ weight
   ______ net force ______ acceleration
   (direction only)

3. As the elevator moves between floors.

   ______ contact force ______ weight
   ______ net force ______ acceleration
   (direction only)

4. As the elevator slows to a stop.

   ______ contact force ______ weight
   ______ net force ______ acceleration
   (direction only)

What is the difference between the weight and the contact force? Describe the two interactions responsible for each of these forces. (i.e. Identify both the fundamental force and the two objects that are interacting to cause the force.)

What relationship do you observe between the net force and the acceleration?

I personally participated in the activity and wrote the response in my own words:

Signature: ____________________
Title: Newton's Laws of Motion

Objective: To test the validity of Newton's second and third laws of motion when sitting on a rollerboard and interacting with other objects.

grading: This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

instructions: Obtain the following equipment or check it out from the TA lab (N252 ESC): Two rollerboards, a ten-foot length of rope, and a 2 liter bottle filled with rice, or some other object of equivalent mass. You will also need a companion (preferably someone whose weight is quite different than your own). For each of the following experiments, report what you observe and how it is accounted for by Newton’s laws of motion. Carefully note the evidence of forces and observed accelerations in the following situations. When appropriate, contrast the strength of the various forces and explain the differences in acceleration of interacting objects.(Text p.21)

1. Pushing. Sit toe to toe on the rollerboards and push away from each other. What happened?

   Explain what happened in terms of Newton’s laws.

2. Pulling. Sit on the rollerboards about ten feet apart holding the rope between you. Try to pull your companion toward you. Have your companion try to pull you toward her/him. What happened?

   Explain what happened in terms of Newton’s laws.

3. Tossing the mass. Be careful. Try the experiment gently at first. Sit on the rollerboards, facing each other about three feet apart. Toss the mass to your companion. Have your companion toss the mass to you. What happened?

   Explain what happened in terms of Newton’s laws.

I personally participated in the activity and wrote the response in my own words:

Signature:__________________
Title: "Cartesian Retriever"

**Objective:** To gain an understanding of how the buoyant force can be changed and to alter the buoyant force on an object in such a way as to control its motion.

**grading:** This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

**instructions:** Go to the TA lab (N252 ESC) and locate a "Cartesian Retriever". Some describe it as a poor man's video game. This is an invitation to go and try the game for credit. By squeezing on the bottle, you can move a hook up and down and, if you are good enough, catch an object on the bottom of the bottle. Actually, it can be pretty difficult, so it doesn't matter so much whether you are successful in mastering the game. The idea is to control the buoyant force on the retriever by changing its volume. When you do, you will observe that the retriever accelerates. By controlling the motion, try to pick up the object in the bottom of the container with the hook on the retriever.

Describe on this sheet how you change the **buoyant force** on the retriever and why that causes it to accelerate. Use Archimedes' principle and Newton's Laws in your description of this simple event. (Text p. 47)

I personally participated in the activity and wrote the response in my own words:

Signature: ____________________
Title: Change of State

**Objective:** To allow you to demonstrate that you understand temperature and heat flow in terms of the molecular model and can correctly relate changes in temperature to changes in internal kinetic and internal potential energy.

**grading:** This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

**instructions:** When water boils, a funny thing happens. When you put water on the stove and turn the stove on, the temperature of the water begins to rise. When you reach the boiling point, the temperature stops rising, even though the water is boiling madly and the stove is still turned on. In case you don't believe it, this is a chance to find out. After all, if you really want to "know", you have to do the experiment.

A thermometer, hot plate, beaker and water will be available to do the experiment in the TA lab. If you wish to do the activity at home, try the experiment with a candy thermometer. If you don't have one, borrow one from a friend. When prepared with the right equipment and a note pad, turn on the stove and record the temperature every 30 seconds or so until after you reach the boiling point. Make two or three measurements after the water is boiling. Now explain in your own words what you observed, and why it happened. (Make sure that the thermometer's bulb is not touching the side of the container, and that the lower portion of the thermometer stem is completely covered by water at all times during the experiment.) (Text p. 98-99)

I personally participated in the activity and wrote the response in my own words:

Signature:____________________
Objective: To allow you to observe discrete and continuous spectra in order to better understand how different atoms emit different colors of light.

grading: This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

instructions: On the East wall of the hallway leading from the foyer of the Eyring Science Center to the TA lab (N252 ESC), you will find a "spectrum maker". The display contains a normal light bulb and several special gas tube lamps. There is a diffraction grating in front of the lamps that separates the light into a spectrum.

1. Turn on the incandescent (normal) light bulb. It takes a few seconds to warm up before it comes on. What type of spectrum is produced?

2. Turn on the gas tube lamps. Look through the diffraction grating there to be sure you have seen that different kinds of atoms produce different discrete spectra. Briefly describe (or sketch) two different spectra.

3. In the neighboring case, there is a normal florescent tube tube containing an unlabeled plasma. Identify the gas in the center florescent tube by comparing its spectrum to that of the labeled tubes.

4. Explain how atoms give rise to discrete spectra. (Text p. 136)

I personally participated in the activity and wrote the response in my own words:

Signature:__________________
Title: Rainbows and waves

Objective: To observe waves and to understand a rainbow.

grading: This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

instructions: Maybe you don't want to know how a rainbow works. Maybe it is like knowing how da Vinci created Mona Lisa's smile. Nevertheless, here is a chance to understand a rainbow.

In the hallway leading from the foyer of the Eyring Science Center to the TA lab (N252 ESC), you will find a "rainbow maker." Go play with the rainbow maker, read the posted material and then explain how rainbows are formed. (p. Text 116-117)

1. Explain how rainbows are formed. Sketch the path of a light ray through the ‘raindrop’ below and show how reflection and refraction of waves play a role in forming a rainbow.

I personally participated in the activity and wrote the response in my own words:

Signature:____________________
Objectives: To look at metals and salts and to review how some of their properties are determined by the bonds that hold them together.

grading: This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

instructions: BYU is home to some beautiful mineral exhibits. Some are displayed in display cases in the main hallway between the south stairways on the 2nd floor (between rooms C285 and C295).

1. Find the large pieces of native copper. Describe them. Do you think they would flatten out if you pounded on them with a hammer, or would they shatter? Use your understanding of a metallic bond to explain your answer. (Text p. 178)

2. Now find the beautiful crystals of fluorite (CaF₂). Describe them. Are they transparent? Why? Would they flatten out or shatter if you pounded on them with a hammer? Use your understanding of ionic bonds to explain your answers. (Text p. 180)

3. Take a minute and look at the other beautiful specimens. Which did you find most interesting?

I personally participated in the activity and wrote the response in my own words:

Signature:____________________
Title: Orbitals

Objective: To gain a better understanding of what a standing wave is, how it behaves, and how standing waves and orbitals are related.

Grading: This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

Instructions: Go to the TA lab (N252 ESC) and check out a 25-foot long piece of rubber tubing. For this one you will need another person to hold one end of the tube while you make waves. Do this activity outside the building. While it may be very tempting to use the hallway outside the lab, professors and other students using the hallway have been hit with the tubing, so go outside.

(A) Pull the end of the tubing to one side and wiggle it back and forth. Do you produce a longitudinal wave or a shear wave by doing this? BE CAREFUL! Don’t let go when the tubing is stretched. You can hurt someone.

(B) Send a wave down the tubing again and then additional waves just as the previous waves reflects from the other end. What kind of interference can you create? (Text p. 118)

(C) See if you can create “standing waves” (Text p. 151) in the tubing by swinging it from side to side in rhythm. It takes a little practice. How many nodes can you get to stand at one time (the record is 7)?

(D) The speed of a wave on the tubing increases as you increase the tension in the tubing. Now, stretch the tube. If you wiggle the stretched tube at about the same frequency, does it get longer or shorter? Does increasing the tension tend to increase or decrease the number of nodes for about the same frequency? Use the following relationship to explain your answer:

\[ \text{wave speed} = \text{frequency} \times \text{wavelength} \]

(E) Describe what an orbital is. How is a standing wave of probability produced and what does it represent? (Text p. 143)

I personally participated in the activity and wrote the response in my own words:

Signature: ____________________
Objective
To examine and think about dinosaurs and other fossils. Specifically, to imagine the conditions that produced the fossils.

Grading
This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

Location
BYU Earth Science Museum at 1683 North, Canyon Road in Provo, directly west of the Cougar Stadium. (801)378-3680.
North American Museum of Ancient Life at Thanksgiving Point 2095 Thanksgiving way off of I15 in Lehi. 766-5000 (There is a charge, and many exhibits are not opened yet.)

Note: Before going to the Museum, please check to see when they are open.

Instructions
Go to either the BYU Earth Science Museum or the Museum of Ancient Life.

List 5 different dinosaurs, the approximate time they lived, and the corresponding geologic era.

<table>
<thead>
<tr>
<th>Name</th>
<th>Absolute Date (in Years)</th>
<th>Relative Date (Era not Period)</th>
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Estimate how tall the tallest of the animals would have stood? _______________

A floor on a building occupies ten feet. How many stories tall would the animal have been? _______________

Describe one thing in the Museum that you found to be most interesting to you.

I personally went to the museum this semester or term and wrote the response in my own words:

Signature: ____________________
BYU Earth Science Museum

Step Back in Time and Discover a Real Jurassic Park

Explore a world filled with creatures of fantastic size. Imagine Jurassic predators tall enough to peer over a two-story building. Picture Jurassic plant-eating giants one-third of a football field long able to look into a fifth-story window. Envision strange, unfamiliar trees stretching toward the sky and subtropical plants competing for the remaining sunlight.

Step into the BYU Earth Science Museum and Discover.....

Dinosaurs, ice-age mammals and ancient forms of sea life.

Museum exhibits include...
• Expansive 20x11 foot mural depicting Ultrasaurus and Supersaurus as they may have appeared during the Jurassic period.
• 9-foot shoulder blade of Ultrasaurus.
• 150 million year old Jurassic dinosaur egg with X-ray revealing an embryo; discovered by BYU fossil preparator, Dee Hall. The egg is the most complete and only the second found form the Jurassic period.
• Preparation lab window showing museum personnel preparing fossils in the lab.
• Two fully mounted skeletons of camptosaurus and Allosaurus.
• A touch table featuring real fossils.
• Displays of Tyrannosaurus Rex, Triceratops & Deinosuchus (a monstrous 50-foot crocodile).

Tours
The Earth Science Museum offers guided and self-guided tours. Call the Museum at (801)378-3680 for more information.

Prehistory Week
Each May, the Earth Science Museum sponsors Utah Prehistory Week activities and lectures. Call 378-3680 for more information.

Gift Shop
Fossil casts, Rocks, Gems, T-shirts, posters, postcards, books, dinosaur “doodads” and other items are available at the museum gift shop.

Hours
Monday through Friday: 9am-5pm
Saturday: 12 to 4pm

Location
The Earth Science Museum is at 1683 North, Canyon Road in Provo, directly west of the Cougar Stadium. (801)378-3680.

Gift Shop
Fossil casts, Rocks, Gems, T-shirts, posters, postcards, books, dinosaur “doodads” and other items are available at the museum gift shop.

Hours
Monday through Friday: 9am-5pm
Saturday: 12 to 4pm

Location
The Earth Science Museum is at 1683 North, Canyon Road in Provo, directly west of the Cougar Stadium. (801)378-3680.
Title: Speed of a Dinosaur.

Objective: To observe a "trackway" of a dinosaur and to reason from the fossil evidence and the assertions of a scientist how fast the dinosaur that left these tracks could run. The trackway can be found on the wall in the north-south hallway near C295 ESC.

grading: This assignment will receive either 0 or 5 points. It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

instructions: Estimate the length of the dinosaur’s stride in centimeters (a stride = two steps) and the length of the dinosaur’s foot. You will use the information to calculate how fast the dinosaur was moving. It might be helpful to use a reference distance, such as an 8 ½” x 11” (~20cm x ~30 cm) piece of paper to get a more accurate estimate.

Length of dinosaur stride in centimeters= ____________________

Length of the dinosaur’s foot=________________

Research shows that the length of this dinosaur’s foot is approximately 1/4 the length of its leg. Calculate the length of the dinosaur’s leg.

Length of the dinosaur’s leg=_______________

In the April 1991 edition of Scientific American there is an article that shows how to estimate how fast a dinosaur moved. The author, R. MacNeil Alexander, does this by analysis of the relationship of stride length, length of leg, and observed speed in modern animals. According to Alexander’s research, the length of a walking stride is 1-2 times the length of a leg. The length of a running stride is 3-5 times the length of a leg.

Was this dinosaur walking or running?____________________

Calculate the speed of this dinosaur using one of Alexander’s equations below. Show all work.

If walking:    \( (speed)^2 = 1000 \text{cm/s}^2 \times \text{(length of leg in centimeters)} \)
If running:    \( (speed)^2 = 4000 \text{cm/s}^2 \times \text{(length of leg in centimeters)} \)

Note: \( 1000 \text{cm/s}^2 \) is the gravitational acceleration in units \( \text{cm/s}^2 \).

In these units, the speed will emerge in centimeters per second.

Speed in centimeters per second=________________

(A fast human walk is 220 centimeters per second and the best sprinters run at about 1100 centimeters per second.)

I personally participated in the activity, did my own calculations, and wrote the response in my own words:

Signature:____________________
Title:  Rock Canyon Geology

Objective:  To identify and describe several geologic structures observed in the mouth of Rock Canyon.

grading:  This assignment will receive either 0 or 5 points.  It will be graded in front of you by a TA, and you will then have the opportunity to correct your mistakes.

instructions:  Seeing geologic structures first-hand is far better than merely reading about them.  So grab a friend and go to Rock Canyon (to look at geology)!

Attached to this sheet is a simplified geologic map of the areas just east of the Provo Temple around Rock Canyon.

Go to the site near the upper water tank at the end of the dashed route shown on the map.  Look at the rock surrounding and to the north of the water tank.  It is designated pCmf on the map.  Geologists tell us that this rock is a Precambrian tillite.  That means it was made when glacier action pulverized the rock under the glacier and piled it up.  Now look at the red-brown rocks on top of the tillite (Ct on the map).  Geologists explain that these rocks were formed from sand piled up on a beach.  Also look up at the Great Blue Limestone (Mgb).  These rocks make up many of the high cliffs that you see.  The material making up these rocks was deposited at the bottom of a shallow sea.  Observe the huge boulders that have fallen from these cliffs and are visible to the south.  Can you see any folds in the rocks?  Is there evidence for significant change in the local conditions over time?  Write your answers on this sheet.

I personally participated in the activity and wrote the response in my own words:

Signature:____________________