Simple Machines Lab

Directions: The following labs are around the room in B-100 and one outside. As a table group, complete the lab at your table, then move to a different station to complete the lab at that station. There are some duplicates, so be aware of which one you have already completed. The goal of these labs are more to get you experience setting up these types of machines and collecting data so that you can analyze it afterwards. Some of the data collection may be frustrating when using measurement devices, so if you need help, please ask.

Pulleys

Materials:

- 3 assorted pulleys
- Length of rope
- Assorted masses
- Spring force scale

Procedure:

1. Begin by setting up your beam by resting it between two chairs and threading your rope through 2 pulleys. The first pulley (that will hold the hooked mass) will be the smallest one you have. The second pulley (the large one with a hook) will be attached to the beam. Attach a mass of your choosing (it should be larger than 50 g), then attach the loose end of the rope to the spring scale. Carefully pull on the spring scale and record the value in the table towards the end of the procedure in the appropriate box.
2. Change the pulley that is attached to the mass to the medium sized pulley of the same shape. Repeat step 1 and record the value of the spring scale in the appropriate box.
3. Finally, rearrange the pulley configuration so that the large pulley with a hook is at the bottom with the small pulley attached to the beam above. Thread the rope through the pulley system and record the force reading on the spring scale.
4. Swap the small pulley for the medium sized pulley and repeat step 3, recording the appropriate value in the appropriate box below.

Pulley Arrangement	F_E (grams)	F_R (grams)	IMA	AMA	Efficiency
Hook top, small on bottom	400	500	3	1.25	42%
Hook top, medium on bottom	400	500	3	1.25	42%
Hook bottom, small on top	800	500	3	0.68	23%
Hook bottom, medium on top	700	500	3	0.71	24%

Conclusion Questions:

1. Assuming you come across a situation in which you have an assortment of pulleys (different diameter and masses), which should you attach to the mass you're attempting to lift in order to get the most of your setup?

Heavy pulley on top.

2. From your testing and best educated guess, does the diameter of the pulley seem to change the mechanical advantage by any significant amount?

No, it does not.

3. When you moved the large pulley with a hook to the bottom of the setup, what new factor did you introduce to the mass being lifted? Did this have a large impact on the AMA?

When it was moved down, it introduced more mass for the pulley to deal with which negetavly impacted the AMA

Lever

Materials:

- 2 different lengths planks of wood (2ft & 3ft)
- Assorted masses
- Tape measure
- Fulcrum (triangular wedge)

Procedure:

1. Create a 1st class lever using the 2ft board and the triangular fulcrum. You should have two loops of rope that slide over the board on either end to fix the hooked masses on one side, and the spring force scale on the other. You will be collecting data in the appropriate boxes in the table below.

2. First decide on some amount of mass to hook on one side. This can be considered your resistance force (F_R).

3. Then create static equilibrium by hooking the spring scale on the other side of the lever. Read and record the value indicated on the spring scale. The scale will be in grams and this value is your effort force (F_E).

4. Be sure to measure the distances from the fulcrum (which is up to you) to each force. Record those in the table before you dismantle the lever.

5. You should be able to get the IMA, AMA, and efficiency of the lever from the data you gathered.

6. Repeat steps 1 through 5 for the other three lever types in the table below.

Lever type	D_E (cm)	D_R (cm)	F_E (grams)	F_R (grams)	IMA	AMA	Efficiency
2ft board (1st class)	1.5	1.5	200	200	1	1	100
2ft board (2nd class)	20	10	350	200	2	1.75	87.5
3ft board (1st class)	8	16	45	200	0.5	0.44	88.8
3ft board (2nd class)	32	16	350	200	2	1.42	87.5

Conclusion Questions:

1. Did the efficiency of your first class levers change when you increase the length of the wooden board? If so, speculate why this happened.

   It did not change the efficiency as the length increased due to its equilibriuk\m.

2. Both a 1st class and 2nd class lever give a mechanical advantage greater than 1, but based on your data, which would you choose to lift a heavy object? If there is no mechanical advantage difference, is one more convenient than the other?

   The 2nd class is better to lift a heavy object as it has a better IMA and even in the real world, AMA

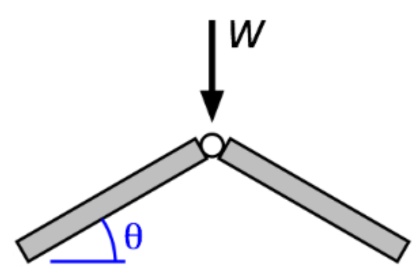
Screws

Materials:

- 2 screw jacks
- Force plate with computer LoggerPro software
- Screwdriver
- Crank handle
- Caliper
- Protractor

Procedure:

1. Using the calipers and the red scissor jack, measure the pitch of the screw for both jacks and record those values in the table below.
2. It may be helpful to tape both jacks to the table with the duct tape if it is not already done.
3. Screw both jack to a position in which the angle is about 20º. The angle location is shown in the diagram to the right.



4. Place a few textbooks on top of the jack in order to provide a weight like in the diagram to the right.
    a. The scissor jack is a little more complex than a simple screw. To get the resistance force on the screw, use the following equation. $\mathbf{F_R = (weight) \cdot cot\Theta}$
5. Once the books are in position, take the screw driver and insert it into the crank position making sure to have the screwdriver horizontal.
6. Take the yellow spring scale and hook it to the end of the screwdriver. Pull on the screwdriver and turn the screw a quarter turn making sure to keep the screw driver at roughly a 90 degree angle to the spring force meter. Be sure to have a group member look at the spring scale, or record video of the spring scale so you can record the force. (The spring scale measures force in grams, so you'll have to convert it to pounds before putting it in the table below.)
7. Set up the black scissor jack to the same configuration as the red scissor jack and repeat steps 3 through 6. Record the values in the appropriate boxes below.

Jack	Thread pitch (in)	Radius of lever arm (in)	F_E (lb)	F_R (lb)	IMA	AMA	Efficiency
Red	0.1 in	4.6 in	1.10 lb	27.2 lb	289	24.72	8.56%
Black	0.1	6in	1.764 lb	27.2 lb	377	15.42	4.09%

Conclusion Questions:

1. The screw jack is a complicated machine that takes into account multiple simple machines. What is one other type of simple machine it contains, aside from the screw?

The lever, acting kind of like a wheel.

2. Is there a significant difference between the actual mechanical advantages of the red and black scissor jack? Is there a reason to choose one over the other?

Red is much more efficient and has a higher mechanical energy

3. Looking at the physical differences between the jacks, what design feature may contribute to the jacks providing different mechanical advantages? If they provide the same MA, do the design features have any impact?

The red one is bigger so it takes less energy to produce the same outcome.

Inclined Planes

Materials:

- 4-wheel cart
- Bathroom scale
- 2x6 wood sections (~40)
- Measuring tape
- Meter sticks

Procedure:

1. With your group, move to the temporary ramp set up by the construction company at the steps of the administration building. Be sure to take the materials with you.

2. Start by creating a method for finding the slope of the incline. There are a couple of different ways to do this. Place your method below in a short response.

Measured one step * 6 for height and measured the slope as well usi9ng the meter stick. Sin to find angle than length to find slope.

3. Record the value of the height (D_R), slope length (D_E), and slope ratio in the table in step 5.

4. Take the cart and the bathroom scale and get ready at the bottom of the ramp. Make sure all 4 wheels of the cart are on the ramp (i.e. the rear wheels are at the lowest point of the ramp). Place the bathroom scale on the back of the cart so that you can push on it, and thereby pushing the cart up the ramp. Record the value of the scale as you push the cart to the top of the ramp. (hint: this can be a bit tricky and you may have to do this a couple of times to get an accurate reading. If necessary, take the average value you observed as you push, or have one person push, while the other looks at the scale). Record that force value in the chart in step 5.

5. The weight of the cart should be written on the board in the classroom. Record that value below, along with all appropriate information in the table below.

F_E (lb)	F_R (lb)	D_E (cm)	D_R (cm)	IMA	AMA	Efficiency	Slope Ratio
30	117	727	84	8.65	2.9	45%	0.116

Conclusion Questions:

1. Does this temporary wheelchair access ramp meet the required slope of the American Disabilities Association of 1:12? (the ratio means for every 1 inch of rise there is 12 inches of run)

No it does not 1:8.655

2. The weight of the cart is 117 lbs. Based on the IMA calculation, how much effort force do you ***ideally*** need to push the cart to get it to the top of the ramp?

13.5 lb

3. What factors of the ramp and cart contribute to the loss in mechanical advantage between the IMA and AMA?

Friction, dampness, human error