Sample questions for Simple Machines
Macomb Elementary Science Olympiad

Preparing students for District and County Competitions

The purpose of this document is to guide parents and coaches on how to develop their own questions to quiz students about simple machines so that they are prepared for the district and county competitions. Sample tests WILL NOT be provided.

Step 1

Gather a selection of objects, or pictures, that represent the use of simple machines in everyday life. Examples are tools, kitchen implements, and other devices.

Step 2

Ask the student to identify one or more simple machines represented by the object or picture. Simple machines tested are:

LeverInclined PlanePulleyScrewWheel & AxelWedge

Step 3

Ask the student to evaluate whether the machine changes any of the following parameters:

Force Direction Distance Speed

Ask the student how they would estimate mechanical advantage

> Note: If you have two different sizes of the same machine, ask the student to compare them in light of the above.

Ask students to measure the length of effort and load arms, or distance traveled by the effort and load as appropriate.

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Identifying Simple Machines:

Each station will include questions requiring students to identify the simple machine(s) present. This may take one of two forms

A. A physical object will be provided and the following types of questions will be asked

SAMPLE #1

Which of the following simple machine(s) are found in the object, on the table?

1)	Inclined Plane	A. Yes	B. No
2)	Wedge	A. Yes	B. No
3)	Lever	A. Yes	B. No
4)	Wheel and Axle	A. Yes	B. No
5)	Pulley	A. Yes	B. No
6)	Screw	A. Yes	B. No

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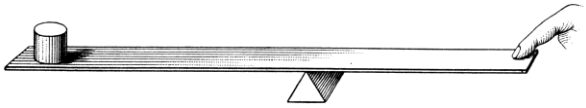
B. A series of pictures will be presented asking students to identify which picture is an example of a particular simple machine.

SAMPLE #2

Using the pictures to the right, answer the following questions.

A

B



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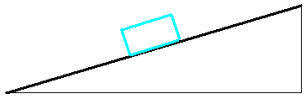

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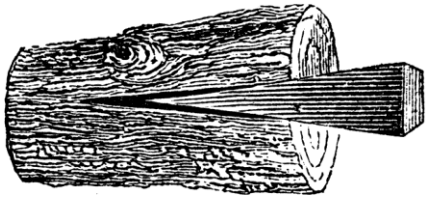

1) Which picture illustrates a screw?

A. Picture A
B. Picture B
C. Picture C
D. Picture D

2) Which picture illustrates a lever?

A. Picture A
B. Picture B
C. Picture C
D. Picture D

3) Which picture illustrates a wedge?

A. Picture A
B. Picture B
C. Picture C
D. Picture D

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Changes to force/distance/speed/direction:

Simple machines change one, or more, of these parameters. Students may be asked to evaluate how, and if, a parameter will change.

Sample questions may take the following forms:

1) Does any part of this machine change the direction of the force?

   A. Yes B. No

2) Which moves farther?

   A. The effort and the load move the same distance
   B. The Effort moves farther
   C. The Load moves farther

3) Which moves faster?

   A. Effort
   B. Load
   C. The Effort and the Load move at the same speed

4) Does this machine change the amount of force?

   A. The force on the load is greater than the effort applied.
   B. The force on the load is less than the effort applied.
   C. The force on the load is equal to the effort applied.

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Comparisons:

Students may be asked to compare different sizes or configurations of the same machine.

Sample questions may take the following forms:

1) How will the force on the load be changed if the handles are made longer? (or the diameter is larger, etc.)

   A. It will increase
   B. It will decrease
   C. It will stay the same
   D. Not enough information to decide.

2) Which machine (Example A or B) applies more force to the Load?

   A. Machine A applies more force to the load
   B. Machine B applies more force to the load
   C. Both Machine A and Machine B apply the same force to the load.
   D. Not enough information to decide.

3) Explain how each machine (example A or B) changes the distance the load moves.

   A. Machine A moves the load farther.
   B. Machine B moves the load farther.
   C. Both machines move the load the same distance.
   D. Not enough information to decide.

4) Explain how each machine (example A or B) changes the speed the load moves.

   A. Machine A makes the load move faster.
   B. Machine B makes the load move faster.
   C. Both machines make the load move at the same speed.
   D. Not enough information to decide.

Mechanical advantage formulas

Students may be asked to estimate the mechanical advantage of a device. All estimates of mechanical advantage will be "Ideal". The effects of friction will be disregarded.

Students may be asked to identify the correct formula as in this example:

1) Using the picture above, how would you estimate the mechanical advantage?

A. MultiplyA by B: MA = A xB
B. Divide B by C: MA = B ÷ C
C. Multiply B by C: MA = B x C
D. Divide A by C: MA = A ÷ C
E. Divide C by B: MA = C ÷ B

Or, indirectly as in these examples:

2) Using this machine, how much weight can be lifted with one pound of effort?

A. 1 pounds
B. 2 pounds
C. 3 pounds
D. 4 pounds
E. 5 pounds

3) Which change will increase the mechanical advantage of this machine?

A. Make the length from point A to Point B longer
B. Make the length from point A to Point B shorter
C. Make the length from point B to point C shorter
D. Make the length from point B to point C longer
E. The mechanical advantage cannot be changed

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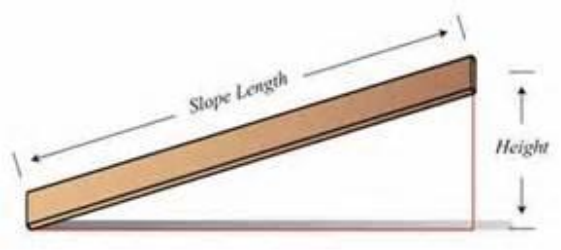
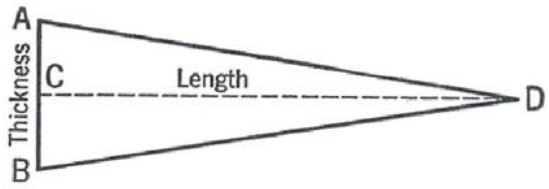
The following is provided to help students with estimating mechanical advantage:

Inclined Plane: Estimate the mechanical advantage of an inclined plane by comparing the length of the ramp to the height.



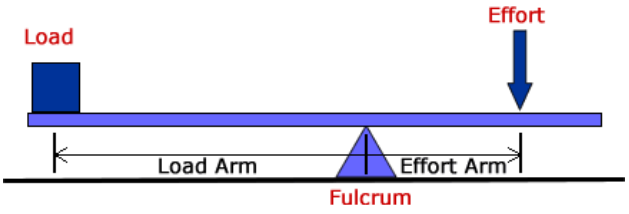
Formula: $MA = \frac{\text{Length}}{\text{Height}}$

Wedge: Estimate the mechanical advantage by comparing the length of the wedge by its thickness.



Formula: $MA = \frac{\text{Length}}{\text{Thickness}}$

Lever: Estimate the mechanical advantage by comparing the length of the Effort Arm to the length of the Load Arm.



Formula: $MA = \frac{\text{Effort Arm}}{\text{Load Arm}}$

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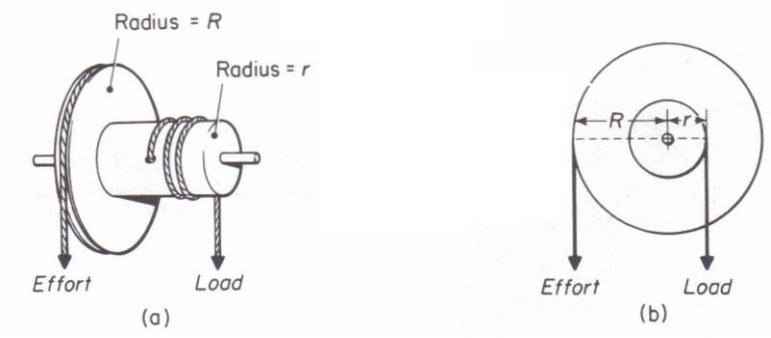
Wheel and Axle: Estimate the mechanical advantage by comparing the radius (or diameter) of the wheel to the radius (or diameter) of the axle.



Formula*: MA = $\frac{\text{Wheel radius}}{\text{Axle radius}}$

* Assumes that the effort is applied to the wheel(MA may be less than 1)

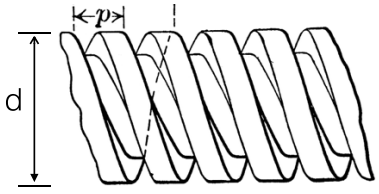
Pulley: Estimates of the mechanical advantage of a pulley system may be determined in a number of ways.

a. You may divide the distance the effort moves by the distance the load moves:

b. Or by counting the number of separate pulleys supporting the load. Alternately, count the number of cords supporting the load.

Screw: To estimate the mechanical advantage of a screw:Determine the pitch (p) of the screw. This tells you how far the screw moves with one complete rotation.Find the circumference of the screw. Measure the diameter (d) and multiply by pi (π).

Finally, divide the circumference of the screw by the distance it moves in one complete rotation (pitch).



MA = $\frac{\pi\ d}{p}$

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Measurements

Students may be asked to make measurements with the ruler (provided). All measurements will be made between labeled or marked points on the object or picture. Locations of labeled points, and units of measurement (inches or centimeters) will be chosen to simplify measurements and produce, when possible, whole numbers.

Sample questions may take the following forms:

1) Approximately, how long is the Effort Arm?

A. 3 inches
B. 5 inches
C. 7 inches
D. 8 inches

2) Approximately, how long is the Load Arm?

A. 3 centimeters
B. 5 centimeters
C. 7 centimeters
D. 8 centimeters

3) Using the pulley to raise the load 2 inches, approximately how far must you pull the cord?

A. two inch
B. four inches
C. six inches
D. eight inches
E. ten inches

Work

Work is defined as force times distance. This can be visualized as the force (effort) applied times the distance over which the force (effort) is applied. Likewise, it can be the force on the load times the distance the load moves.

Force X Distance

For our purposes, ignoring friction, the work put in to the machine always equals the work output.

Work(in) = Work(out)

or

Force(in) X Distance(in) = Force(out) X Distance(out)

Caution: When estimating the work performed by an inclined plane, the distance traveled by the load is defined as the height above ground to which the load is lifted. See mechanical advantage example.

Questions relating to work may ask the student to evaluate whether more or less work is performed by a specific size or configuration of a machine. Examples:

1) Using the picture above, is more work done by pushing an object to the top of incline A or incline B?

A. Incline A
B. Incline B
C. Both are the same.
D. Not enough information to decide.

2) Using the diagrams above, in which one is the most work being done?

A. Diagram A
B. Diagram B
C. Diagram C
D. Diagram D

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Lever specific questions

Students may be asked to identify the location of the fulcrum, where the effort is applied, and where force is applied to the load. Physical objects and pictures will have these points labeled. For example:

1) Which labeled point is the Fulcrum?

A. Label A
B. Label B
C. Label C
D. Label D
E. Not Labeled

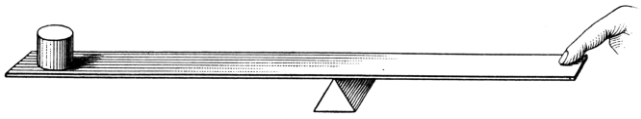
2) The Point with the Label **A** is the:

A. Effort B. Load C. Fulcrum

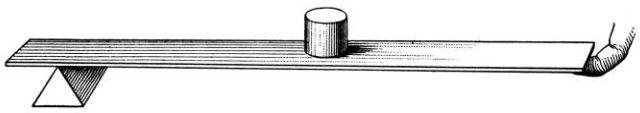
Students may be asked to identify the class of the lever. For example:

3) Which class of levers does this object represent?

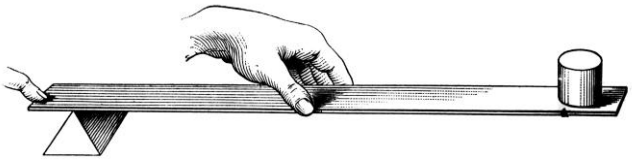
A. First class lever
B. Second class lever
C. Third Class lever
D. Fourth class lever
E. The object is not a lever



First class lever



Second class lever



Third class lever

Screw specific questions

Students may be asked how many revolutions a screw must make for the load to move a given distance.

This is most easily answered by determining the pitch (threads per inch) of the screw.

Example:

1) How many revolutions must the effort make to move the load 1 inch

   A. 6 revolutions
   B. 8 revolutions
   C. 10 revolutions
   D. 12 revolutions
   E. 14 revolutions