

Timekeeping, clocks and pendulums.

Lesson Plan Grade levels: 5th-7th

OVERVIEW

In this lesson students will be able to:

- Explain why timekeeping is important.
- State different early timekeeping mechanisms.
- Explain how gears work.

OBJECTIVES

- Why timekeeping is important.
- Early time keeping.
- Gears and mechanisms.
- Skills and techniques for conducting experiments

MATERIALS NEEDED

1. Wooden clock.(see instructable)
2. Experiment sheet.
3. Student sheet.

ACTIVITY 1-Why timekeeping is important.

1. **Introduce what is time-** There is no simple definition of time, it is defined by a measurement, what the clock reads.

2. **Why timekeeping is important-** We use it daily, in our homes and in school. It is essential that it is kept accurately, if a clock in the market exchange is inaccurate, we'll be losing millions of dollars.
3. **What do we use to measure time-** The standard unit of time is the second. But we also often use minutes, hours and days to measure time.

ACTIVITY 2-Early time keeping.

Introduce and explain following time keeping devices:

1. **Sundials-** Explain that a sundial is a device that tells the time of day using the sun. A sundial consists of a round plate with markings of the time, also called a dial, and a triangular plate, also called a gnomon, which casts a shadow onto the dial. The position of the shadow on the dial will tell the time.
2. **Water clocks-** Explain that a water clock is a device that uses the dripping of water to tell the time. A water clock consists of an elevated container with a very small hole and a bowl to catch the dripping water. The bowl will have markings that will tell the user the time.
3. **Pendulum clocks-** Explain that a pendulum clock is a clock that uses a swinging weight also called a pendulum to keep time. A pendulum swings back and forth at a precise and constant rate. A pendulum clock is more accurate than sundials and water clocks. The clock made is a pendulum clock.
4. **Quartz clocks-** Explain that a quartz clock is a clock that uses an electronic circuit with a quartz crystal to keep time. This crystal vibrates creating a signal with very precise frequency, the electronic circuit measures the vibrations of the quartz crystal and tells time.
5. **Atomic clocks-** Explain that an atomic clock is the most accurate time keeping device. An atomic clock uses a cesium atom that vibrates at a very high frequency. It is used in the global positioning system and the internet. The atomic clock is so accurate that it will only have uncertainty of 1 second in 300 million years.

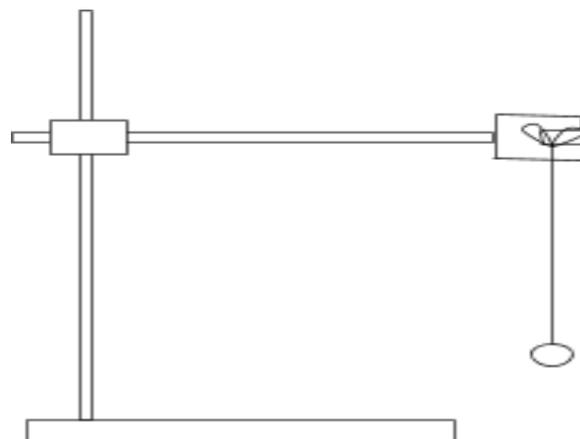
ACTIVITY 3-Gears and mechanisms.

1. **Why are gears important-** Explain that gears are used to transmit energy, they can be used to reduce the speed of a rotation or increase the force, also called torque, of an output. Power tools, vehicles and clocks use gears. Without gears the world will not be as we know it. Show how the gears used in the clock allow it to work.

- 2. Profile of gears-** Explain that a gear has teeth that engage other gears. There are many tooth profiles that a gear can have, most modern gears use a tooth profile called an involute profile. This profile has a property of maintaining a constant speed ratio between the two gears. This can reduce stress and wear on machinery. There are also many types of tooth arrangements such as spur gears and helical gears. The gears used in the wooden clock are spur gears. Spur gears only have one teeth engaged with another gear. Helical gears have multiple teeth engaged with each other, this reduces the noise of the gears and are often used in vehicles.

EXPERIMENT

- 1. Coming up with a hypothesis-** Explain to students that a hypothesis is a prediction. In this experiment the length of the pendulum is the independent variable and the period of the pendulum is the dependant variable. Ask students to write a hypothesis about how the change of the length of the pendulum will affect its period.
- 2. Setting up apparatus-** Show students the correct way to set up the apparatus to do the experiment. Teach the students how to measure lengths and time properly. A diagram is shown below.
- 3. Verifying results and conclusion-** Let students calculate the expected period and compare it to the period from their experiments. Summarise what the students have learnt.
- 4. How is a pendulum used to keep time-** Using the wooden clock show that the pendulum drives an escapement which turns gears. Show that the pendulum is powered by the weights.



Experiment: Pendulums

NAME: _____

DATE: _____

OBJECTIVES

- Demonstrate experimental skills and techniques.
- Construct an experiment setup.
- Make and represent data on a graph.

DESCRIPTION

The period of a pendulum depends on the length of the pendulum and the acceleration due to gravity. In this experiment, you will be able to prove the formula for finding the period of the pendulum.

APPARATUS

- 1 meter/ 3 foot long string
- Plasticine/ Sticky tack
- Retort stand

QUESTION

Does the length of the pendulum affect its period.

HYPOTHESIS

Will the length of the pendulum affect its period? If yes, will the longer pendulum have a larger period?

PROCEDURE

1. Fix one end of the string to the plasticine/sticky tack, tie the other end to a retort stand, 30cm/12 inches apart.
2. Measure the length of the pendulum.

Length: _____

3. Allow the pendulum to oscillate about a small angle(10° - 20°) take the time for twenty complete oscillations.

Time: _____

4. Find the time for one complete oscillation.

Time: _____

5. Repeat this for other lengths and complete the table below.

Length of pendulum	Period

VERIFICATION

Checking if the experiment was done correctly and accurately.

Using the formula below, check if your period is accurate.

$$\text{Period} = 2\pi \times [\text{length of pendulum} / 9.8]^{1/2}$$

You can also use an online pendulum calculator to check. If any one reading is inaccurate, you can redo the experiment to try again.

CONCLUSION

Think about your hypothesis, were you correct? If yes, how can you improve? If not, what were some mistakes you could have made.
