Just a Minute

A Lesson on Measuring Time

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Lesson # 5

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Editor's notes:

Website URLs listed in this resource were current as of publication, but may now be obsolete. If you know of a replacement URL, please suggest it in the resource's "Comments" section http://www.apsarchive.org/resource.cfm?submissionID=3705.

The APS encourages teachers to give students a copy of the "ABC" (Appropriate, Beneficial, Caring) rules for use of animals in the classroom, to discuss the rules, and to ask students to sign the "ABC" rules contract (see References). Also, teachers should have a plan for short term care of the animals (with supporting references for appropriate care guidelines) and for disposal or long-term care of all classroom organisms.

Teachers should carefully review any stimulus or environmental change for an animal being used in experiments or observations before students are allowed to use that stimulus. This is especially important if the stimulus could cause pain or distress to the organism. Teachers may be able to identify a less stressful stimulus for the students to use in their experiment.

Although mammals provide excellent opportunities for observational studies, they require particular care in terms of handling and may cause allergic reactions in some students. The teacher should check local and state guidelines before using mammals in the classroom.

Disclaimer:

This activity was created by the author and reviewed by the American Physiological Society. Any interpretations, statements, or conclusions in this publication are those of the author and do not necessarily represent the views of either the American Physiological Society or the funding agencies supporting the professional development program in which the author participated.

PURPOSE

The students will design and construct a mechanism that measures the passage of one minute of time.

OBJECTIVES

Upon completion of this activity, students will be able to:

- make observations and measurements.
- understand the history of measurement and the technological advances in measuring time.
- understand the advances and necessity of standardized measurement.
- apply reasoning, problem solving, trouble shooting, constructing, and designing a device that indicates when a minute has passed.
- select and test various materials to use in their construction.
- create a unit of time based upon their design and construction.
- use the Internet to obtain information to develop an understanding of the history of measurement, time, and biological clocks (circadian rhythms).
- work collaboratively in groups.
- present a working model of their one minute timer.
- present a motivational speech in the form of an advertisement promoting their one minute timer.

GRADE LEVEL

This activity was planned for grades 6-8.

PRIOR KNOWLEDGE

This lesson should be taught as a review of basic measurement skills and an application of laboratory safety. They should have prior knowledge of the scientific method.

TIME REQUIRED

This lab activity will most likely take five to seven 60 minute class periods.

INCLUDING ALL STUDENTS

A variety of learning styles will be used:

- tactile (hands-on experiment)
- auditory (presentations of data and models)
- visual (presentation of posters)

Any student with physical disabilities should be able to participate with modifications to the procedures as needed.

QUESTIONS TO ASK ALONG THE WAY

- What is time?
- Before clocks, what was used to measure the passage of time?
- Why do we need to make measurements?
- What did civilizations use for measurements?
- Why was there a variation in units of measurements?
- How did the units of measurement vary from occupation to occupation?
- What does “worth your weight in gold” mean?
- If there were no clocks, what could you use today to measure time?
- Why do civilizations need to standardize measurements?
- How could you make your model more precise and accurate?

NATIONAL SCIENCE EDUCATION STANDARDS

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Physical Science
- Motions and forces
- Transfer of energy

Life Science
- Regulation and behavior

Science and Technology
- Understanding about science and technology

Science in Personal and Social Perspectives
- Science and technology in society

History and Nature of Science
- Science as a human endeavor
- History of science

OHIO STATE STANDARDS

Grade 6-8 Benchmarks

Physical Science
- B. Describe the motion of objects and conceptually describe the effects of forces on an object
- D. Describe that energy takes many forms

Science and Technology
- A. Give examples of how technological advances, influenced by scientific knowledge, affect the quality of life;

Scientific Inquiry
- A. Explain that there are differing sets of procedures for guiding scientific investigations and procedures
- B. Analyze and interpret data from scientific investigations

Scientific Ways of Knowing
- A. Use skills of scientific inquiry processes
- B. Explain the importance of reproducibility and reduction of bias in scientific methods
- C. Give examples of how thinking scientifically is helpful in daily life.

Earth and Space Sciences:
- A. Describe how the positions and motions of the objects in the universe cause predictable and cyclic events.

MATERIALS

- goggles
- aprons
- stop watch
- courting candle, or materials to create your own courting candle (candle, aluminum foil)
- matches
- rubber bands
- old tuna and cat food tins as a container to place the used matches
- A combination of materials from general supplies.* For example:
  - ✓ duct tape
  - ✓ scissors
  - ✓ masking tape
  - ✓ string
  - ✓ marbles
  - ✓ ring stands
  - ✓ ring clamps
  - ✓ plastic cups of varying size
  - ✓ cardboard tubes
  - ✓ birthday-sized candles
  - ✓ one liter and two liter plastic bottles
  - ✓ various fluids (e.g., corn oil, corn syrup)
  - ✓ sand

** Based upon the students' design ideas, materials may be supplied by the students as well.*

SAFETY

Note: *Special precaution must be taken if the students are using matches and candles.*

- Teacher should make any holes in the plastic cups and cut thick cardboard instead of the students.
- Students must receive approval for their experimental design from the teacher before proceeding with the experiment.
- Student work areas need to allow adequate space for organization of materials and experimentation of models.
- Keep work areas clean of accumulated clutter.
- When using any fluids, remind students to report all spills immediately and instruct them to clean it up.
- Safety goggles must be worn when testing models and long hair should be tied back when using open flames.

PREPARATION

I. Engage: *Ways of grabbing the students' attention*

One possible attention grabber would involve using a courting candle (see References). By using this candle, one could relate the history and how the courting candle was used to indicate the passage of time.

You could purchase a courting candle, or simply make a smaller model to simulate a courting candle by using a birthday candle and aluminum foil, or flexible wire. Using a stop watch, a student could measure how long it took the candle to melt to the first twist of the aluminum foil. This would serve as a demonstration.

Another possible attention grabber to use in addition to this or by itself would be showing the Rube Goldberg creation clip from the movie, "Chitty, Chitty, Bang, Bang." You need to preview the video or DVD clip before presenting it to the class. The Rube Goldberg "breakfast maker" is about 20 minutes into the movie. Make sure you have the necessary equipment available to play your demonstration. Another good example of a Rube Goldberg creation is the Honda Accord commercial or the tar pitch drop clock experiment that approximately every ten years drops a drop of tar (see References).

PREPARATION

II. Plan an Experiment

Create a scenario in which the students have to design and create a one minute timer. Make the scenario one that is relevant and applicable to the students. An example might be that the LCD screen in the cafeteria microwave is broken. (And conveniently the cafeteria clock has no second hand). In order to melt chocolate to a perfect consistency, it must be microwaved for precisely one minute; 59 seconds and under and the chocolate is too hard—1:01 seconds and the chocolate is too soft.

Teacher Tip: *You may want to remind them of the materials you have available to get their creative ideas flowing. It is also possible to have the students bring in pre-approved materials from home.*

III. Part C: Design and Test the Model

To accurately and precisely measure the student models, use the National Standards time project by the atomic clock which can be downloaded (see References).

PROCEDURE

Teacher Tip: *These steps should be broken up into class periods based upon time allotted and available. Part I may take two or three 60 minute class periods.*

I. Engage

1. Start with any or all of the attention grabbers; that is, the demonstration and explanation of a courting candle, the video clip of the Rube Goldberg alarm clock from, "Chitty, Chitty, Bang, Bang" or the announcement about the broken microwave LCD screen. An example might be:
   At lunch your friends have shared with you the perfect technique to melt a bar of chocolate in the cafeteria microwave. Placing the chocolate bar in the microwave for precisely one minute melts it to perfection. Cooking for under a minute, even 59 seconds, and the chocolate is too hard. Cooking it for 1:01 seconds and the chocolate is too soft. Unfortunately the old microwave in the cafeteria has a broken LCD screen, and there is no way to tell when one minute has passed. To avoid under cooking or overcooking the chocolate, you need to know when a minute has passed. You and your team need to design and construct a device that can accurately measure the passage of one minute of time.
2. Refer to your opening demonstrations as a vehicle to jump start their imaginations.
3. Since you used the courting candle as an example, the candle as a timing device is not allowed to be adapted by the students.
4. You may want to replay the "Chitty, Chitty Bang, Bang" clip and have the students time how long it takes for the Rube Goldberg breakfast machine to run to its end. Although students will want to get together and discuss and design their models at this time, remind them that they need to establish and gather some information to assist them in their design work.

PROCEDURE

5. Distribute a KWL sheet to each student, and ask them to write what they **know** about measurement and particularly the measurement of time.
6. Discuss as a class and record the students' responses to a class KWL sheet, using an overhead transparency.
7. Continue the class discussion by completing the "W" section.
8. Divide the students into teams of two to four students, depending on your class size.
9. Distribute the student handout and the rubric, clarifying any questions the students may have.
10. Group the students into teams of two to work on the Internet Treasure Hunt. Using the Internet, research the history of measurement, the history of time and clocks and our circadian rhythm and any items the students listed in the "W" section of the KWL sheet. Allow adequate time for treasure hunt completion.
11. Regroup to discuss the results of the Internet Treasure Hunt.

II. Plan an Experiment

1. Students, working in their teacher-designated groups, should have gleaned some design ideas from their Internet Treasure Hunt.
2. Review the steps to the scientific method: problem, hypothesis, procedure (experimental design), observation (data collection, data tables, and other observations), results and conclusion (based on results of data.)
3. Allow the students time to discuss possible design options for their one minute timers, and to ask you about various materials to use and its availability.
4. Students will complete and fill out the "Just a Minute" form, indicating what the problem is, their hypothesis, and their procedures and then create a data table.
5. At this time, you may want to discuss what the group intends to name their unit of measurement as they need to create a unit of time based upon their design and construction.
6. Students must receive teacher approval before proceeding to the next step.

III. Design and Test the Model

1. Review lab safety procedures with the class.
2. Review and discuss the good experimental design procedures and practices.
3. Permit the students to design, create and test their models.
4. You may need to demonstrate what it means to have a consistent rate in the timer; i.e., the same amount of material used in a minute.
5. Allow each group access to the atomic clock website if they desire to check their model for accuracy.
6. Each group's model will be tested, ideally using the atomic clock as the standard.
7. The model will be evaluated according to the rubric.
8. The Honda Accord website is an ideal culminating Rube Goldberg device for the students to watch (see References).

PROCEDURE

IV. Part D: Create and Present an Advertisement

1. Each group will create an advertisement to market their one minute timer.
2. The advertisement should include a poster.
3. Each group member will contribute to the oral presentation in front of the class.
4. The oral presentation will be evaluated according to the rubric.

WHERE TO GO FROM HERE

- If no one came up with the idea of a pendulum, explore this topic, and investigate variables and controls while discovering what has the greatest effect upon the rate of a pendulum; the mass of the bob, the length of the pendulum (the length of string to the middle of the bob), the shape of the bob, or the angle in which the pendulum is released. It could make a great inquiry lesson.
- Explore the interior mechanisms the gears of clocks.
- Explore the history and use of time zones and daylight savings.
- Extend the study of biochronology and circadian rhythm into a unit on genetics.

SUGGESTIONS FOR ASSESSMENT

- Evaluate how accurately the mechanism indicates the passage of one minute.
- Evaluate how well the students collaborated and successfully worked together.
- Evaluate how well the students understood and comprehended the website selections
- Peer evaluation
- Evaluate oral presentations of the advertisement
- Evaluate experimental design

REFERENCES AND RESOURCES

1. *Atomic Clock for Windows*
www.1000files.com/free/atomic.html
You can download the atomic clock to Windows from this website.

2. *Biological Clock Web Site*
http://cal.man.ac.uk/student_projects/1999/sanders/start.htm
This web site provides an introduction to bioclocks or chronobiology.

3. Broccoli, A. (Producer). (1968). *Chitty Chitty Bang Bang* [Motion Picture]. United States: Metro Goldwyn Mayer. This is a film based upon Ian Fleming's book, *Chitty Chitty Bang Bang*. Twenty minutes into the film one of the main characters uses a Rube Goldberg to help with the dishes.

4. *Clockwork from Sundial to the Atomic Second*
http://www.britannica.com/clockworks/article.html
This web site allows you to enter into an animated exhibit of the history of measurement.

5. *Courting Candle*
http://courtingcandle.com
This shows a photograph of a courting candle and gives a brief historical background of the courting candle.

6. *Decimal Time - Clock*
http://www.decimaltime.hynes.net/clocks.html
This site describes the metric system, metric time and decimal time. There is a metric clock that can be activated.

7. *A History of Measurement and Metrics*
http://www.cftech.com/BrainBank/OTHERREFERENCE/WEIGHTSandMEASURES/MetricHistory.html
This web site describes how ancient civilizations developed measurement systems and why the world needs a standardized system. There is a U.S. history of the attempt of implementation of the metric system.

8. *Honda Accord Advertisement*
http://www.steelcitysfinest.com/HondaAccordAd.htm
This web site is a flash movie advertisement shot is real time. It is demonstration of a Rube Goldberg device.

9. Lantz, H.B., Jr. (2004). *Rubrics for Assessing Student Achievement in Science Grades K-12*. Thousand Oaks, CA: Corwin Press.

10. *Ohio Science Academic Content Standards*
http://www.ode.state.oh.us/GD/Templates/Pages/ODE/ODEPrimary.aspx?page=2&TopicRelationID=334
Ohio Department of Education.

REFERENCES AND RESOURCES

11. *Pitch drop experiment*
http://en.wikipedia.org/wiki/Pitch_drop_experiment
This web site is an explanation of the history of the University of Queensland's pitch drop experiment which measures the flow of a piece of tar pitch over many years.

12. *Time and the History of its Measurements*
http://www.zetnet.co.uk/sea.jnp/earth.4/time.htm
This site describes how one can use the sun and water to measure the passage of time.

13. *Time-for-Time for Students and Teachers*
http://www.time-for-time.com/howold.htm
This interactive web site calculates your age and next birthday in small units. It also has historical information about time.

14. *The Time of Our Lives*
http://learn.genetics.utah.edu/features/clockgenes/
This web site provides an explanation of circadian rhythm and how it is biologically controlled.

15. *A Walk Through Time*
http://physics.nist.gov/GenInt/Time/time.html
This site describes the history of ancient calendars, early clocks, and time keeping through the atomic age.

16. *What is Horology?*
http://www.nawcc.org/headquarters/ktime/stories/horology.htm
This website defines horology and describes the historical development of measuring time.

KWL

What I *Know*
What I *Want* to Know
What I *Learned*

Name ____________________
Period ________

Topic of Discussion: **History of Measurement and Time**

What I *Know* about this topic/question	What I *Want* to know about this topic/question	What I *Learned* about this topic/question

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Assignment

Your team's mission is to design and create a device that will accurately measure the passage of one minute of time. Upon completion of your one-minute timer, your group will be responsible for creating an advertisement that your team will present to the class. A visual aide such as a poster is required.

The team members are: _____

_____

_____

_____

Your team must successfully complete the following tasks. Use this check list to guide you. Once you have completed this checklist, have your teacher sign it BEFORE you work on your Student Experimental Design Worksheet.

_____ The team completes the Internet Treasure Hunt.

_____ The team brainstorms ideas for the design of your one minute timer.

_____ The team has decided on what materials to bring into school from home.

_____ The team has spoken with the teacher to find out what materials are available from the classroom.

_____ Each team member has created a rough draft drawing of what the one minute time will look like.

_____ The team has discussed what safety precautions to follow while working in this lab.

Comments, thoughts, questions from the team:

Teacher signature representing approval to move on to the next step.

_____

Internet Treasure Hunt Name: _____ Date: _____

This web info search will help you find information about the history of measurement and time. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 1: How did ancient civilizations measure the passage of time?		
	Site 1 *A Walk Through Time* http://physics.nist.gov/GenInt/Time/time.html	**Site 2** *Time and History of its Measurement* http://www.zetnet.co.uk/sea.jnp/earth.4/time.htm
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Internet Treasure Hunt Name: _____ Date: _____

This web info search will help you find information about the history of measurement and time. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 2: What are some disadvantages to the early clock models?		
	Site 1 *What is Horology?* http://www.nawcc.org/headquarters/ktime/stories/horology.htm	**Site 2** *Time and History of its Measurement* http://www.zetnet.co.uk/sea.jnp/earth.4/time.htm
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Internet Treasure Hunt Name: _____ Date: _____

This web info search will help you find information about the history of measurement and time. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 3:	**What parts of the human body did civilizations use and what were their respective units called?**	
	Site 1 *Department of Weights and Measures General Information* http://inventors.about.com/gi/dynamic/offsite.htm?site=http://www.brocktonmass.com/weights/history.html	**Site 2** *A History of Measurement and Metrics* http://www.cftech.com/BrainBank/OTHERREFERENCE/WEIGHTSandMEASURES/MetricHistory.html
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Internet Treasure Hunt Name: _____ Date: _____

This web info search will help you find information about the history of measurement and time. You will be looking at pre-selected web sites to answer each question. It is important to not only find the information at the site, but also to consider who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 4:	**What are biological clocks or circadian rhythm? Give an example of how biological time and how it affects humans.**	
	Site 1 *Genetic Science Learning Center* http://learn.genetics.utah.edu/features/clockgenes/	**Site 2** *Biological Clock Web Site* http://cal.man.ac.uk/student_projects/1999/sanders/home1.htm
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

Experimental Design Worksheet Name: _____ Date:_____

Lab Partner(s): _____

Use the following worksheet to log your scientific experiment. Once you have completed the problem, hypothesis, and experimental design sections, and designed your data tables, have your teacher approve your experiment BEFORE proceeding. Use additional paper, if needed.

A. Problem:

_____

_____

B. Hypothesis:

_____

_____

C. Experimental Design: List the steps of your procedure:

_____

_____

_____

_____

_____

_____

_____

D. Observations: Data collection, data tables and other observations)**:**

E. Conclusion: (based on results and data):

_____

_____

_____

_____

(Attach additional paper if needed.)

Experimental Design Rubric

Name(s): _____

_____

Performance Criteria	Assessment		
	Points	Self	Teacher
1. There is a testable question for the experiment.			
2. The design of the experiment tests the hypothesis.			
3. A list of all necessary materials is included.			
4. A detailed step-by-step procedure is included.			
5. The procedures are written clearly enough so that another person could repeat the experiment.			
6. The procedures shows that repeated trials were done.			
7. Data were collected and recorded for each trial.			
8. Conclusions were drawn using the data.			
9. The conclusions refer back to the hypothesis.			

Adapted from Lantz, H.B., Jr. (2004) Rubrics for Assessing Student Achievement in Science Grades K-12, Corwin Press, CA.

Model Diagram Design Rubric

Name(s): _____

_____

Performance Criteria	Assessment		
	Points	Self	Teacher
1. Written plans/designs of the model were developed, reviewed, and revised before constructing the actual physical model.			
2. The written plan uses metric measurements throughout.			
3. All the measurements are labeled.			
4. Any safety issues regarding the model are described in the written explanation.			
5. The model has been constructed with care and attention to details.			
6. The model accurately measures one minute.			

Adapted from Lantz, H.B., Jr. (2004) Rubrics for Assessing Student Achievement in Science Grades K-12, Corwin Press, CA.

Model Accuracy Rubric

Names of group members:

_____ _____

_____ _____

Category/Points	**4**	**3**	**2**	**1**	**0**
Device	Device is built and functions well. No hands touch the device.	Device is built but does not function well. Hand touches the device.	Device is only partially built.	No construction is completed on the device.	No work.
Category/Points	**4**	**3**	**2**	**1**	**0**
Device Accuracy	Device is 100% accurate plus or minus 4 seconds.	Device is accurate within 5-10 seconds.	Device is accurate within 11-16 seconds.	Device is accurate within 17-20 seconds.	Device is not accurate within 20 seconds.
Category/Points	**4**		**2**		
Rate Consistency	Rate is constant: all materials used up in a minute.		Rate is inconsistent: all materials not used up in a minute.		
Category/Points	**4**		**2**		
Measurement Standard	Created a clear method for standard measurement.		Created an unclear method for standard measurement.		

Oral Presentation Rubric

Name(s): _____

_____

Performance Criteria	Assessment		
	Points	Self	Teacher
1. The poster contains a title that clearly reflects the design of the one minute timer.			
2. The format of the poster is appropriate to the content, purpose, and audience.			
3. The poster uses effective use of space, color, texture, and shape.			
4. The poster is creative and draws attention.			
5. The presentation is made in an interesting, logical sequence: introduction, body, and conclusion that the audience can follow.			
6. The advertisement captures the audiences' attention.			
7. Every team member speaks to the audience.			
8. The audience can clearly hear and understand the presenters.			
9. Eye contact includes the entire audience.			
10. Presenters maintained good posture and stood upright.			
11. Successfully demonstrated model to the audience.			

Adapted from Lantz, H.B., Jr. (2004) Rubrics for Assessing Student Achievement in Science Grades K-12, Corwin Press, CA.