SCIENCE, GRADE 9: A TEACHING RESOURCE

ACKNOWLEDGEMENTS

CONTENTS

Introduction

Unit 1: Science, Technology, Society, and the Environment

SCIENCE, TECHNOLOGY, SOCIETY, AND THE ENVIRONMENT

Value of STSE

Articles about science or containing science surround us. Daily, we hear about pollution, homeopathic medicine, genetic engineering, alien visits, the newest laundry detergent, cloning, etc. Often, a writer's opinion is said to be "true" based on scientific evidence. It is our job as consumers to be skeptics; that is, to able to separate the true science from the false or the improperly investigated.

The science may be real but we need to be able to ask the questions to get all the facts. For example, suppose you asked your doctor if the allergy medicine you were taking was safe for your liver. The research you found may have indicated that no tests produced dangerous results. Does this mean the tests indicated that the medicine did not cause liver damage? Or, does this mean there have not been enough tests or enough time passed to have problems show up? These questions are the kind we, as responsible consumers (and skeptics), must ask.

Bias in Writing

Bias, in writing, is defined as presenting facts and opinions to support a point of view. Every writer writes with a point of view. Often, it is the job of the writer to persuade us to that point of view. It is our job to find enough differing points of view to cover all the questions we should be asking.

Approaches

When writers write they may use a direct or an indirect approach to persuade us.

The Direct Approach

This approach is straight forward. It begins with an introduction that contains your purpose embedded in a context and then develops that purpose incrementally throughout the document. You might visualize the "essential shape" as a triangle with a wide base on the top and a point on the bottom. It's appropriate when your message will have little emotional impact, or when you honestly believe your audience would react best to having the information presented directly. This rhetorical structure is also known as deductive reasoning.

The Indirect Approach

In contrast to the direct approach, you might visualize the "essential shape" of the indirect approach as a triangle with a point on top and a wide base on the bottom. The indirect approach reveals your message slowly, gradually revealing the purpose while leading your reader through your rationale. This rhetorical structure is also known as inductive reasoning. This approach (or a modified version of it) is often used in persuasive/bad news writing. It "softens the blow" by acknowledging the audience's position on the subject, leading the reader(s) through the reasoning process, and giving the reader time to absorb the impact.

STSE Topics

- Frankenfoods—Genetically modified foods
- Fertility Drugs and Multiple Births
- Spinal Cord Injury
- Head Transplants
- Xenotransplantation
- Use of Fetal Tissue to Treat Human Diseases
- Hermaphroditism
- Causes and Treatment of Infertility
- Definition of Death
- Pharmaceutical Testing on Ill Patients
- Fetal-maternal Conflict
- Sustaining Biodiversity
- Cloning
- Kryogenetics
- Control Systems

- Jurassic Park
- Criminolgy (DNA)
- Hygenics
- Sex Change
- Small Pox and Anthrax—Biological Warfare/Gulf War Syndrome
- Life (forms, DNA, evolution)
- Environmental Illness (sick building syndrome, allergies, scents)
- Trans-genics
- Air Quality
- Super Bugs
- Nutraceutical

Evaluation

How thoroughly and carefully you have discussed the answers to the questions will be the basis of your evaluation. The following chart of expectations will be your guide to producing quality work.

Sample Rubric for STSE Activities

Level I	Level II	Level III
❏ All questions were not answered. ❏ Answers to the questions are incomplete. ❏ Answers to the questions do not show understanding of the task. ❏ Complete sentences that do not need the presence of the question were not used.	❏ All questions were answered. ❏ Examples were provided when asked. ❏ An understanding of the task is shown in the details of the answers. ❏ Evidence of effort and thought are found in the care and detail of the answers. ❏ Answers are presented in a neat, easy-to-read format. ❏ Complete sentences that stand without the question were used.	❏ All questions were answered in great detail showing thought and discussion of the task. ❏ Examples were provided wherever they were needed to enhance an answer. ❏ An understanding of the task is shown in the detail, care, thought and effort put into the answers. ❏ Evidence of effort and thought are found in the extra attention to detail in the answers. ❏ Student went beyond the instructions to produce a quality assignment. ❏ Answers are presented in ❏ a neat, easy-to-read format. ❏ Complete sentences that stand without the question were used.

STSE Projects

Outcomes

Students will be expected to

- recognize that the nucleus of a cell contains genetic information and determines cellular processes (305-1)
- explain the importance of using the terms gene and chromosome (109-14)
- illustrate and describe the basic processes of mitosis and meiosis (304-11)
- distinguish between sexual and asexual reproduction in representative organisms (305-2)

Question

Is keeping stems cells good for society?

Procedure

Use the following keywords to find Web sites including Canadian ones, your textbook, the article from *Time* magazine and any resources (audio, video, magazines, newspaper, interviews, etc.) to work through the following group of activities.

Each group will have common activities to complete and report on. Each group will have one issue question to come to some consensus based on what you have learned about cells and reproduction.

Keywords: stem cells, Canadian federal government

Before you begin the activities, read your issues question. As a group, discuss and complete the KWL (in Secondary Science document) worksheet. You now have the basis for your search.

As you finish an activity, submit it for evaluation. Be sure the activity is complete and as detailed as you can make it. The more attention the beginning activities get, the better the analysis of your issues question. Begin working on activities 1–4. The order you do these is not important.

Keep all beginning activities in a folder so your group has information with which to analyse your issues question.

Activity 1

- Distinguish between asexual and sexual reproduction.
- As a group, divide up the information in the textbook into asexual and sexual.
- Each person in the group will look for similarities and differences.
- As a group, discuss what you have learned. Complete the Compare/Contrast worksheet (from Secondary Science document).

Activity 2

- As a group, discuss the page of words and how they are related. Read the Time article. Place the words in the word cycle worksheet as they are related to each other. In the spaces in between the circles, write how the words are related to each other.

Activity 3

- Read pp. 17–19 in text.
- What is the purpose of mitosis? Where does mitosis occur?
- Draw the steps of mitosis in the circles on the worksheet. Write one sentence under the circle describing what in happening.
- Share and compare your drawings and what you have learned in your groups.
- Repeat steps 1–3 for meiosis (pp. 47–50).
- When your group is clear about mitosis and meiosis, make a distinction between mitosis and meiosis using the concept relationship frame worksheet.

Activity 4

- As a group, work through Think and Link (pp. 14–15) in text. Show your understanding of the discussions your group had for Experiments A, B, and C by writing the answers to Analyse #1, 2, (p. 15). Read The Nucleus in Control p. 16. What is the importance of a nucleus in a cell?

Activity 5

Choose one of the five issues questions below to analyse. Be sure to reserve your question. Only one group may address a question.

- If stem cells are not used for research, what can they be used for?
- Why not just use the existing populations of stem cells?
- Why not just use adult stem cells?
- What is Canada's stand on use of stem cells?
- Who should keep control of stem cell populations?

Your group will prepare a report addressing the issues in your question. Use outside resources, the *Time* article and the web sites listed above. Your presentation can take the form of a panel discussion, a debate, a PowerPoint or Hyperstudio presentation or some other form (check out any brilliant ideas your group has).

Evaluation

Evaluation will be based on the detail and accuracy of your presentation, the linking of the concepts you learned in the other activities, the depth of your research and the shared responsibility for constructing and delivering your issue.

Take care in your presentation to present informed opinions (backed by scientific knowledge). Avoid attacks on groups or individuals.

UNIT 2: SPACE

Clothes Make the Astro-Settler

Question

- What modifications would clothes and vehicles need to help humans live successfully on another planet?

Materials

- paper
- coloured pencils
- scraps of fabric
- foil
- other recycled materials as you see fit

Procedure

Design a line of clothing which would allow a human to live successfully on a researched planet of your choice. You will need to consider human requirements for survival as well as the demands put upon a human on the particular planet you have chosen.

Design a line of transportation which shows your understanding of the climate, terrain, and gravity conditions on your planet.

As an extension, you could design a line of jewelry based on the geology of your chosen planet. Consider the minerals or other formations which could exist on your planet.

Results

Sketches or models of your inventions with an explanation of the innovations you have included which show your knowledge of your chosen planet.

Clothes Make the Astro-Settler
Teacher Notes

Outcomes

Students will be expected to

- describe the compositions and characteristics of the following components of the solar system: terrestrial and gas planets and Pluto, periodicity of comets, asteroids/meteors (312-5)
- describe the effects of solar phenomena on Earth: sun-spots, solar flares, solar radiation (312-6)
- calculate the travel time to a distant star (planet) at a given speed: define and explain a light year (210-9)
- receive, understand and act on the ideas of others (211-1)
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (211-3)
- identify new questions and problems that arise from the study of space exploration (210-16)

Background Information

Using researched information to create imaginary designs allows students to make connections between theory and practicality. The second outcome is satisfied if a student or group chooses to protect humans, in the future, on Earth from the effects described in the outcome. If, in this activity, students are encouraged to make actual models of their inventions, one has made an art-science link, a link between idea and technological design and allows those students who learn kinesthetically to express their ideas with success.

Examination of the International Space Station and some design considerations could be examined first to give students inspiration by looking at what scientists have had to consider when designing and building these living quarters. A visit to the Web site for the International Space Station could be a jumping off place.

For this activity, the groups within the class could concentrate on a planet and have group members become specialists as clothing/jewelry designers or transportation planners, i.e., one or two students in a group concentrate on transportation, clothing, etc., after the group has researched the planet itself. This allows a group to work collaboratively to collect information on the planet (climate, gravity, geology, etc.) then a person or a pair could become the expert in designing one of the choices.

Alternatively, the teacher may decide to pick only one design element from the three choices above and have the class concentrate on it, i.e., all groups design a line of clothing for a given planet.

Create a Song

Materials

Audio versions of "Vincent" and "Starry, Starry Night."

Procedure

Listen to the song "Vincent" by Julio Iglesias and the song "(Vincent) Starry, Starry Night" by Don McLean for inspiration.

Use your knowledge of a nebula, galaxies, giant stars, dwarf stars, quasars, black holes you have learned about to create the words to your own song.

Add your own music or set it to your favourite tune and record your creation.

Results

An audio or video version of your creation.

Create a Song
Teacher Notes

Outcomes

Students will be expected to

- describe and classify the major components of the universe: nebula, galaxies, giant stars, dwarf stars, quasars, black holes (321-1)
- receive, understand and act on the ideas of others (211-1)
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise (211-3)

Background Information

A cross-curricular link to art history and music, this activity could work as an extension to reading *The First Starry Night* by Joan Shaddock Isom (ISBN#) since the students knowledge of Van Gough's life will make Don McLean's song more meaningful.

An extension to this activity would be to have the students create a PowerPoint presentation with information about their chosen topic and use their song as an audio enhancement of their presentation.

Starry Night Backyard Activities

Starry Night Backyard Activities
Introduction

Outcomes

Students will be expected to

- describe and explain the apparent motion of celestial bodies (312-4)
- describe and classify the major components of the universe (312-2)
- calculate the travel time to a distant star a given speed (210-9)
- describe and classify the major components of the universe (312-2)
- explain the need for new evidence in order to continually test existing theories about the composition and origin of our solar system and galaxies (110-6, 210-3)
- identify new questions and problems that arise from the study of space exploration (210-16)
- working collaboratively with group members, prepare a comparative data table on various stars, and design an model to represent some of these stars relative to our solar system (209-4, 211-1, 211-3)

Background Information

Sienna Software's Starry Night Backyard virtual planetarium software is being provided for grade 9 classrooms in Nova Scotia. Using Starry Night Backyard, you can view the skies from any place on Earth at any time between 4713 BC and AD 1999. The program lets users add other bodies to the solar system (asteroids, comets, etc.), study the orbits of existing planets and satellites, view simulations of celestial phenomena like solar or lunar eclipses, comets, conjunctions. Here are a number of activities using this software that would meet the outcomes listed below. Further information and a tutorial for this product can be found at the publisher's website.

Starry Night Backyard requires some exploration time by the students (and teachers) before proceeding with the activities.

Sample Activities

Four sample activities are the pages which follow this. They are:

- As Time Goes By
- Database Galactica
- The Sky's the Limit

- Starry Night (or Day)

As Time Goes By

Materials

- Computer with Starry Night Backyard

Procedure

Select a location and time (today, the day you were born, the day you'll graduate). List the celestial objects you find in the sky before you run the program. Leave room to add more as the time passes.

Run the program to watch the sun, moon, planets and any comets and/or meteors move through your sky from the time and location of your choosing.

Choose time periods of 1 hour, 2 hours, 4 hours, 8 hours, 16 hours, 24 hours. Record your observations of the celestial objects at these times. Be sure to add those that appear (and when) and those that disappear (and when).

Analysis

Using the observations you have collected, create a diary of your sky observations. Write in the first person as if you were watching the sky in the field.

As Time Goes By
Teacher Notes

Outcomes

Students will be expected to

- describe and explain the apparent motion of celestial bodies (312-4)

Materials

- computer with Starry Night Backyard
- database program

Background Information

Groups could chose different locations (especially different hemispheres), same time.

Groups could chose same location, different time.

Compare diaries by having students read aloud.

A different time frame could be designed to give a monthly, yearly, by the decade look at celestial movement.

Alternative Assessment

As an alternative to a diary entry, you could have your students complete an observation table. Sample 1 is quite open-ended while Sample 2 is very structured.

Sample 1 - Observation Table for "As Time Goes By"

Time Period	Observations of Celestial Objects
1 hour	
2 hours	
4 hours	
8 hours	
16 hours	
24 hours	

Sample 2 - Observation Table for "As Time Goes By"

Time Object	1 hour	2 hours	4 hours	8 hours	16 hours	24 hours
Sun						
Moon						
Planet 1 (name)						
Planet 2 (name)						
Planet 3 (name)						
Number of stars						
Comets						
Meteors						
Other						

Database Galactica

Materials

- computer with Starry Night Backyard
- database program

Procedure

Working in pairs, create a database using the following fields as well as any other fields which your teacher approves.

- name of galaxy
- age of galaxy
- distance from Earth
- location relative to Earth
- shape/type
- other interesting/important information

Using Starry Night Backyard computer program, find, travel to and gather information on galaxies including our own.
Enter the data in your database.

Analysis

Using your knowledge of light years, calculate how long it would take to travel to three of the galaxies you have researched. A chart would be a good way to organize your calculations.

Database Galactica
Teacher Notes

Outcomes

Students will be expected to

- describe and classify the major components of the universe (312-2)

Materials

- computer with Starry Night Backyard
- database program

Background Information

Students who are unfamiliar with database programs will need help setting up the fields and entering the data.

If your students are comfortable with databases, this activity should take approximately 45 minutes.

The Sky's the Limit

Materials

- computer with Starry Night Backyard
- calculator
- paper and pencil

Procedure

Working in pairs, pick a star which you have encountered in your exploration of this program.

Set the speed on your program; set the destination.

Using your knowledge of a light year and space travel, calculate how long your journey will take. Travel using the program.

Recalculate with a faster and slower speed and try these using the program.

Analysis

- What is a light year? Why do scientists use this unit of measurement?
- How do your calculations compare with the time given by the program? Explain any differences?
- Do you think humans will travel to distant stars? Why? How?
- Discuss with your partner what problems humans face in space travel. List some here.
- Devise an ingenious method which would make it possible for humans to experience life on a distant star. Remember: the sky's the limit! Sketch or describe your ingenious method.

The Sky's the Limit
Teacher Notes

Outcomes

Students will be expected to

- calculate the travel time to a distant star a given speed (210-9)
- describe and classify the major components of the universe (312-2)
- explain the need for new evidence in order to continually test existing theories about the composition and origin of our solar system and galaxies (110-6, 210-3)
- identify new questions and problems that arise from the study of space exploration (210-16)

Materials

- computer with Starry Night Backyard
- calculator
- paper and pencil

Background Information

Students who are mathematically challenged will need help performing the calculations.

If your students are comfortable with the math, this activity should take approximately 45 minutes.

Discussion of a light year before doing this activity is necessary for students to understand the scope of space.

Starry Night (or Day)

Materials

- computer with Starry Night Backyard
- database/spreadsheet integrated program

Procedure

Working in pairs, design a database with at least the following fields:

- name of star
- location
- distance from Earth
- magnitude
- size
- colour
- solar system
- other fields you think are interesting/important

The more stars you research, the better your scatterplot will be.

Working in pairs, explore the universe using the Starry Night Program to find data about various types of stars. Enter this information into your database.

Using your database, form a spreadsheet with at least the first three fields mentioned above.

Create a scatter plot graph from your spreadsheet. Print. Colour code your stars using your colour data.

Analysis

Using your scatter plot, discuss any patterns you see in your graph. For example: groupings of stars, colours of stars, sizes, etc.

Have you included most of the stars in space? Why? Estimate the time needed to complete this recording. Be sure to discuss as many possible problems as you and your partner can think of.

Pick your favourite star. Highlight and label it on your scatter plot. Create a small data card to be displayed along side your graph when you post it.

Starry Night (or Day)
Teacher Notes

Outcomes

Students will be expected to

- working collaboratively with group members, prepare a comparative data table on various stars, and design an model to represent some of these stars relative to our solar system (209-4, 211-1, 211-3)
- describe and classify the major components of the universe (312-2)

Materials

- computer with Starry Night Backyard
- database/spreadsheet integrated program

Background Information

Students who are unfamiliar with database/spreadsheet programs will need help setting up the fields and entering the data.

If your students are comfortable with the programs, this activity should take approximately 90 minutes.

"It was a dark and starry night … "

Question

How can I show my understanding of technologies associated with space exploration?

Procedure

Create a story to show your knowledge of Canadian space technology. Choose one of the following sentences to start the story with one of the four themes listed below. Make sure your story includes facts and knowledge you have gained during the study of this unit. Evaluation will be based on good, scientific knowledge and proper story style.

Opening sentences:

- "In my dream it was twilight ..."
- "It was a dark and starry night ..."
- Your choice (have it approved before you get started)

Themes

- A visit to the International Space Station
- A day spent with a Canadian scientist studying space
- A chance meeting with a Canadian astronaut
- You are a fly on the wall during the invention of Canadian space technology

Results

Drafts and a final copy of your story showing the knowledge you have gained during this unit.

"It was a dark and starry night ... "
Teacher Notes

Outcomes

Students will be expected to

- explain how data provided by technologies contribute to our knowledge of the universe (109-3)
- receive, understand and act on the ideas of others (211-1)
- describe examples of science- and technology-based careers in Canada that are associated with space exploration (112-11)
- describe the science underlying three technologies designed to explore space (109-11, 111-15)

Materials

- Video (*Space for Four*), available from Learning Resources and Technology

Background Information

Combining research with fiction allows students to make practical applications of their knowledge and their imaginations. Peer editing of student work will satisfy outcome 211-1.

Students will already have explored some design principles used in the International Space Station in the "Clothes Make the Astro-Settler" activity.

Just the Facts

Question

Can I collect and organize information on facts of our universe and others?

Materials

- Internet connection, database program, Hyperstudio

Procedure

Design a database with facts collected on two of these topics:

- various stars
- nebula
- galaxies
- giant stars
- quasars
- black holes
- dwarf stars
- sun spots
- solar flares
- solar radiation
- asteroids/meteoroids
- periodicity of comets

Using the facts you have just collected, design a game with question and answer cards using Hyperstudio.

Results

You will have a complete and correct database of facts based on your topics and a creative game for others to play using Hyperstudio.

Evaluation

Evaluation will be based on extent of your research (find a cross-section of facts instead of focusing on one aspect).

Just the Facts
Teacher Notes

Outcomes

Students will be expected to

- describe and classify the major components of the universe: nebula, galaxies, giant stars, dwarf stars, quasars, black holes (312-2)
- receive, understand and act on the ideas of others (211-1)
- describe the effects of solar phenomena on Earth: sun-spots, solar flares, solar radiation (312-6)
- describe the composition and characteristics of the following components of the solar system: terrestrial and gas planets and Pluto, periodicity of comets, asteroids/meteors (312-5)
- describe and explain the apparent motion of celestial bodies: moon, sun, planets, comets, asteroids (312-4)
- working collaboratively with group members, prepare a comparative data table on various stars and design a model to represent some of these stars relative to our solar system (209-4, 211-1, 211-3)

Background Information

Time required

- Two hours to research and build database
- One hour to design game
- One hour to play game

The class could be divided into 6 groups which would permit information gathering on all of the topics. This would allow the games to be used as a complete review of the space unit.

This activity could be used at the end of the unit as an evaluation tool.

Students must take care to build a database using correct information.

The playing of the Hyperstudio game could be done with younger children, allowing our students to assume leadership roles.

Make an Impression

Question

How can I show my understanding of components of the solar system?

Materials

- Internet
- watercolour paints
- paper

Procedure

Use the Internet to view some Impressionist art including Van Gogh's Starry Night painting.

Listen to the audio clips (two) discussing the painting technique and Van Gough's life.

Using your knowledge of planets, the stars, constellations, comets or asteroids/meteors create your own painting in the Impressionist style.

Results

You will have created your own painting in the Impressionist style showing the knowledge you have gained while studying the planets, stars, constellations, comets, asteroids/meteors.

Make an Impression
Teacher Notes

Outcomes

Students will be expected to

- describe the composition and characteristics of the following components of the solar system;
  – terrestrial and gas planets and Pluto
  – periodicity of comets
  – asteroids/meteors (321-5)
- receive, understand, and act on the ideas of others (211-1)
- work co-operatively with them members to develop and carry out a plan, and troubleshoot problems as they arise (211-3)

Background Information

This activity makes a cross-curricular link between art and science.

To enhance students understanding of Van Gough and his painting, read *The First Starry Night* (ISBN 1-879085-96-8) by Joan Shaddock Isom.

Extension

Where grade nine students have opportunities to interact with younger students, there are several options, allowing our students to become teachers.

Read together *The First Starry Night* by Joan Shaddock Isom and explore together various websites

Present the Case

Materials

- Information on the theories of the formation of the universe
- Knowledge of the rules of debate

Procedure

Working in a small group, research several theories on how our solar system was formed. Some theories to consider are Oscillating Theory, Big Bang Theory, cultural theory such as one from the Mi'kmaw culture, etc.

Find facts "for" and "against" all the theories you research. Your group must prepare for both sides to anticipate what the other team might say in defense of their theory.

Groups will draw to defend a particular theory. Prepare to argue the "for" side of one of the drawn theory.

Opposing group will defend another drawn theory.

Rules for Cross-Examination

- The examiner controls the cross-examination. The respondent should be permitted reasonable—but not unnecessary—time to answer questions.
- The respondent must answer all relevant questions and must not ask questions except to request clarification.
- A debater shall not seek assistance from this partner while asking or answering questions
- Judges should penalize speech-making, irrelevance, flippancy, discourtesy or any attempt to personally discredit an opponent. Judges should also penalize lack of co-operation by a respondent and browbeating and rebutting by an examiner. (Examiners should only ask questions.)
- New contentions and evidence may be introduced during cross-examination.
- The examiner should ask fair, relevant questions. Questions need not relate to the speech just delivered but should relate ultimately to the topic at hand.
- If an irrelevant answer is given to a relevant question, the moderator, on request or on his/her own initiative, should order the respondent to answer the question properly.

Results

A properly run debate will convince the audience that one team has made better arguments than the other.

Present the Case
Teacher Notes

Outcomes

Students will be expected to

- explain how data provided by technologies contribute to our knowledge of the universe (109-3)
- receive, understand and act on the ideas of others (211-1)
- identify new questions and problems that arise from the study of space exploration (210-16)
- describe theories on the formation of the solar system (312-1)
- explain the need for new evidence in order to continually test existing theories about the composition and origin of our solar system and galaxies (110-6, 210-3)
- describe theories on the origin and evolution of the universe: Big Bang Theory and Oscillating Theory (312-3)
- defend their position regarding societal support for space exploration (211-5)

Background Information

This activity could be used as an evaluation of the skills and knowledge gained by the students during study of the theories.

Students must take care to use correct information.

Verbal presentation of knowledge gained is important to our students who have difficulty expressing themselves on paper.

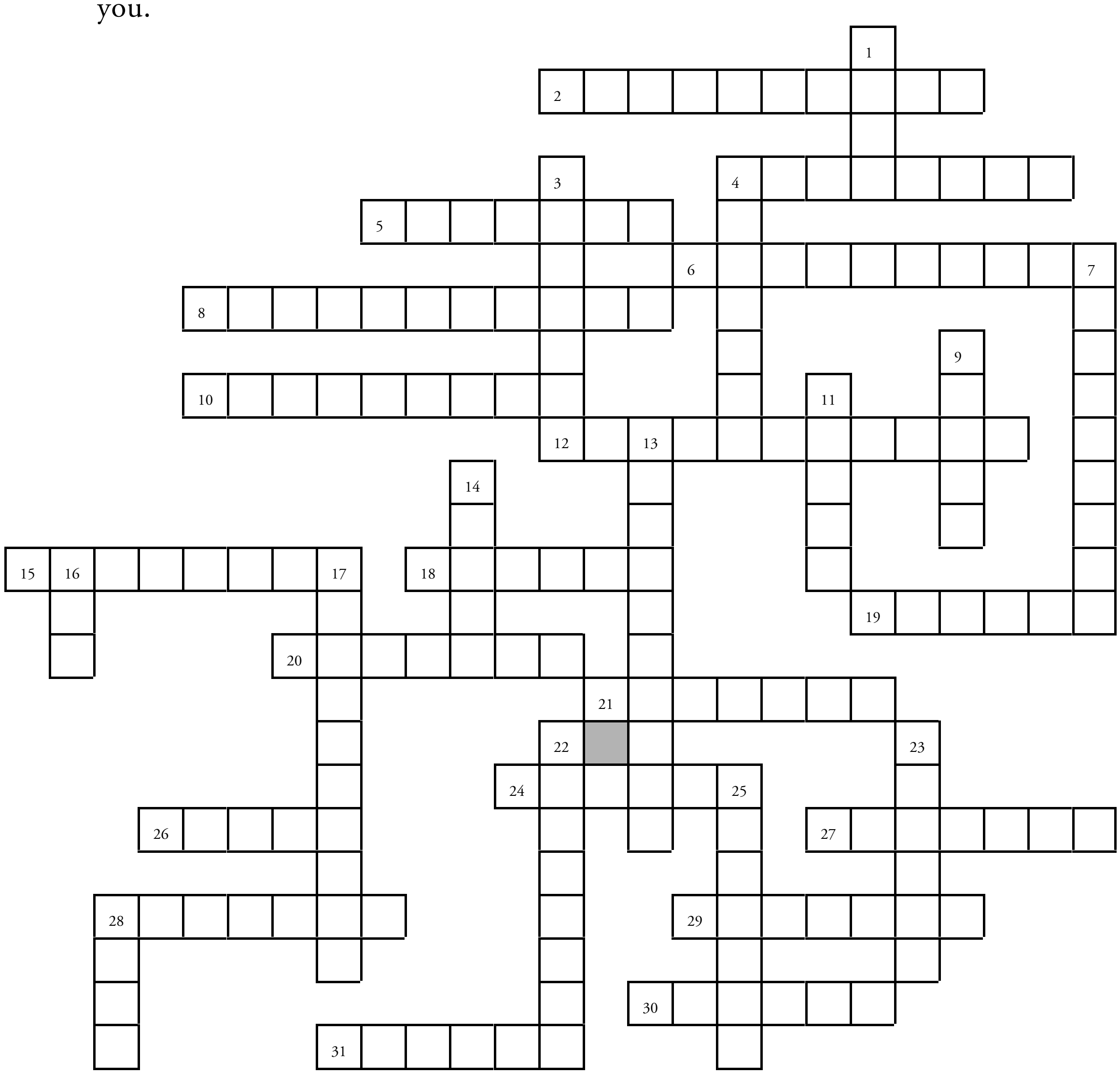
Debating a point of view in front of peers helps our students gain confidence in themselves and allows them practice in expressing a point of view based on information and their own opinion.

Extension

The last outcome is accomplished if the alternate topic of arguments “for” and “against” space exploration is chosen instead of the one described in the student worksheet.

A Spacey Puzzle

Complete the crossword puzzle below using the clues on the next page to help you.



Clues for A Spacey Puzzle

Across

2. These have masses 8 to 100 times that of the Sun
4. Dark spots on the Sun
5. Explosively erupting cores of colliding galaxies
6. The shape of the orbit traced by Earth as it revolves around the Sun
8. Mercury, Venus, Earth, and Mars are classified as this class of planet
10. An object having such strong gravity that nothing, not even light, can escape it
12. Theory that suggests the universe will expand to a certain point in time and then contract
15. Any one of the millions of small planets between the orbits of Mars and Jupiter
18. Telescope which orbits 600 km above Earth
19. A solid body that enters Earth's atmosphere from outer space
20. Jupiter, Saturn, Uranus, and Neptune are classified as this class of planet
21. Theory that suggests the universe originated from a massive explosion
24. Titan, the largest of this planet's 18 moons, has an atmosphere
26. Small celestial body that has a bright nucleus and a fainter tail
27. One of its 8 moons, Triton, has the coldest measured temperature in the solar system, -235ºC
28. This planet's daytime surface temperature can reach 430 ºC
29. This planet is 2.5 times the mass of all the other planets combined
30. Celestial body that orbits a star and does not produce its own light
31. Planet which rotates on an axis tilted 90º to the plane of the solar system

Down

1. The red planet
3. Inventor of the telescope
4. High-temperature eruptions of gases
7. The distance light travels in space in one year
9. This planet has a thick atmosphere which is 96% carbon dioxide gas; the planet of love
11. The water planet
13. First astronomer to propose that Earth orbits the Sun
14. Some scientists believe that this planet is an example of large debris left from the formation of the solar system or Mickey Mouse's pet dog
16. Giant gas ball at the centre of our universe
17. These gas balls can be red, white, brown, or black
22. Huge accumulations of stars, gas, and dust held together by gravity
23. The founder of modern optics and the first person to correctly explain planetary motion

25. Vast clouds of gas and dust which may be the birthplaces of stars
28. A celestial body revolving around a planet

A Spacey Puzzle
Teacher Notes

Outcomes

Students will be expected to

- describe and explain the apparent motion of celestial bodies: moon, sun, planets, comets, asteroids (312-4)
- describe theories on the formation of the solar system (312-1)
- describe the composition and characteristics of the following components of the solar system: terrestrial and gas planets and Pluto, periodicity of comets, asteroids/meteors (312-5)
- describe and classify the major components of the universe: nebulae, galaxies, giant stars, dwarf stars, quasars, black holes (312-2)
- define and explain a light year (210-9)

Background Information

This puzzle reviews many of the terms and theories covered in the Space Exploration unit. It would make a good review prior to a test.

References

SciencePower 9, Toronto: McGraw-Hill Ryerson Limited, 1999.

Sample Results

The answers for the clues are given below and the completed crossword is on the next page.

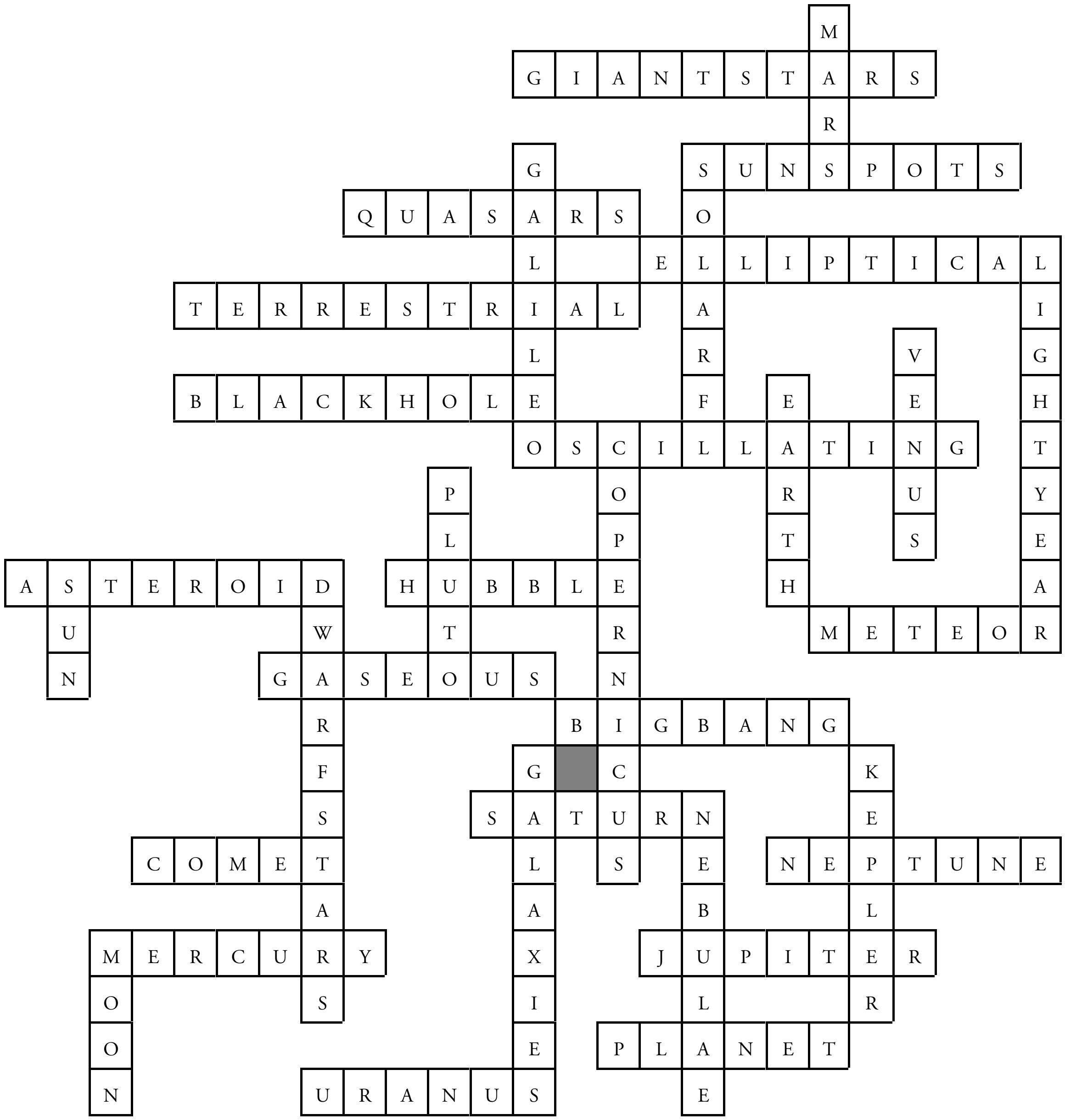
Across

2. Giant stars
4. Sunspots
5. Quasars
6. Elliptical
8. Terrestrial
10. Black hole
12. Oscillating
15. Asteroid
18. Hubble

19. Meteor
20. Gaseous
21. Big Bang
26. Comet
27. Neptune
28. Mercury
29. Jupiter
30. Planet
31. Uranus

Down

1. Mars
3. Galileo
4. Solar flares
7. Light year
9. Venus
11. Earth
13. Copernicus
14. Pluto
16. Sun
17. Dwarf stars
22. Galaxies
23. Kepler
25. Nebulae
28. Moon


GIANTSTARS
MARS
SUNSPOTS
QUASARS
GALILEO
ELLIPTICAL
SOLARFLARE
TERRESTRIAL
LIGHTYEAR
VENUS
BLACKHOLE
EARTH
OSCILLATING
PLUTO
OPEN
ASTEROID
HUBBLE
SUN
DWARFSTARS
METEOR
GASEOUS
OPENCLUSTERS
BIGBANG
KEPLER
SATURN
GALAXIES
NEBULAE
COMET
NEPTUNE
MERCURY
JUPITER
MOON
PLANET
URANUS

UNIT 3: ATOMS AND ELEMENTS

Safety Plates
Teacher Notes

Outcomes

Students will be expected to

- demonstrate a knowledge of safety and WHMIS standards (209-7)
- show concern for safety (434) (PAN-CANADIAN?????)

Background Information

It is important that the teacher and students, collectively and collaboratively, develop a set of lab safety rules based on provincial safety guidelines and areas of concern in the lab. Rules should be discussed, agreed upon, and posted. This activity can be used to communicate these rules.

Materials

- license plate templates or transparency of template
- overhead transparency of sample plates
- list of safety rules

Procedure

Photocopy enough templates for your students or have them copy one from the overhead. Show students the sample license plates.

Have students work in pairs to create a safety plate. Most license plates contain only seven letters and/or numbers but you could allow them up to eight. Colouring the plates is an option if time permits.

Once groups have completed their plates, have the pairs take turns showing their plates to the class and have the other groups determine the safety rule involved.

Post the plates on the walls of the lab and/or classroom as a reminder to students of the safety rules.

Alternate Activities

- cartoon of a safety procedure

- disposal procedure poster

Sample Results

There are three sample plates on the next page. The safety rules involved are:

- "Safety first"
- "Cover your eyes"
- "Tie back hair"

NOVA SCOTIA

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Canada's Ocean Playground

NOVA SCOTIA

Canada's Ocean Playground

Theories of the Atom: Research and Presentation

Questions

What were the theories of the atom proposed by

- the Greeks
- Bohr
- Dalton
- Rutherford
- Thompson?
- What were the strengths and weaknesses of their theories?
- How has technology changed our view of the atom?

Background Information

In this activity, each group member will be responsible for becoming an expert on the group's assigned topic. Check all parts to make sure you cover the topic you have been assigned; do not stray into another group's research. All groups are responsible for

- finding detailed and accurate information on your topic
- preparing an informative and correct power point presentation of the information you found presenting your information in a clear, concise way so others may take good notes

Topics

- *The Greeks*—Describe their theory of the atom along with its strengths and weaknesses. Be sure to include the theory which replaced that of the Greeks and why.
- *Niels Bohr*—Who was he? Describe his theory of the structure of the atom along with its strengths and weaknesses. Be sure to include the theory which replaced his and why.
- *Joseph John Thomson*—Who was he? Describe his theory of the structure of the atom along with its strengths and weaknesses. Be sure to include the theory which replaced his and why.
- *John Dalton*—Who was he? Describe his theory of the structure of the atom along with its strengths and weaknesses. Be sure to include the theory which replaced his and why.

- *Ernest Rutherford* —Who was he? Describe his theory of the structure of the atom along with its strengths and weaknesses. Be sure to include the theory which replaced his and why.
- How has technology changed our view of the atom? Provide examples of technologies that have enhanced, promoted, or made possible scientific research into atomic structure. Describe the technologies and their impact on the changing theory of the structure of the atom.

Evaluation

Evaluation will be based on the following:

- 10 points for your part of the group research and note taking
- 10 points for participating in the preparation of the PowerPoint presentation
- 10 points for participating in the presentation of your research
- 10 points for detailed, accurate note on all parts of this activity
- 5 points for a bibliography listing all the sources of information you used for your research done in an appropriate format
- 5 points for developing five multiple choice questions on your topic

Theories of the Atom: Research and Presentation Teacher Notes

Outcomes

Students will be expected to

- identify major shifts in scientific world views involving major changes in atomic theory (110-3)
- provide examples of technologies that have enhanced, promoted, or made possible scientific research into atomic structure (111-4)
- select and integrate information from various print and electronic sources (209-5)
- compile and display data, by computer, in a variety of formats (210-2)
- communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, oral language, and other appropriate means (211-2)

Questions

- What were the theories of the atom proposed by the Greeks, Bohr, Dalton, Rutherford, and Thompson?
- What were the strengths and weaknesses of their theories?
- How has technology changed our view of the atom?

Background Information

Theories of the atom can be conceptually challenging and dry. The variety of groups should enliven the unit and help keep the concepts at a level appropriate to this grade.

This activity will require a significant amount of class time (about five periods of 35–40 minutes each) in order to complete the research and to develop the PowerPoint presentation. The presentations themselves will require approximately two class periods.

Students should be instructed to make notes during each presentation. The multiple choice questions which each group creates should be used for a class quiz at the end of the presentations. If computer equipment and projectors are not available, overhead projectors and transparencies will work quite well.

Materials

- Internet connection
- videos (see appendix)

Sample Results

Greek Model

Features	Strengths	Weaknesses
Matter is made up of hard, spherical, indivisible particles called atoms. (From Greek work *atomos*, meaning uncut)	Introduced our modern notion that matter is made up of particles. (Matter is discontinuous)	Does not explain chemical change or properties of matter.

Dalton's Atomic Theory

Features	Strengths	Weaknesses
Matter is made up of hard, spherical, indivisible particles. Atoms of each element are all alike in size and mass. Atoms of different elements differ in size and mass. Atoms cannot be destroyed or created. Chemical changes are the result of the union or separation of atoms. Atoms combine in simple whole number ratios.	Revived the Greek notion of the atom. It was used to explain laws of chemical change such as the law of conservation of mass and the law of constant (definite) composition. This indicated that atoms were involved in chemical reactions.	He was wrong about all atoms of the same element being the same. (Didn't know about isotopes) Matter can be created and destroyed through nuclear reactions. The model couldn't explain the results of experiments with gas discharge tubes.

Thompson's Plum Pudding Model

Features	Strengths	Weaknesses
Atoms consist of a sphere of positive electricity with positive charge distributed evenly and thinly throughout atom, like a spherical cloud of positive charge. The electrons are scattered evenly throughout. There is no concentration of either positive charge (protons) or negative charge (electrons).	Could account for the presence in atoms of the newly discovered particles (electrons and protons) found during experiments with gas discharge tubes.	Cannot explain the results of Rutherford's gold foil experiment.

Rutherford's Nuclear Model

Features	Strengths	Weaknesses
Atoms consist of an extremely small, dense, positive, central portion called a nucleus. All of the positive charge and most of the mass of the atom is located in the nucleus. The electrons are located at a relatively large distance from the nucleus, moving around the nucleus. The atom is mostly empty space.	Explained the results of the gold foil scattering experiment. Most of the positive alpha particles passed straight through without deflection because the atom is mostly empty space. Some alpha particles were deflected at small angles because they were repelled as they passed near the positive (79 protons) nucleus of the gold atom. Alpha particles were deflected at large angles when they came very close to the nucleus. A few alpha particles bounced off the gold foil because they were going straight at the nucleus and were repelled straight back.	Could not explain why electrons in motion would not give off energy and slow down and be attracted into the nucleus (atom collapses). Could not explain why electrons are not attracted into the nucleus by the positive charge of the nucleus (atom collapses). Could not explain the line spectrum of hydrogen. Why were there only certain colours (energies) in the spectrum of hydrogen instead of all the colours we see in a continuous spectrum of sunlight or white light.

Bohr's Model

Features	Strengths	Weaknesses
This model was really designed for the hydrogen atom. Atom has a nucleus containing all the positive charge. Atom is mostly empty space. Electrons travel at great distances from the nucleus in circular paths called orbits (actually some paths could be elliptical). Each orbit represents a certain distance from the nucleus and a certain energy. The electron's energy is quantized; that is, it could only have certain amounts of energy (this meant that the electron could only be in certain orbits, certain distances from the nucleus). An electron could change orbits by either gaining energy or losing energy. The farther the orbit is from the nucleus the more energy the electron has. An electron changes orbit instantaneously not gradually. Electrons will tend to remain in the lowest energy orbits.	Introduced the idea of the electron's energy being quantized. Explained the line spectrum of hydrogen very well. Said the energy of the electron in an orbit was constant and, therefore, should not be giving off energy and slowing down to fall into the nucleus. Said the electron is not attracted into the nucleus because it is in motion. Recognized that particles as small as electrons behaved differently (motion) than baseballs and planets.	Could not explain the line spectrum of atoms with two or more electrons. Did not explain why the electron's energy is quantized. Treated the electron as a particle only whose exact motion could be known (moving at fixed distance from the nucleus). Experiments had shown that the electron could behave as both a particle and a wave.

Wave Mechanical or Quantum Mechanical Model—Teacher Use ONLY

Features	Strengths	Weaknesses
Atom has a nucleus containing all the positive charge. Atom is mostly empty space. Position and motion of the electron are uncertain. Electrons are located in orbitals that are three dimensional regions of space in which you are most likely to find an electron. Electron's energy is quantized, that is the electron can only be in certain orbitals. While in an orbital the electron's energy is constant. An electron can change orbitals by gaining or losing energy. It changes orbitals instantaneously. Particles as small as electrons behave differently (motion) than baseballs and planets and require new laws of motion. Motion of electron is such th at it appears to occupy the volume of an atom. The electron has properties of both a particle and a wave. It is because of this that atoms are often said to be surrounded by an "electron cloud." All orbitals have the same central nucleus. Electrons tend to occupy the lowest energy orbitals unless they become "excited." A mathematical equation called a wave equation is used to describe the behaviour of the electron. This equation takes into account the energy, mass, and wave-like properties of an electron. Thus, it treats the electron as both a particle and a wave. Solutions to the wave equation result in a set of numbers (quantum numbers) which describe the energy of the electron, type of orbital it is in, orientation of the orbital it is in, and the motion (spin) of the electron. We can thus assign an orbital for each electron in an atom! An orbital may be empty, have one electron, or have two electrons in the same orbital they must have opposite spins.	Explained the line spectra of all elements. Explained the idea of quantization of the electron's energy. As a result of treating the electron as both a particle and a wave, it can only have certain allowed energies. Treats the electron as both a particle and a wave. Can be used to explain chemical bonding (how and why atoms join together to form larger particles called molecules).	Using this model to calculate the predicted energies of the line spectra of elements is very accurate only when certain approximations are made in doing the calculations. Computers are not capable of handling the calculations without these approximations.

Exploring the Elements

Question

What are characteristics of the elements in the periodic table?

Materials

- resource books (chemistry books, encyclopaedias paper and CD-ROM)
- Internet
- index card (one per person)

Procedure

Choose an element from the periodic table to research. Go to the sign-up list and write your name next to that element. If your first choice is taken, choose another.

Find the information listed below.

- name, symbol
- atomic number
- atomic mass
- characteristics of element:
  – What does it do?
  – Where does it occur in nature?
  – How does it react with other elements?
  – Colour, state
- historical facts
- when it was discovered and by whom
- periodic table group number
- one additional fact you found interesting

Studentium
280
St
200

Using an index card and the model to the right, create an information card to present to the class and suitable to mount on our bulletin board. On the blank side and creating a rectangle taller than it is wide,

- print the full name of the element top centre of card
- put the element symbol in large, bold print under the name
- put the atomic mass top centre under the name, above and to the left of the symbol
- put the atomic number under the symbol and to the left
- on the lined back side, put all other information in jot note form and print your name

Evaluation

Evaluation is based on detail from research (10 points) and presentation of information on card (5 points).

Exploring the Elements
Teacher Notes

Outcomes

Students will be expected to

- describe and explain the role of collecting evidence, finding relationships, proposing explanations, and imagination in the development of scientific knowledge (109-2)
- use a periodic table to predict properties of a family of elements (210-1)
- select information from a variety of print and electronic sources and prepare a presentation on a particular element (209-5)
- identify examples of common elements, and compare their characteristics and atomic structures (307-15)
- identify and write chemical symbols of common elements (307-16)

Question

- What are characteristics of the elements in the periodic table?

Background Information

Once students have completed their research and presentations, have them recreate the periodic table using their elements. This can be done on a bulletin board, chalkboard, or wall. Using the information from their cards, students should be able to identify the periodic nature (The Periodic Law) of the elements within groups (columns) and periods (rows) based on their similarities. The cards can be classified according to

- atomic mass
- mass number
- atomic number

Using these similarities, have students predict the properties of an element which was not researched or that you removed from the table.

Students should also determine that elements are arranged in order of increasing atomic number.

If you have several classes of Science 9, assign the elements so that all are researched. This will lead to easy identification of the similarities in groups and periods.

Follow-up

A discussion of the “evolution” of the modern periodic table would reinforce the usefulness of periodicity by showing students how scientists have utilized these properties in the development of periodic tables. By identifying the reasons that each version of the table was replaced, students will see that science is fluid and can be changed by advances in knowledge.

What's in the Box?
Teacher Notes

Outcomes

Students will be expected to

- state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea (210-11)
- use models in describing the structure and components of atoms and molecules (307-14)

Background Information

This activity introduces how scientists developed a model of an atom.

Teachers can discuss the idea that the atomic theory was developed without scientists being able to see the atom. It is a theory based on the best observations scientists could make and all the past experiences and knowledge they had accumulated.

Have enough boxes for groups of three.

Procedure

Divide class into groups of three. Give each group a sealed box. The boxes can contain anything, children's toys, objects from your household, or classroom junk drawers.

Groups will have 15 minutes to guess what's in their box. Each student in the group will act as recorder for five minutes while the other two members discuss. Students are not allowed to damage or open the box.

After 15 minutes, each group will present their consensus and observations to the class. When everybody has completed this activity, the boxes can be opened.

Mystery Element

Question

What experiments can you plan to find out your element? Perform a few simple tests on the element. What is your element?

Mystery Element
Teacher Notes

Outcomes

Students will be expected to

- demonstrate a knowledge of WHMIS standards by using proper techniques for handling and disposing of lab materials (209-7)
- state a conclusion, based on experimental data, and explain how evidence gathered supports that conclusion (210-11)
- investigate materials and describe them in terms of their physical properties (307-12)

Background Information

This activity can be used as a refresh of the periodic table or of physical properties of an element.

Student will identify a mystery element by measuring a variety of properties or by suggesting experiments that could be performed to measure properties of the element.

In cases where experiments may be beyond the scope of what can be explored in the classroom, the teacher may provide the needed information. *The Handbook of Physics and Chemistry* is a good source of data for this activity.

Procedure

Give each student a chunk of the mystery element (zinc, silicon, and carbon are inexpensive, non-toxic, and readily available). Students will research and plan experiments to measure properties of the element. Alternatively students can describe experiments in detail, including calculations, to the teacher.

Analysis

Students will either prepare a formal report or participate in a class discussion of their findings. This exercise will allow students to relate properties of elements to their positions in the periodic table.

Safety

Most elements cannot be handled. Zinc metal is very safe; however, zinc dust is not. Remind students that they must always wash their hands well after handling any chemical.

Sample Results

Appearance	Density	Melting Point
hard, bluish-white metal, inflexible has a luster	7.14 g/mL	419°C (given by teacher)
Conclusion	Given these properties, the element must be zinc.	

Making Rock Candy

Questions

- How do you make rock candy?
- Does the formation of rock candy represent a chemical or a physical change?

Materials

- 2 cups bottled water
- 5 cups sugar
- heavy saucepan
- clean metal spoon
- Styrofoam cups
- aluminum foil
- bamboo skewers
- oven mitts
- candy thermometer (optional)

Safety

The temperatures involved in making rock candy are very high. Be extremely careful while stirring and pouring the mixture.

Procedure

The teacher will divide the class into pairs. Each group will have 2 cups of bottled water and put 2 cups in each cup. In 2 Styrofoam cups, place 2 skewers (one for each member of the group). Make sure the cups and skewers are absolutely clean or the candy will not form.

If a candy thermometer is available, dissolve the sugar in the water while stirring and cook until it reaches 250°F. Don't stir after you've dissolved the sugar. If you don't have a candy thermometer, dissolve the sugar fully while stirring. Once the sugar is dissolved, use a clean spoon to drop a small amount of the mixture into a cupful of very cold water. Test the resulting ball with your fingers. It should form a hard ball that holds its shape but is pliable. Keep testing small amounts until the mixture reaches this point.

Pour the hot liquid into the cups. One partner should hold onto the skewers while another pours the liquid. Cover the pan with foil and don't touch it for 7 days!

Making Rock Candy
Teacher Notes

Outcomes

Students will be expected to

- determine, where possible, if the change in a material or object is physical or chemical based on experimental data (210-11)
- investigate materials and describe them in terms of their physical properties (307-12)

Background Information

Hot plates or stoves are the best heat sources for this lab. If your school has a cooking lab, it would have many of the required materials such as saucepans, oven mitts, and stoves. This activity should be started before you introduce physical and chemical changes. The candy should be ready on the day when you discuss evidence of such changes. In this way, the completed candy can be the focus of the discussion. At the end of the class, everyone gets to eat their candy!

Discussion should focus on evidence which indicates physical versus chemical change. Students should understand that a chemical change involves the production of new substances with new properties. While there are particular types of evidence which can be used to support the inference of a chemical change (e.g., bubbles being formed, change of colour, odour, temperature change), it is important that students understand that this is not conclusive evidence, since many physical changes may also fit these categorizations. Some changes, such as those in which a precipitate (an insoluble solid) is formed, indicate a chemical change. Some changes such as dissolving, as in the rock candy, are more difficult to classify. Dissolving is usually listed as physical, but many chemical interactions occur. Many chemical reactions are easily reversible (equilibrium reactions) while many physical changes are not easily reversible (shredding paper, sanding down wood). Making rock candy is a physical change which results in a product that does not look like the original nor is it easily reversed to typical sugar crystals.

Many of the materials required for this activity (spoons, cups, foil, skewers) are available in large quantities at dollar stores. Students could be responsible for bringing in sugar, saucepans, oven mitts, and water if your school does not have distilled or filtered water available and if you are not using a cooking lab.

Safety

The temperatures reached in this activity are very high and could cause serious burns. Lab equipment must ***not*** be used in place of saucepans and spoons. Teachers should be aware of food allergies, sensitivities, and conditions such as diabetes among students in their classes.

Physical and Chemical Changes

Question

Which of the following represent physical changes and which represent chemical changes?

Safety

- Be careful of hot wax.
- Be sure to hold the tin lids/watch glasses with tongs or heat resistant gloves.
- Do not set fire to the paper in Station 9. Hot plates produce a great amount of heat.

Procedure

Make notes as you go through the stations using a chart of your own design.

Station 1

- Light the candle.
- Scrape a bit of wax onto tin lid.
- Using tongs, hold lid over Bunsen burner flame.
- Record observations.
- Remove lid from flame; cool.
- Record observation.
- What kind of change is this?
- Clean up and reset station for next group.

Station 2

- Light the candle.
- Observe the candle as it burns.
- Extinguish the candle.
- Record observations.
- What kind of change is the burning of the candle?
- Clean up and reset station for next group.

Station 3

- Add salt to water and stir gently.
- Record observations.
- Place a small amount of salt water on the tin lid and heat over the burner.

- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 4

- Apply the sandpaper to the block of wood.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 5

- Mix the sand and filings in a Petrie dish; stir gently.
- Record observations.
- Pass the magnet over the mixture.
- Record observations.
- What kind of change is this?
- Clean up and reset station for the next group.

Station 6

- Place a small amount of sugar on a lid.
- Ask to have the candle lit.
- Hold lid over flame; record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 7

- In a Petrie dish, add vinegar to milk using a different eye dropper for each liquid.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 8

- Gently warm some water in a beaker.
- Add a small amount of yeast and sugar.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 9

- Using a stirring rod, write your name on a piece of paper with lemon juice.
- After the juice dries, record observations.
- Heat your paper over the hot plate.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 10

- Place some corn starch in a Petrie dish.
- Add a drop of iodine.
- Record observations.
- Clean the dish and add some alcohol.
- Add a drop of iodine.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Physical and Chemical Changes
Teacher Notes

Outcomes

Students will be expected to

- demonstrate a knowledge of WHMIS standards by handling lab materials (209-7)
- display data collected on the physical properties of materials (210-2)
- determine, where possible, if the change in a material or object is physical or chemical based on experimental data (210-11)
- identify new questions about physical and chemical changes that arise from investigations (210-16)
- investigate materials and describe them in terms of their physical properties (307-12)

Background Information

Stations are a good way of conducting brief labs while keeping students actively involved. Each activity requires about five minutes to complete. Stations require significant advance preparation.

Each station should have a large copy of the instructions for that station posted along with anything necessary for clean-up after each activity (on the pages which follow). Each station could have the supplies grouped in a box/bag so that the set-up and clean-up is efficient and organized. This can then be used for future activities without the same amount of preparation time.

Discussion should focus on evidence which indicates physical versus chemical change. Students should understand that a chemical change involves the production of new substances with new properties. While there may be evidence to support the inference of a chemical change (e.g., bubbles being formed, change of colour, odour, temperature), it is important that students understand that this is not conclusive evidence since many physical changes may also fit these categorizations. Some changes, such as those in which a precipitate is formed, indicate a chemical change. Some changes, such as dissolving (as in the rock candy activity) are more difficult to classify. Dissolving is usually listed as a physical change, but many chemical interactions occur. Many chemical reactions are easily reversible (equilibrium reactions like plaster hydrating) while many physical changes are not easily reversible (shredding paper, sanding down wood).

Possible leading questions for post-lab discussion could include: "Are there examples of changes that are not easily identified as chemical or physical?" "What does it mean when you say a new substance is formed?" and "Can you always tell when a final substance is different from the starting materials?" This activity and discussion should make students aware that the theoretical definitions of physical and chemical changes are more clear cut than their operational definitions.

Materials

Station 1

- candles
- matches
- several tin lids
- lit Bunsen burner
- tongs
- paper towel
- garbage can

Station 2

- candles
- matches

Station 3

- container of salt with a scoop
- water bottle
- small beakers
- stirring rod
- several tin lids or watch glasses
- paper towel
- waste bucket
- large beaker for salt and water mixture

Station 4

- sand
- iron filings
- magnet
- Petrie dishes
- stirring rod
- disposal container for mixture

Station 5

- sugar
- several tin lids
- candles
- matches
- paper towel
- garbage can

Station 6

- vinegar
- milk
- eye droppers
- Petrie dishes
- beaker to dispose of mixture
- paper towel
- garbage can

Station 7

- sandpaper
- small blocks of wood
- paper towel
- garbage can

Station 8

- water bottles
- small beakers
- hot plate
- can of yeast
- sugar
- scoops
- large beaker for disposal of mixture
- paper towel
- garbage can

Station 9

- several small pieces of paper
- lemon juice
- hot plate

- stirring rod
- tongs
- garbage can

Station 10

- corn starch
- scoop
- Petrie dishes
- iodine
- paper towel
- beaker of alcohol with eye dropper
- containers for disposal of mixtures
- garbage can

Safety

Watch students carefully when they are working with the candles, hot plates and paper.

Station 1

- Ask to have the candle lit.
- Scrape a bit of wax onto tin lid.
- Using tongs, hold lid over Bunsen burner flame.
- Record observations.
- Remove lid from flame; cool.
- Record observation.
- What kind of change is this?
- Clean up and reset station for next group.

Station 2

- Ask to have the candle lit.
- Observe the candle as it burns.
- Extinguish the candle.
- Record observations.
- What kind of change is the burning of the candle?
- Clean up and reset station for next group.

Station 3

- Add salt to water and stir gently.
- Record observations
- Place a small amount of salt water on the tin lid and heat over the burner.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 4

- Apply the sandpaper to the block of wood.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 5

- Mix the sand and filings in a Petrie dish; stir gently.
- Record observations.
- Pass the magnet over the mixture.
- Record observations.
- What kind of change is this?

- Clean up and reset station for the next group.

Station 6

- Place a small amount of sugar on a lid.
- Ask to have the candle lit.
- Hold lid over flame; record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 7

- In a Petrie dish, add vinegar to milk using a different eye dropper for each liquid.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 8

- Gently warm some water in a beaker.
- Add a small amount of yeast and sugar.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 9

- Using a stirring rod, write your name on a piece of paper with lemon juice.
- After the juice dries, record observations.
- Heat your paper over the hot plate.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Station 10

- Place some corn starch in a Petrie dish.
- Add a drop of iodine.
- Record observations.
- Clean the dish and add some alcohol.
- Add a drop of iodine.
- Record observations.
- What kind of change is this?
- Clean up and reset station for next group.

Bucky Balls

Question

What information can we find about the compounds that surround us?

Materials

- 3 sheets of paper pentagons to construct a bucky ball
- tape or glue
- string
- reference books
- access to the Internet

Procedure

Choose a partner. Each pair will draw the name of a compound from a container as the teacher passes it around the class. Each pair will research their compound and create a paper model (bucky ball).

You and your partner must find 12 properties of your compound, one of which must be the compound's purpose. Use available reference books and Internet sites to find any safety information about your compound.

Cut out the pentagons, leaving approximately half a centimetre around the perimeter and cutting notches at the corners. On each of the 12 shapes, write one fact. Use tape or glue to construct a bucky ball with a string loop at one of the intersection points.

Present your compound to the class. Display the bucky balls in the classroom.

Bucky Balls
Teacher Notes

Outcomes

Students will be expected to

- compile and display data collected on the physical properties of materials investigated (210-2)investigate materials and describe them in terms of their physical properties (307-12)

Background Information

To gain an appreciation of how physical properties can be used to identify materials, students will describe everyday objects in terms of their physical characteristics. Physical properties are properties that do not involve the formation or creation of a new substance. Examples of physical properties include odour, colour, taste, melting point, boiling point, solubility, malleability, and density.

Materials

- 3 sheets of paper pentagons to construct "Bucky ball"
- tape or glue
- string
- reference books
- access to Internet

Chemistry Clue

Fill in the chart below using the information from the clues that follow.

Transition elements

- *C* has four protons.
- I is the lightest element.
- M, in period 2, can be used to tell how old some fossils might be.
- Th has an atomic number of 13.
- Ea is less active than
- P but more active than Ve.
- En has the highest atomic mass in group 2 and is important for your bones and teeth.
- Ap is a Noble gas in period 3.
- Y is the most active nonmetal.
- In, when neutral, has an electron configuration of $1s^2 2s^2 2p^6 3s^2 3p^2$.
- T has 12 protons, 12 neutrons, and 12 electrons when neutral.
- Nh is more reactive than Ca but both are in period 3.
- Gs has three more protons than Ea.
- N has a mass number of 20 and an atomic number of 10.
- He has an electron configuration of $s^2 2s^2 2p^1$.
- Lo has a full energy level with two electrons in the energy level.
- Gs is a less active nonmetal than Is but they are in the same group.
- Tr is the element that is essential in the atmosphere for breathing.
- Gs has five electrons in its outer energy level and is in the third row.

What message is contained in the completed periodic table?

The symbols are not the correct elements from the Periodic Table. Rather, these symbols are representing the characteristics of a particular element in the Periodic Table.

Chemistry Clue
Teacher Notes

Outcomes

Students will be expected to

- describe and explain the role of collecting evidence, finding relationships, proposing explanations, and imagination in the development of scientific knowledge (109-2)use or construct a classification key (210-1)identify examples of common elements, and compare their characteristics and atomic structure (307-15)

Background Information

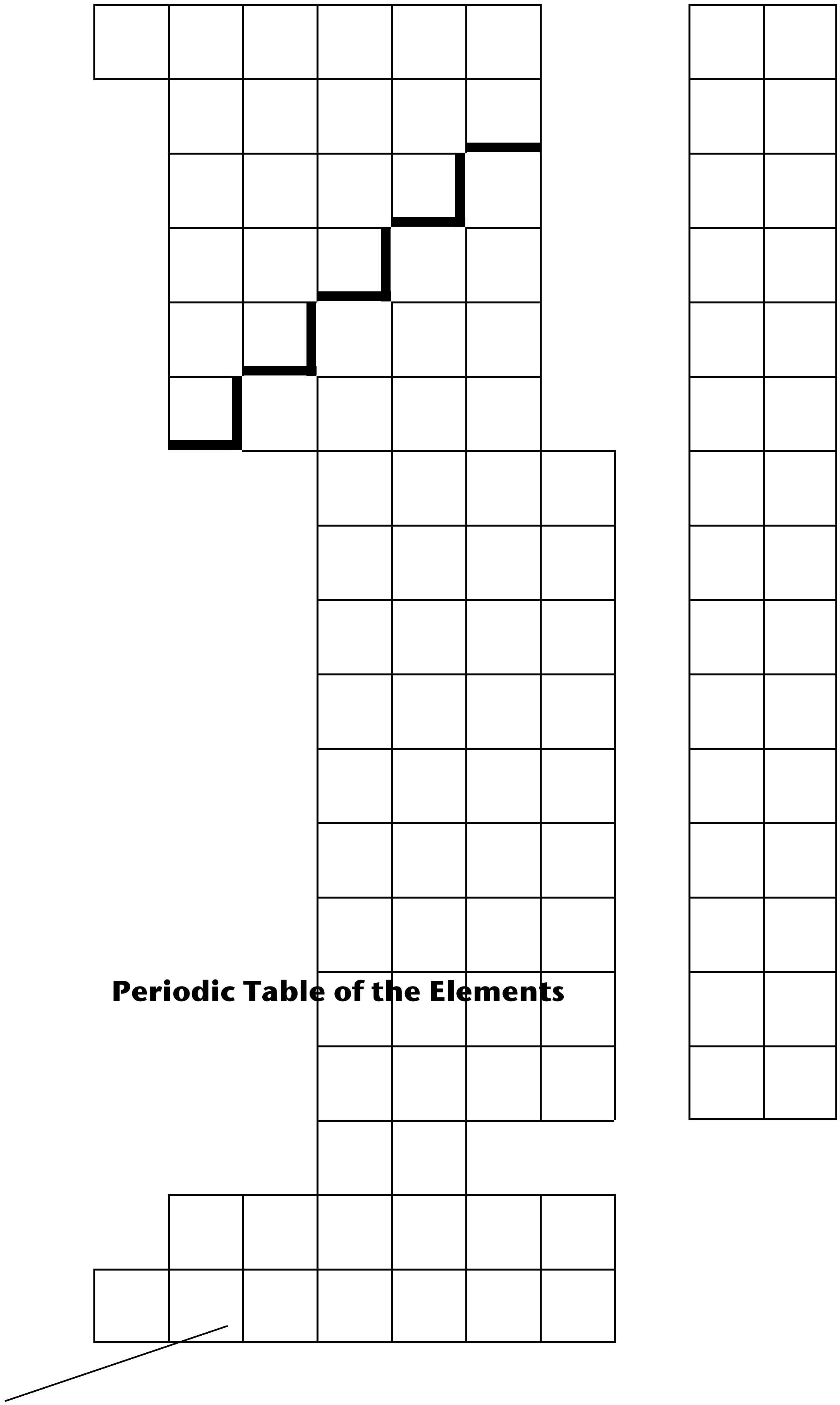
This activity enables students to test their understanding of electron configurations and some of the trends in the periodic table.

Sample Results

The table should be completed like the one below.

I								Lo
Ve	C		He	M	Is	Tr	Y	N
Ea	T		Th	In	Gs	Ca	Nh	Ap
P	En	Transition elements						

Periodic Table of the Elements



Atoms and Isotopes

Part A

Identify the elements and the number of atoms of each element in each of the following chemical formulas. The first one is done for you as an example:

Compound	Elements	Number of Each Element in Compound
H_2O	Hydrogen, oxygen	H = 2 atoms, O = 1 atom
H_2O_2		
CH_4		
CO_2		
CO		
$CaCO_3$		
C_3H_8		
$NaCl$		
H_2		
N_2		
CCl_4		
NH_4Cl		
CH_3COOH		
$Ca(NO_3)_2$		

Part B

Fill in the following table for each of the isotopes listed. DO NOT USE YOUR PERIODIC TABLE! The first one is done as an example:

Symbol	Atomic Mass	Atomic Number	Number of Protons	Number of Neutrons	Number of Electrons
$^{23}_{11}Na$	23	11	11	12	11
$^{20}_{10}Ne$					
$^{200}_{80}Hg$					
$^{65}_{30}Zn$					
$^{27}_{13}Al$					
$^{118}_{50}Sn$					
$^{210}_{83}Bi$					
$_{3}Li$				4	
No		102		157	
Lu				104	71

Atoms and Isotopes
Teacher Notes

Outcomes

Students will be expected to

- identify examples of common elements, and compare their characteristics and atomic structure (307-15)
- use models in describing the structure and the components of atoms and molecules, and explain the importance of choosing words that are scientifically appropriate: determine the number of protons and electrons in the atom of an element, given its atomic number; determine the number of protons, electrons, and neutrons, given the mass number and the atomic number; and be able to write the appropriate symbol for an isotope, given the number of protons and neutrons (109-13, 307-14)

Background Information

These worksheets help strengthen basic skills and knowledge. It is very important they use the information presented in Part B to determine the answers instead of the periodic table. The atomic mass on the periodic table is the weighted average of all of the isotopes of that element; each isotope has a mass in whole numbers because there are no fractions of electrons or neutrons.

Sample Results

The tables should be completed as indicated on the next page.

Table from Part A

Compound	Elements	Number of Each Element in Compound
H_2O	Hydrogen, Oxygen	H = 2 atoms, O = 1 atom
H_2O_2	Hydrogen, Oxygen	H = 2 atoms, O = 2 atoms
CH_4	Carbon, Hydrogen	C = 1 atom, H = 4 atoms
CO_2	Carbon, Oxygen	C = 1 atom, O = 2 atoms
CO	Carbon, Oxygen	C = 1 atom, O = 1 atom
$CaCO_3$	Calcium, Carbon, Oxygen	Ca = 1 atom, C = 1 atom, O = 2 atoms
C_3H_8	Carbon, Hydrogen	C = 3 atoms, H = 8 atoms
NaCl	Sodium, Chlorine	Na = 1 atom, Cl = 1 atom
H_2	Hydrogen	H = 2 atoms
N_2	Nitrogen	N = 2 atoms
CCl_4	Carbon, Chlorine	C = 1 atom, Cl = 4 atoms
NH_4Cl	Nitrogen, Hydrogen, Chlorine	N = 1 atom, H = 4 atoms, Cl = 1 atom
CH_3COOH	Carbon, Hydrogen, Oxygen	C = 2 atoms, H = 4 atoms, O = 2 atoms
$Ca(NO_3)_2$	Calcium, Nitrogen, Oxygen	Ca = 1 atom, N = 2 atoms, O = 6 atoms

Table from Part B

Symbol	Atomic Mass	Atomic Number	Number of Protons	Number of Neutrons	Number of Electrons
$^{23}_{11}$Na	23	11	11	12	11
$^{20}_{10}$Ne	20	10	10	10	10
$^{200}_{80}$Hg	200	80	80	120	80
$^{65}_{30}$Zn	65	30	30	35	30
$^{27}_{13}$Al	27	13	13	14	13
$^{118}_{50}$Sn	118	50	50	68	50
$^{210}_{83}$Bi	210	83	83	127	83
$^{7}_{3}$Li	7	3	3	4	3
$^{259}_{102}$No	259	102	102	157	102
$^{175}_{71}$Lu	175	71	71	104	71

Chemmy: The Game

Materials

- deck of 80 Chemmy cards
- paper and pencil

Rules of the Game

- Players: 3 to 5 players
- Deck: 80 Chemmy cards
- Object of the Game: to make complete sets of element information. For instance, a complete set of information for Calcium would be as illustrated below:

40 20	Ca	Calcium	Ca	20

- Deal: Each player receives 9 cards. After the cards have been passed out, put the remaining cards face down in the middle of the playing area to form the Stock Pile and turn the top card face up and place it next to the Stock Pile to form the Discard Pile.
- Play: Play begins with the person to the dealer's left. He/She can either take the top card off the Discard Pile or the top card off the Stock Pile. He/She then may put down any complete sets of element information and then discard a card.
- Drawing from the discard pile: When a player wants to draw from the discard pile he/she can. The player takes only the top card then puts down any sets and discards a card. The player may not discard the card that was picked from the discard pile!
- If the Stock Pile runs out: If the Stock Pile runs out of cards, flip over the Discard Pile so that the cards are face down. Do not shuffle the deck.
- Going out: When a player makes sets of all his/her cards (with or without a final discard), the hand is over.
- Scoring: After a player goes out, he/she receives 5 points for every piece of deadwood (cards that were in the opponent's hand when the player went out) in each opponent's hand.

The game is over when one player reaches a total of 200 points (or another amount indicated by the teacher).

Chemmy: The Game
Teacher Notes

Outcomes

Students will be expected to

- identify examples of common elements, and compare their characteristics and atomic structure (307-15)
- use models in describing the structure and the components of atoms and molecules, and explain the importance of choosing words that are scientifically appropriate: determine the number of protons and electrons in the atom of an element, given its atomic number; determine the number of protons, electrons, and neutrons, given the mass number and the atomic number; and be able to write the appropriate symbol for an isotope, given the number of protons and neutrons (109-13, 307-14)

Background Information

Chemmy cards can be constructed using blank index cards (available at business supply stores for about $2/100 cards) and labels. The templates on the pages which follow can be copied onto any 5.1 x 10.2 cm (2 x 4") labels and then applied to the index cards.

Hydrogen	H
1	$^{1}_{1}H$
Helium	He

2	$^{4}_{2}He$
Lithium	Li
3	$^{7}_{3}Li$

Beryllium

$^{9}_{4}Be$

Be

4

Boron

$^{11}_{5}B$

B	5
Carbon	C
6	$^{12}_{6}C$

Nitrogen

N

7

$^{14}_{7}N$

Oxygen

O

8

$^{16}_{8}O$

Fluorine

$^{19}_{9}F$

F

9

Neon	$^{20}_{10}Ne$
Ne	10
Sodium	Na

11

$^{23}_{11}Na$

Magnesium

Mg

12

$^{24}_{12}Mg$

Aluminum	Al
13	$^{27}_{13}Al$
Silicon	$^{28}_{14}Si$

Si	14
Phosphorus	$^{31}_{15}P$
P	15

Sulfur	S
16	$^{32}_{16}S$
Chlorine	Cl

17	$^{35}_{17}Cl$
Argon	Ar
18	$^{40}_{18}Ar$

Potassium	$^{39}_{19}K$
K	19
Calcium	$^{40}_{20}Ca$

Ca 20

Unit 4: Electricity

Charge it!

Questions

- How many ways are there to charge an electroscope?
- How many different charge conditions are there?

Background Information

An electroscope is a device used in the study of electric charges. Two foil leaves hanging down inside the glass sided box are free to swing outwardly. Since the leaves are connected to the ball on top, charged objects brought near the ball will affect the charge on the leaves. If they both become charges, the leaves push away from each other. The greater the charge on them, the further the leaves push apart. If the electroscope is charged already, the leaves will move together if an object of opposite charge is brought near the ball on top.

Hypothesis

Write a hypothesis about how an electroscope may be charged and then write an appropriate prediction about your hypothesis.

Materials

- plastic bags
- ebonite rod (plastic comb or piece of vinyl strip)
- glass rod (please be careful with it because it may roll of the desk and they break easily)
- fur
- paper towel or wool
- electroscope

Safety

Be careful not to break the electroscope or the glass rod.

Procedure

You have a collection of materials to use in your investigation. How can you test each of the possible situations and identify the charge condition produced? For example, select a piece of vinyl plastic or ebonite rod. Rub it with a piece of paper towel (fur or wool). Bring it near the ball of the electroscope and observe what happens to the leaves. Move the vinyl strip slowly away from the electroscope. What happens? Bring the strip in and touch it to the electroscope, then remove the strip. What happens? Bring the strip near the electroscope again. What happens? Bring the paper you used to charge the vinyl strip near to the electroscope. What happens? You have just charged the electroscope by contact or CONDUCTION which allows charges to move from one object to another. What movement of charge do you think happened in this case?

Continue to explore other combinations of objects and charging materials. Record the results. Record similarities in combinations of objects and charging materials.

Another way to charge an electroscope is by INDUCTION. Follow the following steps carefully. Touch the electroscope with your finger to make sure it has no excess charge on it. Bring a charged vinyl strip near enough to the top of the electroscope to make the leaves separate, but NOT so close that any charges transfer in either direction. While holding the vinyl in this position, touch the top of the electroscope with a finger on your other hand. What happens? Remove your finger first, then take the vinyl strip away. What happens? How does the charge on the electroscope compare with the charge on the vinyl strip? How do you know this? Use other charged objects in the same way and write about your observations.

Observations

Record your observations in a chart of your own design.

Analysis

Explain your observations in terms of the movement of negatively charged electrons. The positively charged particles do not move around.

Conclusions

Use the questions from the beginning of the activity to help develop your conclusion.

Charge It!
Teacher Notes

Outcomes

Students will be expected to

- identify properties of static electric charges (308-14)
- explain the production of static electric charges in some common materials (308-13)
- identify and suggest explanations for discrepancies in the data (210-8)

Background Information

Students should be careful when carrying the electroscope. Put one hand underneath and don't shake it. If a leaf should fall off, use forceps to put it back on. Oils from your fingers will interfere with the effectiveness of the electroscope. A dry day is best for this activity.

An electroscope is a device used in the study of electric charges. The two foil leaves hanging down inside the glass sided box are free to swing outwardly. Since the leaves are connected to the ball on top charged objects brought near the ball will affect the charge on the leaves. If they both become charged, the leaves push away from each other. The greater the charge on them, the further the leaves push apart. If the electroscope is charged already, the leaves will move together if an object of opposite charge is brought near the ball on top.

If the negatively charged vinyl strip is brought near the top of the electroscope, the electrons in the ball are repelled down into the leaves. The leaves have the same negative charge, and repel each other. If you use the paper towel or glass rod which is positively charged, then electrons move up from the leaves to the ball and the leaves become positively charged. If the electroscope is touched by any of the charged objects, electrons either go onto the scope or leave the scope and the leaves become charged. After removing the object, the scope remains charged.

During charging by induction, the vinyl strip repels electrons down into the leaves. When you put your finger on the scope top, you transfer electrons from your finger onto the positively charged top. When you remove your finger, the surplus electrons are left on the electroscope. When the vinyl strip is taken away, the electrons evenly redistribute themselves over the leaves and top. Since there is a surplus of electrons, the leaves have the same charge and repel each other.

Materials

Teachers can get supplies from science supply companies which have ebonite and glass rods. A plastic ruler can be used or vinyl may be obtained from someone who installed vinyl siding and has leftovers. Fur or woolen sweaters can be obtained from a used clothing store.

Reference

Physics: Principles and Problems. Merrill (1992). Zitzewitz, Paul W., and Robert F. Neff.

Obey the Law! Electric Charges Do

Questions

- Are there different types of electric charges?
- Can you tell the difference between electric charges?
- Do electric charges follow the "Law of Electric Charges"?

Background Information

You are already aware that rubbing your feet across the carpet and then touching someone gives them a shock. You cannot see the cause of the shock, so how do you know electric charges exist? Electrons and protons are too small to ever see directly or even with the most powerful microscope. The only way you know that they exist is that collectively the charges exert enough force on things to make them move. This activity will give you time to explore electric charges and their interactions.

Materials

The list of materials is a starting list. You can add to the list if you want to test other items. Plastic bags, ebonite rod (or plastic comb), glass rod (please be careful with it because they roll off the desk and they break easily), Bluegrass seeds, fur or wool, electroscope or puffed rich (wheat) on fine thread (two per group), thin steam of water running out of a tap.

Safety

Wear safety goggles.

Be careful not to break the glass rod.

Procedure

Use the materials to explore ("play" with) electric charges and their interactions. Write down ten different observations you make. Pool the classes observations at the end of the exploratory time. Use the Law of Electric Charges to explain the observations you made.

Observations

Record your observations in your note book. Add other observations that your group did not make.

Analysis

Try to explain each observations using the Law of Electric Charges.

Conclusion

Use the questions from the beginning of the activity to help develop your conclusion.

Obey the Law! Electric Charges Do
Teacher Notes

Outcomes

Students will be expected to

- identify properties of static electric charges (308-14)
- explain the production of static electric charges in some common materials (308-13)
- identify and suggest explanations for discrepancies in the data (210-8)

Background Information

This is an opportunity for students to literally play with electric charges and write about their observations. They can be given the materials and told what to do with each set, such as rub the fur and the ebonite rod together and put the rod over the grass seeds; however they will discover this after a while without the directive. The pooled observations could give 15–20 or more. Students can give you their list to be written on an overhead and then add to the initial list if there observations are different. Any conflicting observations can be checked by repetition. Observations the students can't explain could be further investigated.

Choose a dry day with low relative humidity for this activity to give best results. The ebonite rod will pick up electrons from the wool or fur and become negatively charged just as amber originally did. If the rod is placed near the grass seeds, the seeds will "jump" (be pulled) up to the rod because the rod is highly charged. The seeds are neutral but the electrons on the seeds' surface are repelled to the opposite end of the seeds. This leaves the end of the seeds closest to the rod positively charged and the seeds are attracted to the rod. The seeds stick to the rod for a short time until the seeds pick up some charged glass rod nearby, seeds will 'jump' from the ebonite rod to the glass rod and back again as the seeds change their charge. The plastic bag you rub the glass rod on has the same charge as the ebonite rod, while the fur will end up with a positive charge. If the puffed rick kernels hang side by side and are touched with a charged object, they become charged with the same charge and repel each other. A charged object will attract the water column and make it bend towards it. If the object gets wet, it will lose its charge to the water. If you touch oppositely and equally charged objects together, they will neutralize each other's charge.

Materials

Teachers can get supplies from science supply companies which have the ebonite and glass rods. Purchase the frosted end glass rod because they become more strongly charged. Fur can be obtained cheaply at a used clothing store. The Bluegrass seed can be bought at a garden supply store.

References

Physics: Principles and Problems. Merrill (1992). Zitzewitz, Paul W., and Robert F. Neff.

Energy at what cost?

Questions

- How much would it cost to run a 1200 W hair dryer for 15 minutes?
- How much do the electric appliances you use in your home cost to operate per month?

Background Information

The Nova Scotia Power (NSP) charges households using electricity for the energy used. The metre reader comes to your place of residence once every two months to determine the number of kilowatt-hours (kWh) registered on the metre. From these readings, the NSP can calculate how much energy your home has used and then you are charged $0.0835 for every kWh used. The bill for electricity comes by mail every two months or six times a year. A kilowatt-hour is 1000 watts (W) of power used for one hour.

Procedure

Calculate the cost to run each electrical device for the time periods given. A table such as the example below could be used

Electrical Device	Power Rating	Time Used per Month	Monthly Cost
Dishwasher	1500 W	15 hours	
Freezer	440 W	284 hours	
Microwave	1500 W	22 hours	
Blender	300 W	0.75 hours	
Television	240 W	240 hours	
Light Bulb	40, 60, & 100 W	130.5 hours	
Air Conditioner	960 W	120 hours	
Stereo	40 W	500 minutes	
VCR	30 W	300 minutes	
Toaster	1250 W	.75 hours	

Sample

Calculations

How much will 500 kWh of electricity cost me?

Cost = power (kW) x time (h) x $0.0835/kWh

= 500 kW x 1.0 h x $0.0845/kWh

Cost = $ __________

How much does the 1200 W hair dryer cost to fun for 15 minutes?

Before this calculation can be done, watts must be converted to kW and the time must be converted to hours.

There are 1000 W in a kilowatt, divide 1200 W by 1000 – 1.2 kW
There are 60 minutes in 1 hour, divide 15 minutes by 60 – 0.25 h
the formula for calculating cost of energy is Cost = Power (kW) x time (h) x cost/kWh = 1.2 kW x 0.25 h x $0.0835/kWh

Safety

Be careful when inspecting electrical devices. Watch out for and report damaged wires or plugs.

Energy at what cost?

Teacher Notes

Outcomes

Students will be expected to

- relate electrical energy costs to domestic power consumption costs (308-18)
- evaluate the design of a technology and the way it functions on the basis of identified criteria such as cost and the impact on daily life and the environment (113-6 Pan-Canadian)

Background Information

Answers to sample questions — $0.43 and $0.03

Teachers may wish to use the following alternative approaches:

Students could be given just the list of electrical devices and then construct their own chart based on a home survey of their household. If they were to estimate the monthly use for each item and its cost, they could compare the calculated cost with the household monthly bill. Some major devices are missing such as the hot water heater and baseboard heaters. Students could then suggest ways to conserve energy use in their home.

Students could create a spreadsheet using a computer program. The data could be put into the cells, and a formula developed for the final cell, which automatically calculates the cost of each device. Students could then change the values for time used, and observe the change in cost.

Students could use the spreadsheet format they created to input information about their own household appliances and monthly use. Comparisons for differing appliances or for different seasons could then be made.

Wired

Background Information

NOTICE! Always be careful when doing electrical experiments. Make sure all connections are tight. Make sure no wires touch where you do not want them to. This can cause a “short” circuit, which means that a shorter (or easier) path is provided for charges to travel, often with no device in the path. This can result in a very large current, which can melt the conductor and cause the circuit to break. With household circuits this can be a serious hazard. Always check circuits carefully before you close the switch to start the experiment.

Heat can build up in wires during an experiment. This can be hazardous, and will also affect your results. It is best to close a switch for short periods to take readings. Always leave the switch for short periods to take readings. Always leave the switch open when you are not making observations.

Electrical instruments are very delicate, especially ammeters. Follow these directions carefully. An ammeter counts the charges moving in a wire, and therefore must be connected “in line”. Make sure the positive and negative connections are in the correct directions. When you are ready to operate the circuit, close the switch very briefly at first. If the needle moves in the correct direction, go ahead and close the switch firmly. If an ammeter is hooked up backwards, it may be permanently damaged, ending your experiment. If your circuit has more than one path, you may put an ammeter in each path or a single ammeter may be moved from path to path.

The voltmeter is not usually hooked up to the circuit permanently. It is designed to compare the energy electrons have at two points in the circuit, which is called potential (energy) difference. Therefore it is usually connected to two leads and the leads are touched to two points in the circuit long enough to take a reading. The two points are usually before and after the item you wish to evaluate, and this is called “bridging”. In this way, the voltmeter can be quickly moved from one part of the circuit to another.

Questions

- How does current in a circuit change as more light bulbs or resistors are added in series? ... in parallel?
- How does voltage change in parts of a circuit as more light bulbs or resistors are added in series? ... in parallel?

Materials

- two 1.5 V dry cell batteries
- wire
- socket sand light bulbs and/or resistors
- ammeter
- voltmeter

Safety

Be careful to follow the directions. Connect the voltmeters and ammeters correctly. Do not connect more than two 1.5 volt batteries in series.

Procedure

Construct circuits with wire, ammeter, and voltmeter and the following combinations or dry cell(s) and light bulbs or resistors.

- One cell, one bulb
- One cell, two bulbs in series (one line)
- One cell, three bulbs in series
- One cell, two bulbs in parallel (on separate lines)
- One cell, three bulbs in parallel
- Two cells, three bulbs in series

Before you start, draw diagrams of each circuit and create a data table in which you can record your measurements. For each set-up, determine the current in all parts of the circuit and the potential difference (voltage) at the source and at each of the bulbs or resistors. In each circuit, determine the ratio V/I (volts/amps) for each bulb or resistor.

Results

Record your current and voltage measurements in the chart you have drawn.

Analysis

Calculate the ratio of voltage/current (volts/amps) for each bulb. How does this value compare from trial to trial?

- Draw a graph of current versus number of resistors in a series circuit.
- Draw graph of the current versus number of resistors in a parallel circuit.
- Use the results of all of the groups in the class to improve your reliability.

- Are there any trends or patterns that you notice from the data?

Conclusion

Use the questions from the beginning of the activity to help develop your conclusion.

Wired
Teacher Notes

Outcomes

Students will be expected to

- use an ammeter and voltmeter to measure current and voltage in series and parallel circuits (209-3)
- identify potential sources of error in ammeter and voltmeter readings (210-1)
- identify and suggest explanations for discrepancies in data collection using an ammeter and a voltmeter (210-7)
- present graphically the data from investigation of voltage, current, and resistance in series and parallel circuits (210-5, 211-2)
- describe series and parallel (maximum two resistors) circuits involving varying resistance, voltage and current using Ohm's Law. Draw circuit diagrams using circuit symbols for a cell, switch, battery, lamp, resistor, multi-range metre (308-17)

Background Information

Students may find the concepts of the series and parallel circuit easier to keep separate if the activity is done on two different days. Do all series work one class and the parallel part the next.

Following directions is very important for the students to achieve meaningful results. If you are drawing a circuit diagram or drawing a diagram of a built circuit, put the paper in the middle of the desk and then have the circuit around the outside of the paper. Hang the wires over a stand so they don't get tangled when not in use. Have the students show you the circuit before they close the switch, then you can check to see if positive and negative are correct to prevent metre damage. Also, don't leave extra batteries lying around. The more spirited students most certainly want to discover what happens when they hook up many batteries in series. They may damage the metres doing this or overheat the resistors. If you use light bulbs as resistors, the initial readings may be lower than later readings because resistance of a wire (filament) increases when it heats up.

Materials

Teachers can get supplies from science supply companies. However, if you can read the code for resistors you could scavenge them from a scrapped circuit board to save money. Students could also bring a multi-metre for measuring both current and resistance if none are available.

References

Physics: Principles and Problems. Merrill (1992). Zitzewitz, Paul W., and Robert F. Neff.

Windmill Olympics

Questions

- Which design of windmill will produce the most torque?
- How much current can a small windmill produce using 1.5 volt DC motor as generator?

Background Information

Utilizing wind energy to generate electricity efficiently in commercial quantities is relatively new technology. Isolated homes have used this alternative source of electricity in the past. The windmill turns a generator to produce electricity, which in turn charges a battery system. The batteries provide electricity on days when there is little or no wind. Atlantic Canada has some potential for generating commercial quantities of electrical energy through wind power if the price of producing electricity by traditional means becomes expensive.

Materials

- recycled tape deck motors or DC motors
- vinyl strips
- wood
- plastic
- multimeter
- electric fan

Safety

Be careful of spinning fan and windmill blades which can be dangerous to fingers.

Do not use electric DC generators larger than the designated one.

Procedure

Your group is asked to design and build a windmill to produce electricity using a small 1.5 Volt DC motor (that can also be used as a generator). The size of the whole windmill cannot exceed 0.75 metres in any single dimension. The windmill may not be closer than 25 cm to the electric fan used to provide a source of wind. On test day you will have two chances to produce electric current with your windmill. Fan blades from a commercially made fan may not be used.

Evaluation

Maximum current produced during one minute of operation is 50% (prorated where the highest amount received 50 points, second place receives 47 points to least). Operating windmills which do not produce any electric current will receive a mark of 25 points). Creative use of recycled materials is 25%. Creative design/evidence of experimentation with design is 25%.

Windmill Olympics
Teacher Notes

Outcomes

Students will be expected to

- use an ammeter and a voltmeter to measure current and voltage in a series and parallel circuits (209-3)
- give examples of the development of alternative sources of energy (such as wind energy and solar energy) that are the result of cost of availability and the availability of materials (109-6)
- appreciate that the application of science and technology can have advantages and disadvantages (423 Pan-Canadian)
- confidentially pursue further investigations and readings (426 Pan-Canadian)
- consider observations and ideas from a variety of sources during investigations and before drawing conclusions (428 Pan-Canadian)
- persist in seeking answers to difficult questions and solutions to difficult problems (430 Pan-Canadian)
- work together collaboratively in carrying out investigations as well as in generation and evaluating ideas (431 Pan-Canadian)
- illustrate how technologies develop as a systematic trial and error process that is constrained by cost, the available and properties of materials , and the laws of nature (109-6 Pan-Canadian)

Background Information

Students can investigate which configuration of fan blades will catch the most wind and change it into rotational motion. They will also have an opportunity to experiment with pulleys and with generating electric current using a small 15 volt DC motor. The motors can be recycled from old tape players or motorized toys, or if standardization is needed the motors may be purchased from an electrical/ electronics supply store. A large "O" ring, the rubber pulley from the tape deck, string, or elastic band may be used to transfer energy from the energy from the windmill to the generators. If students use too large a pulley on the windmill end there may not be enough torque to turn the generator very fast. They will have to experiment with this. A large box fan is good for producing the wind. Students should know which fan will be used for testing. The maximum current measured in one trial was 280 milliamps. Students were given some time to repair or change the windmill if it didn't work on the first try. If the windmill turned but no electricity was produced then the group received a mark of 25 out of 50 for performance. Students were good about helping each other and sharing generators if someone's didn't work.

Materials

Recycle old tape deck motors, radio/electronics supply store for DC motors. Recycled materials from home (e.g., vinyl siding, wood, plastic buckets, etc.). The multimeter and fan may be borrowed from a student/parent since they are only used for the project.

You've Got the Power

Questions

- How much energy does it take to boil water for a cup of tea?
- Using a microwave?
- Using the kitchen stove?
- Using the electric kettle?

Background Information

The technology to use electrical energy developed at a hectic pace many years ago, sometimes running ahead of theoretical science. As a result, some vocabulary came into usage which is inappropriate. Power is one of those terms. We speak about our "power" bill, the "power" company, and so on.

In physics, the terms energy and power are clearly separate terms. To begin with, Work is defined as the product of an applied force and the distance through which it moves an object. For example, if a force of 50.0 Newton (N) is applied to a large box and it is moved 3.00 metres (m), the work done is 150 Nm, or Joules. When work is done, a change results in the object. If it gains speed, we say the object gained kinetic energy. If it gains height from the Earth's surface, the object gains gravitational energy. If the object drags across the floor, the friction converts the work to thermal energy. Energy change is always equal to work done. If 150 Joules of work is done in the example, then 150 Joules of energy must appear in some form. Power is the rate at which work is done. In the example, if the 150 Joules of work was done in 5.00 seconds, then the power is 30.0 Joules/second (J/s). The common name for this unit is watt (W); 1.0 W = 1 J/s.

This is a very small quantity and it is common to use kilowatts (kW) which is equal to 1000 watts in typical situations.

The "power" company is not interested in how fast electrical work is done in your home. The company only needs to bill you for the total work done or the total energy used. If you look at the bill for electricity, the units of energy on the bill are kilowatt-hour (kWh). If power = work/time, then work (or energy) = power × time. A kWh is really 1000 watts × 3600 seconds = 3 600 000 watt-seconds. A watt-second is the same as 1 N-m × s = 1 N-m (since s/s = 1). A kWh is therefore equal to 3600 kiloJoules (kJ) of work or energy. Some new appliances are rated in kiloJoules.

Materials

- hot plate
- microwave oven
- kettle
- appropriate containers for water

Safety

Take care when handling hot water to avoid spilling.

Do not touch hot surfaces.

Do not use metal containers in the microwave.

Procedure

You will work in groups to design and conduct experiments to help answer the questions.

As a class you need to make some decisions before detailed planning of experiments, so the data collected by each group may be meaningfully compared to other group's data. In planning these investigations, decide

- which variables must be controlled in each investigations and list them (if some variables can not be
- controlled, suggest ways the differences caused may be minimized)
- which variable(s) are manipulated and list them
- which variable(s) are responding and list them
- how many times the experiment should be repeated

In your assigned groups, report on the question your group will investigate. Each group should design their experiment based on the class discussion of variables.

In your group,

- write a hypothesis about energy use by the appliances
- make a prediction about which appliance you think will use the least/most amount of energy to boil the cup of water
- write out your materials list and your procedure
- identify the safety precautions for your investigation

Check with your teacher before you start.

Results

In your group,

- record "suitable" data and display the data for presentation
- determine the amount of energy used to boil water in each experiment
- use three significant digits throughout your data collection (where possible).

As a class,

- report and collate results as a class
- discuss the differences in each experiment and how that relates to the amount of energy required to boil a cup of water for tea.

You've Got the Power
Teacher Notes

Outcomes

Students will be expected to

- determine quantitatively the efficiency of an electrical appliance that converts electrical energy to heat energy (308-19)
- relate electrical energy to domestic power consumption costs (308-18)
- compare examples of past and current technologies that used current electricity to meet similar needs (110-9)
- evaluate the design of a technology and the way it functions on the basis of identified criteria such as cost and the impact on daily life and the environment (113-6 Pan-Canadian)

Background Information

Students will need to find out the power rating (number of watts) of the individual appliances. This can usually be found underneath or on the back of smaller household appliances. The electric stove may have it on the back or near the fuse panel on the stove. The stove information manual may also be consulted. Students will need to measure the length of time (in seconds) needed for each appliance to bring a cup (250 mL) to boiling. If the activity is done at the students' homes, then more data will be collected, but the makes and models of appliances will be different. Averaging the wattage and times for the three ways of heating water provide a way of dealing with the variation. It could be a good lesson in methods of dealing with a variable you want to control but cannot. The other variable that may present a problem is the container used to boil the water. Using the same amount of water may not be possible since the electric kettle may need more than one cup to operate. Students will also need to decide how to deal with using a non-metal container in the microwave versus none for the electric kettle versus the pot on top of the stove.

Technology Connections

Students may wish to find out when the appliances were invented/first used. They may also want to find out how a microwave oven works and the construction of a stove element.

Materials

A hot plate may used instead of the stove. The microwave and kettle can be brought from home.

Circuits

Use Ohm's Law to answer the following questions:

1.Determine the circuit current for a circuit that has 150 V of applied voltage and a resistance of 10 Ω.

2. If the voltage in Problem 1 decreased to 75 V, but the resistance remained at 10 Ω, what would be the new circuit current?

3. Suppose that both voltage and resistance doubled for the circuit in Problem 1:

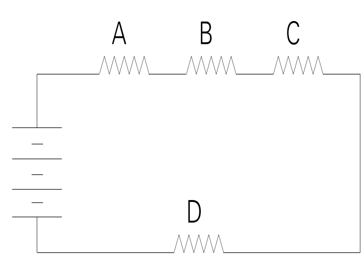
   a) What would happen to the circuit current? Would it increase, decrease, or remain the same?
   b) Use Ohm's law and calculate the actual value resulting from these changes.

4. a) Draw a schematic diagram showing a voltage source, an ammeter, and a resistor.
   b) Assume the voltage applied is 30 V and the ammeter indicates 2 mA of current. Calculate the circuit resistance and circuit power dissipation.

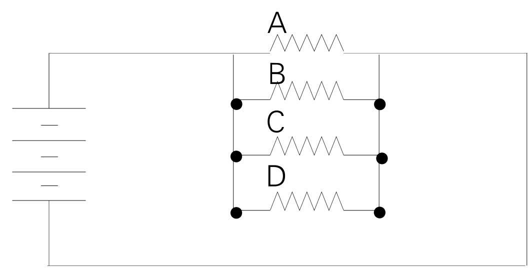
Answer the questions for each of the circuits which follow, assuming that:

– all bulbs have the same resistance
– the battery delivers 9 V
– the current leaving the battery is 2 A

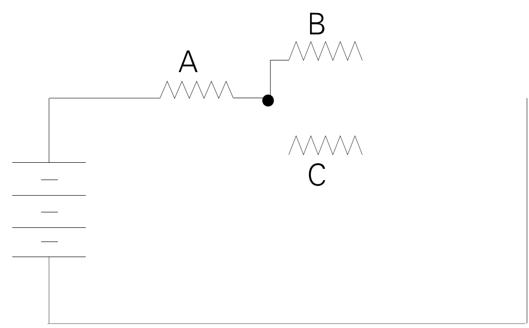
5. What voltage does each bulb use? What current flows through each bulb?



6. What voltage does each bulb use? What current flows through each bulb?



7. What current flows through each bulb?



Circits
Teacher Notes

Outcomes

Students will be expected to

- describe series and parallel (maximum two resistors) circuits involving varying resistance, voltage and current using Ohm's Law. Draw circuit diagrams using circuit symbols for a cell, switch, battery, lamp, resistor, multi-range metre (308-17)

Background Information

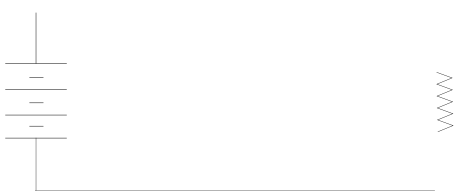
Sample Results

1. I = 15 A

2. I = 7.5 A

3. a) Remains the same
   b) 15 A

4. a)



b) R = 15 k Ω

2.25 V, 2 A

9 V, 0.5 A

A = 2 A, B = 1 A, C = 1 A

Working with Electricity

Questions

What careers involve working with electricity?

Procedure

Each member of the group individually should decide which careers involve electricity and then record the decision in the chart below.

As a group, discuss each career and reach consensus on which careers involve electricity. Be prepared to defend your choices during the class discussion.

Record the group's decisions in the class chart on the next page. Record a brief reason for the decision under each career.

The class will compare and discuss their choices.

Results

Record your decisions in the chart on the following page.

Individual's Name:

Career	Electricity		Career	Electricity	
	Yes	No		Y es	No

Class Chart:

Career	Electricity		Career	Electricity	
	Yes	No		Y es	No

Working with Electricity
Teacher Notes

Outcomes

Students will be expected to

- provide examples of careers related to electricity in their community and province (112-10)

Background Information

Sample Results

Student/group responses will vary depending on how directly related they were looking for them to be. The most important thing is that students opinions are heard and students realize that many careers are either directly or indirectly associated with electricity.

Electricity—It's a Puzzle!

Place the correct word(s) in the blank beside each clue on the next page. Then find the word(s) in the word jumble below.

P	N	O	I	S	L	U	P	E	R	I	R	R	A	O	O	A	S	E	E
V	O	L	T	M	E	T	E	R	U	E	Q	U	C	W	P	T	R	L	G
R	N	T	C	K	S	G	K	S	S	H	S	A	E	M	A	T	E	E	R
A	K	N	E	W	K	O	A	I	K	L	G	G	X	T	R	R	T	C	A
L	S	R	I	N	M	I	S	T	R	I	R	I	I	Y	A	A	E	T	H
O	G	T	E	P	T	T	L	E	L	A	X	C	G	R	L	C	M	R	C
S	C	E	M	T	O	I	S	O	H	O	E	O	R	O	L	T	M	O	E
H	N	A	N	R	E	I	A	C	W	L	V	O	P	T	E	I	A	M	V
A	L	O	V	E	S	M	E	L	E	A	T	Z	W	C	L	O	S	O	I
V	M	J	R	T	R	V	E	C	D	A	T	A	A	U	Z	N	E	T	T
R	K	P	A	T	I	A	T	G	L	I	L	T	L	D	V	T	R	I	I
W	E	N	E	T	C	R	T	U	N	S	F	A	H	N	K	H	I	V	S
O	C	W	A	R	I	E	S	O	M	A	E	F	J	O	M	E	E	E	O
E	Z	G	O	C	E	N	L	H	R	I	R	U	E	C	U	Q	S	F	P
R	E	G	I	P	I	G	O	E	F	N	H	I	O	R	Z	R	J	O	T
N	R	T	T	N	E	R	R	U	C	C	I	R	T	C	E	L	E	R	K
U	Y	L	L	I	M	D	N	I	W	M	M	G	P	L	C	N	R	C	U
L	I	G	H	T	N	I	N	G	R	O	D	S	E	G	U	Y	C	E	A
B	A	T	T	E	R	Y	K	C	O	H	S	K	Z	Q	M	M	U	E	S
D	C	S	B	E	F	A	E	R	E	Y	J	N	T	B	Q	B	G	Q	Z

Clues

_________________ 1. Uses wind to create electricity

_________________ 2. Represented by the symbol Ω

_________________ 3. Material that allows electric charges to move freely on and through it

_________________ 4. Difference in electric potential energy at one point in a circuit and another

______________ 5. A component that resists the passage of a current

______________ 6. Device for measuring current

_________________ 7. Negatively charged particles

_________________ 8. Type of circuit with only one path for the flow of current

_________________ 9. Force between like particles

_________________ 10. Used to protect houses during electrical storms

_________________ 11. Unit of measurement loved by Nova Scotia Power

_________________ 12. Results from a deficiency of protons

_________________ 13. Produces a potential difference

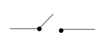
_________________ 14. The amount of potential difference

_________________ 15. Force between unlike particles

_________________ 16. V = IR

_________________ 17. P = E ÷ t

_________________ 18. Stationary electric charges

_________________ 19. 

_________________ 20. Basic unit for measuring the strength of an electric current

_________________ 21. Converts mechanical energy to electrical energy

_________________ 22. Another term for voltage

_________________ 23. Circuit where current can flow through two or more branches

_________________ 24. Measures potential difference

_________________ 25. Opposion to passage of current

_________________ 26. Type of energy produced by the sun

_________________ 27. The flow of electric charge

_________________ 28. Material that does not allow heat to move freely on or through it

_________________ 29. Device which can measure voltage or current

_________________ 30. Results from an excess of protons

_________________ 31. Build up of static electricity discharged by touch

Electricity—It's a Puzzle
Teacher Notes

Outcomes

Students will be expected to

- use precise language in science and technology (109-14)

Background Information

This lexicon style puzzle would make a fun review of the terms in the Characteristics of Electricity unit. The clues require them to know the definitions before solving the puzzle.

Sample Results

The completed puzzle is shown below with the answers to the clues on the next page.

P	N	O	I	S	L	U	P	E	R		R					A	S	E	E
V	O	L	T	M	E	T	E	R		E					P	T	R	L	G
R		T			S	G			S				E		A	T	E	E	R
A			E	W	K		A	I				G		T	R	R	T	C	A
L		R	I	N		I	S	T	R		R		I		A	A	E	T	H
O	G	T	E	P	T	T	L	E	L	A		C		R	L	C	M	R	C
S	C	E	M	T	O	I	S	O	H	O	E		R	O	L	T	M	O	E
H	N	A	N	R	E	I	A	C	W	L	V	O		T	E	I	A	M	V
A	L	O		E	S	M	E	L	E	A	T		W	C	L	O	S	O	I
	M		R	T	R	V	E	C	D	A	T	A		U		N	E	T	T
R		P	A	T	I	A	T	G	L	I	L	T		D			R	I	I
	E	N	E	T	C	R	T	U	N	S	F		H	N			I	V	S
	C	W	A	R	I	E	S	O	M	A		F		O			E	E	O
E		G	O	C	E	N	L	H	R		R		E	C	U		S	F	P
	E		I	P	I		O	E				I		R		R		O	
N		T	T	N	E	R	R	U	C	C	I	R	T	C	E	L	E	R	
	Y	L	L	I	M	D	N	I	W					L		N		C	
L	I	G	H	T	N	I	N	G	R	O	D	S			U		C	E	
B	A	T	T	E	R	Y	K	C	O	H	S					M		E	

Answers to Clues

Windmill	1. Uses wind to create electricity
Lamp	2. Represented by the symbol Ω
Conductor	3. Material that allows electric charges to move freely on and through it
Potential Difference	4. Difference in electric potential energy at one point in a circuit and another
Resistor	5. A component that resists the passage of a current
Ammeter	6. Device for measuring current
Electrons	7. Negatively charged particles
Series	8. Type of circuit with only one path for the flow of current
Repulsion	9. Force between like particles
Lightning Rods	10. Used to protect houses during electrical storms
Kilowatt Hour	11. Unit of measurement loved by Nova Scotia Power
Negative Charge	12. Results from a deficiency of protons
Battery	13. Produces a potential difference
Voltage	14. The amount of potential difference
Attraction	15. Force between unlike particles
Ohm's Law	16. V = IR
Power	17. P = E ÷ t
Static Electricity	18. Stationary electric charges
Switch	19 
Ampere	20. Basic unit for measuring the strength of an electric current
Generator	21. Converts mechanical energy to electrical energy
Electromotive Force	22. Another term for voltage
Parallel	23. Circuit where current can flow through two or more branches
Voltmeter	24. Measures potential difference
Resistance	25. Opposion to passage of current
Solar	26. Type of energy produced by the sun
Electric Current	27. The flow of electric charge
Insulator	28. Material that does not allow heat to move freely on or through it
Multirange Meter	29. Device which can measure voltage or current
Positive Charge	30. Results from an excess of protons
Shock	31. Build up of static electricity discharged by touch

UNIT 5: REPRODUCTION

Around the World

Procedure

Create a board game using the following themes as cards to move around the board and using the Mcgraw-Hill Web site as a resource.

- biodiversity
- genetic diversity
- species diversity
- ecosystem diversity

As a group, decide which form of diversity each member (if there are four in the group) or each pair (if there are eight) will be responsible for researching.

As a group, decide on a logo (symbol) to represent each diversity. This logo will be drawn on the back of each card later.

Clue Information

Decide what the board game will look like. Consider shape, paths, methods of moving around the board.

Access the Mcgraw-Hill Web site to find interesting questions and answers (15 or more) to fit your particular theme. Make sure you find interesting questions and that your facts are complete and correct.

Using a business card template in your word processor (or design your own using the columns command), create question cards using a large, readable font. Include the answer at the bottom of each card in a smaller but readable font.

When all your cards have been created and verified for correctness, print out your cards on business card stock or on plain paper.

Neatly draw your chosen logo on the back of each card.

Board Development

Create the rules of play. Include in the rules of play, the question cards the groups have created.

Roughly sketch out your ideas on newsprint and play a round or two. Modify the rules to correct any problems of play you have discovered.

When your group is satisfied with the way the game plays, divide up the remaining jobs according to ability to create a board game, markers, a copy of the rules of play and a container to keep the game in.

Challenge your classmates to play your game or try teaming with your science buddies (one buddy, one grade nine as a pair) to play your game.

Around the World
Teacher Notes

Outcomes

Rubric for "Around the World"

Beginning	Adequate	Accomplished
☐ All necessary parts to the game are not present. ☐ Cards are missing, incomplete or incorrect. ☐ Care has not been taken in the drawing, printing, or construction of the game (art work is not neat, glue is poorly applied, cutting needs improvement)	☐ All necessary parts of the theme are present and correctly labeled. ☐ Information is correct. ☐ Art work is neat. ☐ Glue is neatly applied. ☐ Cutting lines are neat.	☐ All necessary cards are present and correctly labeled. ☐ All facts are relevant to the theme chosen and correct ☐ Extra care, attention, and detail have been added to the game to make the appearance pleasing to the eye. ☐ Effort, creativity, and imagination has been added to the shape, detail, or construction of the game board. ☐ Game is interesting, informative; and is challenging to complete.

Background

Evaluation

A Budding Problem

Question

What is the total number of yeast cells that will grow in 5 minutes?

Materials

Access to computer program with spreadsheet and graphing program

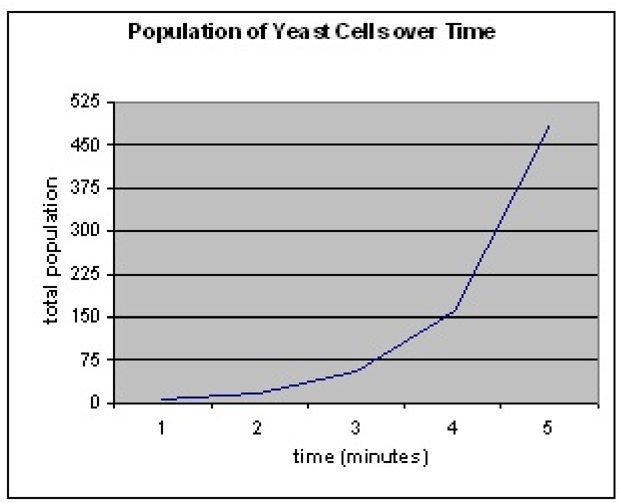
Procedure

Yeast buds were counted every minute. If you started with two yeast cells, create a chart following the growth of the yeast colony for five minutes. Use the chart below as a guide.

Budding of Yeast Cells Over Time

Time (minutes)	Number of buds	Total number of yeast cells
0	2	2
1	4	6
2	12	18
3	36	54
4	108	162
5	324	486

Create a spreadsheet of the growth of this yeast colony. Use the spreadsheet to create a line graph similar to the example below of the growth of the colony.



Use the graph to answer the following questions.

- At about what time was the population 25 animals?
- When had the population grown to 100 animals?
- What was the population as 4.5 minutes?
- At 1.5 minutes, estimate the population.
- Estimate the time when the population reached 150 animals.

E-mail the chart, spreadsheet, and graph to your teacher.

Evaluation

Based on completion of population chart, production of properly constructed spreadsheet and graph.

A Budding Problem
Teacher Notes

Outcomes

Students will be expected to

- determine and graph the theoretical growth rate of a cell and interpolate and extrapolate the cell population from the graph (210-2, 210-4, 210-9)
- compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs and scatter plots (210-2)

Background Information

Although charts and spreadsheets have been included, it is suggested that students work through completing the chart and constructing the spreadsheet and graph using a computer program. Depending on student ability, this will affect the length of time needed to complete the activity.

A Growing Problem

Question

How can I use computers to compile and interpret data on the growth of sunflowers?

Materials

Access to computers with spreadsheet and graphing applications.

Procedure

Kim's grandparents had planted sunflowers in their garden. When Kim arrived to visit for the summer, the sunflowers already measured 20 cm. Kim decided to measure the sunflowers each week during vacation. Below is a chart of the data Kim collected.

Rate of Growth of Sunflowers

Week of Vacation	1	2	3	4	5	6	7	8
Height (cm)	25	42	60	79	99	120	142	165

Analysis

Using Kim's data, create a spreadsheet, then a line graph using the chart function on your computer. Set the scale to increments of 10. Make sure you format your graph to be easy to read. Then, answer the following questions using your graph.

- Halfway between week one and two of vacation, about how high were the sunflowers?
- When, during vacation, were the sunflowers about 130 cm high?
- When were the sunflowers about 110 cm high?
- How long before the sunflowers were about 150 cm high?
- About how high were the sunflowers halfway between weeks 3 and 4?

Evaluation

Based on properly completed charts, spreadsheets, and graphs e-mailed to the teacher within the time frame allowed.

A Growing Problem
Teacher Notes

Outcomes

Students will be expected to

- determine and graph the theoretical growth rate of a cell and interpolate and extrapolate the cell population from the graph (210-2, 210-4, 210-9)
- compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots (210-2)

Background Information

Although charts and spreadsheets have been included, it is suggested that students work through completing the chart and constructing the spreadsheet and graph using a computer program. Depending on the student and the ability, this will affect the length of time needed to complete the activity.

Materials

- access to computers with spreadsheet, graphing applications

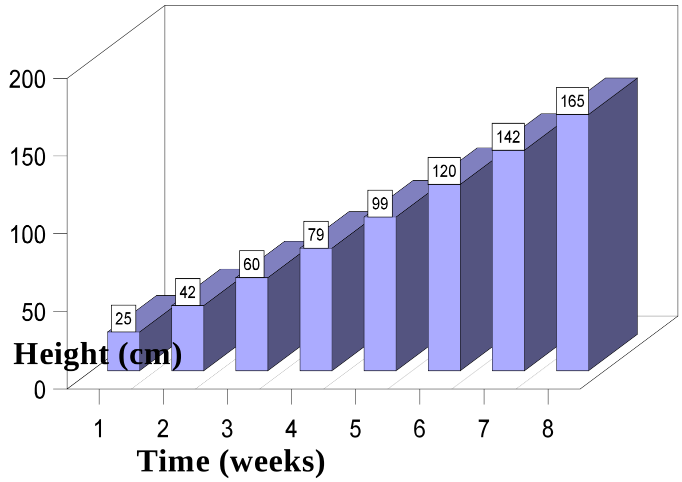
Sample Results

Answers to analysis questions:

There sunflowers were 30 cm high.
The sunflowers were 130 cm high half way between weeks 6 and 7.
The sunflowers were 110 cm high half way between weeks 5 and 6.
The sunflowers were 150 cm high half way between weeks 7 and 8
Between weeks 3 and 4, the sunflowers reached a height of 70 cm.

Possible solution to the graph is on the following page.

Growth of Sunflowers over Time



A Puzzle of a Task

Question

Do I know about cell parts or mitosis or meiosis well enough to put together a jigsaw puzzle showing these themes?

Background Information

In this task, you are being asked to create a jigsaw puzzle of one of the themes listed below. The puzzle you produce can be shared with a science buddy from a younger class or used by you and your classmates to practice the theory you have learned. Remember to check for copyright and ask for any necessary permission before you download any photographs from the Internet.

Materials

- Downloaded photos of a plant or animal cell with its parts or a carefully hand drawn coloured sketch to represent one of the themes listed below. Check to see if your choice is appropriate.
- Heavy cardboard such as ticket board, pre-cut blank jigsaw puzzle templates, thin Styrofoam™, or thin packing foam for backing
- White glue, diluted
- Sharp scissors or X-acto™ knife

Safety

X-acto™ knives are dangerous. Check with your teacher to see if you are to do the cutting or if the teacher will be doing it for you.

If you are using scissors, sharp ones make the best lines for the puzzle pieces. Cut VERY carefully.

Procedure

Choose one theme from the following list to create a visual—cell parts, mitosis, or meiosis.

Sketch or download (check for copyright) appropriate photos to represent the theme you have chosen. Make sure the drawing you make or the photos you download are large enough to make a good sized puzzle.

Puzzle Construction Directions

1. Label all parts correctly using a neat, readable print or font.
2. Carefully lay the sketch or photos and labels on the heavier cardboard.
3. Dilute white glue—one part glue, one part water—in a small cup.
4. Carefully apply the glue mixture over the sketches or photographs in a very thin layer.
5. Check for crinkles, folds, etc. Make sure everything is flat and neat.
6. When the first thin layer is dry, add two to three more thin layers of the glue mixture allowing for drying completely in between layers.
7. Apply one to two thin layers of glue to the back side of the cardboard.
8. When the glue has dried completely, draw interlocking puzzle lines in interesting shapes on the sketch.
9. Cut carefully along the lines to make puzzle pieces.

Place your puzzle pieces in a labelled envelope. Close with a paper clip. Then, challenge a classmate to put together your puzzle.

Evaluation

Use the following rubric as a checklist to aid you in your puzzle development.

Rubric for "A Puzzle of a Task"

Beginning	Developing	Accomplished
☐ All necessary parts to the sketch are not present. ☐ Labels are missing, incomplete or incorrect. ☐ Care has not been taken in the drawing, printing or construction of the puzzle (art work is not neat, glue is poorly applied, cutting needs improvement)	☐ All necessary parts of the theme are present and correctly labelled. ☐ Art work is neat. ☐ Glue is neatly applied. ☐ Cutting lines are sharp and pieces fit together well.	☐ All necessary parts of the theme are present and correctly labelled. ☐ Extra care, attention and detail have been added to the puzzle to make the appearance pleasing to the eye. ☐ Effort, creativity, imagination has been added to the shape, detail or construction of the puzzle. ☐ Puzzle fits together well and is challenging to complete.

A Puzzle of a Task
Teacher Notes

Outcomes

Students will be expected to

- illustrate and describe the basic processes of mitosis and meiosis (304-11)
- recognize that the nucleus of a cell contains genetic information and determines cellular processes (305-1)
- explain the importance of using the terms gene and chromosome properly (110-3)
- work collaboratively in carrying out investigations as well as in generating and evaluation ideas (431) (PAN-CANADIAN?????)

Background Information

The purpose of labelling is to have students review names/parts once more. It should be emphasized that memorizing parts of a cell or the names of steps in mitosis and meiosis are not necessary.

Blank puzzle templates are available at craft supply stores.

Possible extensions could be to do double sided puzzles such as plant cell/animal cell or mitosis/meiosis to make reconstructing more challenging; creating a different shaped puzzle or creating a 3-D puzzle. Thin Styrofoam™ or packing foam are especially good for 3-D models.

This activity blends art and science. For the tactile learner, creating then manipulating the pieces reinforces theory. If there are science buddies, this is a great way for older students to be teachers. If the task is broken up among groups in the class and puzzles are exchanged, students have the opportunity to be peer teachers as well as reinforcing theory for themselves.

Evaluation

A rubric such as the one included on the student page could be used.

Meiosis Game
Teacher Notes

Outcome

Students will be expected to

- illustrate and describe the basic processes of meiosis and mitosis (304-11)

Background Information

While it is not necessary for students to know the names of the steps to meiosis, they should be able to order pictures of the process. Names have been included on the cards but are not the emphasis of this exercise.

Materials

- decks of 45 cards copied from the template included with this activity

Procedure

Rules of the Game

Deal 8 cards from the deck to each player. Remainder of deck is placed face down in centre of table to be used as draw deck.

Player to the left of the dealer draws a card from the deck on the table or from another player. Player may keep the drawn card and discard another or discard into centre discard pile.

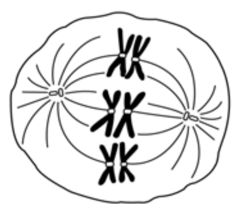
Next player to the left may pick up top card from the discard pile, draw from the draw deck or pick a card from any player. Player must then discard a card to keep the number of cards in their hand to 8.

Play continues until a player may (in her/his turn) lay down a hand with all stages of meiosis. The hand must be laid down in order. Another player may challenge the order. If the order is incorrect, the player who laid down meiosis must draw 8 cards from the draw pile and begin again. The remaining cards are reshuffled into the draw deck. The challenger may then pick any one card from the laid down hand and discard one from her/his hand. Play continues from the challenger's spot with the challenger discarding.

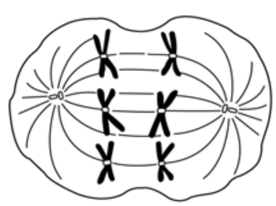
If the order was correct, the player who laid down the hand is finished the game. This player may pick any card from the challenger's hand and give it to another player. Play continues with the recipient of the card discarding any card from his/her hand to keep the proper number of cards.

Play continues until all players have achieved meiosis. Those players from whom cards were taken during play must draw enough cards from the draw deck or the discard pile to return their hand to the proper number of cards.

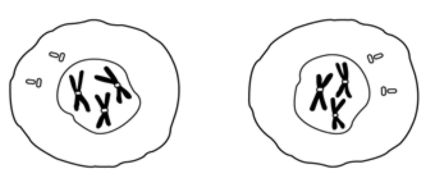
Prophase I



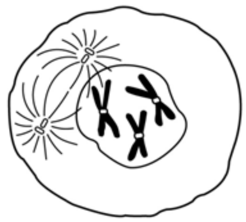
Metaphase I



Anaphase I



Telophase I



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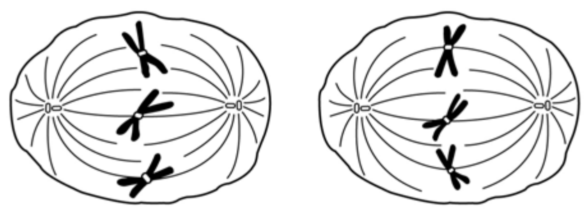

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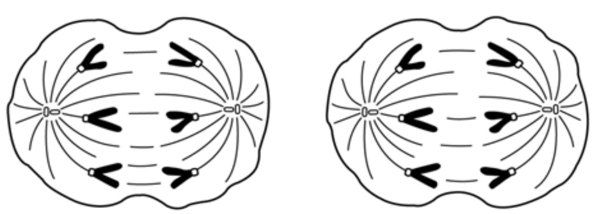

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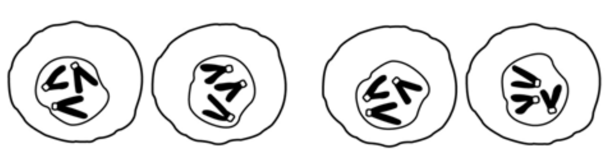


Telophase II

Mitosis Game
Teacher Notes

Outcome

Students will be expected to

- illustrate and describe the basic processes of meiosis and mitosis (304-11)

Background Information

While it is not necessary for students to know the names of the steps to mitosis, they should be able to order pictures of the process. Names have been included on the cards but are not the emphasis of this exercise.

Materials

- decks of 45 cards copied from the template included with this activity

Procedure

Rules of the Game:

Deal 6 cards from the deck to each player. Remainder of deck is placed face down in centre of table to be used as draw deck.

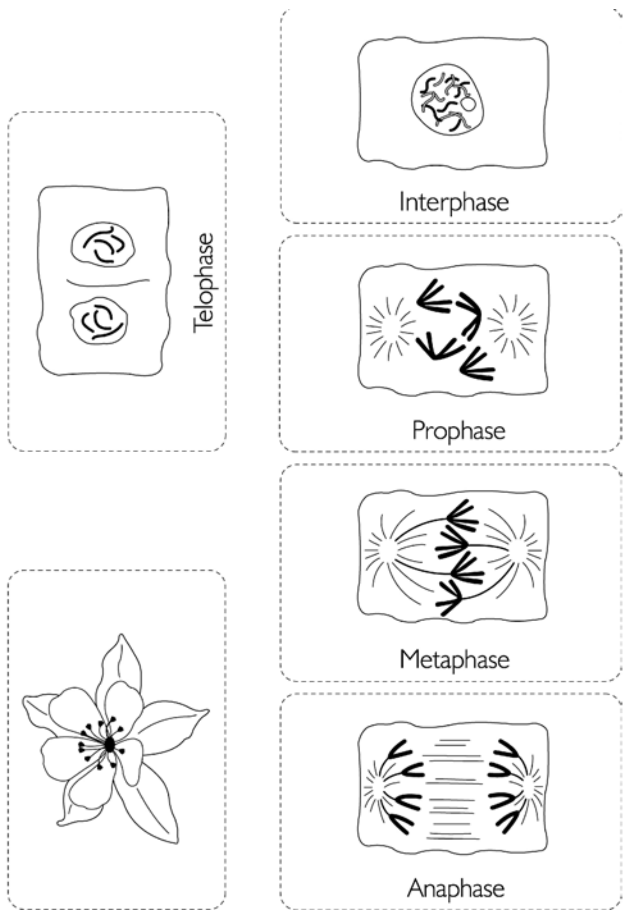
Player to the left of the dealer draws a card from the deck on the table or from another player. Player may keep the drawn card and discard another or discard into centre discard pile.

Next player to the left may pick up top card from the discard pile, draw from the draw deck or pick a card from any player. Player must then discard a card to keep the number of cards in their hand to 6.

Play continues until a player may (in her/his turn) lay down a hand with all stages of mitosis and a life card (either plant or animal, depending on which cells, plant or animal, the player was collecting). The hand must be laid down in order. Another player may challenge the order. If the order is incorrect, the player who laid down mitosis must draw 6 cards from the draw pile and begin again. The remaining cards are reshuffled into the draw deck. The challenger may then pick any one card from the laid down hand and discard one from her/his hand. Play continues from the challenger's spot with the challenger discarding.

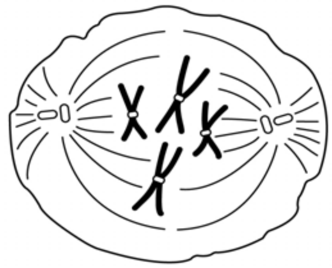
If the order was correct, the player who laid down the hand is finished the game. This player may pick any card from the challenger's hand and give it to another player. Play continues with the recipient of the card discarding any card from his/her hand to keep the proper number of cards.

Play continues until all players have achieved mitosis. Those players from whom cards were taken during play must draw enough cards from the draw deck or the discard pile to return their hand to the proper number of cards in their hand (6). Draw pile may be reshuffled as needed.

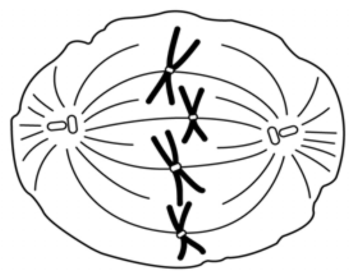


Telophase

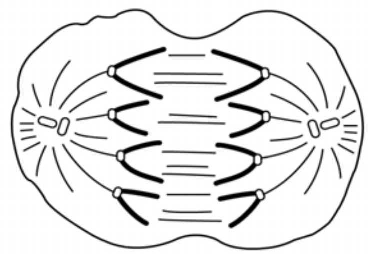
Interphase



Prophase



Metaphase



Anaphase

A Changing Problem

Question

How can I tell others about the differences between complete and incomplete metamorphosis?

Materials

- software programs such as Inspiration and Hyperstudio
- access to the Internet

Safety

Often searching can lead you to undesirable places on the Internet. Just as there are certain places you do not walk in the city, there are certain places on the Internet where it is not suitable for you to be. Using search engine such as Altavista is less likely to lead you somewhere unsuitable but there is no guarantee. Search safely. Report any problems immediately to your teachers.

Procedure

Use Inspiration to brainstorm what you already know about the differences between complete and incomplete metamorphosis. Include your inspiration web in your final Hyperstudio presentation, perhaps as part of your introduction.

Use Hyperstudio to create information on the differences between complete and incomplete metamorphosis. Include photos, data, sound—whatever will enhance your presentation and inform others in your class.

Make sure you record all the sites you used for facts, photos, data, and sounds. This could be one card of the stack called “Credits.”

A Changing Problem
Teacher Notes

Outcomes

Students will be expected to

- select and integrate information from various print and electronic sources or from several parts of the same source (209-5)
- communicate questions, ideas, intentions, plans, and results using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means (211-2)

Background Information

Telling others often reinforces a concept which a student is trying to learn. Creating information presentations, allows students to take an active role in teacher others.

As an extension, students could be encouraged to include a small quiz at the end of the Hyperstudio using correct/incorrect buttons and answer buttons.

Evaluation

A rubric such as the example below could be used.

Rubric for "A Changing Problem"

Beginning	Developing	Accomplished

☐ Information is incomplete. ☐ Information is incorrect. ☐ Cards in stack do not present the information in a teachable manner.	☐ All questions were answered as outlined. ☐ All information was correct. ☐ Photographs added to the information being presented. ☐ Stack had all of the following: introduction, conclusion, and Inspiration thought web and credit page with the sites accessed for the building of the presentation included with the information pages. ☐ An attempt was made to use colour, buttons, and graphics in a manner pleasing to the presentation.	☐ All criteria from the Developing column was met. ☐ Presentation included information beyond the questions asked. ☐ Presentation included photographs, data, graphics, sound, and/or video pertinent to the presentation. ☐ Colour, buttons, and graphics were used in an imaginative and interesting manner. ☐ A quiz was included at the end of the presentation for the user to test what she/he had learned.

Critical Thinking

Background Information

Articles about science or containing science surround us. Daily, we hear about pollution, homeopathic medicine, genetic engineering, alien visits, the newest laundry detergent, cloning, etc. Often, a writer's opinion is said to be "true" based on scientific evidence. It is our job as consumers to be skeptics; that is, to able to separate the true science from the false or the improperly investigated.

The science may be real but we need to be able to ask the questions to get all the facts. For example, suppose you asked your doctor if the allergy medicine you were taking was safe for your liver. The research you found may have indicated that no tests produced dangerous results. Does this mean the tests indicated that the medicine did not cause liver damage? Or, does this mean there have not been enough tests or enough time passed to have problems show up? These questions are the kind we, as responsible consumers (and skeptics), must ask.

Bias, in writing, is defined as presenting facts and opinions to support a point of view. Every writer writes with a point of view. Often, it is the job of the writer to persuade us to that point of view. It is our job to find enough differing points of view to cover all the questions we should be asking.

When writers write they may use a direct or an indirect approach to persuade us.

The Direct Approach

This approach is straight forward. It begins with an introduction that contains your purpose embedded in a context and then develops that purpose incrementally throughout the document. You might visualize the "essential shape" as a triangle with a wide base on the top and a point on the bottom. It's appropriate when your message will have little emotional impact, or when you honestly believe your audience would react best to having the information presented directly. This rhetorical structure is also known as deductive reasoning.

The Indirect Approach

In contrast to the direct approach, you might visualize the "essential shape" of the indirect approach as a triangle with a point on top and a wide base on the bottom. The indirect approach reveals your message slowly, gradually revealing the purpose while leading your reader through your rationale. This rhetorical structure is also known as inductive reasoning. This approach (or a modified version of it) is often used in persuasive/bad news writing. It "softens the blow" by acknowledging the audience's position on the subject, leading the reader(s) through the reasoning process, and giving the reader time to absorb the impact." [1]

Procedure

Investigate some ideas using a good internet search engine and the following keywords:

- cloning
- homeopathic remedies
- genetically modified food
- genetic modifications
- super bacteria
- in utero operations

Questions

- What persuasive approach did the author use? (direct or indirect) Give examples of evidence for your answer.
- Has evidence for more than one side of an argument been presented? Give examples.
- Does the scientific evidence have references that can be checked?
- Is there data to support scientific conclusions?
- Have opinion statements been linked directly to good science or to general statements? For example, in a claim for antibacterial soap, the consumer should know that all soap, by its nature, is antibacterial. Does the statement mean this or have ingredients been specifically added to kill bacteria? What bacteria? How many? For how long? Under what conditions?
- What questions have occurred to you that need more investigation? Make a list. (See the types of questions asked in the example above)
- Has your opinion on this subject been strengthened or changed by this article? Explain in detail.

Evaluation

How thoroughly and carefully you have discussed the answers to the questions will be the basis of your evaluation. The following chart of expectations will be your guide to producing quality work.

[1] Http://www-comerce.concordia.ca/COMM212/shape.htm

Rubric for "Critical Thinking"

Level I	Level II	Level III
☐ All questions were not answered. ☐ Answers to the questions are incomplete. ☐ Answers to the questions do not show understanding of the task. ☐ Complete sentences that do not need the presence of the question were not used.	☐ All questions were answered. ☐ Examples were provided when asked. ☐ An understanding of the task is shown in the details of the answers. ☐ Evidence of effort and thought are found in the care and detail of the answers. ☐ Answers are presented in a neat, easy-to-read format. ☐ Complete sentences that stand without the question were used.	☐ All questions were answered in great detail showing thought and discussion of the task. ☐ Examples were provided wherever they were needed to enhance an answer. ☐ An understanding of the task is shown in the detail, care, thought, and effort put into the answers. ☐ Evidence of effort and thought are found in the extra attention to detail in the answers. ☐ Student went beyond the instructions to produce a quality assignment. ☐ Answers are presented in a neat, easy to read format. ☐ Complete sentences that stand without the question were used.

Critical Thinking
Teacher Notes

Outcomes

Students will be expected to

- explain the importance of using precise language in science and technology (109-14)
- provide examples of Canadian contributions to science and technology related to heredity and genetic engineering (112-12)
- provide examples of genetic conditions that cannot be solved using scientific and technological knowledge at the present time (113-10)
- identify major shifts in scientific understanding of genetics (110-3)
- apply given criteria for evaluating evidence and sources of information (210-8)
- select and integrate information from various print and electronic sources or from several parts of the same source (209-5)
- identify questions to investigate arising from practical problems and issues (208-2)

Background Information

In these times when we are bombarded by "scientific" studies which "prove" a writer's point of view, it is important that students develop skills to evaluate science. The Web sites selected have been identified as having a "pro" or "con" point of view to help students practice these skills. Working with peers and listening to others' opinions also provide an opportunity for learning to accept others whether or not you are in agreement.

Sample Results [evaluation]

Please refer to the rubric included in the student handout.

Where have all the Birds Gone?

Question

- How does human activity impact on wild life and the environment?

Materials

- software programs such as Inspiration and Hyperstudio.
- access to the Internet

Safety

Often searching can lead you to undesirable places on the Internet. Just as there are certain places you do not walk in the city, there are certain places on the Internet where it is not suitable for you to be. Using search engine such as Altavista is less likely to lead you somewhere unsuitable but there is no guarantee. Search safely. Report any problems immediately to your teachers.

Procedure

Use Inspiration to brainstorm what you already know about DDT. Include your inspiration web in your final Hyperstudio presentation, perhaps as part of your introduction.

Use Hyperstudio to create information on the effects of DDT on several bird species. Include photos, data, sound—whatever will enhance your presentation and inform others in your class.

Make sure you record all the sites you used for facts, photos, data, and sounds. This could be one card of the stack called "Credits."

The stack should contain information found by answering the following questions:

- What is DDT?
- Where, when, and why was it used?
- What happened to wild life? Name the particular species of birds affected.
- Follow the fate of one species—What happened to the species? What human interventions were made? How is the species doing today?

Where have all the Birds Gone?
Teacher Notes

Outcomes

Students will be expected to

- identify major shifts in scientific world views (110-3)
- provide examples of scientific knowledge that have resulted in the development of technologies. (111-1)
- provide examples of Canadian contributions to science and technology (112-12)
- identify questions to investigate arising from practical problems and issues (208-2)
- select and integrate information from various print and electronic sources or from several parts of the same source (209-5)
- communicate questions, ideas, intentions, plans, and results using lists, notes in point form, sentences, data tables, graphics, drawings, oral language, another means (211-2)

Background Information

Investigating past ecological disasters may help students become more tuned to the fact that all people must be informed scientific consumers.

Creating informative presentations, allows students to take an active role in teaching others and in becoming advocates for responsible science.

As an extension, students could be encouraged to include a small quiz at the end of the Hyperstudio using correct/incorrect buttons and answer button.

Evaluation

A rubric such as the example below could be used.

Rubric for "Where Have All the Birds Gone?"

Beginning	Developing	Accomplished
☐ Information is incomplete. ☐ Information is incorrect. ☐ Cards in stack do not present the information in a teachable manner.	☐ All questions were answered as outlined. ☐ All information was correct. ☐ Photographs added to the information being presented. ☐ Stack had all of the following: introduction, conclusion, and Inspiration thought web and credit page with the sites accessed for the building of the presentation included with the information pages. ☐ An attempt was made to use colour, buttons, and graphics in a manner pleasing to the presentation.	☐ All criteria from the Developing column was met. ☐ Presentation included information beyond the questions asked. ☐ Presentation included photographs, data, graphics, and sound and/or video pertinent to the presentation. ☐ Colour, buttons, graphics were used in an imaginative and interesting manner. ☐ A quiz was included at the end of the presentation for the user to test what she/he had learned.

An Investigation in Genetic Engineering

Question

Is there bias in scientific research?

Materials

- Internet connection

Safety

Investigation on the Internet requires vigilance and a discussion of how to be safe on the Internet.

Procedure

Using the keyword phrase “genetic engineering” and a good search engine, investigate various sites for bias.

Pick out one topic to find out about within the broad topic of genetic engineering. Have your topic approved before proceeding.

The usual “who”, “what”, “where”, “when”, “why” questions of good essay writing should be answered.

Emphasize the science that goes into your topic. Link some of the detail to what you have learned this year in science.

Give at least two opposing opinions on your topic being sure to site the people and the science involved.

Report all Web sites visited.

Finally,

- evaluate the authenticity of your findings (which sites would have bias and why; how balanced, reliable was the information; how accurate and detailed were the facts)
- express your own opinion about your chosen topic. Include informed opinion based on fact and finally, just your own feelings. Be sure to include “why”, “why not” or “fence sitting” details.

Evaluation

Evaluation will be based on your notes, your recording of facts, including documenting sites and people quoted and the detail and quality of your writing. Your notes may be in the cut and paste form, each with its site recorded. Remember, your final report must be in your own words. Plagiarism is illegal.

An Investigation in Genetic Engineering
Teacher Notes

Outcomes

Students will be expected to

- identify major shifts in scientific understanding of genetics (110-3)
- evaluate information and evidence gathered on the topic of genetics and genetic engineering (209-5, 210-8)
- provide examples of how the knowledge of cellular functions has resulted in the development of technologies (111-1)
- provide examples of Canadian contributions to science and technology related to heredity and genetic engineering (112-12)
- select and integrate information from various print and electronic sources or from several parts of the same source (209-5)
- communicate questions, ideas, intentions, plans, and results using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means (211-2)

Background Information

This activity could be used as a culmination to a small section on assessing bias in research. See appendix activity. Brainstorming using Inspiration some topics within the broad topic of genetic engineering would help identify topics to be investigated by students. Make sure the topic chosen is not so broad as to be unwieldy to research properly in the short time allowed.

Materials

- Internet connection

Safety

Investigation on the Internet requires vigilance and a discussion of how to be safe on the Internet.