SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH
COLORADO STATE UNIVERSITY EXTENSION

ST[EMpower]

SEASONAL CLIMATES

VOLUME 8, ISSUE 1, JANUARY 2019

THIS MONTH':

- REASON FOR THE SEASONS - DEMO
- REASON FOR THE SEASONS - EXPERIMENT
- REASON FOR THE SEASONS - DATA COLLECTION
- REASON FOR THE SEASONS - ANALYSIS
- CAREERS - JOB SATISFACTION

POWER WORDS

- **altitude**: the height in relation to sea level
- **glacial**: the presence of ice especially in the form of glaciers: a glacial period
- **interglacial**: a period of milder climate between two glacial periods: interglacial period
- **latitude**: angular distance of a place north or south from the Earth's equator

CAREERS

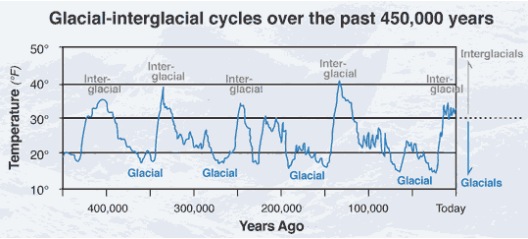
Job Satisfaction is another aspect of your career. You will be spending approximately forty hours a week at your job. It certainly makes sense that you enjoy it!

See page 8 for careers activity in this month's issue.

OUR EARTH IS CONSTANTLY CHANGING

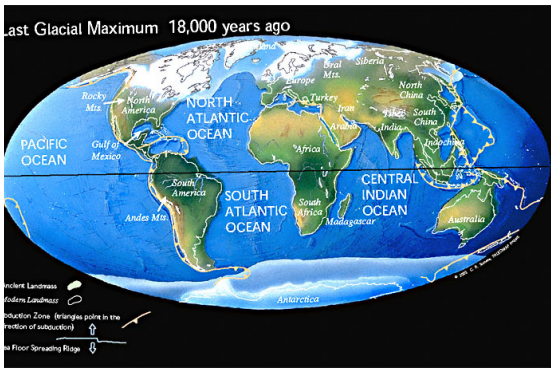
Climate Change is not new. We are in an interglacial period since the last glacial cycle, which ended 11,700 years ago. Since then, the climate has been fairly constant.

The graph below depicts the average global temperature over the past 450,000 years. The low temperatures were times when glaciers moved from the Arctic down to as far south as Ohio. Glaciers also advanced into Europe. The fjords in Iceland and Norway were formed by these ice sheets. Antarctica glaciers advanced towards the southern lands of Africa, South America, and Australia.



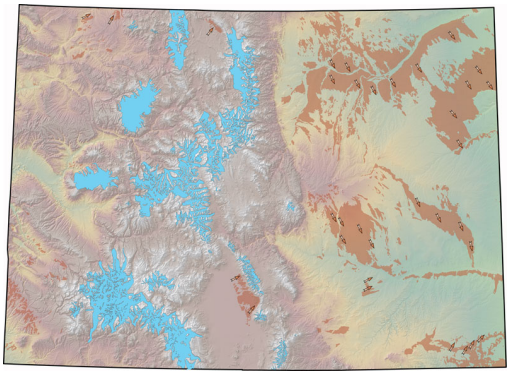
Generally, the higher in latitude the colder the climate. The latitudes 30° North and South are belts of desert, and the Equator is tropical. Climate is influence by proximity of large bodies and the altitude of the landscape.

Dr. Scotese's research focuses on plate tectonics and climate through time, and then he generates maps.



The map above depicts what Earth would have looked like 18000 years ago.

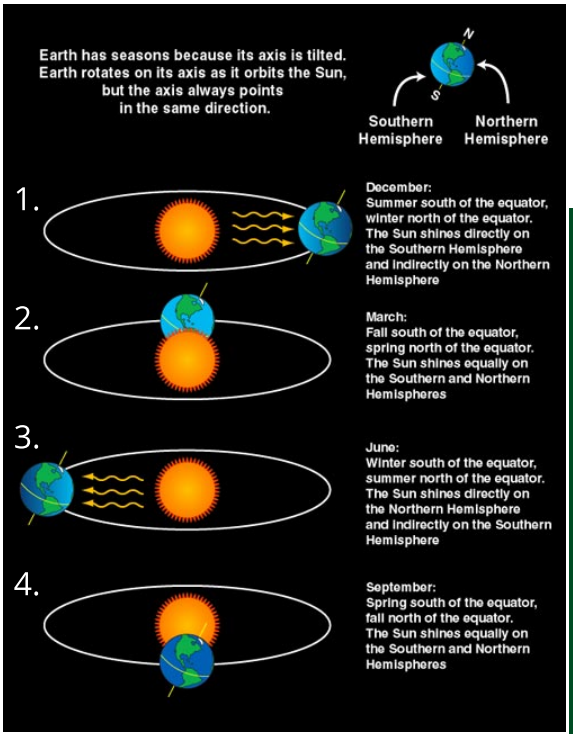
Colorado also formed alpine glaciers. The Colorado Geological Society map below depicts glaciers (blue), sand dunes (brown), and wind direction (arrows) during this time.



Finally, seasons influence climate. The Earth orbits the sun at a tilt. That tilt accounts for the season.

Directions:

- Carefully push the pointed end of the skewer completely through the Styrofoam ball.
- Darken the room and turn on the lamp without a shade. The lamp must be at the same height you hold the ball.
- Hold the skewer (axis of the Earth) at 23.5° angle using the protractor. Note which wall or corner the top of the skewer points. Always point it in the same direction for each step.
- Be sure that you do not stand between the "sun" (the lamp) and the "Earth" (the Styrofoam ball).
- The top of the Styrofoam ball represents the Northern Hemisphere, and the bottom is the Southern Hemisphere.
- Follow the NASA diagram of the Earth/Sun (below). Start with the ball's skewer pointed furthest away from the lamp. For each step (1, 2, 3, and 4), move the ball 1/4 the way around the lamp. At each step, carefully observe where the light directly strikes the ball.



1. Winter solstice is December 21st, the shortest day in the Northern Hemisphere, and we receive the least amount of direct light. The Southern Hemisphere received the most direct light.

> The reason for seasons is the Earth's tilt, not how close or far we are from the sun

2. Move counterclockwise 1/4 the way around the lamp. Spring Equinox is March 20th. The sun's direct light is on the equator, and day and night are 12 hours each there.
3. Move counter- clockwise 1/4 the way around the lamp. Summer Solstice is June 21st. This is the longest day in the year in the Northern Hemisphere.
4. Move counterclockwise 1/4 the way around the lamp. Fall Equinox is September 23rd. The sun's direct light is on the equator, and day and night are 12 hours each there.

POWER WORDS

- **equinox**: the time or date (twice a year) at which the sun crosses the celestial equator, when day and night are equal length
- **solstice**: either of the two times in the year, the summer solstice or winter solstice, when the sun reaches its highest or lowest point in the sky at noon, marked by the longest or shortest days

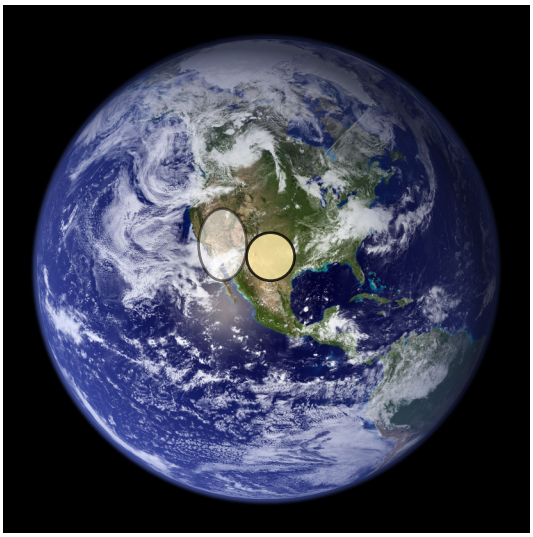
- **NOTE:** each time you move your "Earth" around the "Sun," the axis (bamboo skewer) must remain at the same angle and pointing in the same direction in space.

MATERIALS

- Styrofoam ball
- bamboo skewer
- dark room
- lamp without a shade
- flashlight
- box or book (2-3" high)
- toilet paper tube
- 2 metric rulers
- clipboard
- Print:
  - data sheet (page 4)
  - 4 sheets graph paper (pg 6)
  - protractor (pg 7) and cut out
- red, green, blue, and black markers
- masking tape
- scissors

Directions:

- This experiment collects data on light (flashlight is proxy for solar energy) striking the Earth surface (clipboard) at different angles during summer, spring/ fall, and winter. In Colorado, angle of incidence is greatest during the winter, and closest to 90° during the summer.
- *Hypothesis*: Examine the NASA image below.
  - yellow circle represents area of light striking the Earth during the summer
  - white circle represents light striking the Earth during the winter.



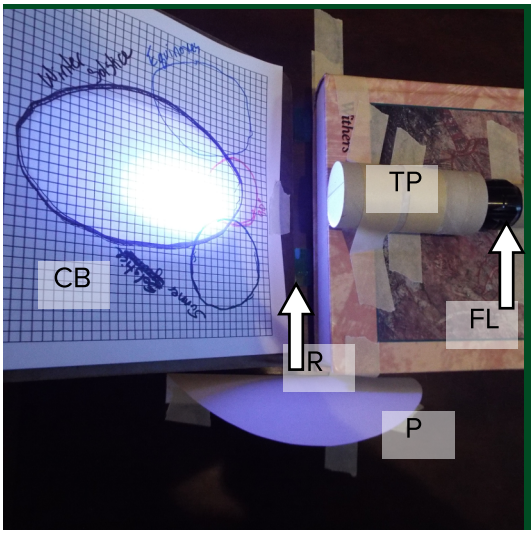
- Predict which area receives more intense solar radiation: yellow summer or winter white.

Build the experiment:

- The base for the experiment must be 5-8.5 cm high (2-3"). Use a narrow corrugated box or a large hardcover book. Tape the TP tube on the top edge of the box/book, making sure the TP tube is aligned 90° with the box.
- Align and place the flashlight just into the TP tube, and tape the flashlight on the box.
- Print four copies of the graph paper (page 6), and attach 3 sheets to the clipboard. With a bit of masking tape, secure the bottom of the paper to the clipboard so it won't move.

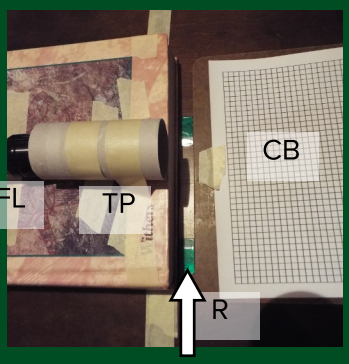
We are closest to the Sun (perihelion) in December!

- Set the box on a table. Place each ruler on either side of the box, extending in front by 1 cm. Tape the rulers in place. You can also tape the box to the table so it will not slip.
- Place the clipboard in front of the box, touching the two rulers, so the clipboard is 1 cm away from the end of the TP tube. Align the protractor to the clipboard perpendicular (90°) to the table.
- *Control*: Turn on the flashlight. Keep the clipboard at the 90°, and with the red marker, draw the outline of the light circle on the graph paper.

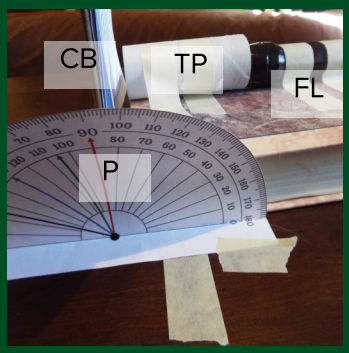


POWER WORDS

- **angle of incidence**: the angle a ray of light strikes a surface
- **insolation**: the amount of solar radiation in a given area
- **perihelion**: when the Earth is closest to the Sun during the year
- **perpendicular**: at an angle of 90° to a given line, plane, or surface
- **proxy**: the power to act for another (flashlight acting for the sun)
- **radiation**: energy



- TP = TP tube
- FL = Flashlight
- P = Protractor
- R = Rulers
- CB = Clipboard w/graph paper



What data to collect:

- Colorado is between latitudes 37° N and 41° N. We will use the center latitude of **39° N**, for this experiment.
- The Earth's tilt is 23.5° in relation to the Sun.
  - In Colorado, the Sun's angle is 74.5° above the horizon during the Summer Solstice.
  - In Colorado, the Sun's angle is 51° above the horizon during the Fall and Spring Equinoxes.
  - In Colorado, the Sun's angle is 27.5° above the horizon during the Winter Solstice
- Use a different color marker for each angle.
- Hint: move the clipboard left or right each time so your circles/ovals do not overlap.

Trial A:

- ***Summer Solstice***: Tilt away from the flashlight, and measure the clipboard to 75.5° on the protractor (90° - 15.5°). Trace light outline with a green marker.
- ***Equinoxes***: Tilt away from flashlight, and measure the clipboard to 51° (90° - 39° = 51°). Trace light outline with a blue marker.
- ***Winter Solstice***: Tilt away from flashlight, and measure the clipboard to 27.5° (90° - 62.5° = 27.5°). Trace the light outline with a black marker.

Trial B and Trial C:

- Use the 2nd sheet of graph paper for Trial B and a 3rd sheet of graph paper for Trial C, repeating the above steps.

Solar Insolation Datasheet

Trials / Angle	Trial A Number of Squares	Trial B Number of Squares	Trial C Number of Squares	Average # Squares (A+B+C/3)
Control 90°				
Summer Solstice 75.5°				
Equinoxes Fall/Spring 51°				
Winter Solstice 27.5°				

- Count the number of grid squares in each circle or oval (red control, green Summer, blue Equinoxes, and black Winter) and record on your data sheet above. If the line is more than halfway through the square, count that square. If the line is less than halfway through the square, do not count it.
- Repeat this step for Trial B and Trail C.

Closest to 39° N.:

- Grand Junction
- Aspen
- Leadville
- Fairplay
- Colorado Springs
- Hugo

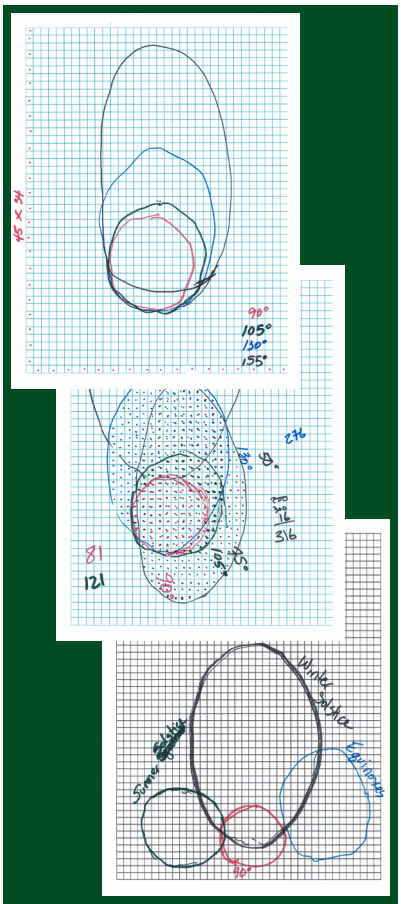
Analyze and interpret your data:

- Now that you have collected your data, you can begin analyzing what you collected.
- Find the average number of grid squares for each season (Summer Solstice, the Fall and Spring Equinoxes, and the Winter Solstice). Add Trial A, B, and C together, then divide the total answer by 3 to find the mean (average). For each season, you have the average area (number of squares).
- Develop a graph of your data. What kind of graph do you think will best represent your data? Do you know what each of the graphs below are?
  - bar chart
  - line graph
  - pie chart
  - scatter plot
  - stem and leaf
  - histogram
- The graph that will be a good choice for these data is a bar graph. The graph paper included in this issue is 45 x 34 squares. Take your largest number of squares average (Winter Solstice) and divide by 45 (number of squares long).
- **Example**: if your Winter Solstice had an average of 316 squares, you would divide 316 by 45. 316/45≅7. Round 7 up to 10. For your bar graph, every square on the graph paper equals 10 squares of data. Count 31.6 squares up, and color in with that column of 31.6 squares with black marker.
- Did you observe the intensity (how bright) of light on the clipboard's graph paper. Look carefully at the image on page 3 of the flashlight held at 155°. What happens as the light spreads out towards the top of the graph paper?
- Think about the following questions:
  - On the equator, where is the sun located during the Spring Equinox?

The Southern Hemisphere is closest to the sun during their summer (our winter).

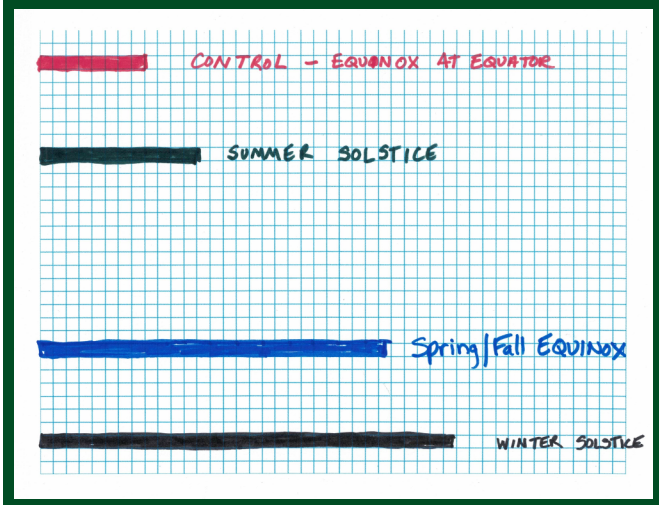
How about the Fall Equinox? (equi comes from aequus, which means equal, and nox means night in Latin).

  - At the North Pole, how long is day on June 21st (the Summer Solstice)? How long is the day on December 21st (the Winter Solstice)?\
  - What happens as the light spreads over a larger surface (compare light at 90° and 155°)?
  - What do you conclude?



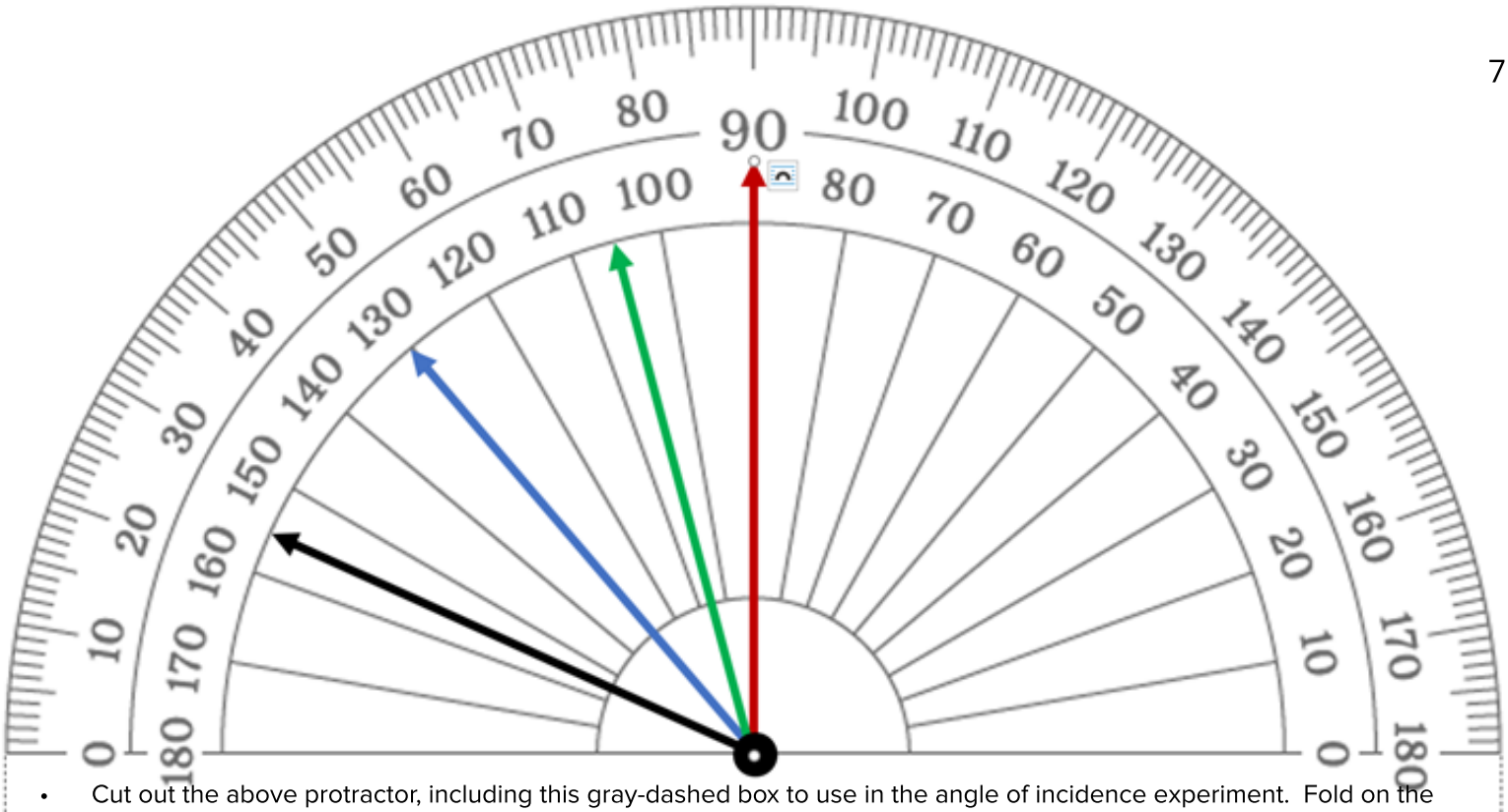
DATASHEETS 1, 2, AND 3

LIGHT AT 90°



Graphed results

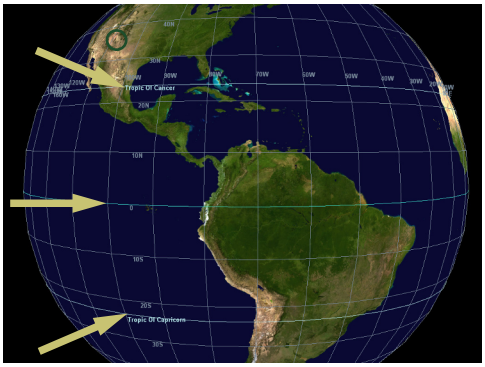
Needs a title, the x and y axis identified, a legend, and a brief description.



- Cut out the above protractor, including this gray-dashed box to use in the angle of incidence experiment. Fold on the 0°/180° line. The red arrow points to 90°. At the Equator, the Sun is at 90° at both the Spring and Fall Equinoxes, directly overhead. During the Solstices at the equator, the Sun is either 23.5° North or 23.5° South from directly overhead.

How to Calculate the Math to Find the Angle of Incidence in Colorado

- Latitudes are the imaginary lines on the Earth. The Equator is at 0 Latitude. Colorado falls between the 37° and 41° Latitude; for this exercise, we will use 39° Latitude.
- We measure the sky like the above protractor: 0° is the horizon and 90° is directly overhead.
  - **Equinoxes**: Equinoxes are at 90° overhead at 0° Latitude, the Equator. Colorado is at 39° Latitude. To find the angle of incidence of the sun during the Equinoxes, you need to subtract 39° Latitude on Earth from 90° (directly overhead) = 51°, the angle above the horizon we see the sun in Colorado on March 20 and September 23, 2019. The blue arrow points to 51°.
  - **Summer Solstice**: The sun is highest in the sky during Summer Solstice in the Northern Hemisphere, directly over latitude 23.5° North (called Tropic of Cancer). Colorado is Latitude 39°, which is 15.5° in latitude higher. (23.5° + 15.5° = 39°). When the sun is highest in the sky in Colorado, it is 75.5° from the horizon (90° - 15.5° =75.5°).
  - **Winter Solstice**: The sun is lowest in the sky during the Winter Solstice in the Northern Hemisphere, and it is located over latitude 23.5° South (called the Tropic of Capricorn). The angle of incidence is very shallow in Colorado, around 27.5° above the horizon. (23.5° + 39° = 62.5°; 90° - 62.5° = 27.5°).
- While you work through these calculations, follow on the NASA image of the Earth with latitudes imposed on it. The green circle is Colorado, and the arrows point (from top to bottom) 23.5° North, 0°, and 23.5° South.



Why do people work?

Think forward to when you are an adult, and consider the following:

- Would you work if you were independently wealthy? How would you spend your time if you didn't work?
- Is there more to working than just making money?

Why do you work? Check the following if they apply to you:

- ☐ earn money
- ☐ be useful
- ☐ help others
- ☐ make a difference
- ☐ be a leader/boss
- ☐ be appreciated
- ☐ be successful
- ☐ feel competent
- ☐ be with other people
- ☐ other _____
- ☐ other _____
- ☐ other _____
- ☐ other _____

How can you figure out if career satisfaction is important? You can interview people in different careers to find out if people generally feel job satisfaction, and how important that is to them.

Who to interview (suggestions):

- parents
- neighbors
- teacher(s)
- religious leader (e.g. priest)
- 4-H leader or agent
- a store manager
- people in careers you have identified as interesting

People love to talk about their jobs, and will be happy to help you. Let them know you are specifically curious about job satisfaction.

Preparing for the interviews:

- In the green box at the bottom of this page are some interview question ideas. Rewrite them in your own words.

> **Job Satisfaction:** the feeling of pleasure and achievement that you experience in your job when you know that your work is worth doing, or the degree to which your work gives you this feeling
>
> Cambridge Dictionary

- Call to set an interview with the people you have identified as potential interviewees.
- Dress professionally, and arrive on time.
- Listen as your interviewee responds. You may have more questions.
- Bring a pencil and paper or a tablet with your questions, and a place to jot down notes.
- Have fun!

JOB SATISFACTION

DR. LUIS RUEDAS

DR. RENEE RUMRILL

MR. SETH POTTS

What does it all mean?

- Did everyone you interview have a sense of job satisfaction? Why or why not?
- Review notes and write your own definition of job satisfaction.

INTERVIEW QUESTIONS IDEAS:

- How would you describe the job you do?
- What are the main tasks of the job?
- The skills we learn in school are important in the jobs we do at home and at school. In your opinion, which school subjects help you the most (in this job)?
- What are your reasons for doing this job?
- Tell me a little bit about what you really like about this job.
- What don't you like?
- What are your overall thoughts and feelings

AUTHORS

Dr. Barbara J. Shaw, Colorado State University Extension Western Region STEM Specialist, 4-H Youth Development

Tom Lindsay, retired HS science teacher (AP and IB Chemistry, Physics, Biology, and Calculus) and university instructor (geology and paleontology)

ACKNOWLEDGMENTS

Funding for this project provided by Colorado State University System Venture Capital Fund

CJ Mucklow, Colorado State University Extension Western Regional Director; Annette Haas, Colorado State University Extension State Office, State STEM/4-H Specialist; Kellie Clark, Colorado State University Extension Western Region Program Assistant; and Nicole Goza, Colorado State University Extension Montrose County 4-H Assistant

Dr. Joe Cannon and Marketing Strategies students: Berlyn Anderson, Jenna Balsley, Rachel Kassirer, Rachel Richman, Colorado State University, College of Business, for marketing strategies and kit graphics.

Joanne Littlefield, Colorado State University Extension Director of Communications and Doug Garcia, Colorado State University Creative Services Communication Coordinator/ Designer

Citations:

Graph of temperatures over the past 450,000 years:
https://geology.utah.gov/map-pub/survey-notes/glad-you-asked/ice-ages-what-are-they-and-what-causes-them/

Scotese map from the end of the last glacial maximum ~18,000 years ago: Scotese, C.R., 2002, http://www.scotese.com, (PALEOMAP website). (http://scotese.com/lastice.htm)

Colorado's last Ice Age Map: http://coloradogeologicalsurvey.org/colorado-geology/glacial-geology/

NASA image of Earth and Sun throughout the year: https://spaceplace.nasa.gov/seasons/en/

Graph Paper: https://incompetech.com/graphpaper/plain/

Planet Earth NASA image: https://www.nasa.gov/topics/earth/overview/index.html

Latitude map of Colorado: https://www.mapsofworld.com/usa/states/colorado/lat-long.html

Earth's Latitudes image:
https://ti.arc.nasa.gov/tech/cas/advanced-exploration-knowledge-networks/world-wind/screenshots/globe/

Career Connection ideas: https://dese.mo.gov/sites/default/files/CD_7_A_Grade4-6_L3.docx