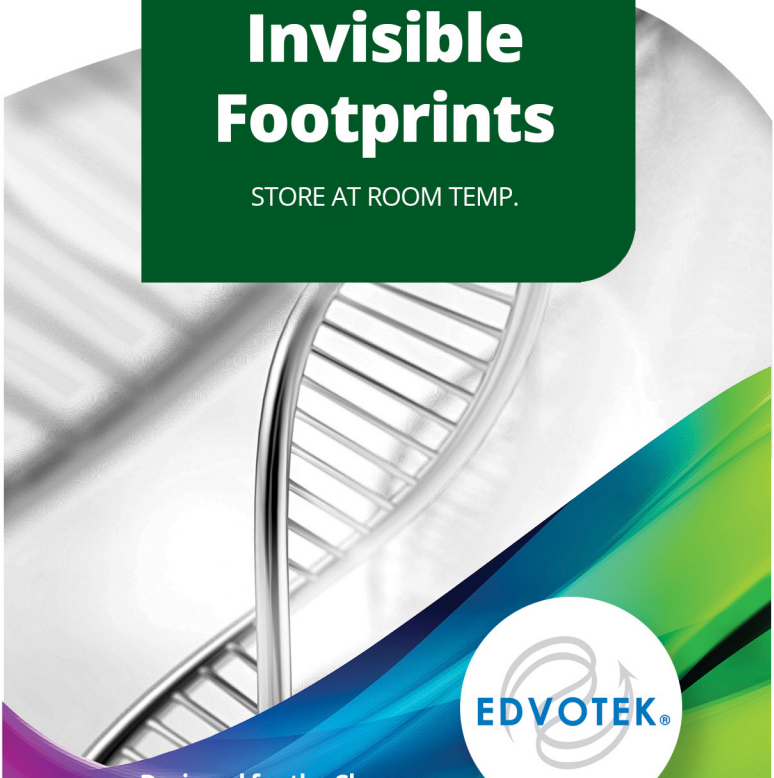
EDVOTEK® MyLab™ #1930

Invisible Footprints

STORE AT ROOM TEMP.



EDVOTEK®

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OBJECTIVES

Sometimes the effect that our actions have on the environment can be hard to see. In this experiment, students use color changing atmospheres to explore carbon emissions and climate change solutions.

COMPONENTS

This experiment contains reagents and disposables for three (3) experiments.

A Atmosphere Powder
B CO_2e Powder
C Color Change Solution
D Mitigation Solution (concentrate)
- Conical Tubes
- Microcentrifuge Tubes
- Transfer Pipettes

REQUIREMENTS

- Distilled Water
- Gloves and Goggles
- Test tube holder
- Computer

GENERAL SAFETY PRECAUTIONS

Parental or adult supervision required.

1. Designate a clean and uncluttered area for performing experiments.
2. Read all instructions before you begin.
3. Do not eat or drink. Do not apply make-up or contact lenses. Adult(s) should not smoke while performing experiments.
4. Wash your hands before and after performing the experiment.
5. Gloves and goggles should be worn routinely as good laboratory practice.
6. Disinfect the counter top or bench with 70% isopropyl alcohol (rubbing alcohol, or place clean newspaper over the area to be used.

SAFETY PRECAUTIONS

At the end of the experiment, soak all tubes in 10% bleach for at least 20 minutes before discarding them in the trash.

WARNING: Choking hazard. Product may contain small parts.
Not appropriate for children under 5 years old.
No human or animal products are used in any experiments.

INTRODUCTION

Carbon is an abundant and versatile chemical element. It can be found in the air, oceans, rocks, soil, and in all living things. Importantly, carbon is dynamic and can easily move between these different places. The continuous movement of carbon is aptly called the carbon cycle and is an essential part of life. When carbon is in the air it is part of the atmosphere - a layer of gases that surround Earth.

In the atmosphere, carbon is attached to oxygen as carbon dioxide (CO_2) or to hydrogen as methane (CH_4). These two molecules - along with a handful of other gases - have unique structures that enable them to trap heat that would otherwise escape into space. This heat-trapping process is called the greenhouse effect. Just like the glass panes in a greenhouse, these gases allow energy from the sun to enter Earth's atmosphere but block heat from escaping.

Greenhouse gases are essential to life. Without them, Earth's average temperature would be freezing (around 0°F or -18°C)! However, today the greenhouse effect is becoming too strong. A rapid increase in greenhouse gases is leading to higher temperatures worldwide and global climate change. Two major drivers of this current increase are the burning of fossil fuels and major land-use changes.

Fossil fuels are the buried remains of plants and animals that lived thousands of years ago. They include petroleum, coal, and natural gas. Around 200 years ago we began digging these up and using them to power our factories, cars, and power plants. Our society is partially a result of having access to these powerful energy sources. However, using fossil fuels also moves carbon that was previously stored for millions of years underground into the atmosphere which has profoundly altered the carbon cycle.

At the same time, we have also modified much of Earth's surface - about two-thirds of Earth's ice-free land is now used by humans to work, live, play, raise livestock, and grow crops. Compared to the original ecosystems these new landscapes have a lower capacity to absorb carbon.

This is causing many changes including an increase in average yearly temperatures, larger temperature extremes, new precipitation patterns, shifts in where different plants and animals live, more extreme weather events (like hurricanes, heat waves, blizzards, and droughts), melting ice, rising sea levels, and ocean acidification. These changes, in turn, affect everything living in the environment - including us.

The social consequences of climate change are complex and varied. Some changes are life-threatening, others inconvenient, and others positive (Figure 1). Currently, individuals who live in the arctic, coastal nations, and drought or fire-prone areas are experiencing climate change much more directly. However, as the effects of global warming continue to intensify, the costs to society are likely to grow and affect everyone.

To live and thrive on Earth humans need to address climate change. This includes finding effective responses to the environmental changes that are and will continue to occur. Even more importantly, to avoid more disastrous changes in the future, humans need to reduce greenhouse gas emissions.

Carbon footprint calculations are a tool used by individuals, groups, companies, and even nations to examine and better understand their climate impact. In this context, "footprint" is a metaphor for the total impact that something has and "carbon" is shorthand for all greenhouse gas emissions that are causing climate change. These calculations address questions like: how much carbon dioxide do I/we release into the atmosphere? What actions are responsible for these emissions? And what can be changed?

One weakness of carbon footprint calculations is that they focus entirely on the negative impacts of an individual or group. However, this is only half of the picture! Every day, people are positively addressing climate change through changing habits, innovation, and co-operation. Carbon handprints are a way to describe and quantify actions that lead to climate change mitigation. Similar to footprints, every individual, group, business, and nation has a handprint.

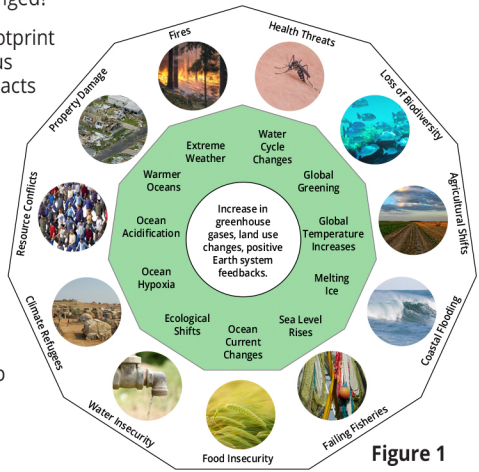


Figure 1

EXPERIMENTAL PROCEDURES

IMPORTANT! Some components in this kit are sent as powders or concentrate and must be diluted before beginning the experiment.

- To prepare the atmosphere solution: Combine the provided powder and 40 mL of distilled water in a 50 mL tube.
- To prepare the CO_2e solution: Combine the provided powder and 20 mL of distilled water in a 50 mL tube.
- To prepare the mitigation solution: Combine the provided concentrated solution and 18 mL of distilled water in 50 mL tubes.

1. **DOWNLOAD** a carbon footprint sheet at: **www.edvotek.com/site/doc/Edvotek_CarbonFootprintQuestions.docx**
2. **READ** through the questions and **CIRCLE** the answer that best applies to you or your family.
3. Use Table 1 to **DETERMINE** the number of CO_2e drops associated with your answers. **WRITE** this number next to each question. Sum the total number of drops and record here:_____.
4. **LABEL** one small transfer pipet "Atmosphere", another "CO_2e", and another "Mitigation". Use these with the appropriate solutions.
5. **ADD** 1 mL of the atmosphere solution to a microcentrifuge tube. **LABEL** this tube "Starting Atmosphere".
6. **ADD** 10 mL of the atmosphere solution to a large conical tube. **LABEL** this tube "My Atmosphere".
7. Using your carbon footprint sheet, **ADD** the appropriate number of drops to the "My Atmosphere" tube. (This is easier to do one questions at a time!)
8. **TRANSFER** 1 mL of the new solution to a microcentrifuge tube. **LABEL** this tube "Footprint Atmosphere".
9. Using a large transfer pipette, **ADD** 3 drops of the color change solution to your "Starting Atmosphere" and "Footprint Atmosphere". **INVERT** several times to mix. What color did your atmosphere turn? _____.
10. **SAVE** your starting and footprint atmosphere for reference and **STORE** your "My Atmosphere" tube in the freezer while you complete steps 11, 12, 13 and 14. Also save all transfer pipets.
11. **DOWNLOAD** a carbon handprint sheet at: **www.edvotek.com/site/doc/Edvotek_CarbonHandprintActions.docx**

12. **READ** through the list of Carbon Handprint Actions and SELECT ONE or MORE actions that you would like to do and that you think you could successfully carry out during the next week.
13. Act on these choices! **PRACTICE** the new habit(s) during the week or **FINISH** the actions(s)/project(s) that you selected.
14. Use Table 2 (pg. 7) to **IDENTIFY** the impact points for each handprint activity that you practiced/accomplished last week. **TALLY** and **RECORD** this number here:_____.
15. **THAW** the solution in the "My Atmosphere" tube.
16. For each impact point, **ADD** one drop of mitigation solution to your atmosphere. **MIX** the solution by capping the tube and inverting it several times.
17. **TRANSFER** 1 mL of this new solution to a 1.5 mL tube. **LABEL** it "Handprint Atmosphere".
18. Using the large transfer pipette, **ADD** 3 drops of the color change solution to this tube. **INVERT** several times to **MIX**.
19. **COMPARE** your starting, footprint, and handprint atmosphere tubes. **MATCH** the color of these tube with the Color Change Key (below).

TABLE 1: CARBON EMISSIONS KEY

Question	a	b	c	d	e
#1	40	20	5	0	0
#2	5	2	0	N/A	N/A
#3	20	10	0	N/A	N/A
#4	0	5	10	N/A	N/A
#5	0	15	30	45	60
#6	20	15	10	N/A	N/A
#7	6	3	2	N/A	N/A
#8	4	8	12	N/A	N/A
#9	40	30	20	10	0
#10	0	2	4	N/A	N/A
#11	0	3	6	N/A	N/A
#12	0	2	4	N/A	N/A
#13	6	3	1	N/A	N/A
#14	0	8	4	N/A	N/A
#15	1	2	3	N/A	N/A
#16	2	4	6	8	9
#17	30	20	10	5	0
#18	12	9	6	3	0
#19	5	4	3	2	0
#20	5	4	3	2	0
#21	6	5	4	3	0
#22	4	3	2	1	0
#23	4	3	2	1	0
#24	0	3	6	N/A	N/A
#25	0	10	N/A	N/A	N/A
#26	3	1	0	N/A	N/A
#27	0	2	4	N/A	N/A
#28	10	5	0	N/A	N/A
#29	20	15	10	5	1
#30	3	1	0	N/A	N/A
#31	0	5	N/A	N/A	N/A
#32	1	3	6	9	12
#33	0	2	4	N/A	N/A
#34	0	2	N/A	N/A	N/A
#35	0	1	N/A	N/A	N/A
#36	0	4	N/A	N/A	N/A

COLOR	G1	G2	G3	Y1	Y2	O1	R1
2050 CO_2 Concentration	420 ppm	454 ppm	620 ppm	1705 ppm	775 ppm	855 ppm	1255 ppm
Predicted Temperature Increase	1.5°C (2.7°F)	1.8°C (3.2°F)	2.6°C (4.7°F)	3°C (5.3°F)	3.2°C (5.8°F)	3.5°C (6.2°F)	4.5°C (8.1°F)

TABLE 2: HANDPRINT ACTIONS KEY																											
Action #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Impact Points	80	150	80	30	50	80*	80*	80	130	60	50	80	30	40	50	100	30**	80	50	50	60	70	60	110	80	70	130
Action #	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Impact Points	120	80	80**	80**	50	50	30	40	50*	40	50	70	100	20	60	60	40	90	80	90	90	90	90	50	80	90	100

*plus 10 for every hour volunteered **plus 10 for every person recruited

STUDY QUESTIONS

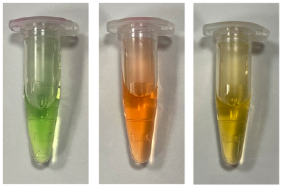
1. What role(s) do humans play in the carbon cycle?

2. How does the concentration of atmospheric greenhouse gases affect earth's temperature?

3. Choose one way that our climate is changing. Then brainstorm 2-3 ways this change will affect society or the natural environment.

RESULTS

Results will vary. See example at right.
Left - Starting Atmosphere
Center - Footprint Atmosphere
RIght - Handprint Atmosphere



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ANSWERS TO STUDY QUESTIONS

1. Humans influence the carbon cycle in many ways. Some of the most significant are using fossil fuels, clearing land for development, raising livestock like cows that release high levels of methane, and planting cropsigrasslandsiforests that serve as carbon sinks.

2. As the concentration of atmospheric greenhouse gases increases more of the sun's energy is trapped by the atmosphere causing an overall increase in global temperatures.

3. Example answer: One way the climate is changing is that some areas are experiencing higher temperatures and less rainfall. This is combining with other factors to create bigger and more frequent forest fires. People's lives, homes, and livelihoods are threatened by these fires. Smoke from fires also affects the health of surrounding populations. Putting out these fires, assisting displaced individuals, and preventing future fires represent a large and growing social cost. Fires are also forcing individuals to reconsider where they can safely workilive. These fires also affect the natural environment and favor the growth and survival of new species.