

Tardigrades Student Handout

Name: Date:

Directions: Students read the prompts and answer in complete sentences in the box to the right.

Part 1: What are Tardigrades?

Section A: Mission Brief	
What does the Mission Brief suggest about your task to help The Aerospace Corporation?	

Section B: Tardigrade Introduction	
Why do space scientists want to study tardigrades? List what variables they study.	

Section C: Vocabulary Development			
Word	Definition	Image	Description in Own Words
Tardigrade	Also known as a Water Bear, these animals have 8 legs and are found everywhere. They are best known for being extremophiles and living in all different environments around the world.		



<p>Temperature</p>	<p>The measure of heat. Scientists typically use Celsius or Kelvin to measure temperature instead of Fahrenheit.</p>	<table border="1"> <thead> <tr> <th>Reference Point</th> <th>Celsius (°C)</th> <th>Fahrenheit (°F)</th> <th>Kelvin (K)</th> </tr> </thead> <tbody> <tr> <td>Boiling water (Finnish sauna)</td> <td>100</td> <td>212</td> <td>373.15</td> </tr> <tr> <td>Human body temperature</td> <td>37</td> <td>98.6</td> <td>310.15</td> </tr> <tr> <td>Room temperature</td> <td>21</td> <td>69.8</td> <td>294.15</td> </tr> <tr> <td>Freezing point of water</td> <td>0</td> <td>32</td> <td>273.15</td> </tr> <tr> <td>Absolute zero</td> <td>-273.15</td> <td>-459.67</td> <td>0</td> </tr> </tbody> </table>	Reference Point	Celsius (°C)	Fahrenheit (°F)	Kelvin (K)	Boiling water (Finnish sauna)	100	212	373.15	Human body temperature	37	98.6	310.15	Room temperature	21	69.8	294.15	Freezing point of water	0	32	273.15	Absolute zero	-273.15	-459.67	0	
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<p>Vacuum</p>	<p>In space, there is no pressure so there is no air. Things that we send to space that are not strong enough (like animals, normal airplanes, and plants) will explode.</p>																										
<p>Radiation</p>	<p>The sun radiates many different forms of energy. Earth is protected from most of them by our magnetic field and atmosphere. In space, these energy rays can be dangerous and damaging to organisms and equipment.</p>																										
<p>Dehydration</p>	<p>Removing water from a living organism can be very dangerous. Humans can only go 3 - 4 days without water, whereas Tardigrades can survive for 30 years without it.</p>																										
<p>Extremophile</p>	<p>Extremophiles are plants or animals that live in extreme environments, such as lava, the deep ocean under very high pressure, or in Antarctica.</p>																										



Survival	The ability to live. Tardigrades survival is based on their ability to resume life when normal conditions return.		
Space Resiliency	Human's ability to survive and adapt in space is constantly being expanded. The better our technology enhancements and longer our equipment survival, the more ways we can survive and explore in space.		

Section D: Tardigrade Lab Exploration

1. Describe the shape of a tardigrade as seen under the microscope.	
2. Describe how a tardigrade moves. (This means you will need to search the field for a tardigrade that is in motion to observe).	
3. If you can find one that is eating, describe how a tardigrade eats. Include the movements it takes to eat and how the body changes with the addition of food.	

Section E: Why Tardigrades?

Answer after watching the video:	
1. What variables do scientists study when looking at tardigrades? Explain what you think each variable means.	
2. What information do scientists hope to gain from studying tardigrades?	



Explain how that information will help space travel and exploration.	
Answer after the class discussion:	
3. Which variable is most interesting to you in tardigrade studies? Explain what about it interests you.	
4. Why do we study tardigrades?	

Part 2: Why are Tardigrades Model Organisms for Experimental Study?

Section F: Modeling the Experimental Design Process	
Complete the radiation example as a class.	
Tardigrade Research Question <i>Example: How does (independent variable) affect (dependent variable)?</i>	
Independent Variable <i>Hint: What variable are you investigating?</i>	Dependent Variable <i>Hint: What are you going to observe/measure?</i>
Control Variables <i>What must you control in your experiment? Remember, only one variable should change at a time in an experiment (independent variable), so what should stay the same each trail/test?</i>	Experimental Set-Up Describe or draw your experiment set-up here. Be sure to label all pictures and write out details about the experiment where it is necessary.
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Section G: Student-Led Experimental Design

Complete your experimental design in the boxes below.

Tardigrade Research Question <i>Example: How does (independent variable) affect (dependent variable)?</i>		
Independent Variable <i>Hint: What variable are you investigating?</i>	Dependent Variable <i>Hint: What are you going to observe/measure?</i>	
Control Variables <i>What must you control in your experiment? Remember, only one variable should change at a time in an experiment (independent variable), so what should stay the same each trail/test?</i>		Experimental Set-Up Describe or draw your experiment set-up here. Be sure to label all pictures and write out details about the experiment where it is necessary.
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Experiment Approval:		(teacher initials/stamp)

Section H: Modeling Results Analysis

1. What is the independent variable (x-axis) on the graph?	
2. What is the dependent variable (y-axis) on the graph?	
3. What pattern do you see in the graph?	
4. Do tardigrades survive after being introduced to your variable? Yes or No.	
5. How does survivorship change when your variable is introduced to the tardigrades?	



Section I: Student-Led Results Analysis

1. What is the independent variable (x-axis) on the graph?	
2. What is the dependent variable (y-axis) on the graph?	
3. What pattern do you see in the graph?	
4. Do tardigrades survive after being introduced to your variable? Yes or No.	
5. How does survivorship change when your variable is introduced to the tardigrades?	

Part 3: Claim-Evidence-Reasoning

Section J: Modeling Claim-Evidence-Reasoning

1. What pattern did you notice when looking at your data?	
2. Make a claim about how tardigrades responded to your variable compared to humans.	
3. What was the most important observation you made that supports your claim? (This must just be what you noticed. Do not explain what it means or why it supports your claim yet, just say what you saw).	
4. What is another observation you made that supports your claim? (This must just be what you noticed. Do not explain what it means or why it supports your claim yet, just say what you saw).	
5. What is one last observation you made that supports your claim? (This must just be what you noticed. Do not explain what it means or why it supports your claim yet, just say what you saw).	
6. Explain how what you observed (from section D) supports your claim. What does your data mean about how tardigrades will behave in space-like environments? Use words like <i>resiliency/resilient</i> .	



Section K: Writing Claim-Evidence-Reasoning

1. What pattern did you notice when looking at your data?	
2. Make a claim about how tardigrades responded to your variable compared to humans.	
3. What was the most important observation you made that made that supports your claim? (This must just be what you noticed. Do not explain what it means or why it supports your claim yet, just say what you saw).	
4. What is another observation you made that supports your claim? (This must just be what you noticed. Do not explain what it means or why it supports your claim yet, just say what you saw).	
5. What is one last observation you made that supports your claim? (This must just be what you noticed. Do not explain what it means or why it supports your claim yet, just say what you saw).	
6. Explain how what you observed (from section D) supports your claim. What does your data mean about how tardigrades will behave in space-like environments? Use the word <i>resiliency</i> or <i>resilient</i> .	

Section L: Claim-Evidence-Reasoning Share Out

Write your team's Claim-Evidence-Reasoning.

Section M: Reflection Questions

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|---|--|
| 1. Now that you understand how tardigrades respond to space-like conditions, why are tardigrades necessary to study when it comes to humans traveling in space? | |
| 2. What else are you interested in studying about tardigrades? What other variables could be explored? Explain what you would hope to learn from these variables. | |