

# Guiding Inquiry Card: Hydraulic Arcade



## Driving Question

How can we investigate the power of air and water and their ability to do work?



### Challenge 1

Identify how the mechanical advantage produced by hydraulic and pneumatic systems can be used to make games fun and functional



### Before Moving On...

Watch Video 1: Introduction  
Develop a set of inquiry questions and make observations during each exploration to help you answer those questions!



By the end of this challenge

- Understand the properties of hydraulic and pneumatic systems and how they function
- Investigate and make observations about the different types of hydraulic and pneumatic systems in each exploration
- Determine how the ability of water to do work is different than the ability of air to do work



How can we tackle this challenge?

### Ask and revise questions

- Ask questions that will help you investigate the power of air and water and their ability to do work
- Ask what information you will need to collect from each activity, revising your questions as you investigate each machine
- Revise your questions as you make observations about the hydraulics or pneumatics of the machine in each activity

### Locate several relevant and dependable details to support your answer

- Record detailed observations about each machine
- Use your observations to develop possible answers to the questions you asked

# Challenge 1: Exploration 1

## A-maze-ing Air and Water



### Driving Question

How can we investigate the power of air and water and their ability to do work?



By the end of this challenge

- Reflect on the tools and objects in your daily life or in your community that use pneumatic and hydraulic principals
- Explore how mechanical advantage is achieved in both maze games and decide which system (Hydraulic or Pneumatic) you would choose to help you collect as many points as possible
- Make observations that will help you develop your own hydraulic or pneumatic vehicle



How can we tackle this challenge?

### Revise questions

- Revise the questions that you asked as you investigate the maze games, adding any new questions that arise to your list

### Locate several relevant and dependable details to support your answer

- Consider the real-world examples of hydraulic and pneumatic systems that you have encountered or have used
- Examine the mazes and determine which one works best
- Make observations about the functionality of hydraulics and pneumatics in the games, and how each system compares
- List your observations and relevant information that will help you develop your own vehicle



### What could I use to complete this exploration?

- Video 2: A-maze-ing Air and Water
- Observation Research Card
- Hydraulic and pneumatic system tactile analogues (water an air-filled balloons, bottles, or baggies)

# Challenge 1: Exploration 2

## Sink it To Win it



### Driving Question

How can we investigate the power of air and water and their ability to do work?



### What could I use to complete this exploration?

- Video 3: Body Systems
- Living system diagrams: Human Respiratory System, Swim Bladder, Cartesian Diver
- Materials to complete your preferred model
- Observation Research Card



By the end of this challenge

- Build at least one working model of a Cartesian Diver, human respiratory system, or fish swim bladder
- Make observations that will help you develop your own hydraulic or pneumatic vehicle



How can we tackle this challenge?

### Revise questions

- Revise the questions that you asked as you investigate the pneumatics of the human respiratory system and the swim bladder in fish, adding any new questions that arise to your list

### Locate several relevant and dependable details to support your answer

- Examine the Cartesian Diver, lung model, and/or swim bladder diagrams and use them to develop your own model with materials found around you
- Make observations about the functionality of pneumatics within the swim bladders of fish and human respiratory system. Consider how a hydraulic system would be different
- List your observations and information that will be relevant to the design of your own hydraulic or pneumatic vehicle

# Cartesian Diver Card: Hydraulic Arcade



## Guiding Question

How do swim bladders in fish use the inverse relationship between the density and volume of air to function?



## Exploration 2: Sink it to Win it

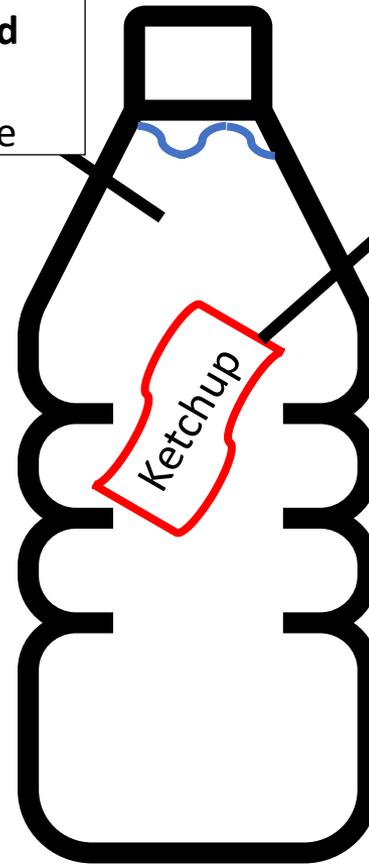


## How Do We Use This Card?

Use this card to help guide you in designing your Cartesian Diver

**One (1) water-filled bottle**

Ocean, river, or lake



**One (1) condiment packet; eyedropper; balloon (a small object that contains some enclosed gas)**

A fish (more specifically, a fish's swim bladder)

# Respiratory System Card: Hydraulic Arcade



## Guiding Question

How do our lungs use the inverse relationship between the pressure and volume of air to function?

 **Exploration 2:**  
Sink it to Win it

 **How Do We Use This Card?**

Use this card to help guide you in designing your lung model

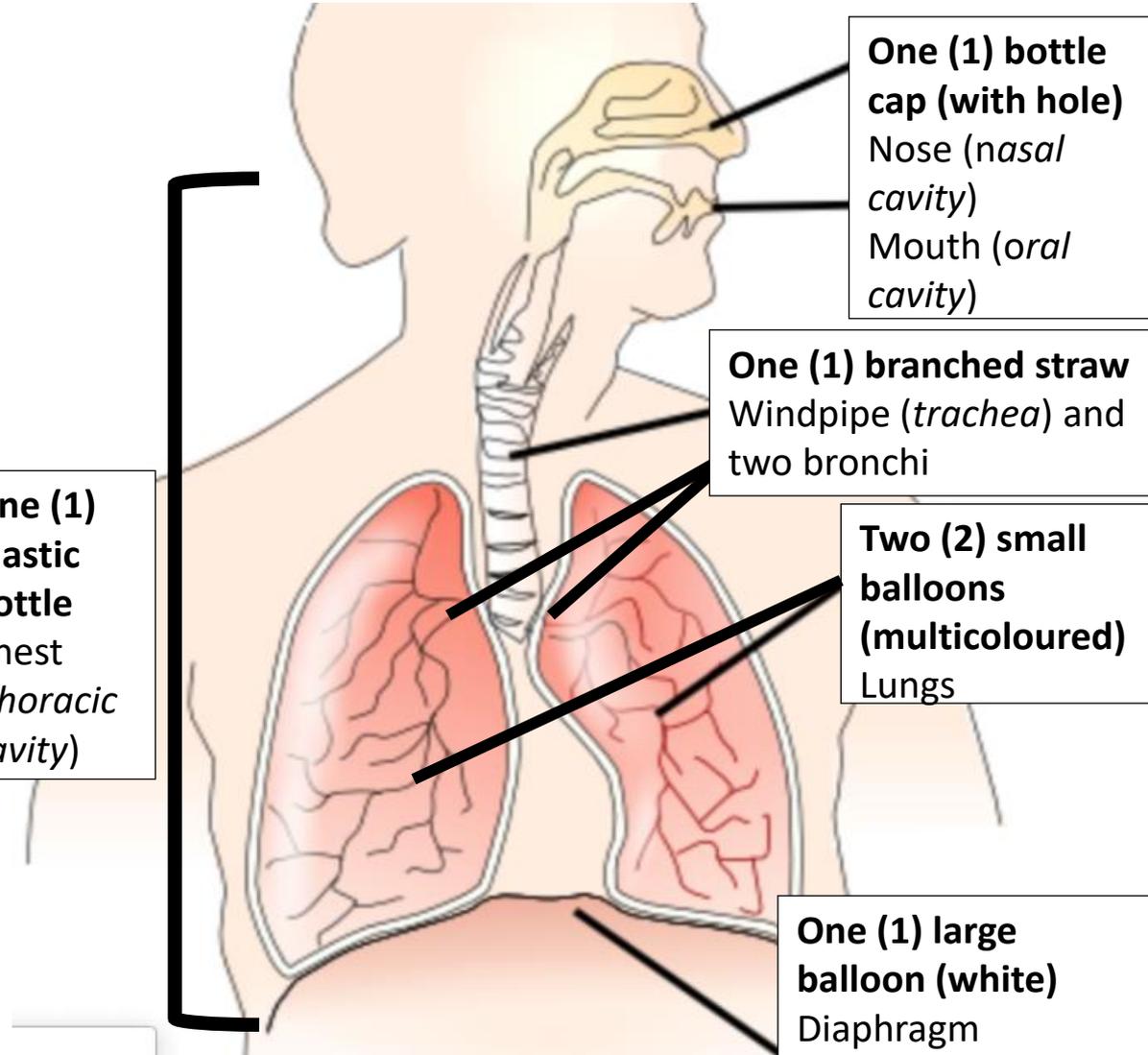
**One (1) plastic bottle**  
Chest  
(*thoracic cavity*)

**One (1) bottle cap (with hole)**  
Nose (*nasal cavity*)  
Mouth (*oral cavity*)

**One (1) branched straw**  
Windpipe (*trachea*) and two bronchi

**Two (2) small balloons (multicoloured)**  
Lungs

**One (1) large balloon (white)**  
Diaphragm



# Swim Bladder Card: Hydraulic Arcade



## Guiding Question

How do swim bladders in fish use the inverse relationship between the pressure and volume of air to function?

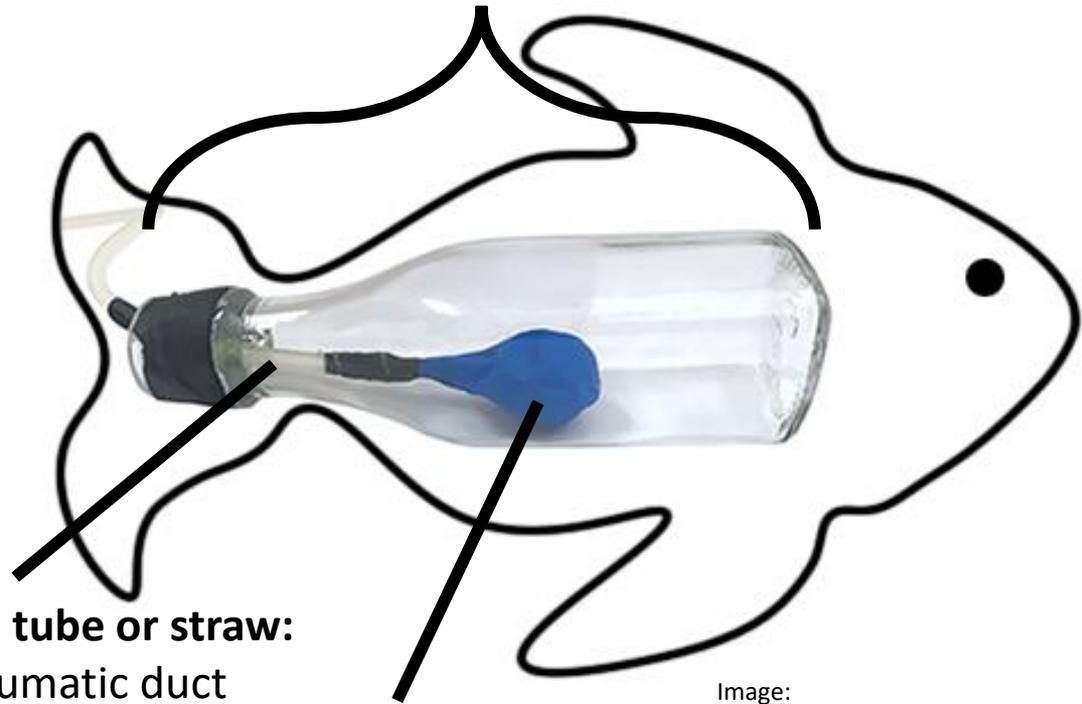
 **Exploration 2:**  
Sink it to Win it

 **How Do We Use This Card?**

Use this card to help guide you in designing your swim bladder model



**One (1) bottle:**  
Fish body



**One (1) tube or straw:**  
Pneumatic duct

**One (1) balloon or bag:**  
Gas-filled swim bladder

Image:  
<https://www.sciencebuddies.org/>

# Guiding Inquiry Card: Hydraulic Arcade



## Driving Question

How can we investigate the power of air and water and their ability to do work?



## Challenge 2

Develop your own hydraulic or pneumatic vehicle



## Before Moving On...

- Watch Video 4: Make Your Own Go-Kart Track Vehicle!
- Complete your Observation Research Card
- Be ready to use your vehicle to prove your understanding of hydraulics and pneumatics!



By the end of this challenge

- Use your observations from Challenge 1 to design your own hydraulic or pneumatic vehicle
- Include within your design the type of system you will use (hydraulic or pneumatic), how your vehicle will move, and what materials you will use
- Explain how mechanical advantage is achieved through hydraulics or pneumatics in your vehicle



How can we tackle this challenge?

## Organize and compare details

- Compile all your observations from Challenge 1
- Rank your observations in order of relevance and complexity for your design and choose which aspects of the machines you want to incorporate into your own design
- Interpret your observations from Challenge 1 to help you develop your own hydraulic or pneumatic vehicle by quickly sketching a design or outlining the steps necessary to build it
- Develop a vehicle based on your design
- Demonstrate how mechanical advantage is achieved through your vehicle
- Describe one way your vehicle could be improved

# Guiding Inquiry Card: Hydraulic Arcade



## Driving Question

How can we investigate the power of air and water and their ability to do work?



### Challenge 3

Observe the designs of your peers  
Share your own design  
Discuss your findings as a class



### Before Finishing...

Suggest at least one modification to your design!



By the end  
of this  
challenge

- Make observations about the hydraulic or pneumatic vehicles that your classmates developed
- Share your vehicle design with the class
- Explore the many applications of hydraulics and pneumatics



How can  
we tackle  
this  
challenge?

#### Identify relationships and recognize represented perspectives

- Determine the relationships between the volume, viscosity, temperature, pressure, and density of air and water and how those relationships impact the abilities of air and water to do work
- Determine how the designs of each of your classmates help you to answer your questions and whether your questions have different answers depending on if the system is hydraulic or pneumatic
- Examine how each person's perspective influenced the design of their vehicle:
  - What problem did they want to solve and why? How did their inquiry questions lead them to develop their specific design?

#### Communicate findings

- Demonstrate how your hydraulic or pneumatic vehicle uses mechanical advantage to do work
- Explain why you chose your specific design
- Suggest improvements to the hydraulic and pneumatic systems observed throughout the workshop
- State when you think it would be best to use hydraulic systems and when it would be best to use pneumatic systems