

Orion Design Challenge

Teacher Notes

Mike Cimino

Science Coach, Heritage Middle School, Volusia County Schools

T³ (Teachers Teaching with Technology™) Instructor

Orion Design Challenge: Teacher

Notes

Objective: Students will design, create and test an Orion capsules capabilities of its heat shield and landing.

Phase 1 (DAY 1) *Engage:* Design the Orion Capsule

Materials needed:

- Youtube Video
- NASA Article
- Something to make capsule out of. Plastic plate or card stock recommended for the base and side of the capsule.
- Tape to attach the pieces together



1. Before beginning, show students the YouTube video explaining what the Orion Capsule is @ <http://www.youtube.com/watch?v=mEwshFC03EQ>
2. Have students read page 2 in the “Orion book” (http://www.nasa.gov/pdf/491544main_orion_book_web.pdf) and answer questions on lab sheet.
3. Review the power point slides through the “guide to building the design” slides; which include the slide below.



When you see this slide (before you begin the model) here are some talking points with your students.

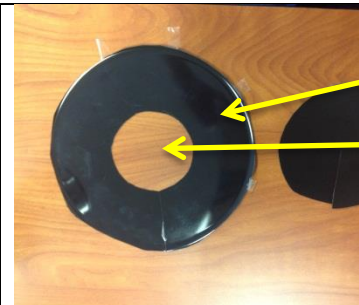
- How long can a crew be supported by the capsule? (600 days)
- What temps can the heat shield withstand? (6000 C)
- How fast can Orion travel? (27,000 mph)
- How does the speed of Orion compare to the space shuttle? (27,000 mph compared to 17,000 mph)

4. Teachers will receive a blueprint for a cut out of an Orion capsule (see attachment 1). Students will first measure the **surface area of the design**, record the data on their lab, then cut and tape the materials together.

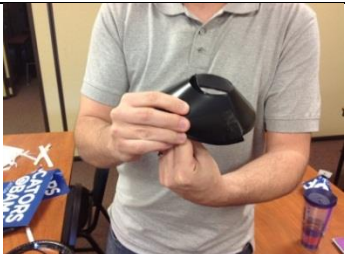

Guide to building the design:

Step 1: Cut out the template and find the surface area of your design

$$\text{Surface Area} = \pi r^2$$



Find the **surface area** of the large circle (L2), and then find the surface area of the small circle (L1). Subtract one from the other (L2-L1) for the total surface area of the capsule.

Step 2: Fold the Design and tape. You will do the same thing with the base, slightly overlapping the cut edges to make a pointy thing at the center on the bottom.		
Step 3: Attach the 2 devices with tape and place a small lid on top.		


By the end of DAY 1, students should have...

1. Watched the Youtube Orion Video
2. Read the article on Orion and answer the pre-lab questions on their lab form.
3. Draw and cut out their circle for the base and side of the Orion Capsule.
4. Find the surface area of the Orion Capsule and record it on their lab sheet.
5. Create a "lid" for the Orion capsule with a small hole on top to insert the temperature probe.

Phase 2 (DAYS 2-3) *Explore*: Construct a Heat Shield around the Capsule

Objective for Phase 2: I will design, create and test a heat shield capable of maintaining a livable temperature for humans inside the Orion Model Spacecraft.

<p>Materials needed</p> <p><u>Limited Materials</u> (<i>Students are limited to the amount calculated according to surface area from Day 1 and can only chose 1</i>):</p> <p>Aluminum Foil Parchment Paper Saran Wrap Fabric Squares</p> <p><u>Unlimited Materials</u> (within reason):</p> <p>Tape (Scotch/Duct) Popsicle Sticks Paint Toothpicks Yarn</p>	<p>Restrictions when constructing:</p> <ul style="list-style-type: none"> • Students may not change the shape of the spacecraft at all • Students may not add ANYTHING to the <u>inside</u> of the spacecraft <p>Teachers expectations when conducting test:</p> <ul style="list-style-type: none"> • Provide students with an overhead light source of a recommended 100 W. • Place the students design underneath the light source at a distance of about 50 cm below the light. • Be sure students place the lid over the open hole on the spacecraft. • Place a thermometer/temp probe inside the top of the spacecraft model and another on the outside next to the model. Have students record the temperature change for both. • If it is a nice day outside, you could bring the device outside to conduct the heat test.
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	<p>The image to the left shows a completed, basic Orion Capsule. The yellow part up top represents the cover which will be taped down when you test the heat shield. The hole in the center is where you insert the temperature probe.</p> <p>Later on in Phase 3, the raw chicken egg will be inserted through the hole in the middle.</p>
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Data Analysis and Scientific Process

1. Students should identify the capsule design as the **testing variable**, the temperature inside the capsule as the **outcome variable** and the temperature outside of the capsule as the **control**.
2. Have students create a materials list and a procedure for how they built and tested their design.
3. Have students create a **line graph showing the linear regression (in slope intercept for $y=mx+b$)** for the warming temperature for both, the capsule temperature and air temperature.

By the end of Days 2-3 students should have...

1. Create a heat shield for their capsule.
2. Fill out lab report.
3. Test heat shield.

Phase 3 Explain and Evaluate (DAYS 4-6): Safe Landing

Objective for Phase 3: Students will design and construct a parachute system capable of safely landing a chicken egg on either sand or water at a drop distance of 6 to 8 feet.

1. Before designing their parachute system, have students create a VENN DIAGRAM discussing the benefits/drawbacks of a water or sand landing. (Students will have the option of either dropping their capsule into a bucket of water or a box filled with sand).
2. Students are to complete the **math worksheet "Parachutes, circles and pi oh my!"** This goal of this activity is to familiarize students with the shapes and sizes their parachutes must be. (1 Day activity)
3. Have students design and build their parachute system based on what was learned from the math worksheet.

Materials: Garbage Bags, Plastic Bags, Coffee Filters, String, Tape, Stapler

4. Have students fill out lab sheet explaining the specifics of their design.

Testing:

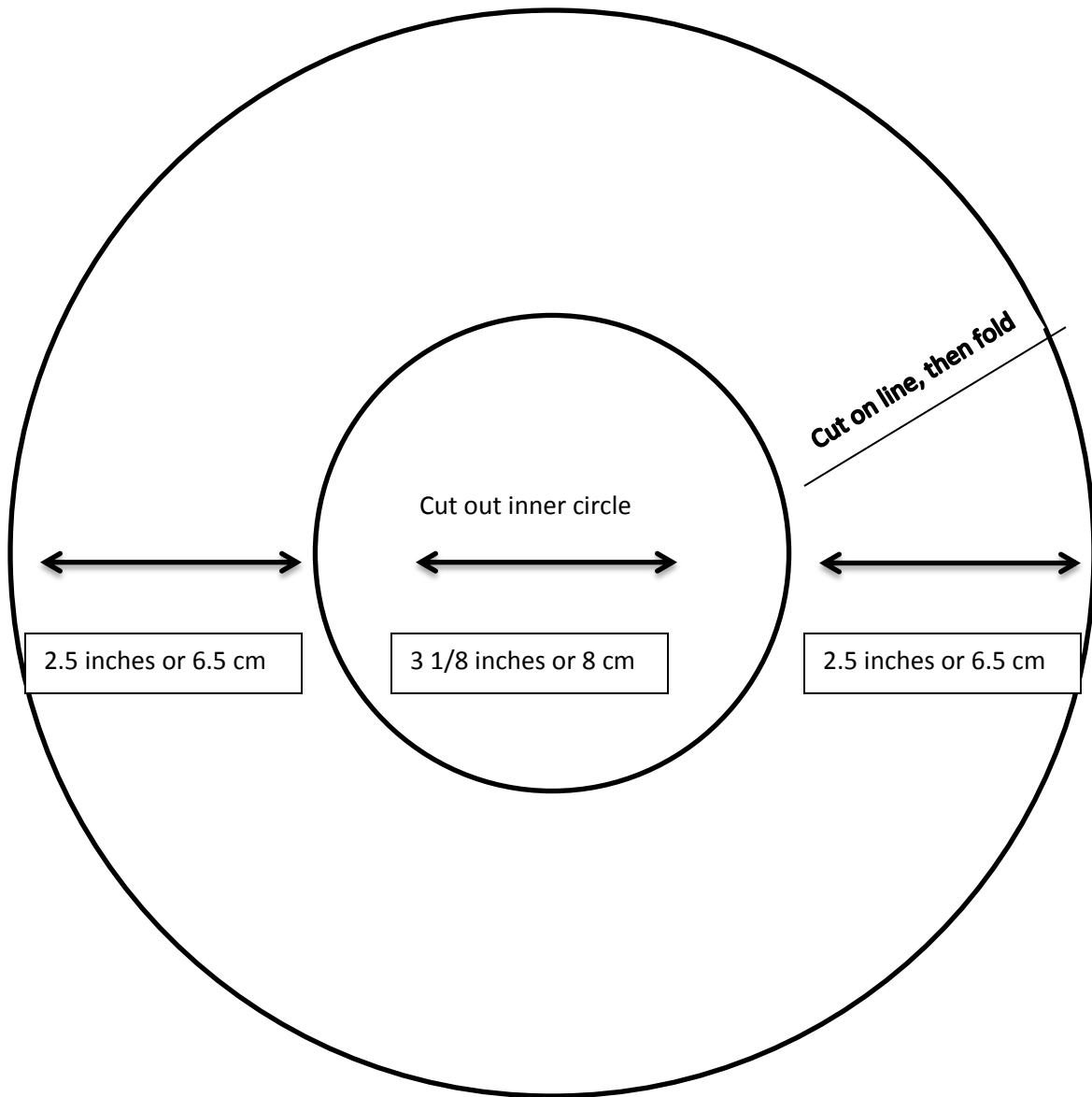
1. Have either a sand pit or small tub of water or small sand pit prepared in advance to drop the small object into.
2. Place an uncooked chicken egg into the capsule.

3. Drop the capsule from a pre-determined height between 6 and 8 feet (teacher's discretion).
4. Record the data as to what happened to the egg inside.

REMEMBER: Students may not modify the inside of the capsule. All they may do is tape the egg down.

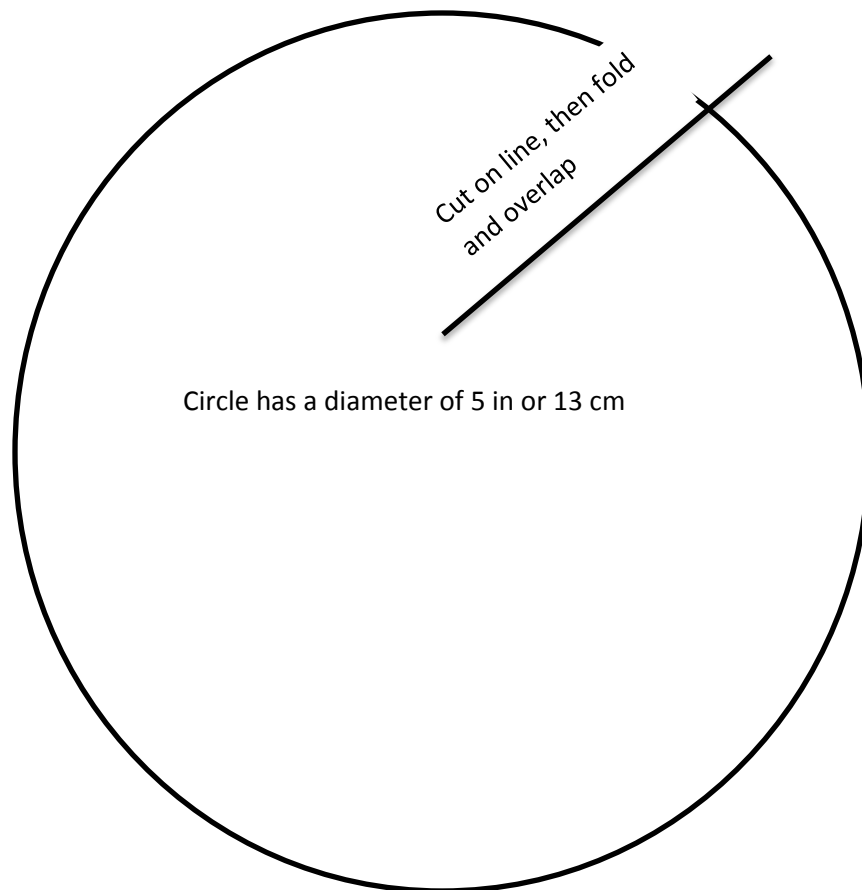
Attachment 1

(Side of Capsule)



Attachment 1

Bottom of Capsule




Name: _____

Date: _____

Orion Design Capsule Lab Sheet

Objective for Day 1: I will understand the differences between the Space Shuttle and Orion program, along with creating a model of the Orion Capsule.

1. How is the Orion program different from the space shuttle?
2. How is the Orion space craft similar to the space shuttle?
3. What measures were put into place to enhance crew safety?
4. What is the purpose of the service module?


 Cut out your capsule and record the surface area. Remember the formula for surface area is πr^2

Surface area of bottom of capsule: _____

Surface area of side of capsule: _____

Total surface area added together: _____

Objective for Phase 2: I will design, create and test a heat shield capable of maintaining a livable temperature for humans inside the Orion Model Spacecraft.

 Remember, some materials are limited! (Aluminum Foil, Parchment Paper, Fabric Squares and Saran Wrap are limited according to your surface area identified earlier.

Materials I used	Procedure on how it was built

Data:

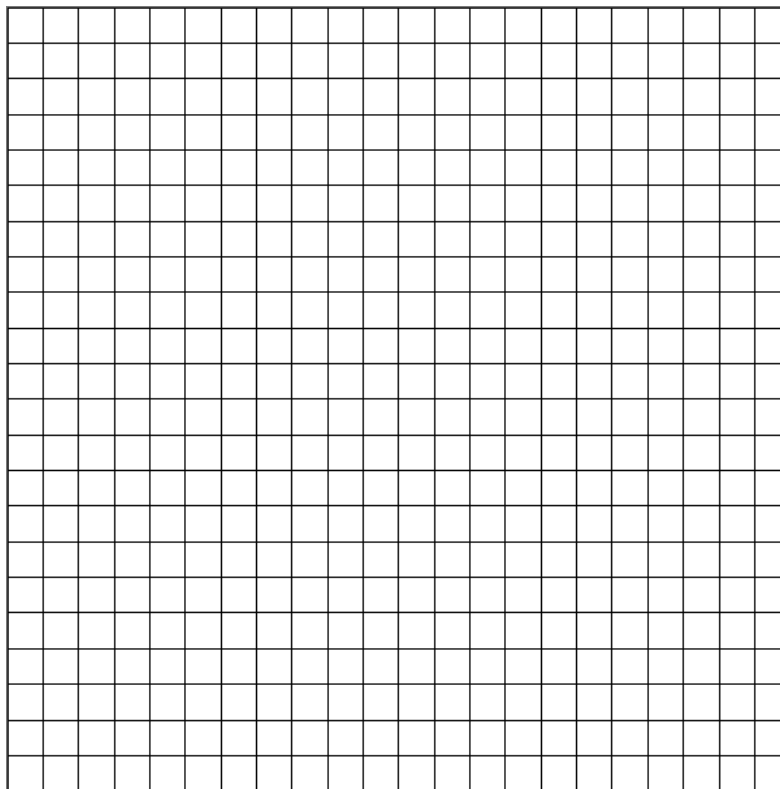
Total time elapsed during test in seconds: _____

Initial Temperature of capsule: _____

Final Temperature of capsule: _____

Total temperature change: _____

Below, create a temperature versus time graph showing the temperature change inside your capsule.

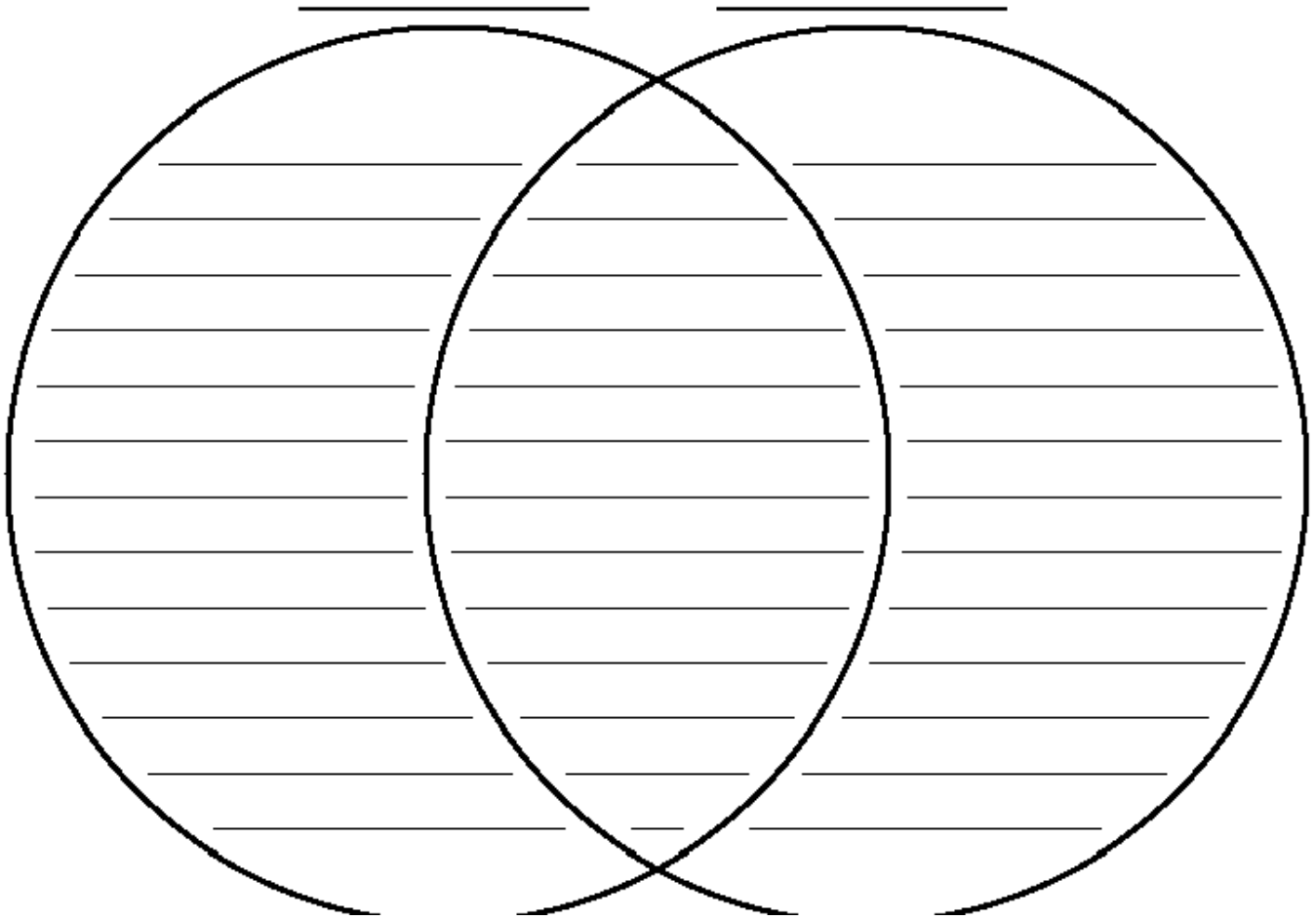


What was the rate of change for the temperature inside the capsule?

(For example, the temperature _____ every _____ seconds)

Objective for phase 3: I will design and construct a parachute system capable of safely landing a chicken egg on either sand or water at a drop distance of 6 to 8 feet.

Complete the Venn Diagram discussing the benefits and drawbacks of a water landing versus a sand landing for your Orion capsule.



Which type of landing would be best and why?

Explain your parachute recovery system through words and images. Be sure to provide the size of your parachutes, length of the string used attached to the parachutes. Include what ideas you used from the parachutes worksheet you completed earlier.

My Orion Capsule Landing Data Sheet

Type of landing chosen:.....

Sand _____ Water

Height Lander was dropped from:.....
_____ meters

Total amount of time elapsed from drop height until it hit the ground.....
_____ seconds

Average Speed of
Capsule:.....
_____ m/s

Did the egg break?..... Yes
_____ No

What improvements could be made to the landing system?

Did you choose the correct surface to land on? Why or why not?

What type of parachute system works best?

Did the mass of your design have an effect on the egg drops performance?

Group

Members: _____

(optional) Make the Lab a Competition Score Sheet

Lowest Score Wins!

Phase 1: Calculate the Surface Area

(Absolute Value of difference)

Actual Answer: 478.85 cm² - Students Answer _____ = _____

Phase 2: Heat Shield

Final Temperature: _____ - Students Initial Temperature _____ = _____

Phase 3: Egg Drop

No crack in egg= Add 0 points

Small Crack in egg= Add 20 points

Large Crack in egg = Add 50 points

Final Score (Add Day 1 + Day 2 + Day 3): _____

A detailed illustration of the Orion spacecraft in space. The spacecraft is shown from a side-on perspective, with its large, dark solar panels extended. The main body of the spacecraft is metallic and complex, with various components visible. In the background, the curved horizon of a reddish-orange planet, likely Mars, is visible against the blackness of space. A small, white, spherical object, possibly a satellite or a small moon, is also visible in the distance.

INSIDE:
LEADING EDGE DESIGN AND ENGINEERING
TECHNOLOGY INNOVATION
BUILDING ORION
TESTING ORION
INVESTING IN OUR FUTURE

LEADING EDGE DESIGN AND ENGINEERING

Drawing from more than 60 years of spaceflight research and development, Orion is designed to meet the evolving needs of our nation's space program for decades to come.

As the flagship of our nation's next-generation space fleet, Orion will push the envelope of human spaceflight far beyond low Earth orbit.

Orion may resemble its Apollo-era predecessors, but its technology and capability are light years apart. Orion features dozens of technology advancements and innovations that have been incorporated into the spacecraft's subsystem and component design.

To support long-duration deep space missions of up to six months, Orion engineers developed a state-of-the-art spacecraft with unique life support, propulsion, thermal protection and avionics systems.

Building upon the best of Apollo and shuttle-era design, the Orion spacecraft includes both crew and service

modules, a spacecraft adaptor, and a revolutionary launch abort system that will significantly increase crew safety.

Orion's crew module is much larger than Apollo's and can support more crew members for short or long-duration spaceflight missions. The service module is the powerhouse that fuels and propels the spacecraft as well as the storehouse for the life-sustaining air and water astronauts need during their space travels. The service module's structure will also provide places to mount scientific experiments and cargo.

Orion is capable of supporting low Earth orbit missions or transporting astronauts on a variety of expeditions beyond low Earth orbit – ushering in a new era of space exploration. Orion can carry astronauts to the International Space Station, deliver cargo for resupply, and remain on orbit under its own power supply to serve as an emergency escape vehicle for the crew onboard.