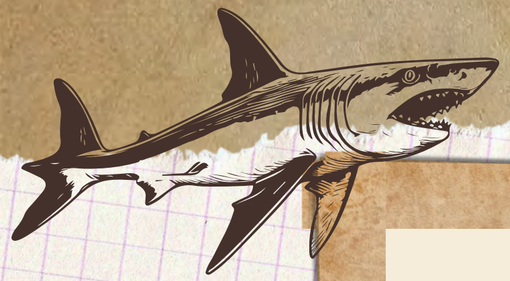


INCREDIBLE FORCES:

AIR & WATER

An Adventure in Time!

Presented by Teacher's Pet

INTRODUCTION VIDEO

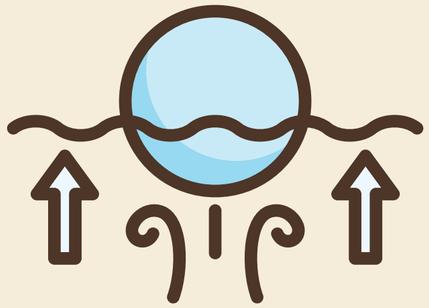
PART ONE:

Archimedes Opposing Forces of Floating Objects

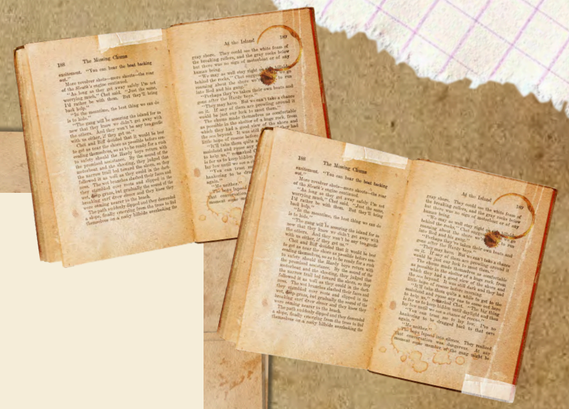
WHO IS ARCHIMEDES?

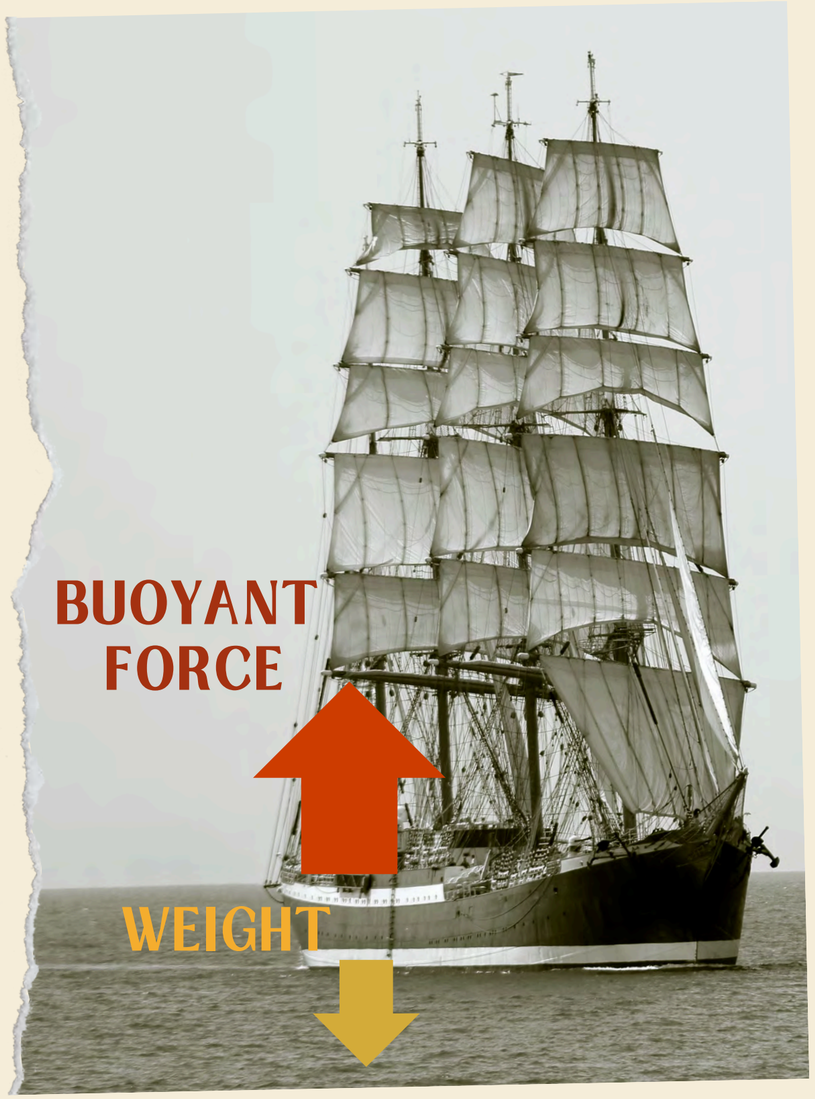
VIDEO

TESTING ARCHIMEDES LAW OF BUOYANCY



Eureka!

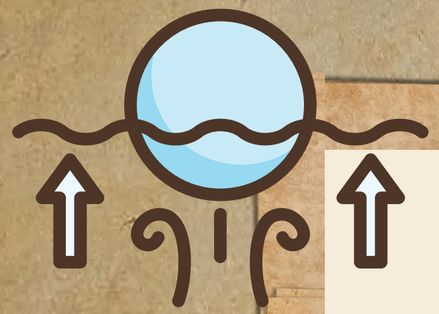




BUOYANT FORCE

It is an upward force exerted by a fluid that opposes the weight of anything placed in the fluid.

TESTING ARCHIMEDES LAW OF BUOYANCY



PREDICT **HOW** AND **WHY**

WE CAN MAKE THE

BOTTLE **FLOAT ON TOP**

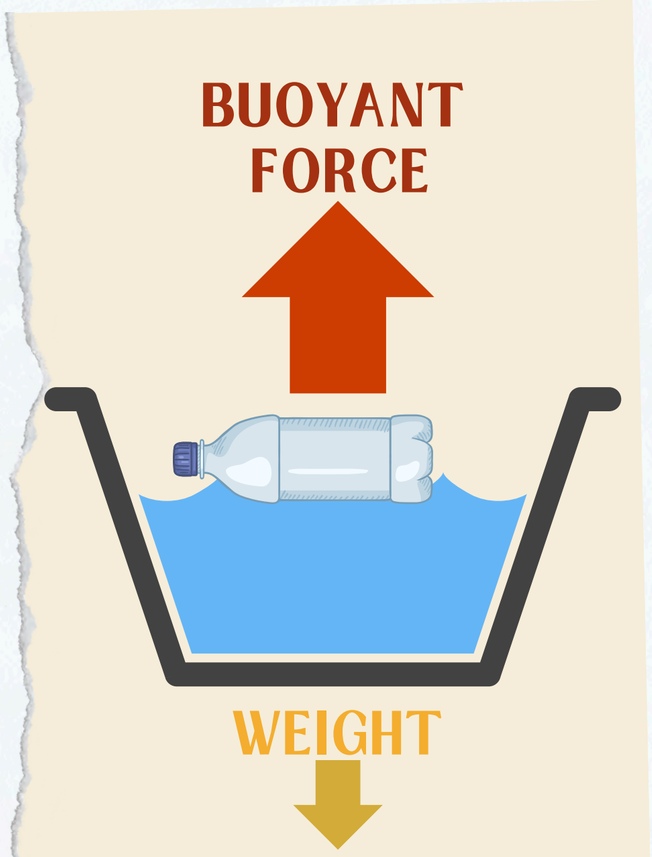
OF THE TUB OF WATER.

STUDENT HANDOUT

Table 1: Testing Archimedes Law of Buoyancy

1. Predict HOW and WHY we can make the bottle float.
2. Change the amount of water inside the bottle. Test the bottle in the tub.
3. Record the results of each experiment in the table below.

Experiment Setup	Prediction	Observation (Fill in less, greater or equals)	Diagram (Draw the liquid level and arrows)
Positive Buoyancy: Bottle FLOATS on top		Buoyant Force is _____ than weight.	Buoyant Force  Weight
Neutral Buoyancy: Bottle SUSPENDED in the middle		Buoyant Force _____ weight.	Buoyant Force  Weight
Negative Buoyancy: Bottle SINKS to the bottom		Buoyant Force is _____ than weight.	Buoyant Force  Weight



POSITIVE BUOYANCY

The bottle FLOATS on top of the water. Positive Buoyancy is achieved.

The bottle is completely filled with AIR.

The buoyant force is GREATER than the weight of the bottle.

BUOYANT FORCE > WEIGHT

Table 1: Testing Archimedes Law of Buoyancy

1. Predict HOW and WHY we can make the bottle float.
2. Change the amount of water inside the bottle. Test the bottle in the tub.
3. Record the results of each experiment in the table below.

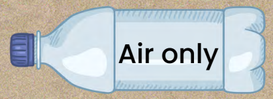
Experiment Setup	Prediction	Observation (Fill in less, greater or equals)	Diagram (Draw the liquid level and arrows)
Positive Buoyancy: Bottle FLOATS on top	Answers may vary	Buoyant Force is **greater** than weight.	Buoyant Force ↑  ↓ Weight
Neutral Buoyancy: Bottle SUSPENDED in the middle		Buoyant Force _____ weight.	Buoyant Force  Weight
Negative Buoyancy: Bottle SINKS to the bottom		Buoyant Force is _____ than weight.	Buoyant Force  Weight

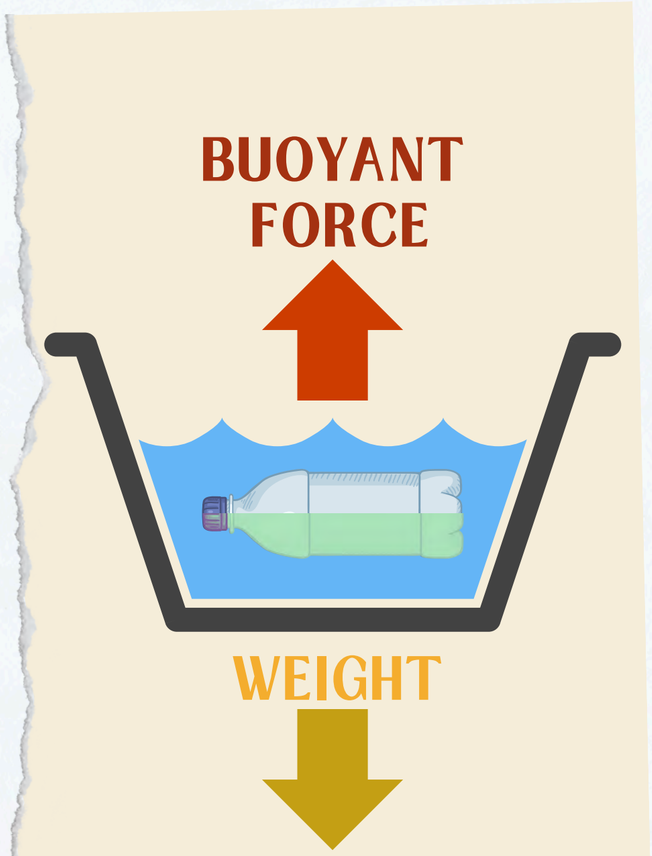
TESTING ARCHIMEDES LAW OF BUOYANCY

PREDICT **HOW** AND **WHY** WE CAN MAKE THE BOTTLE **SUSPEND IN THE MIDDLE** OF THE TUB OF WATER.

Table 1: Testing Archimedes Law of Buoyancy

1. Predict HOW and WHY we can make the bottle float.
2. Change the amount of water inside the bottle. Test the bottle in the tub.
3. Record the results of each experiment in the table below.

Experiment Setup	Prediction	Observation (Fill in less, greater or equals)	Diagram (Draw the liquid level and arrows)
Positive Buoyancy: Bottle FLOATS on top	Answers may vary	Buoyant Force is **greater** than weight.	Buoyant Force ↑  ↓ Weight
Neutral Buoyancy: Bottle SUSPENDED in the middle		Buoyant Force _____ weight.	Buoyant Force  Weight
Negative Buoyancy: Bottle SINKS to the bottom		Buoyant Force is _____ than weight.	Buoyant Force  Weight



NEUTRAL BUOYANCY

Fill the bottle HALFWAY with water.

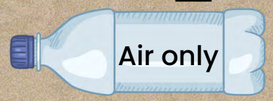
When the buoyant force EQUALS the weight of the object, we achieve NEUTRAL BUOYANCY.

The bottle is SUSPENDED in the MIDDLE of the fluid.

BUOYANT FORCE = WEIGHT

Table 1: Testing Archimedes Law of Buoyancy

1. Predict HOW and WHY we can make the bottle float.
2. Change the amount of water inside the bottle. Test the bottle in the tub.
3. Record the results of each experiment in the table below.

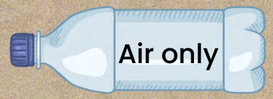
Experiment Setup	Prediction	Observation (Fill in less, greater or equals)	Diagram (Draw the liquid level and arrows)
Positive Buoyancy: Bottle FLOATS on top	Answers may vary	Buoyant Force is **greater** than weight.	Buoyant Force ↑  Weight ↓
Neutral Buoyancy: Bottle SUSPENDED in the middle	Answers may vary	Buoyant Force **equals** weight. Water level rises.	Buoyant Force ↑  Weight ↓
Negative Buoyancy: Bottle SINKS to the bottom		Buoyant Force is _____ than weight.	Buoyant Force  Weight

TESTING ARCHIMEDES LAW OF BUOYANCY

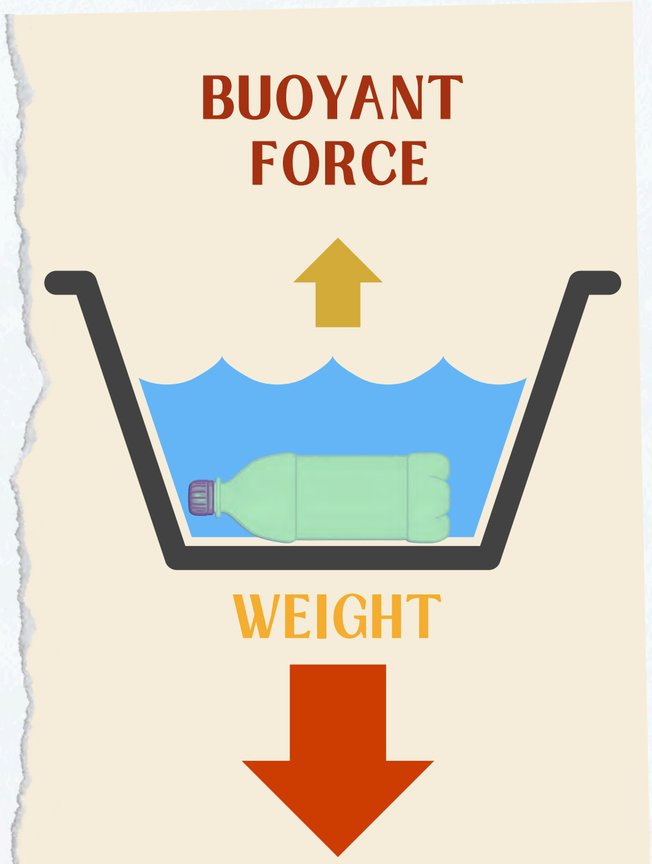
PREDICT HOW AND WHY WE CAN MAKE THE BOTTLE SINK TO THE BOTTOM OF THE TUB OF WATER.

Table 1: Testing Archimedes Law of Buoyancy

1. Predict HOW and WHY we can make the bottle float.
2. Change the amount of water inside the bottle. Test the bottle in the tub.
3. Record the results of each experiment in the table below.

Experiment Setup	Prediction	Observation (Fill in less, greater or equals)	Diagram (Draw the liquid level and arrows)
Positive Buoyancy: Bottle FLOATS on top	Answers may vary	Buoyant Force is **greater** than weight.	Buoyant Force ↑  Weight ↓
Neutral Buoyancy: Bottle SUSPENDED in the middle	Answers may vary	Buoyant Force **equals** weight. **Water level rises.**	Buoyant Force ↑  Weight ↓
Negative Buoyancy: Bottle SINKS to the bottom		Buoyant Force is _____ than weight.	Buoyant Force  Weight

NEGATIVE BUOYANCY



Fill the bottle COMPLETELY with water.

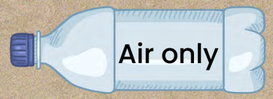
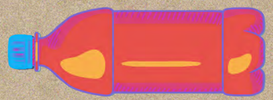
When the buoyant force is LESS than the weight of the object, we achieve NEGATIVE BUOYANCY.

The bottle SINKS to the BOTTOM of the fluid.

BUOYANT FORCE < WEIGHT

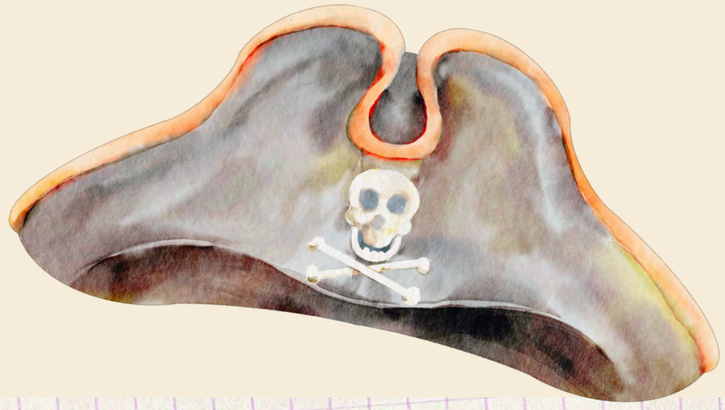
Table 1: Testing Archimedes Law of Buoyancy

1. Predict HOW and WHY we can make the bottle float.
2. Change the amount of water inside the bottle. Test the bottle in the tub.
3. Record the results of each experiment in the table below.

Experiment Setup	Prediction	Observation (Fill in less, greater or equals)	Diagram (Draw the liquid level and arrows)
Positive Buoyancy: Bottle FLOATS on top	Answers may vary	Buoyant Force is **greater** than weight.	Buoyant Force ↑  Weight ↓
Neutral Buoyancy: Bottle SUSPENDED in the middle	Answers may vary	Buoyant Force **equals** weight. **Water level rises.**	Buoyant Force  Weight
Negative Buoyancy: Bottle SINKS to the bottom	Answers may vary	Buoyant Force is **less** than weight. Water level rises more.	Buoyant Force ↑  Weight ↓

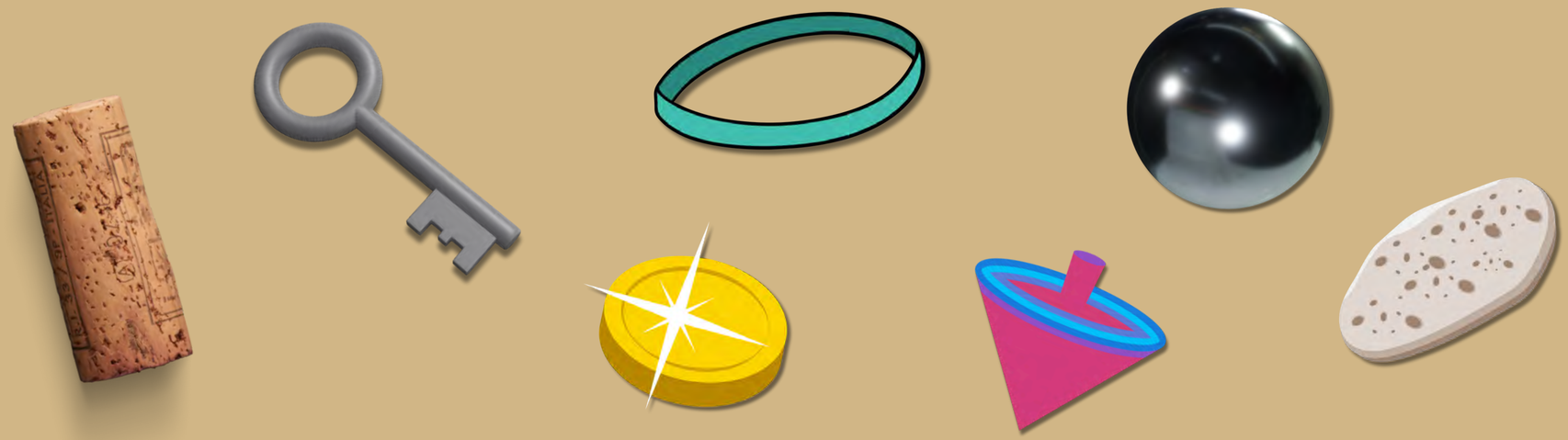
PART TWO: Pirate Zheng Yi Sao

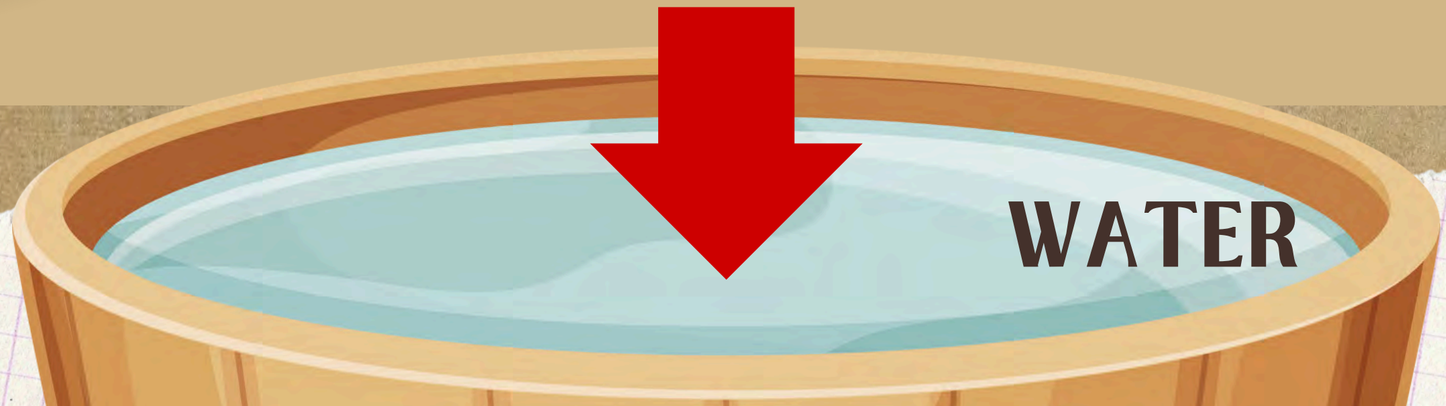
THE PIRATE QUEEN VIDEO



PIRATE ZHENG'S BUOYANCY EXPERIMENTS

Predict which objects will FLOAT and which will SINK when you put them into the tub of water.





STUDENT HANDOUT

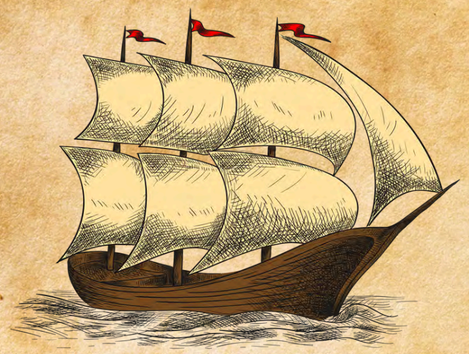


Table 2: Pirate Zheng's Buoyancy Experiment

1. Prediction - Will the object FLOAT or SINK? Circle one.

2. Observation - Record the results of your experiment in the table.

Object	Prediction	Observation
Cork	Float or Sink	
Plastic Coin	Float or Sink	
Metal Key	Float or Sink	
Cannonball	Float or Sink	
Pumice	Float or Sink	
Wristband	Float or Sink	
Spinner	Float or Sink	

STUDENT HANDOUT

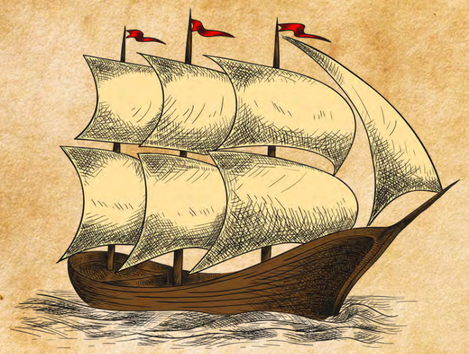


Table 2: Pirate Zheng's Buoyancy Experiment

1. Prediction - Will the object FLOAT or SINK? Circle one.

2. Observation - Record the results of your experiment in the table.

Object	Prediction	Observation
Cork	Float or Sink	Float
Plastic Coin	Float or Sink	Float and Sink
Metal Key	Float or Sink	Sink
Cannonball	Float or Sink	Sink
Pumice	Float or Sink	Float and Sink
Wristband	Float or Sink	Sink
Spinner	Float or Sink	Float

PIRATE ZHENG'S DENSITY EXPERIMENTS

Predict which objects will FLOAT and which will SINK when you put them into PURE WATER & SALT WATER.

Add 1 spoon of salt per student

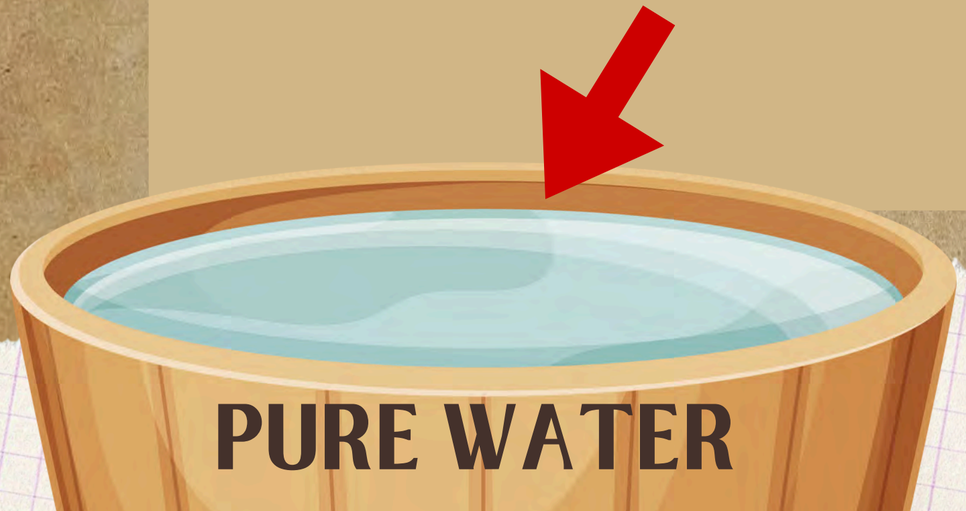
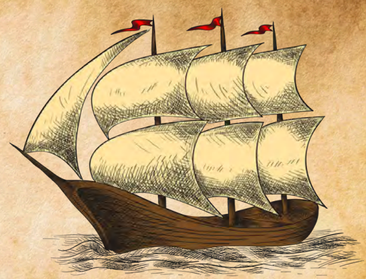


Table 3: Pirate Zheng's Density Experiment



1. Prediction - Will the objects FLOAT or SINK in pure water and in salt water?
2. Observations - Carefully place one object at a time in the pure water container.
3. Each student adds ONE SPOON of salt to ONE container (minimum 4 spoons). Stir carefully.
4. Observations - Slowly place each object in the Salt Water container.
5. Record your results in the table below by writing Float or Sink in each box.

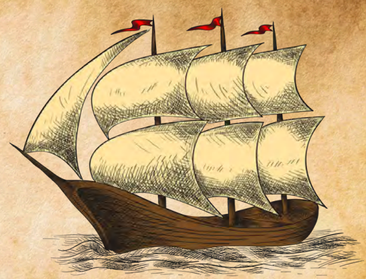
Object	Pure Water PREDICTION	Pure Water OBSERVATION	Salt Water PREDICTION	Salt Water OBSERVATION
Popcorn Kernel				
Wooden Bead				
Plastic Gem				

Did any objects behave differently in pure water versus salt water? If so, list the object(s) that had different results and explain why?

_____

_____

Table 3: Pirate Zheng's Density Experiment



1. Prediction - Will the objects FLOAT or SINK in pure water and in salt water?
2. Observations - Carefully place one object at a time in the pure water container.
3. Each student adds ONE SPOON of salt to ONE container (minimum 4 spoons). Stir carefully.
4. Observations - Slowly place each object in the Salt Water container.
5. Record your results in the table below by writing Float or Sink in each box.

Object	Pure Water PREDICTION	Pure Water OBSERVATION	Salt Water PREDICTION	Salt Water OBSERVATION
Popcorn Kernel	Answers may vary	Sink	Answers may vary	Sink
Wooden Bead	Answers may vary	Float	Answers may vary	Float
Plastic Gem	Answers may vary	Sink	Answers may vary	Float

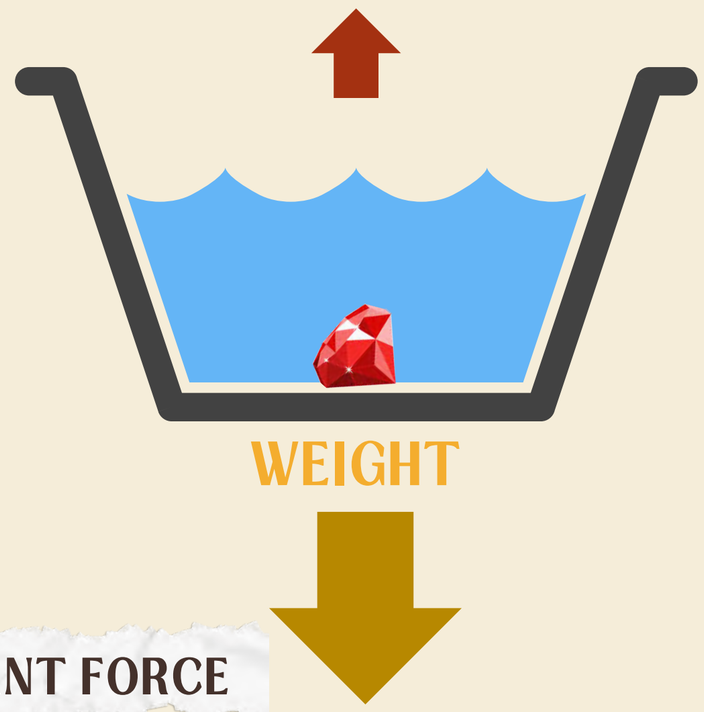
Did any objects behave differently in pure water versus salt water? If so, list the object(s) that had different results and explain why?

Yes, the gem behaved differently. In pure water, the gem is more dense so it sinks. When the salt was dissolved in the water, the salt water became more dense than the gem resulting in the gem floating.

PIRATE ZHENG'S BUOYANCY EXPERIMENT

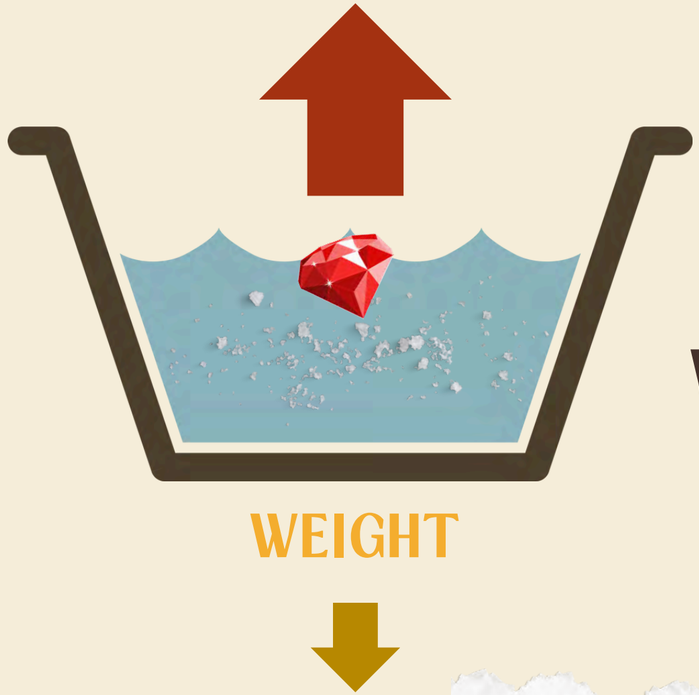
Draw and explain WHY gems SINK in PURE water, but FLOAT in SALT water,

PURE WATER



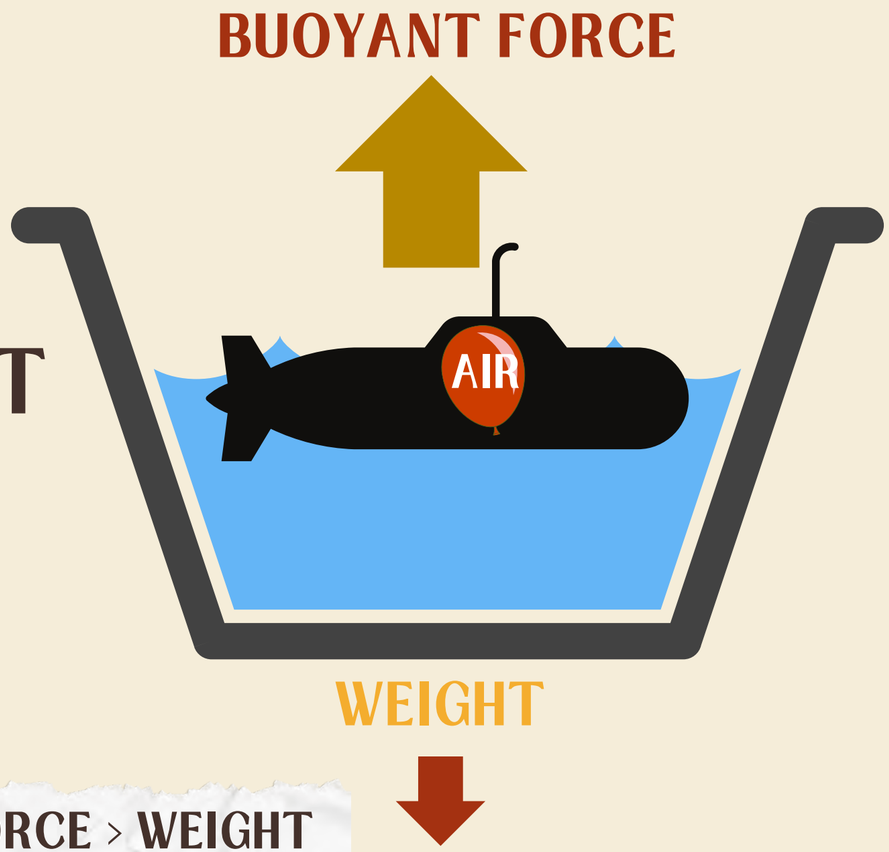
WEIGHT > BUOYANT FORCE

SALT WATER



BUOYANT FORCE > WEIGHT

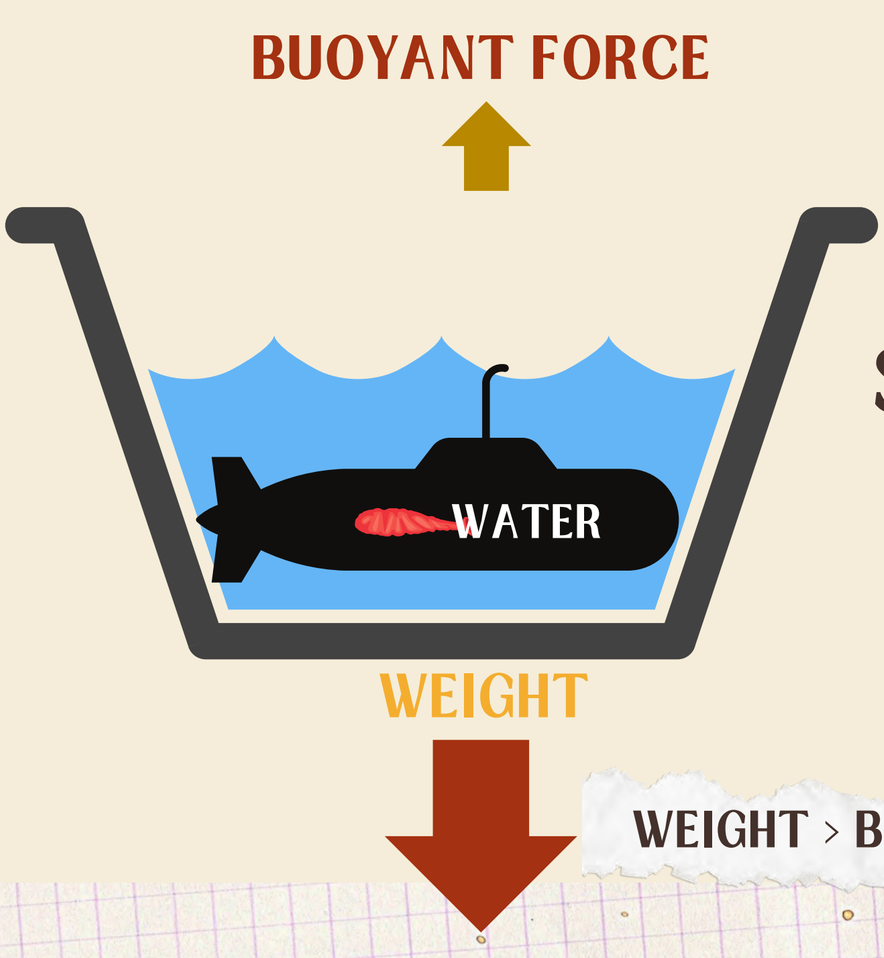
AIR INSIDE the submarine.



FLOAT

BUOYANT FORCE > WEIGHT

WATER INSIDE the submarine.



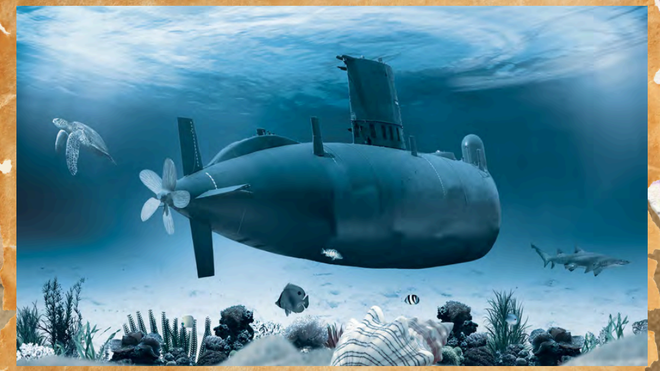
SINK

WEIGHT > BUOYANT FORCE

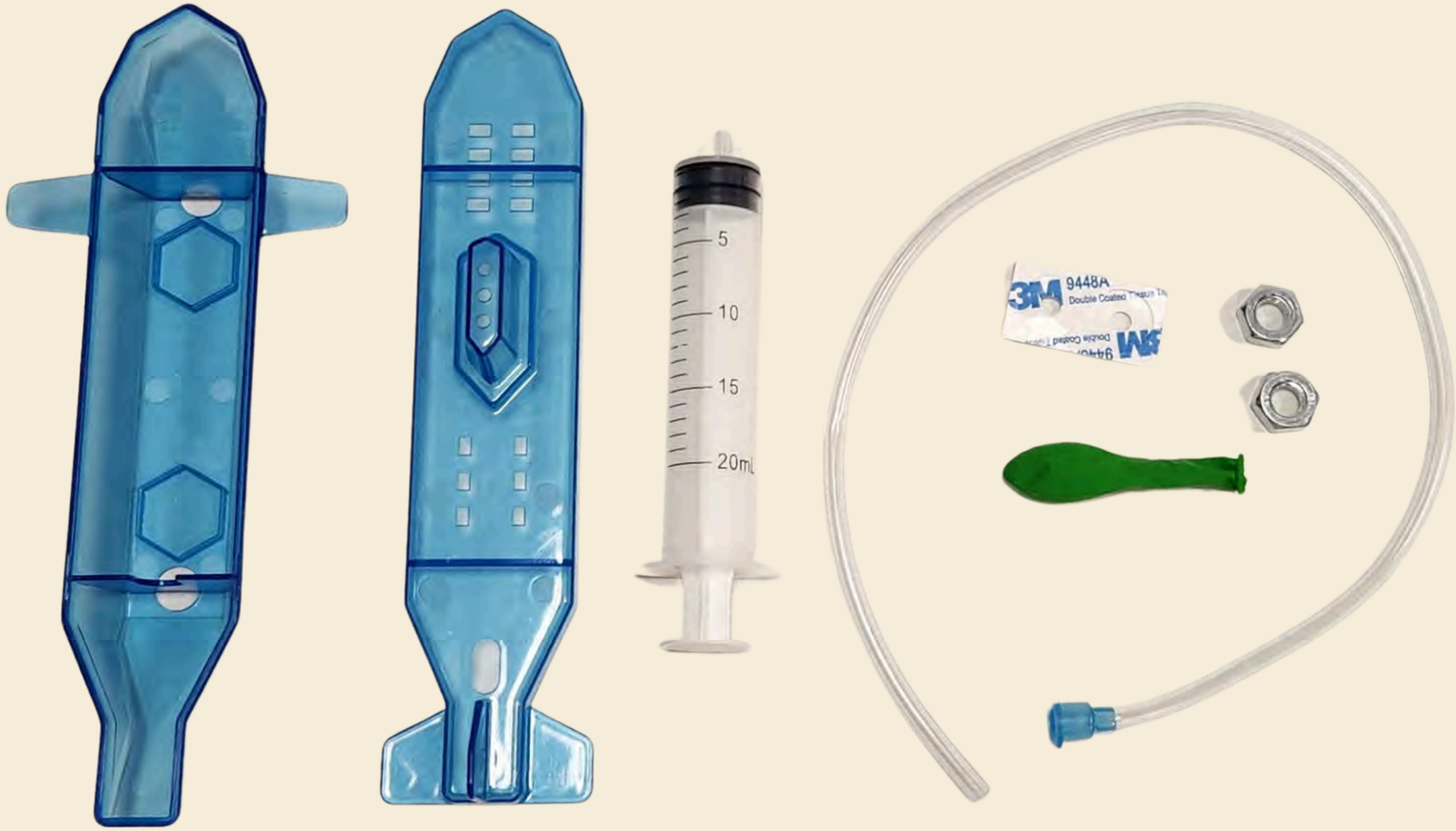
BUILD OUR OWN SUBMARINE MODEL

KEEP YOUR MODEL **DRY**!

TEST THE **EXTRA** SUBMARINE MODELS IN THE WATER.

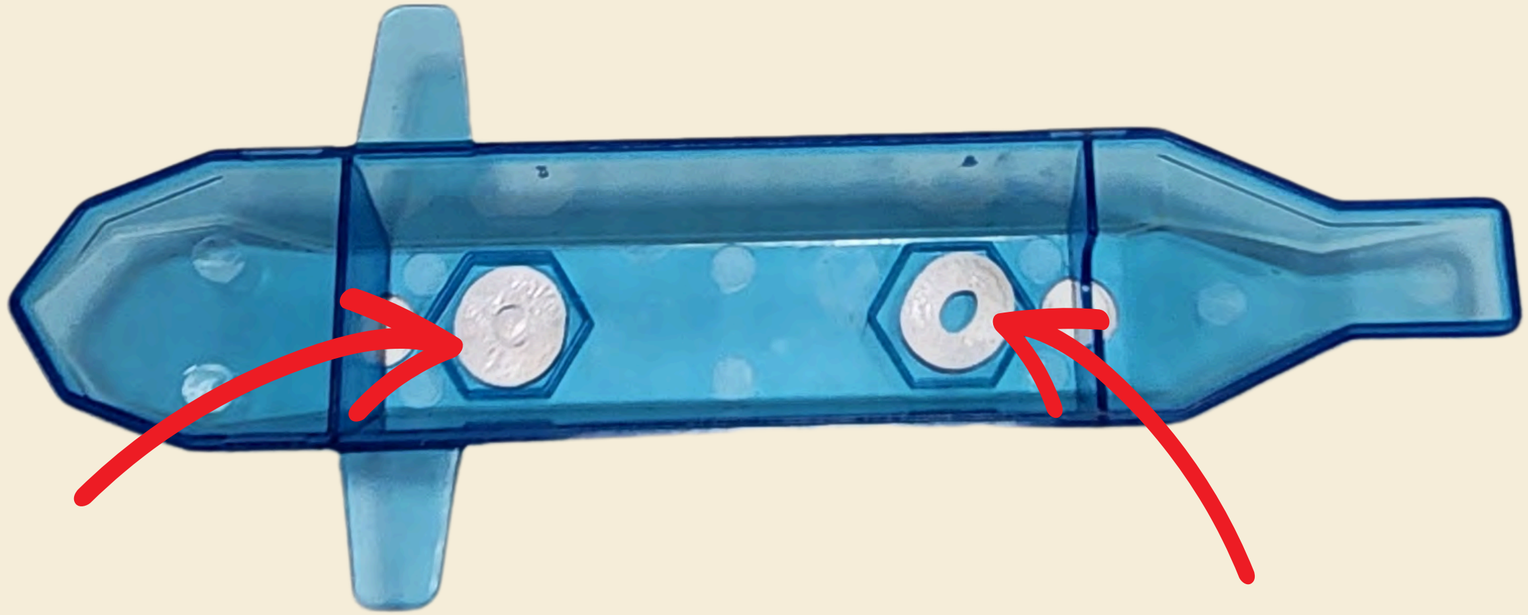


STEP 1 - CHECK MATERIALS

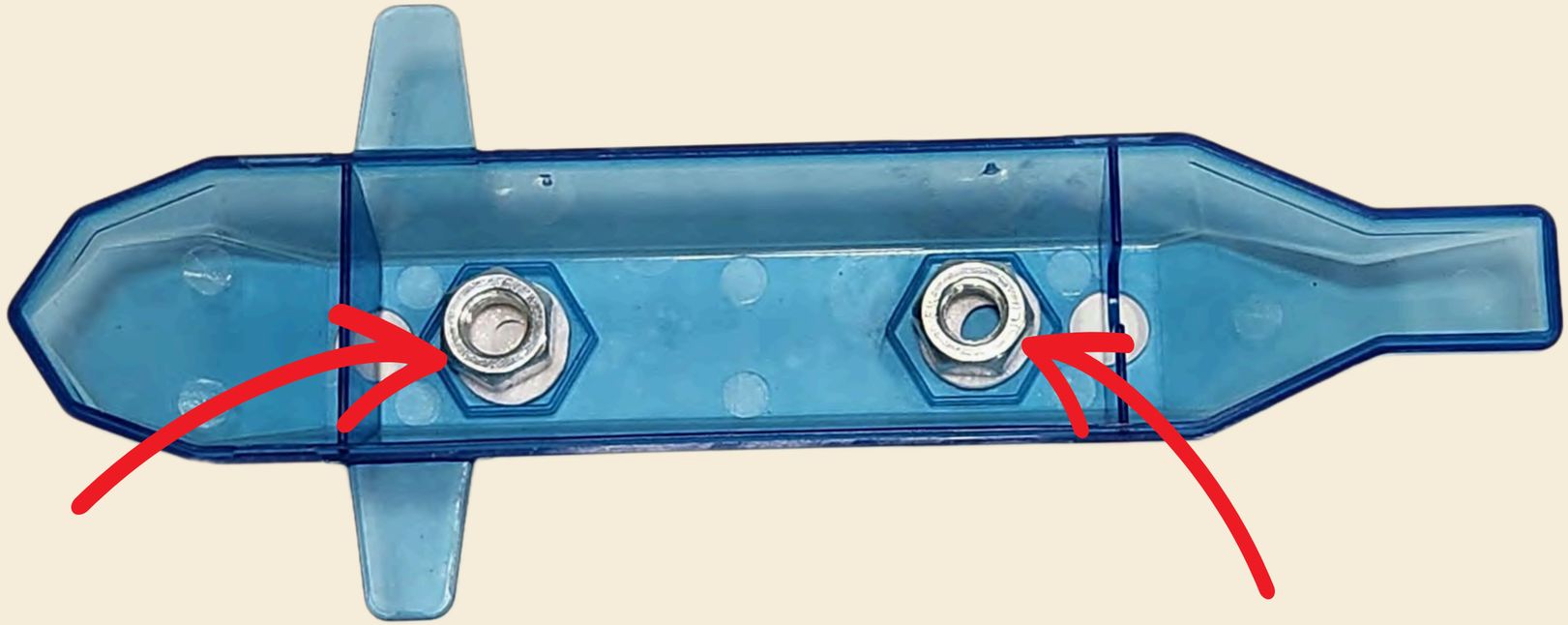


STEP 2 - LABEL THE BOTTOM OF THE BASE

STEP 3 - PEEL ONE SIDE OF EACH DOUBLE-SIDED TAPE. PLACE ONE CIRCLE IN EACH HEXAGON ON THE INSIDE OF THE SUBMARINE BASE.

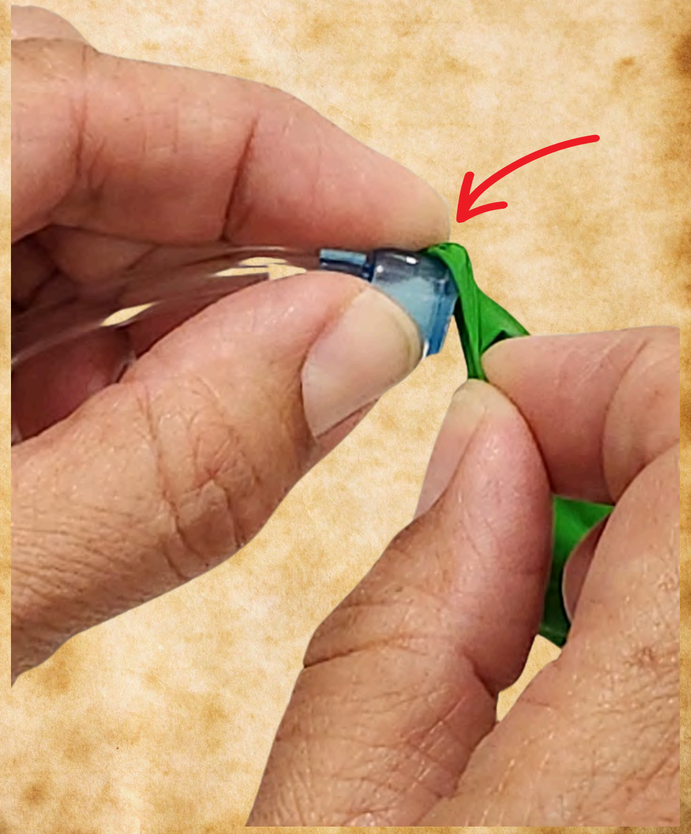


STEP 4 - PEEL THE OTHER SIDE OF EACH DOUBLE-SIDED TAPE AND PLACE THE METAL HEXAGON NUT ON TOP. PRESS DOWN FIRMLY.



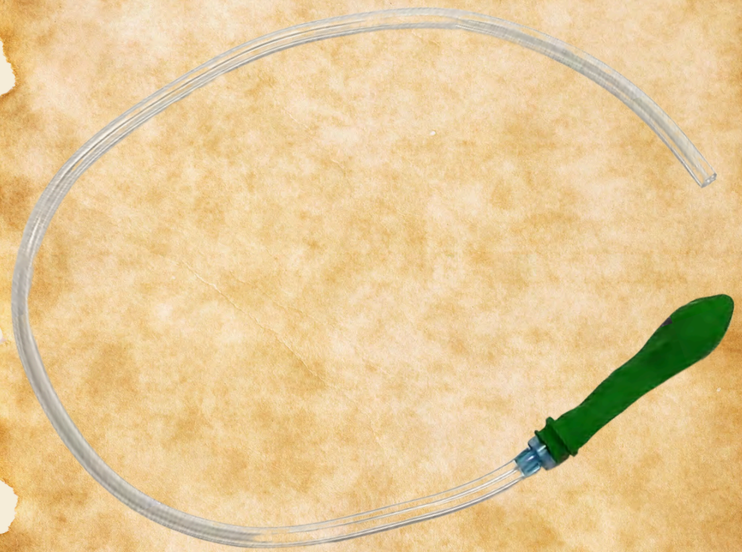
STEP 5 - ATTACH BALLOON TO THE LARGER END OF THE PLASTIC TUBE

A: HOLD BALLOON IN PLACE ON ONE SIDE WITH INDEX FINGER

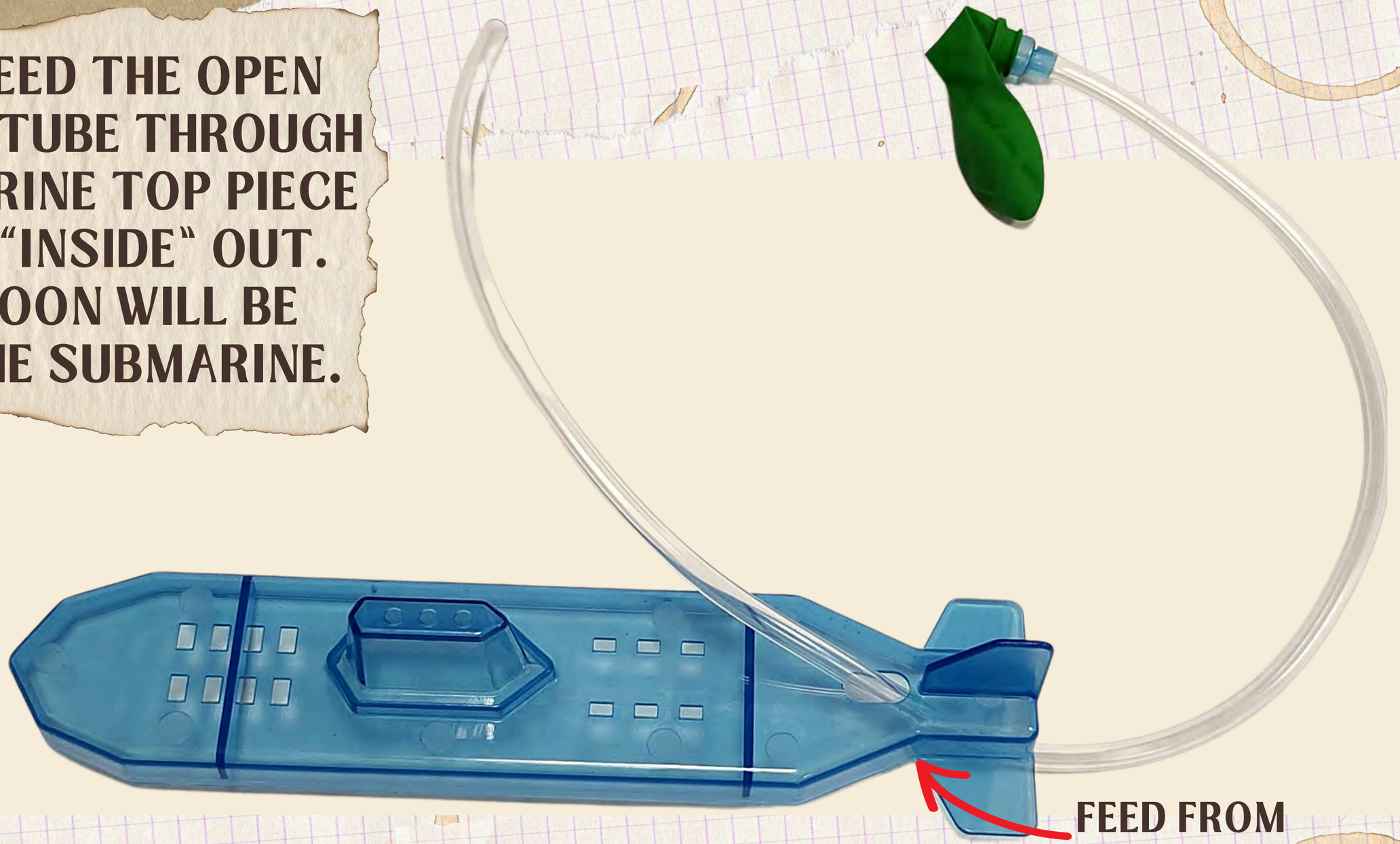


B: GENTLY PULL OPENING OF BALLOON ACROSS THE END OF THE TUBE TO THE OTHER SIDE

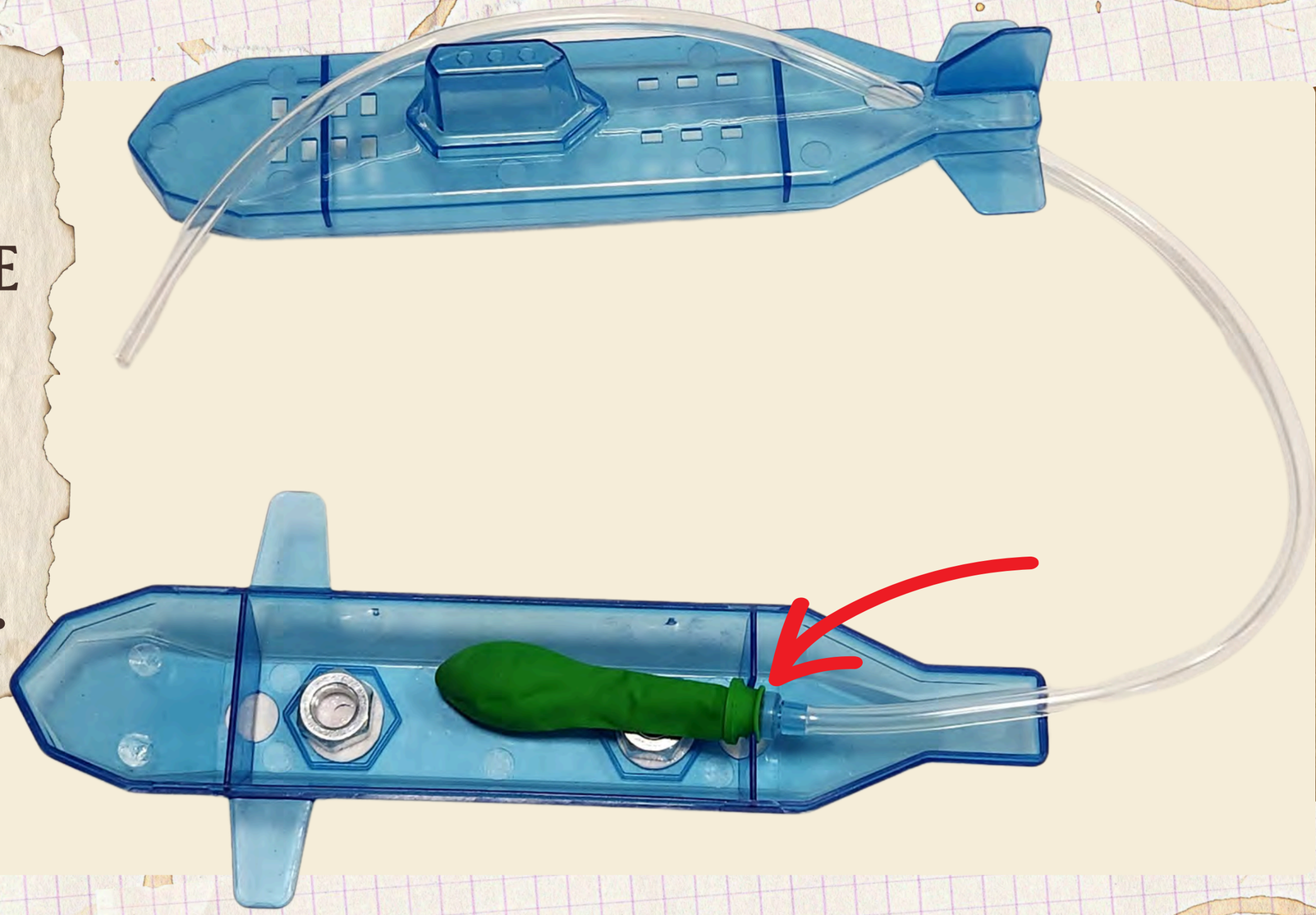
C: CAREFULLY ROLL THE BALLOON FURTHER ONTO THE TUBE



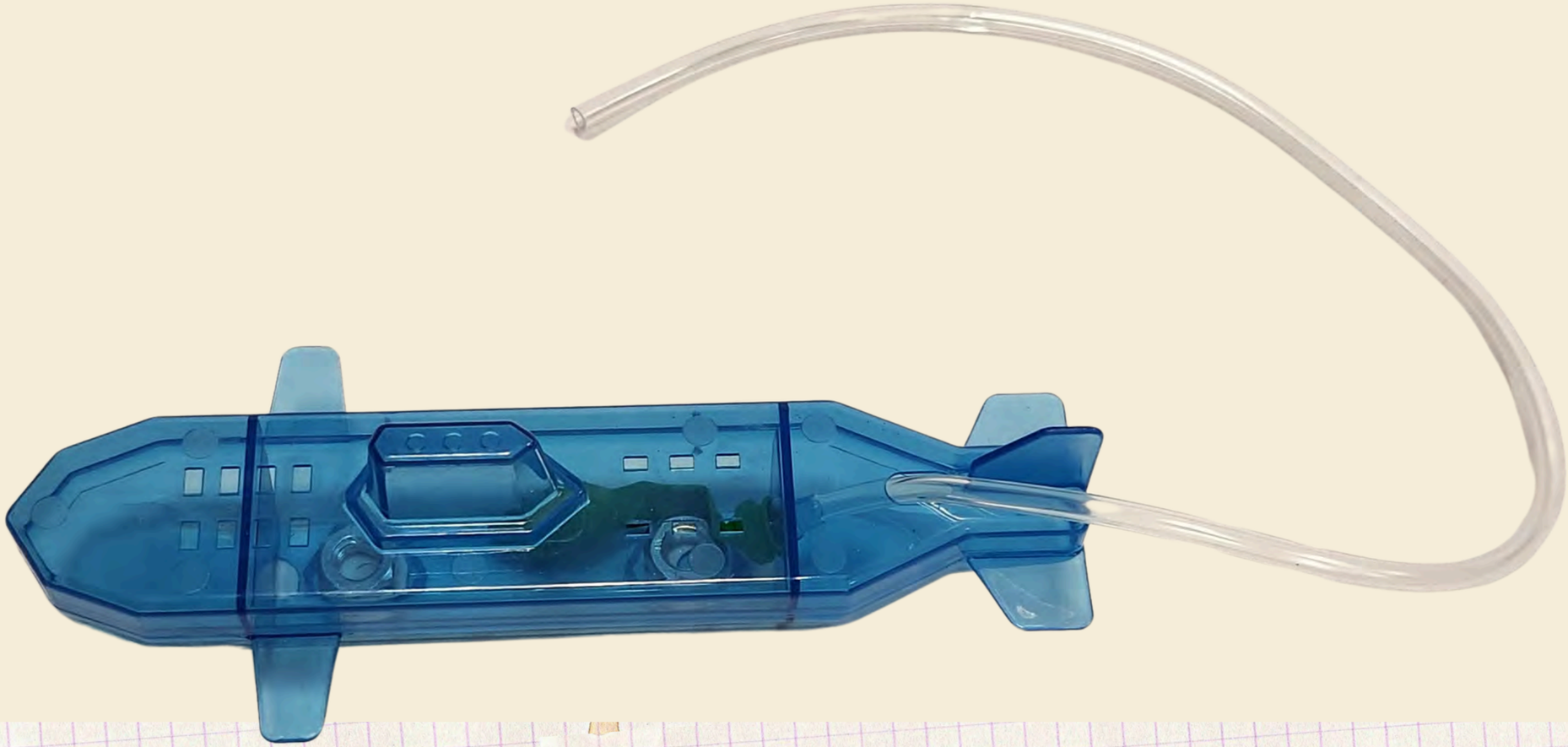
STEP 6 - FEED THE OPEN END OF THE TUBE THROUGH THE SUBMARINE TOP PIECE FROM THE “INSIDE” OUT. THE BALLOON WILL BE “INSIDE” THE SUBMARINE.



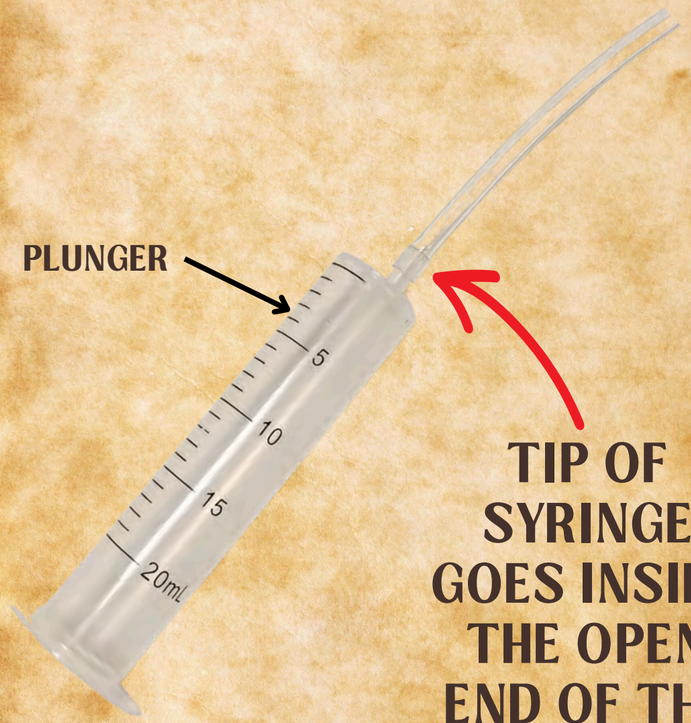
STEP 7 - SLIDE THE BALLOON END INTO THE SPACE ON THE SUBMARINE BASE – THE BALLOON SHOULD BE LAYING ACROSS THE BASE POINTING TOWARDS THE NOSE OF THE SUBMARINE.



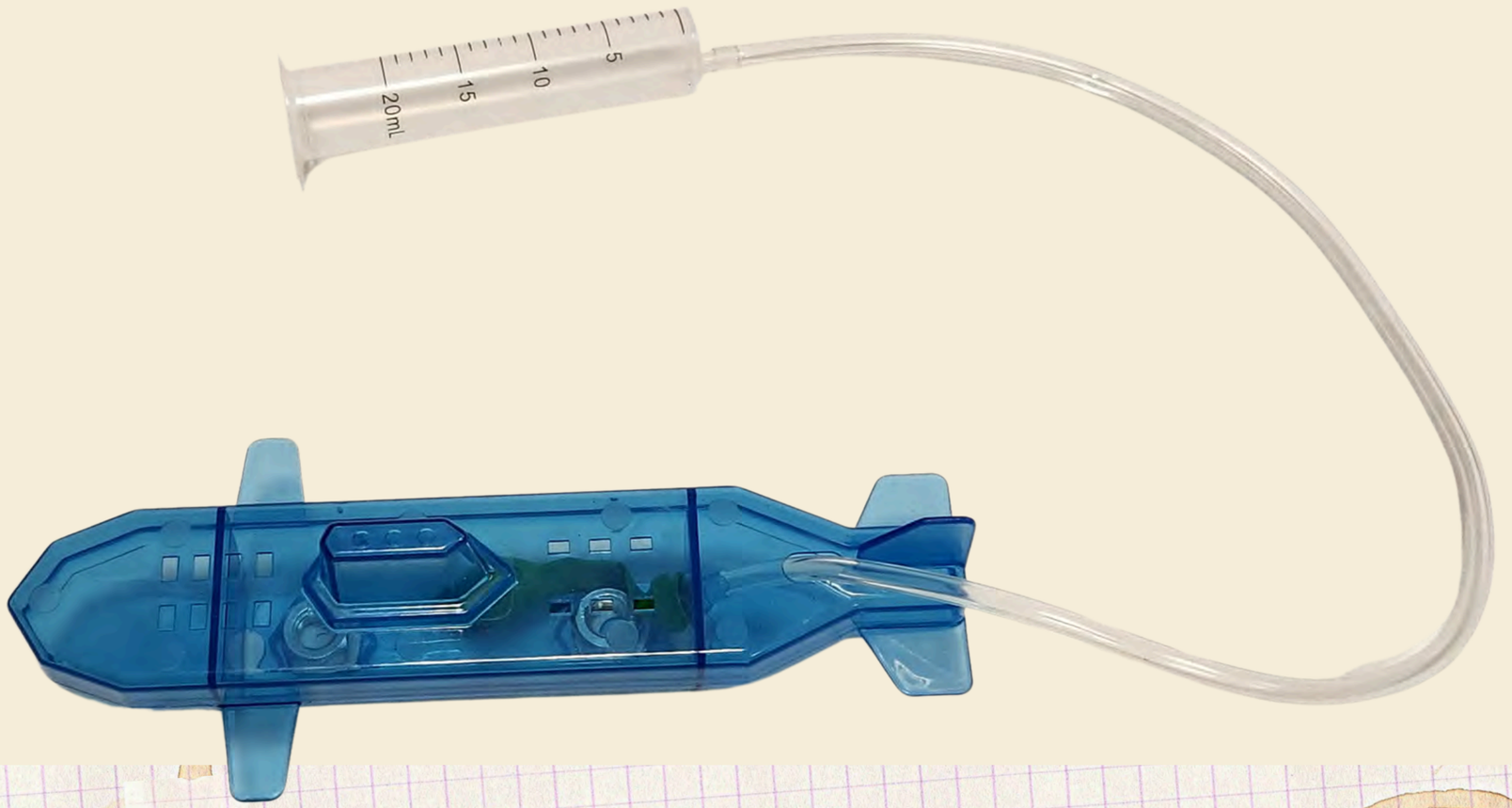
STEP 8 - CAREFULLY SLIDE THE SUBMARINE TOP DOWN THE TUBE TOWARDS THE BASE. MAKE SURE THE BALLOON STAYS IN PLACE BEFORE CLOSING THE SUBMARINE.



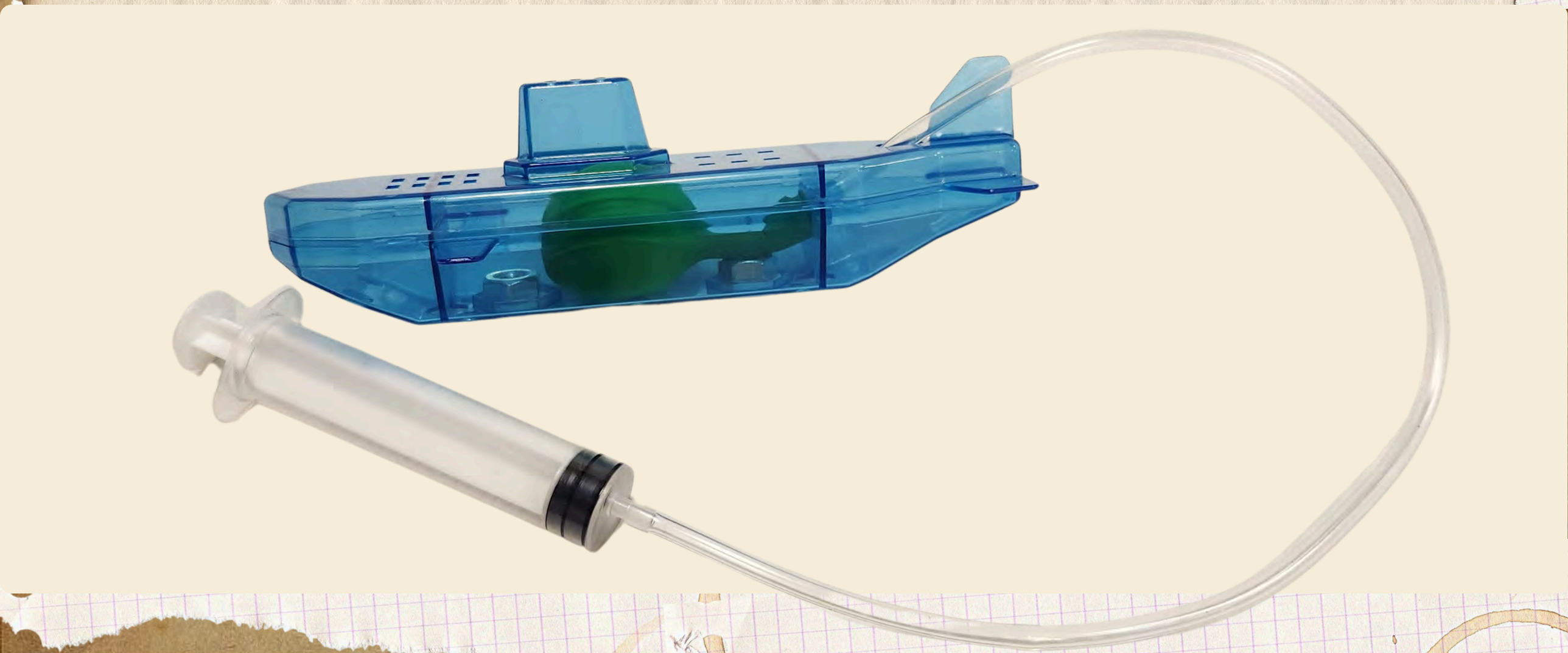
STEP 9 - REMOVE THE PLUNGER FROM THE SYRINGE AND SLIDE THE OPEN END OF THE PLASTIC TUBE ONTO THE TIP OF THE SYRINGE.

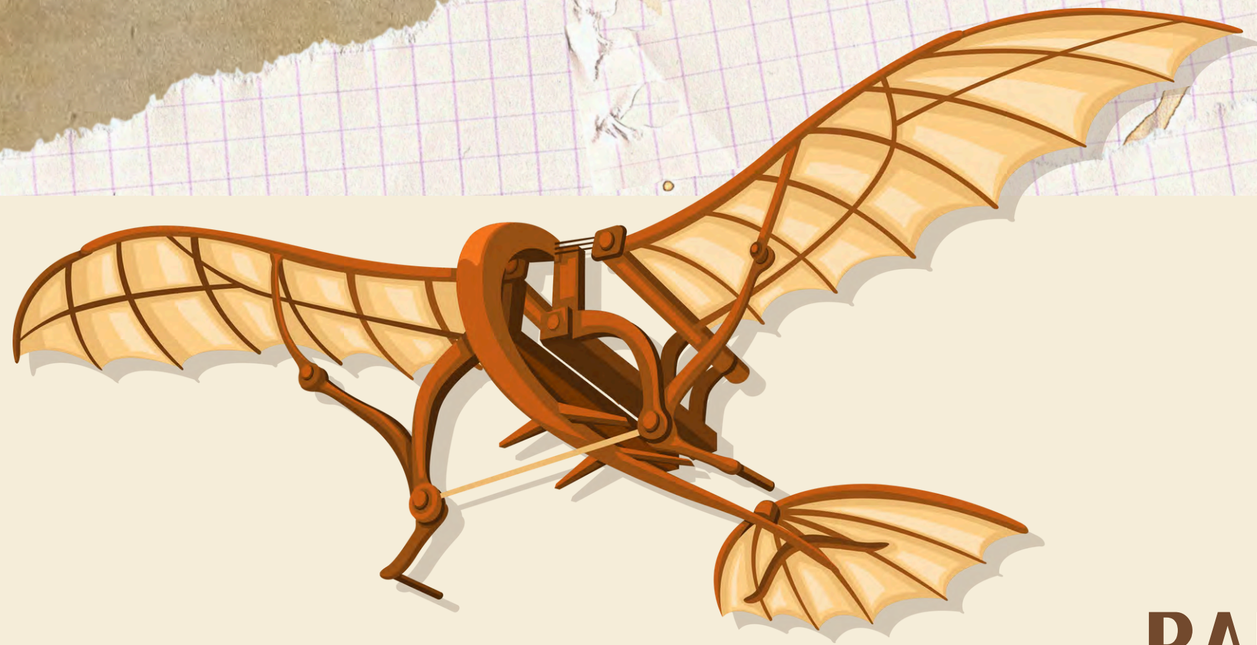


TIP OF SYRINGE GOES INSIDE THE OPEN END OF THE TUBE



STEP 10 - PUT THE PLUNGER BACK INTO THE SYRINGE AND TEST THAT IT INFLATES THE BALLOON.

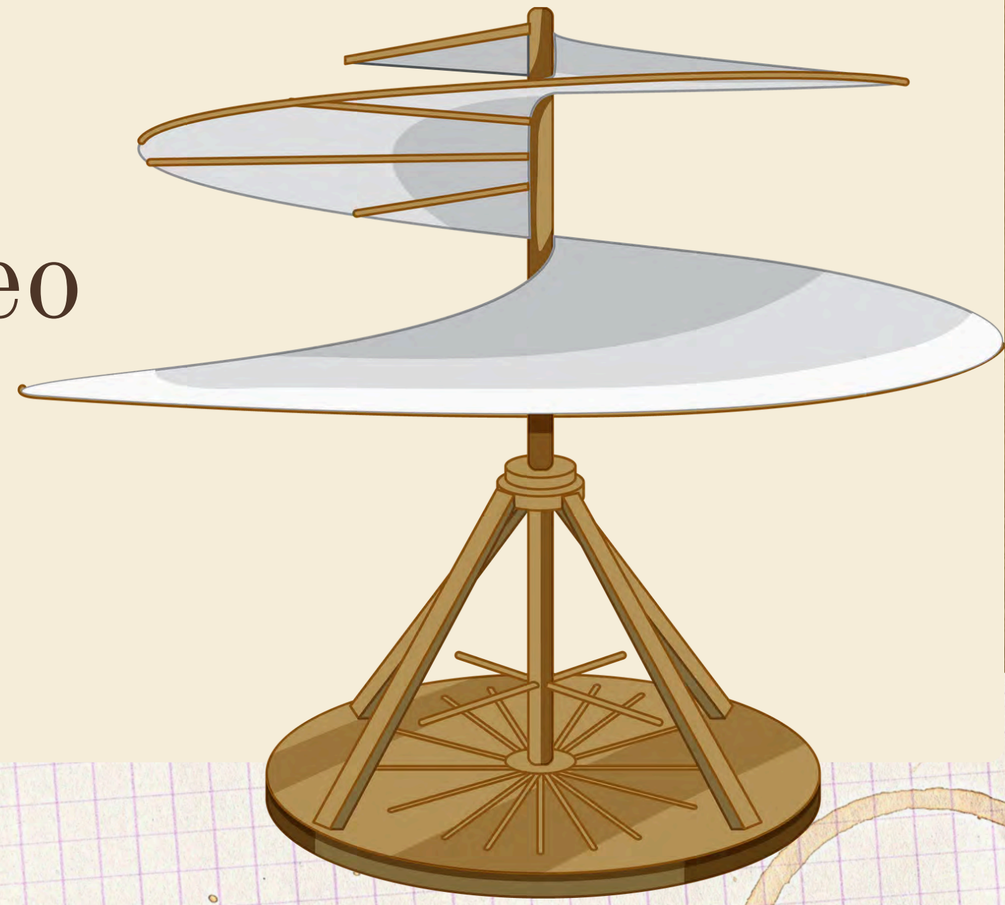


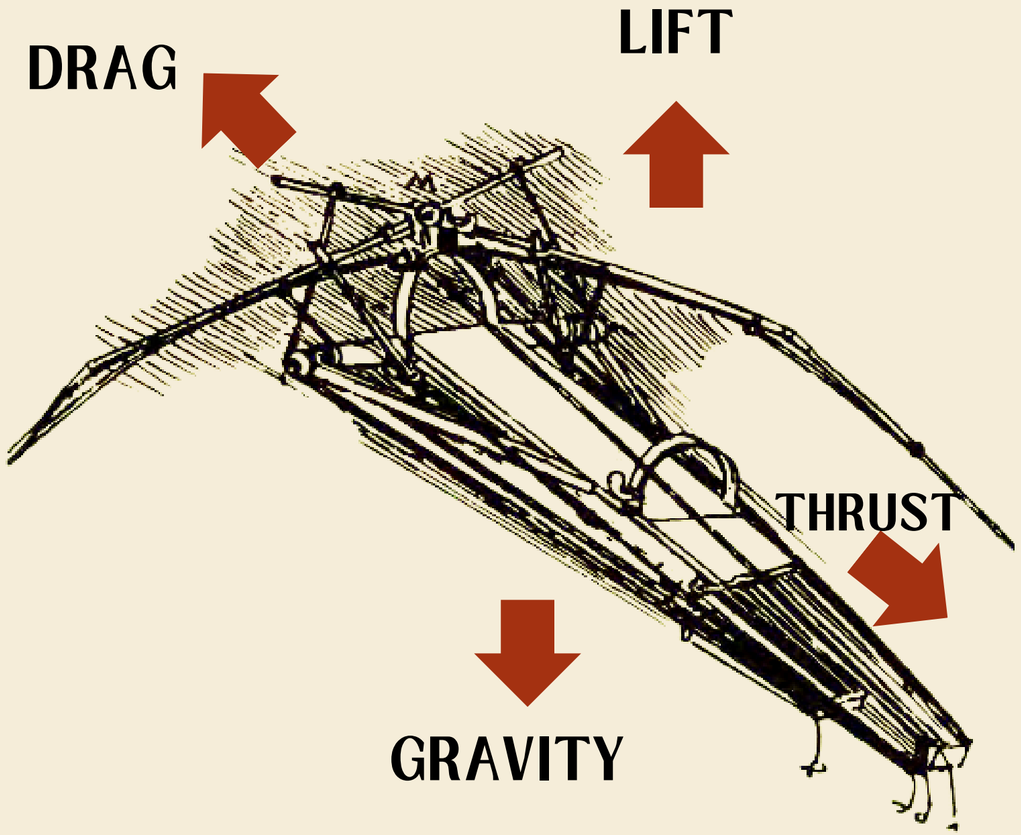


PART THREE:

Leonardo Da Vinci's Flying Machines

Leonardo Da Vinci’s Video





INVESTIGATE DA VINCI'S FLYING MACHINES

Ornithopter

Could it actually fly?

Is it similar to modern designs or animals?

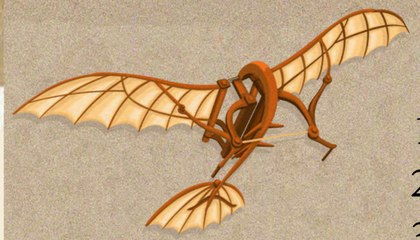
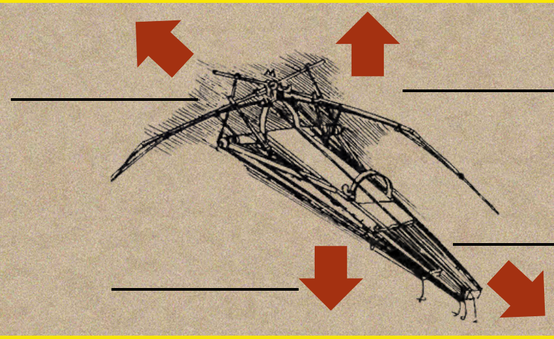
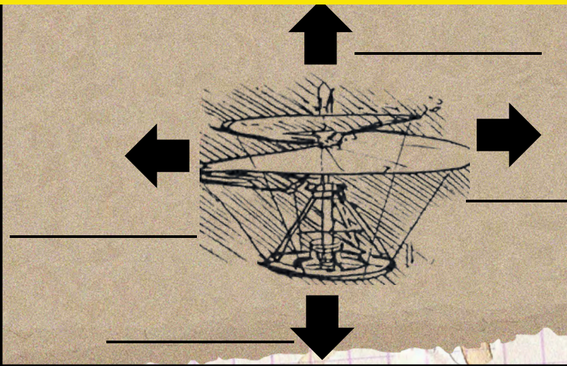
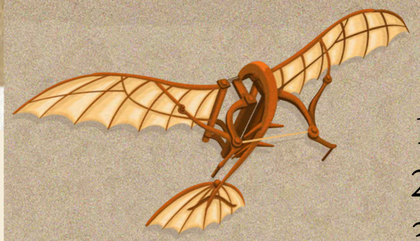


Table 4: Da Vinci's Flying Machines

1. Examine the diagrams and models of Da Vinci's Flying Machines.
2. Label the diagrams with the opposing forces of flight: Lift, Weight, Thrust & Drag
3. Discuss the design features of each flying machine. Complete the table below.

Flying Machine	Label the diagram with the Opposing Forces of Flight	Will the machine actually fly? Why or why not? How is it similar to modern designs or animals?
Ornithopter		
Aerial Screw		



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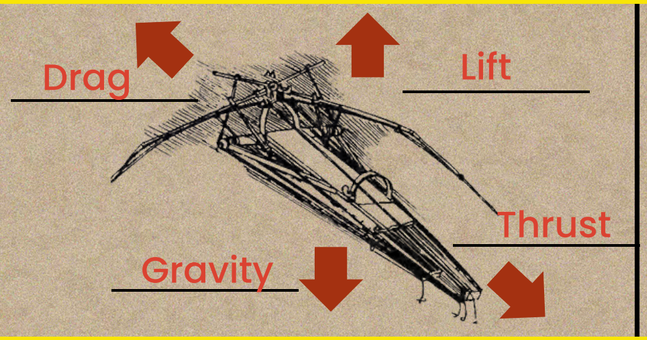
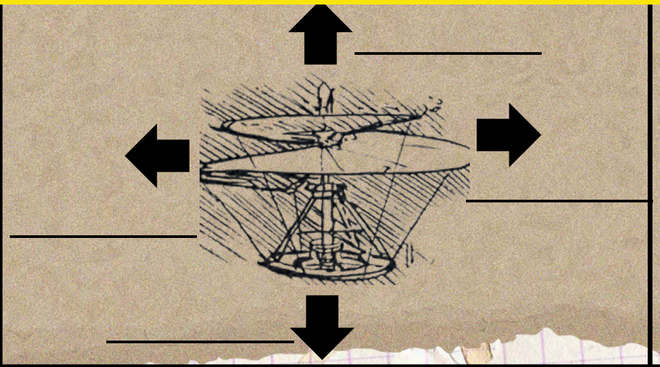
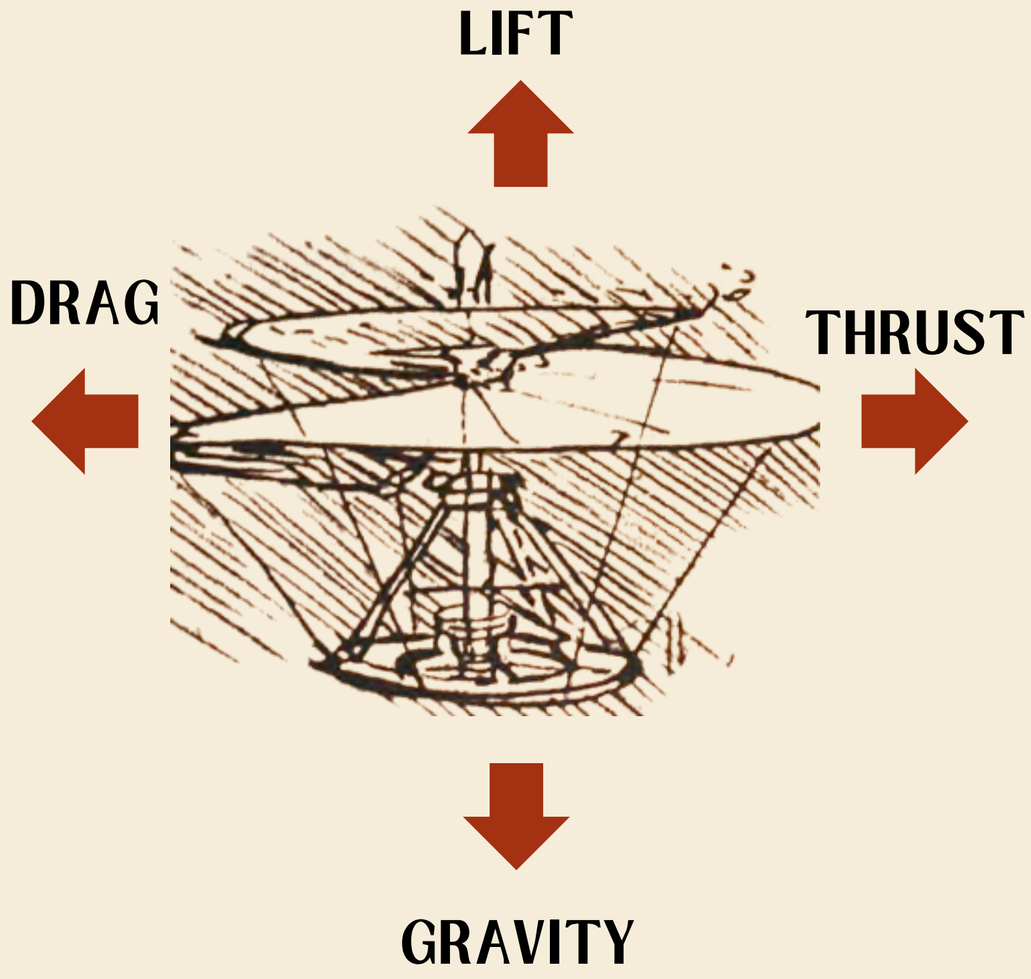
Ornithopter		No, it will not fly because the wings were not able to generate enough lift.  
Aerial Screw		

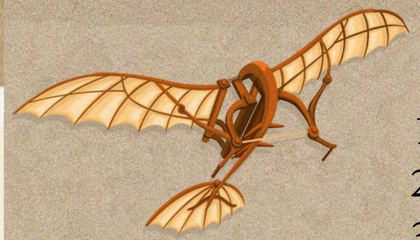


INVESTIGATE DA VINCI'S FLYING MACHINES

Aerial Screw

Could it actually fly?

Is it similar to modern designs or animals?



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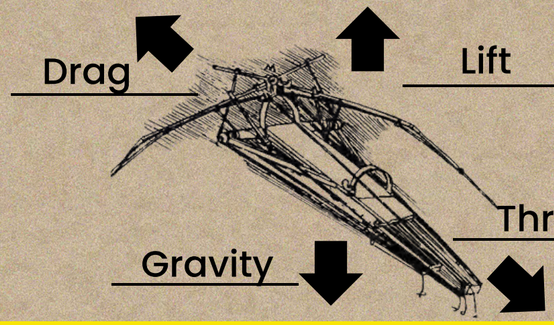
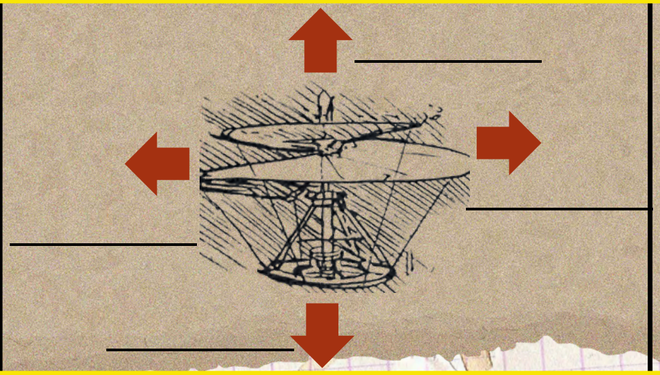
Ornithopter		
Aerial Screw		

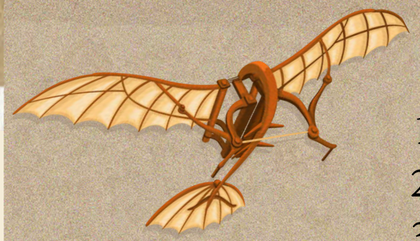


Table 4: Da Vinci's Flying Machines

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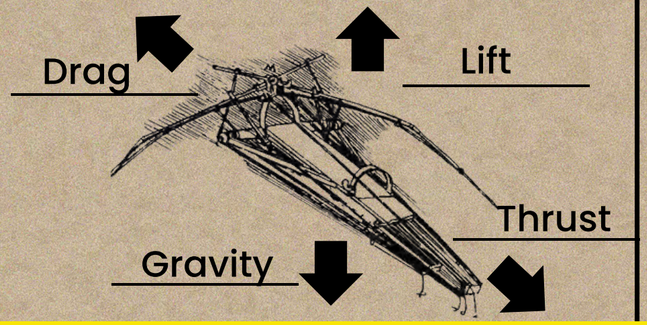
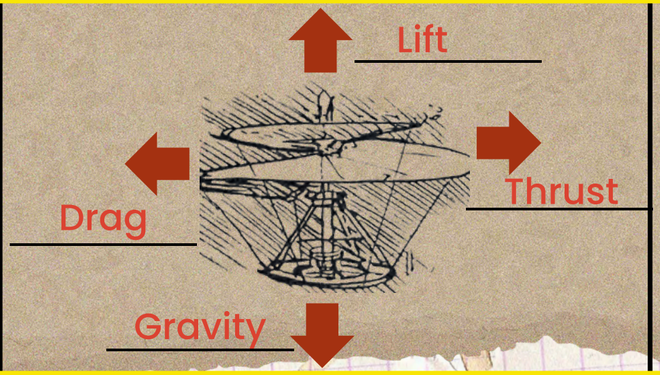
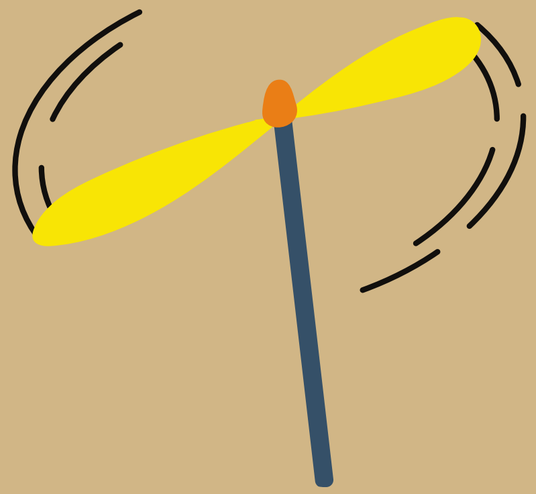
Ornithopter		No, it will not fly because the wings were not able to generate enough lift.  
Aerial Screw		No, it will not fly because the design of the propellers were not able to generate enough force (lift).  

HELICOPTER SPINNER TOY

Forces of Flight

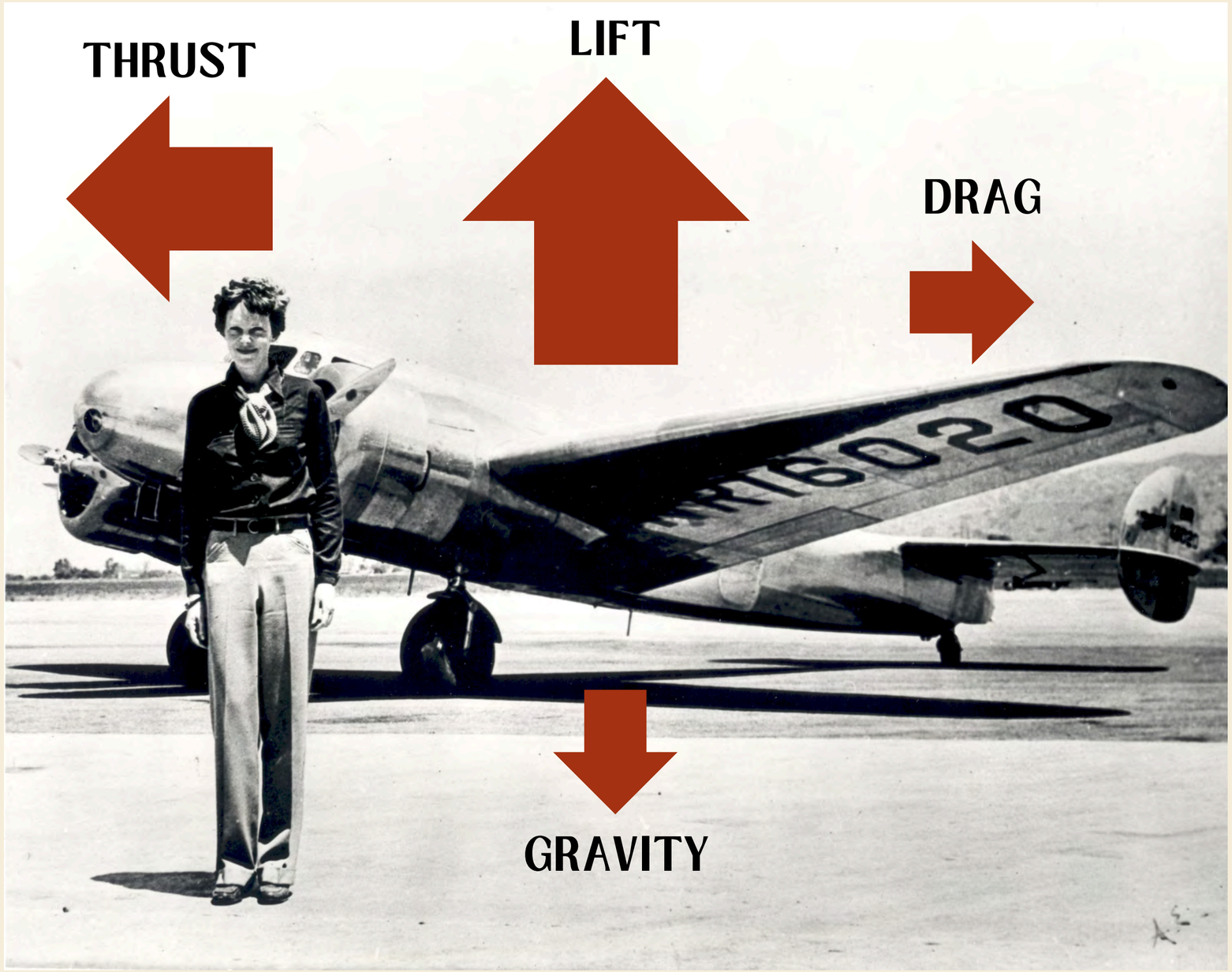


- LIFT created by speed of spinning blades
  - Like a helicopter rotor
- Lightweight design
- LIFT is greater than GRAVITY
- Create THRUST by tilting it
  - Like a plane's propeller
- Lots of VERTICAL movement
- Less HORIZONTAL. movement
- Blades are aerodynamic
  - Less DRAG
  - Gain ALTITUDE quickly, then falls down

PART FOUR:

Amelia Earhart's Fantastic Forces of Flight

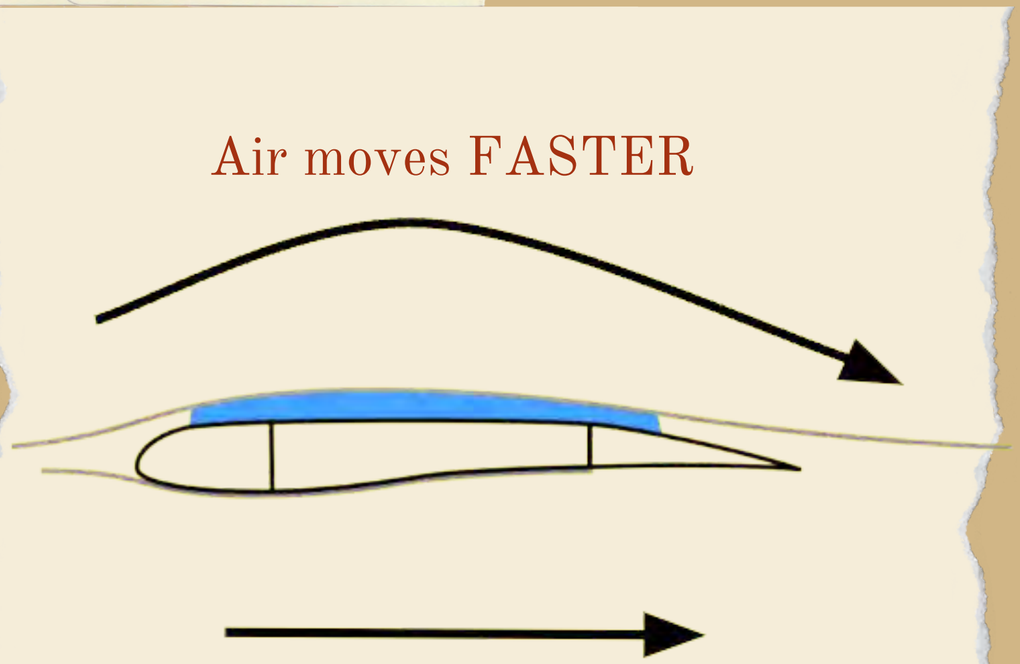
Amelia Earhart's Fantastic Forces of Flight Video


THRUST
LIFT
DRAG
GRAVITY

AIRFOIL

Wing shape creates LIFT!

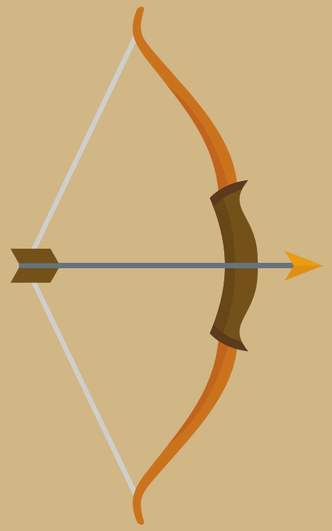
Air must move FASTER as it passes over top of the wing!



Creates HIGHER air pressure & LIFT under the wing!

AMELIA'S FANTASTIC FORCES OF FLIGHT

Travel to 5 stations to investigate different types of FLYING objects.



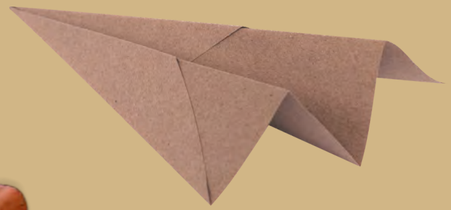
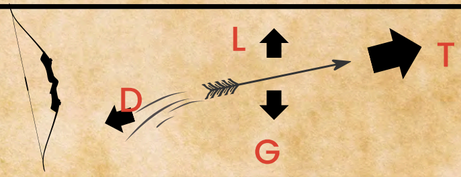
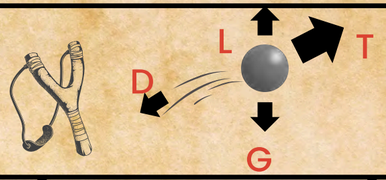
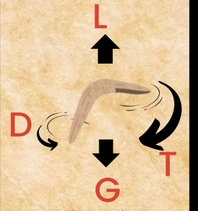
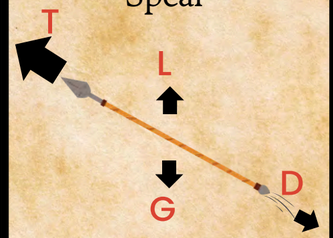
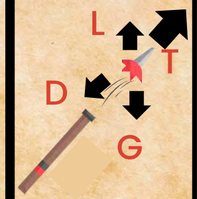
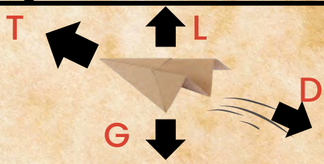
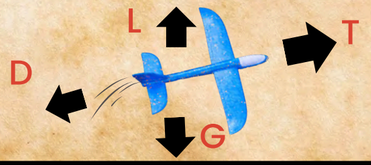


Table 5: Amelia Earhart's Fantastic Forces of Flight

1. Travel to each station and examine the flying objects.

2. LABEL the forces of flight on the diagram: L (Lift), G (Gravity), T(Thrust) & D(Drag).

Flying Objects	Diagram Forces of Flight
Bow and Arrow	
Slingshot	
Flying Projectiles: • Boomerang • Spear • Blow Dart	Boomerang  Spear  Blow Dart 
Paper Airplane	
Model Airplane	

CONCLUSION

Table 6: Incredible Forces in Air and Water - Complete the Table!

Type of Fluid	AIR	WATER
State of Matter	Gas	Liquid
Upward Force	Lift	Buoyancy
Downward Force	Gravity	Weight
Forward Force	Thrust	Thrust
Backward Force	Drag	Drag