

INCREDIBLE FORCES:

AIR & WATER

An Adventure in Time!



INTRODUCTION VIDEO



PART ONE:
Archimedes Opposing Forces
of Floating Objects

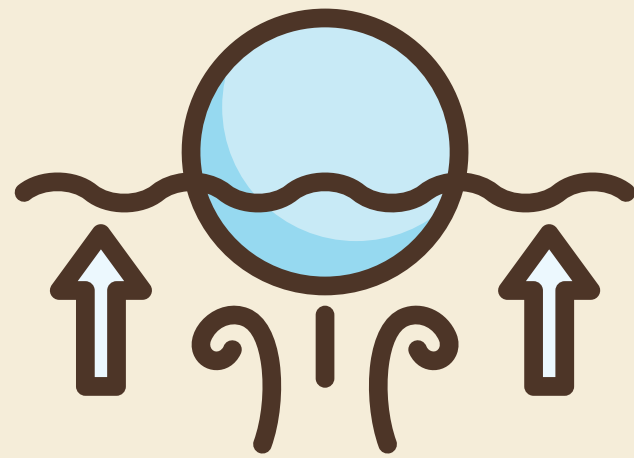


WHO IS ARCHIMEDES?

VIDEO

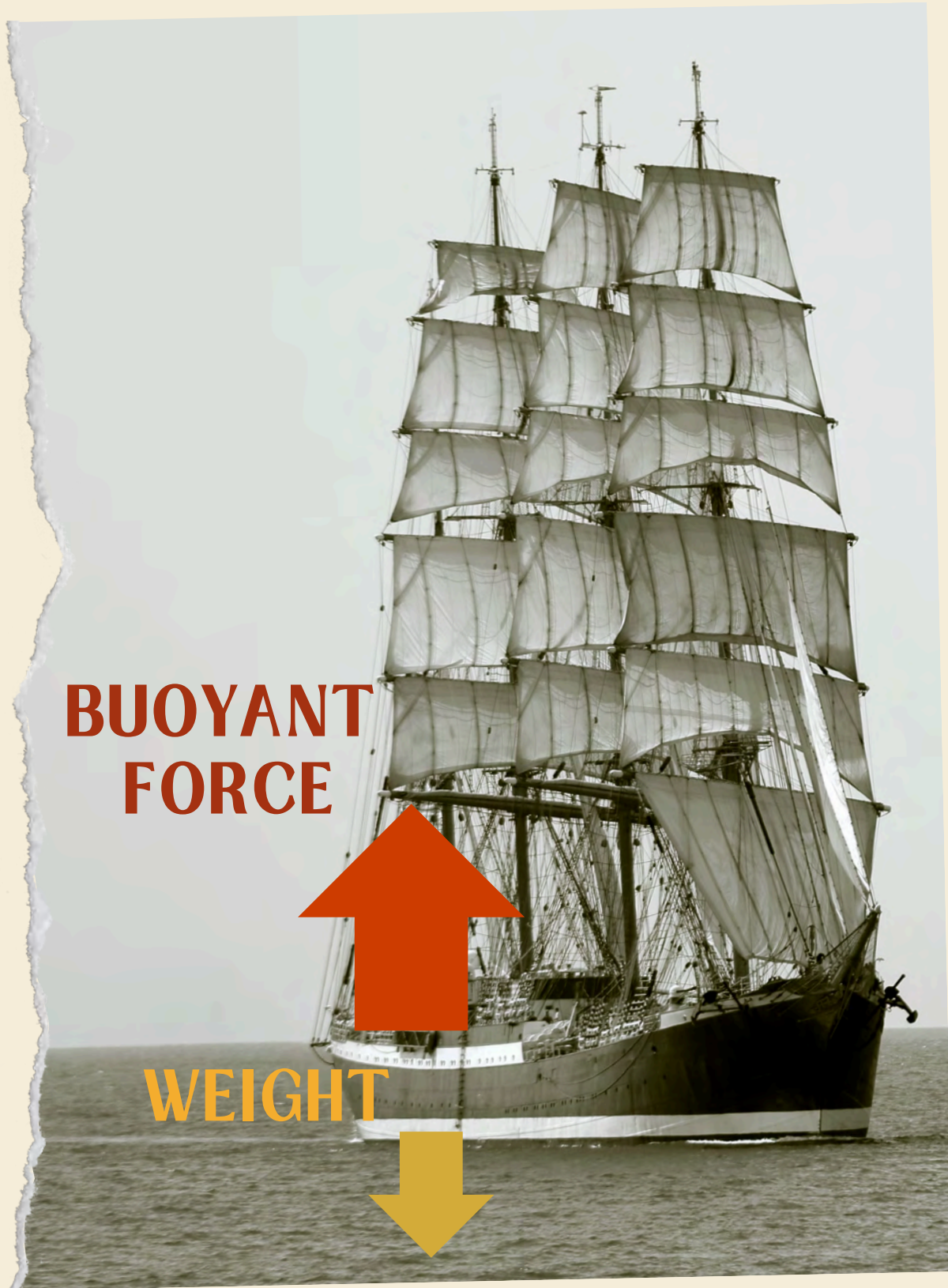


TESTING ARCHIMEDES LAW OF BUOYANCY



Eureka!

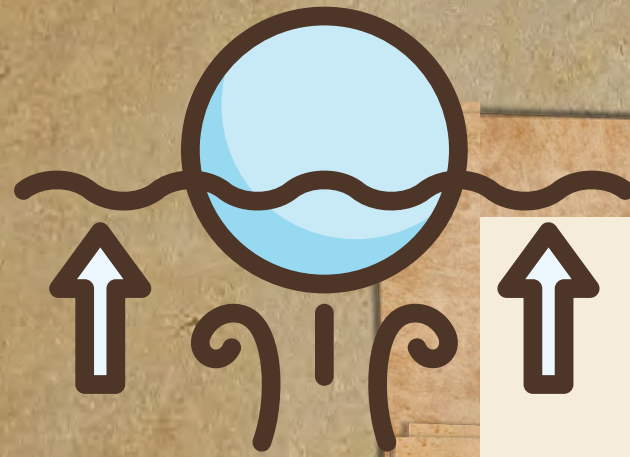




BUOYANT FORCE

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

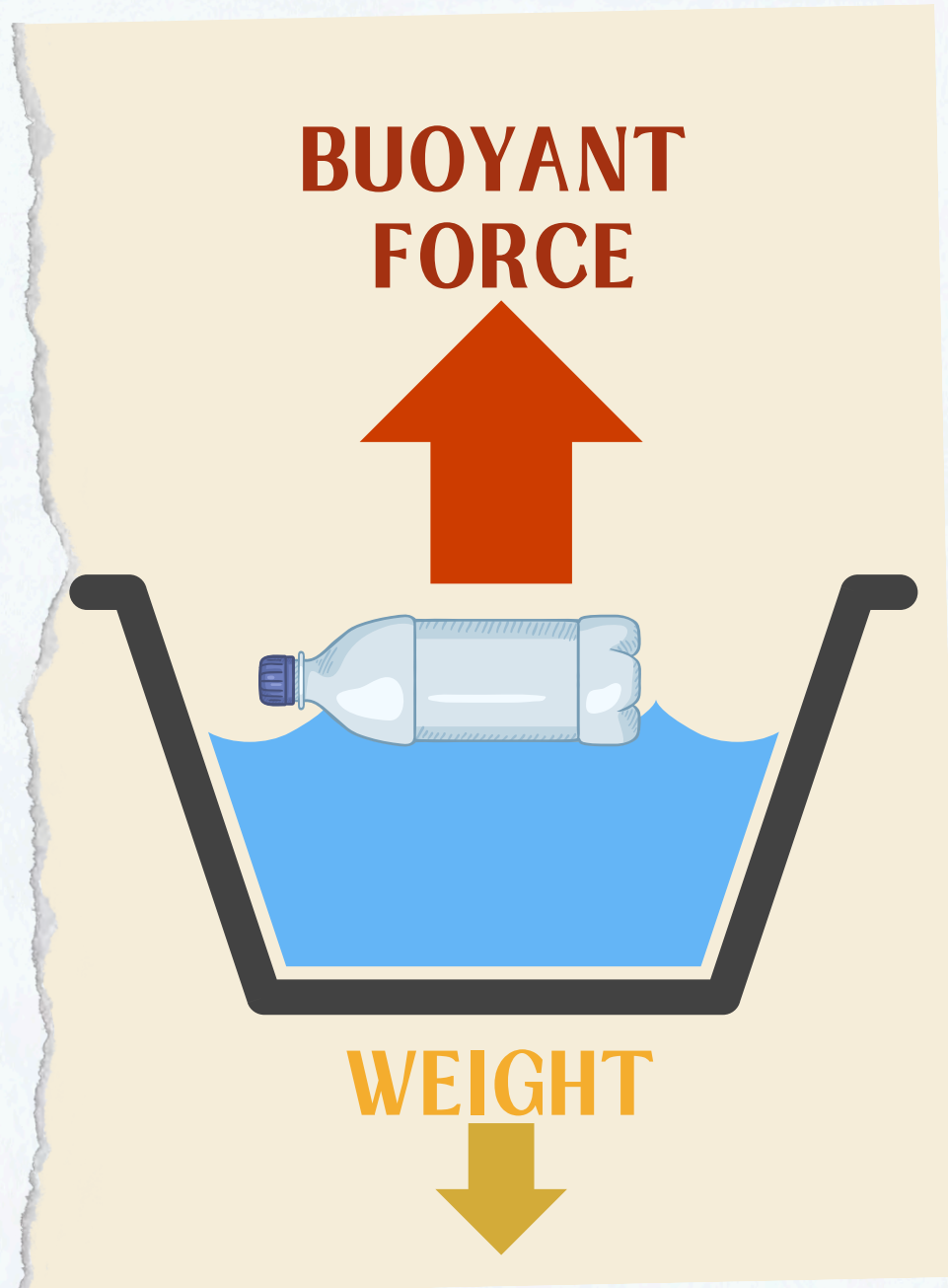
Table 1: Testing Archimedes Law of Buoyancy

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**.





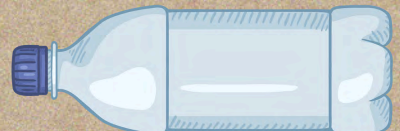
The buoyant force is **GREATER** than the weight of the bottle.

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.



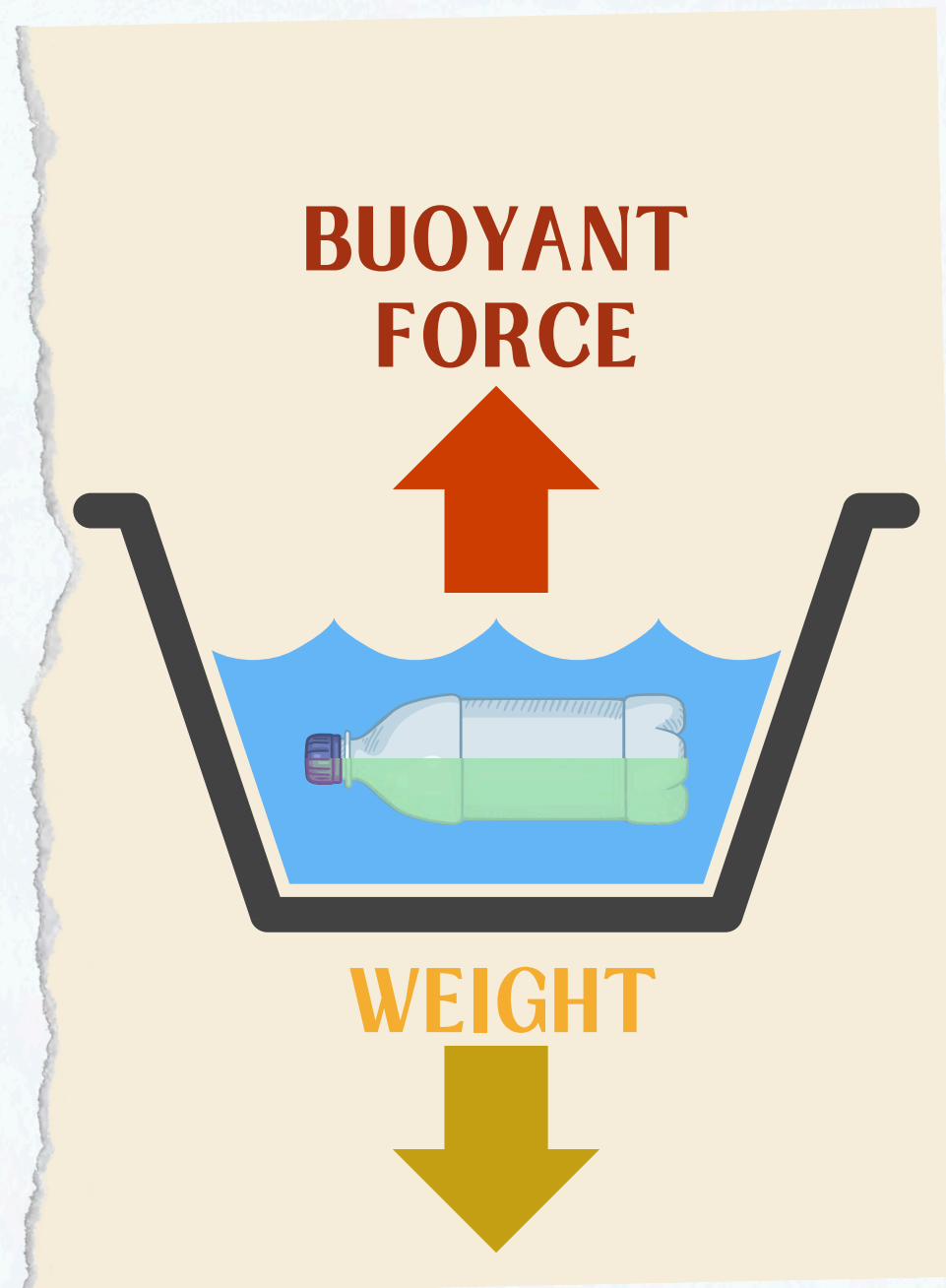
Experiment Setup	Prediction	Observation (Fill in less, greater or equals)	Diagram (Draw the liquid level and arrows)
Positive Buoyancy: Bottle FLOATS on top	Answers may vary	Buoyant Force is <u>greater</u> than weight.	Buoyant Force   Weight 
Neutral Buoyancy: Bottle SUSPENDED in the middle		Buoyant 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.





NEUTRAL BUOYANCY

Fill the bottle **HALFWAY** with water.

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


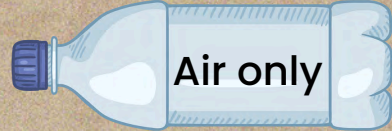





The bottle is **SUSPENDED** in the **MIDDLE** of the fluid.

BUOYANT FORCE = WEIGHT

Table 1: Testing Archimedes Law of Buoyancy

1. Predict HOW and WHY we can make the bottle float.
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Neutral Buoyancy: Bottle SUSPENDED in the middle	Answers may vary	Buoyant Force <u>equals</u> weight. Water level rises.	Buoyant Force   Weight 
Negative Buoyancy: Bottle SINKS to the bottom		Buoyant Force is <u>less</u> than weight.	Buoyant Force  Weight



TESTING ARCHIMEDES LAW OF BUOYANCY

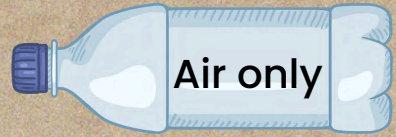
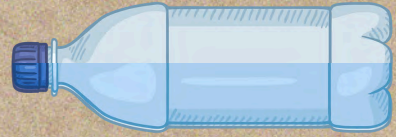

PREDICT **HOW** AND **WHY** WE
CAN MAKE THE BOTTLE **SINK**
TO THE **BOTTOM** OF THE TUB
OF WATER.



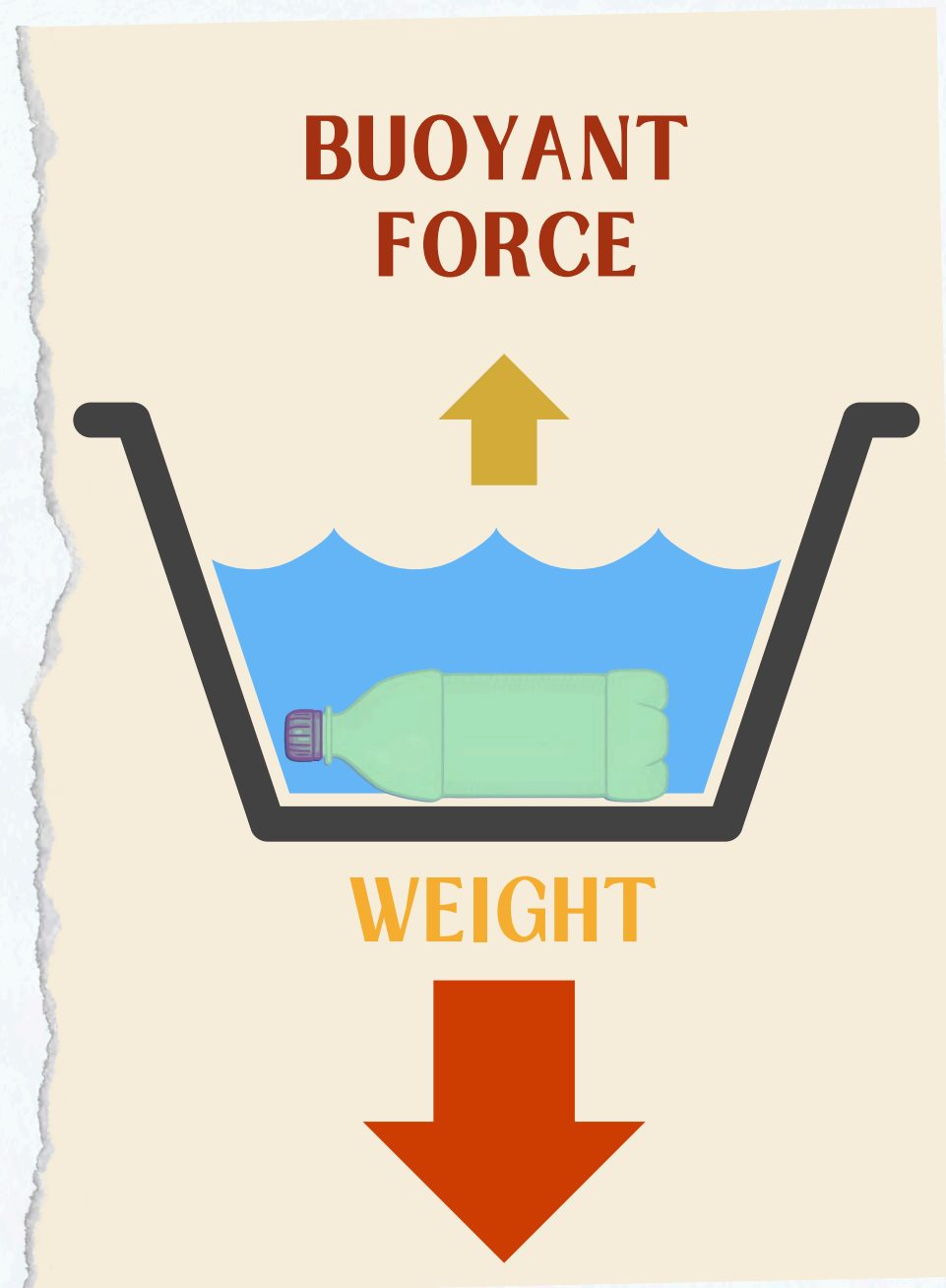
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Negative Buoyancy: Bottle SINKS to the bottom		Buoyant Force is <u>less</u> than weight.	Buoyant Force  Weight





NEGATIVE BUOYANCY

Fill the bottle **COMPLETELY** with water.

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


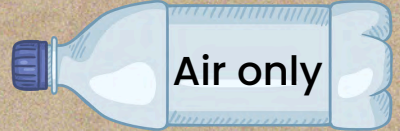

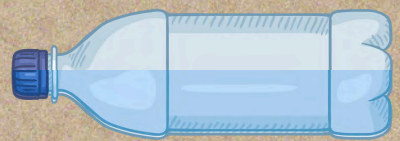



The bottle **SINKS** to the **BOTTOM** of the fluid.

BUOYANT FORCE < WEIGHT

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Negative Buoyancy: Bottle SINKS to the bottom	Answers may vary	Buoyant Force is <u>less</u> than weight. Water level rises more.	Buoyant Force   Weight 

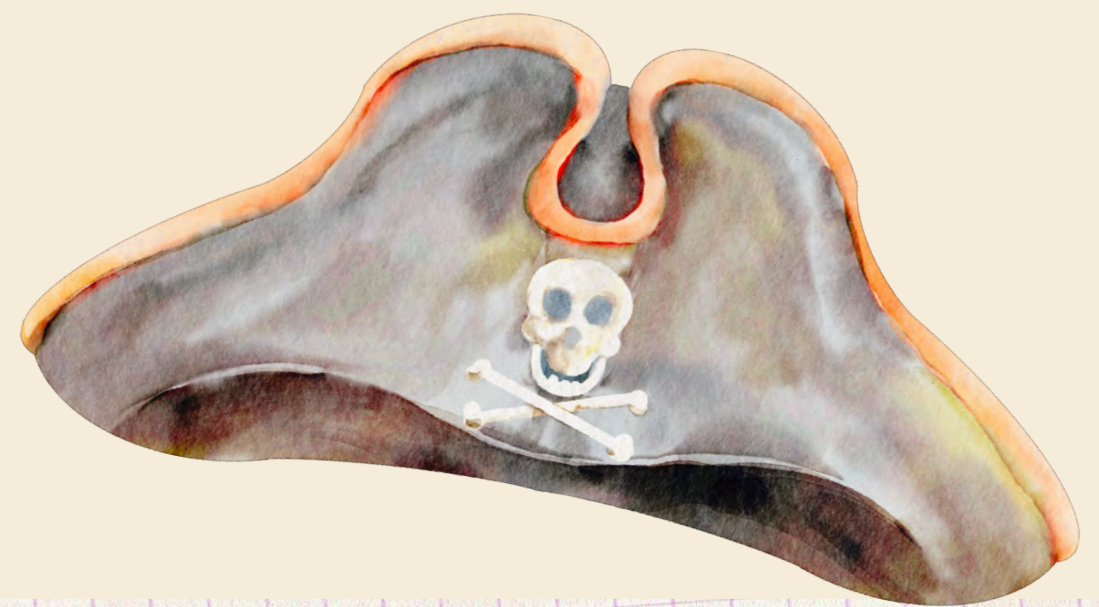


PART TWO: Pirate Zheng Yi Sao



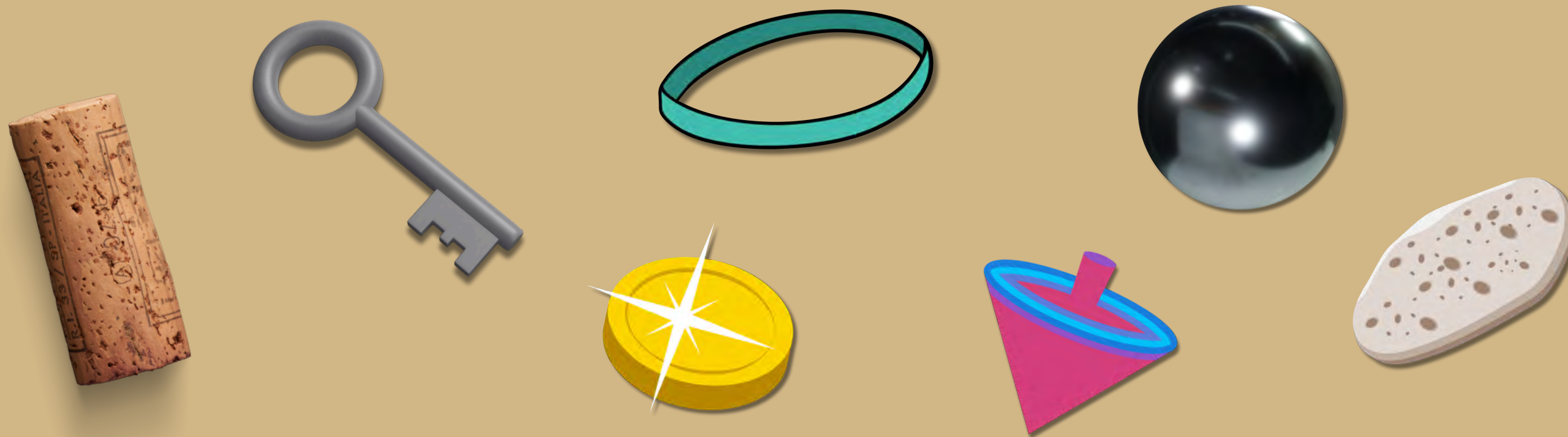


THE PIRATE QUEEN VIDEO



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

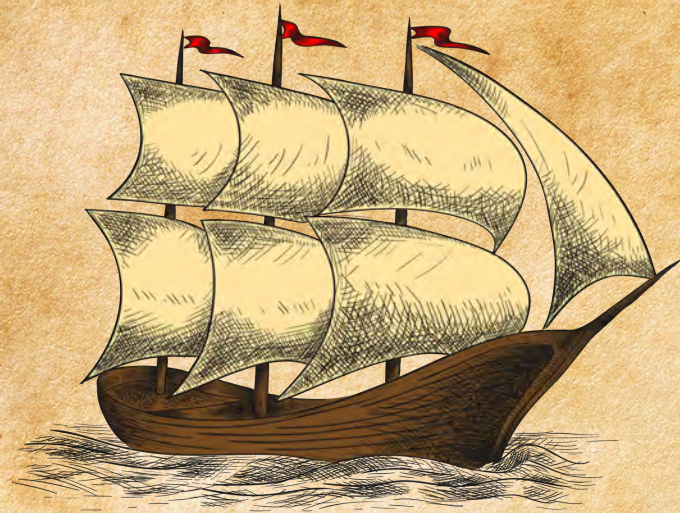


Table 2: Pirate Zheng's Buoyancy Experiment

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

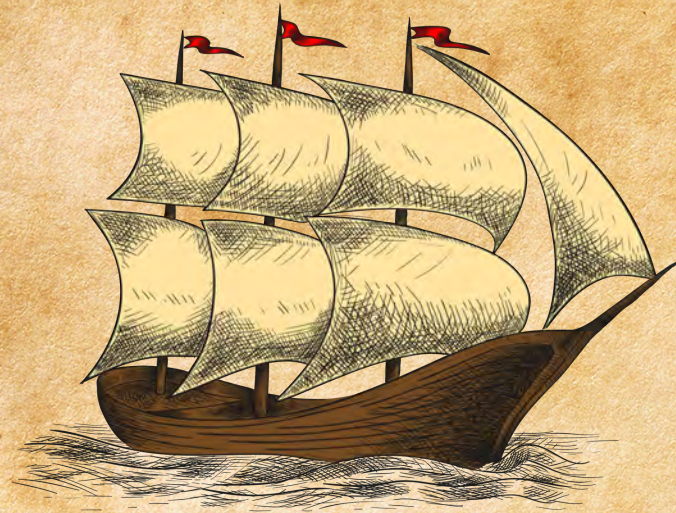


Table 2: Pirate Zheng's Buoyancy Experiment

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

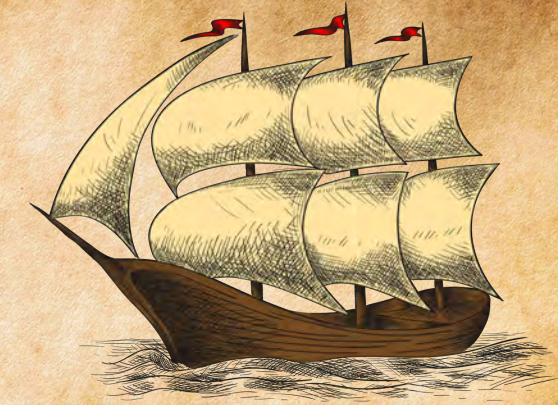


PURE WATER



SALT WATER

Table 3: Pirate Zheng's Density Experiment

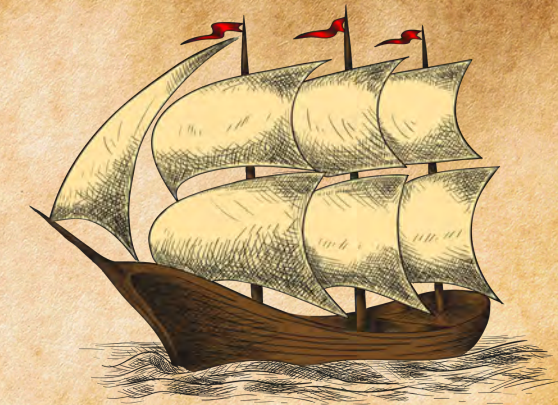


1. Prediction - Will the objects FLOAT or SINK in pure water and in salt water?
2. Observations - Carefully place one object at a time in the pure water container.
3. Each student adds ONE SPOON of salt to ONE container (minimum 4 spoons). Stir carefully.
4. Observations - Slowly place each object in 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	Float	Answers may vary	Float
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.

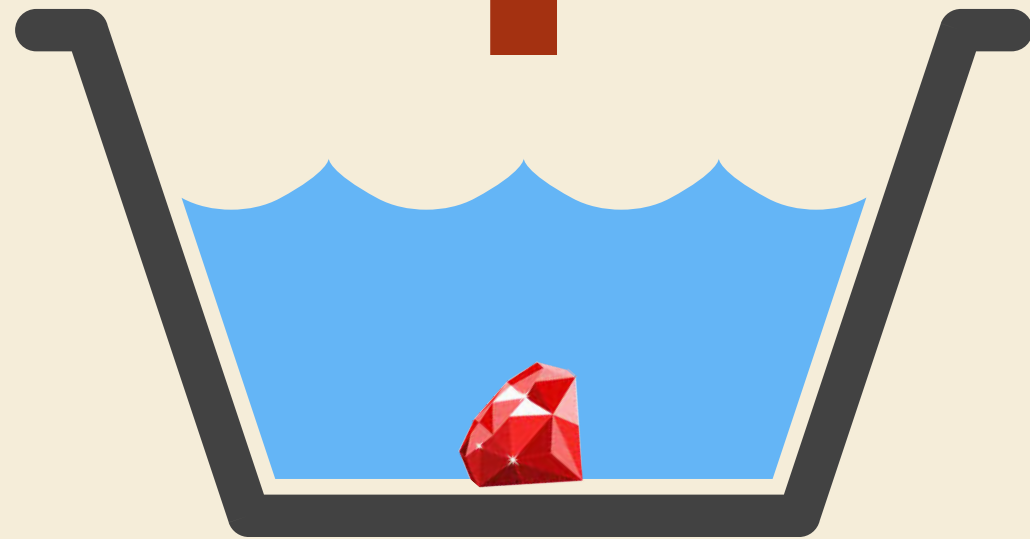
PIRATE ZHENG'S BUOYANCY EXPERIMENT

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

BUOYANT FORCE



**PURE
WATER**

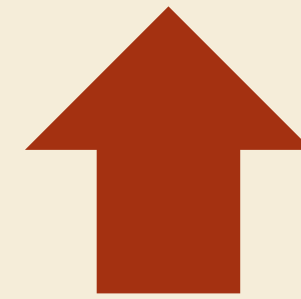


WEIGHT

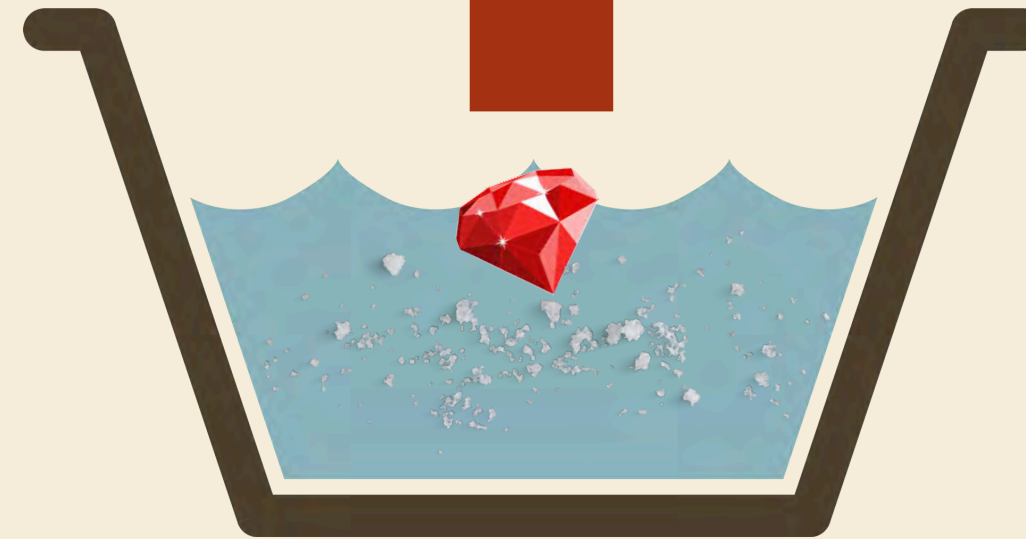


WEIGHT > BUOYANT FORCE

BUOYANT FORCE



**SALT
WATER**



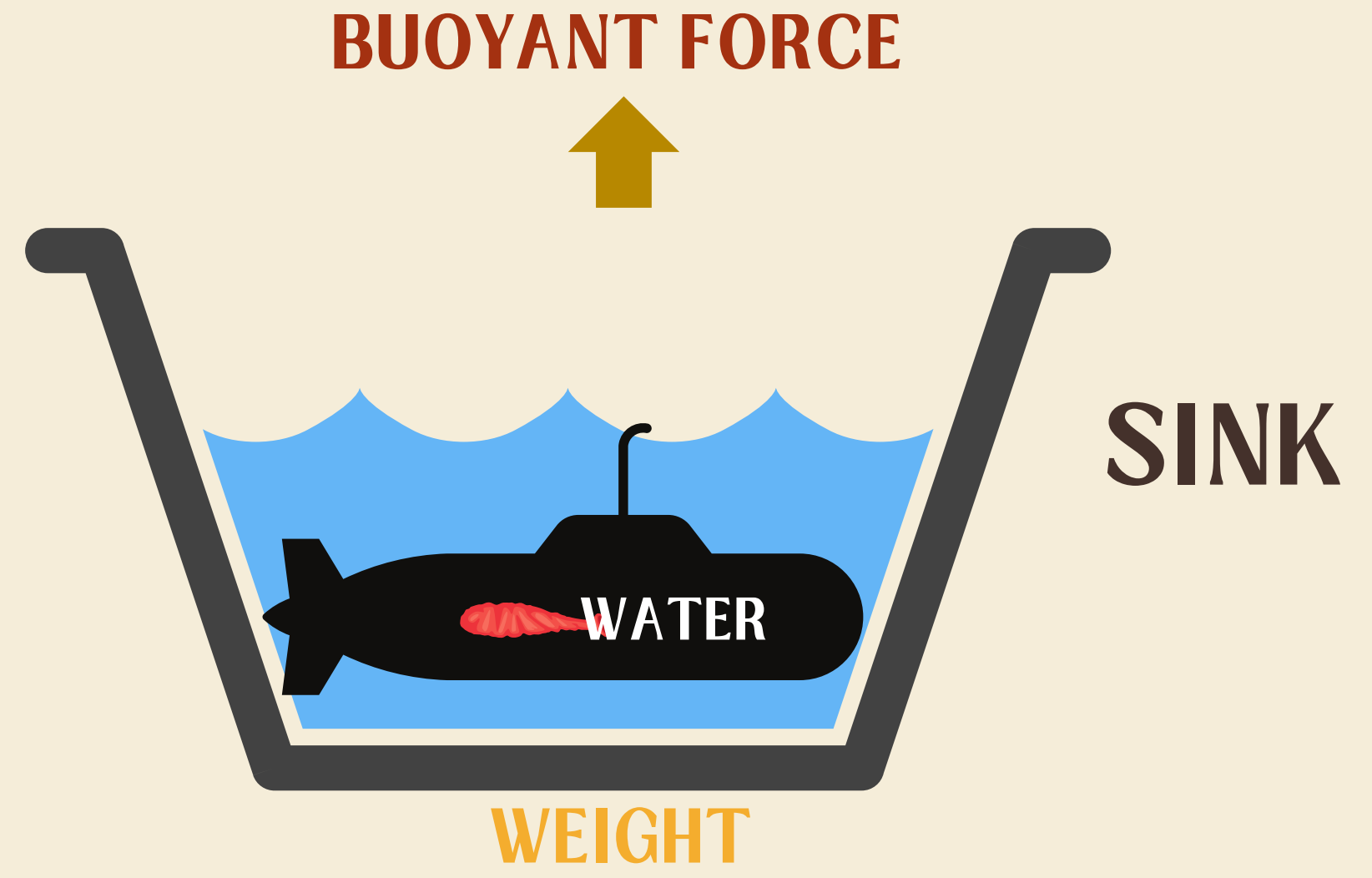
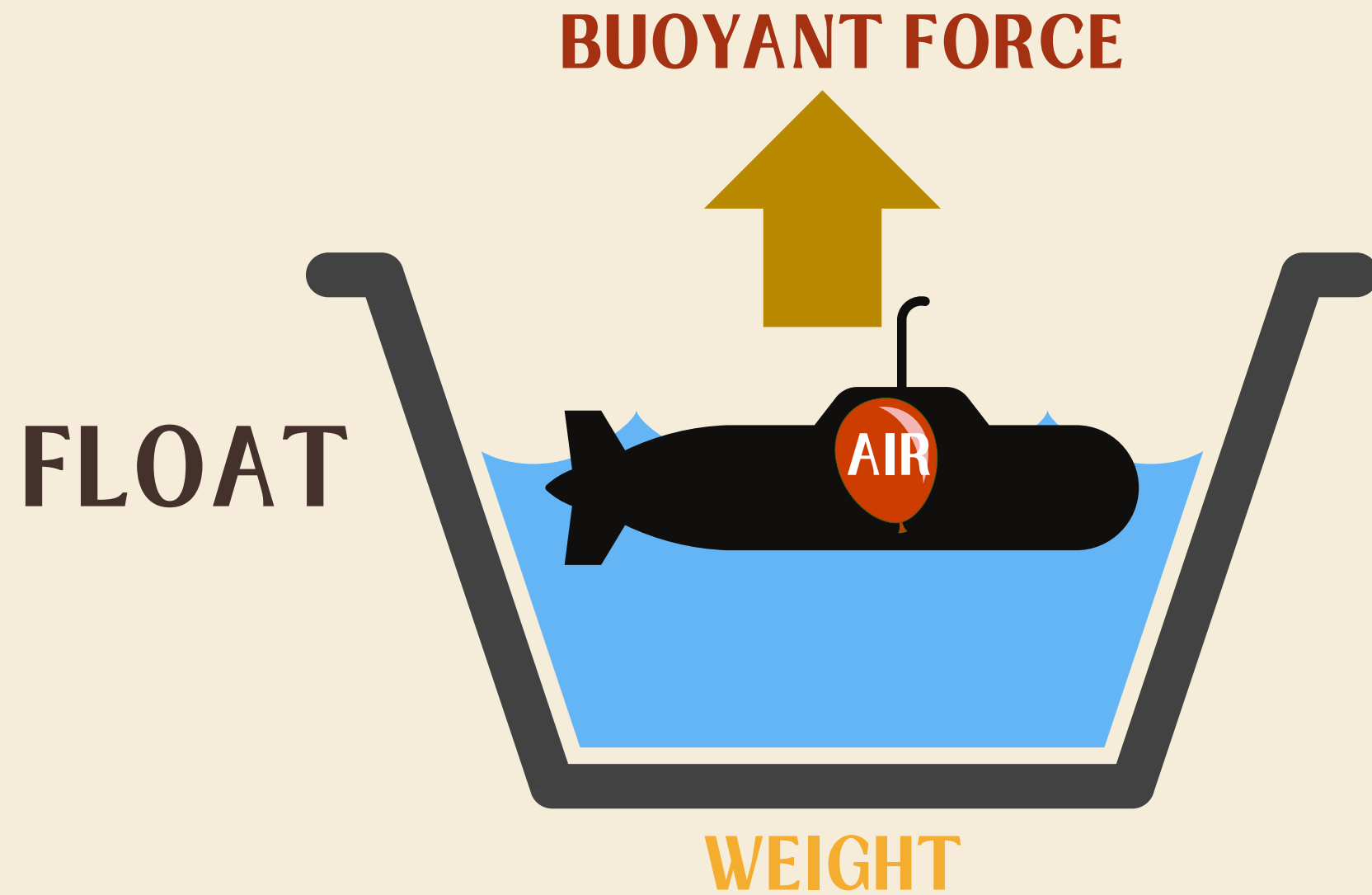
WEIGHT



BUOYANT FORCE > WEIGHT

AIR INSIDE the submarine.

WATER INSIDE the submarine.



BUOYANT FORCE > WEIGHT

WEIGHT > BUOYANT FORCE

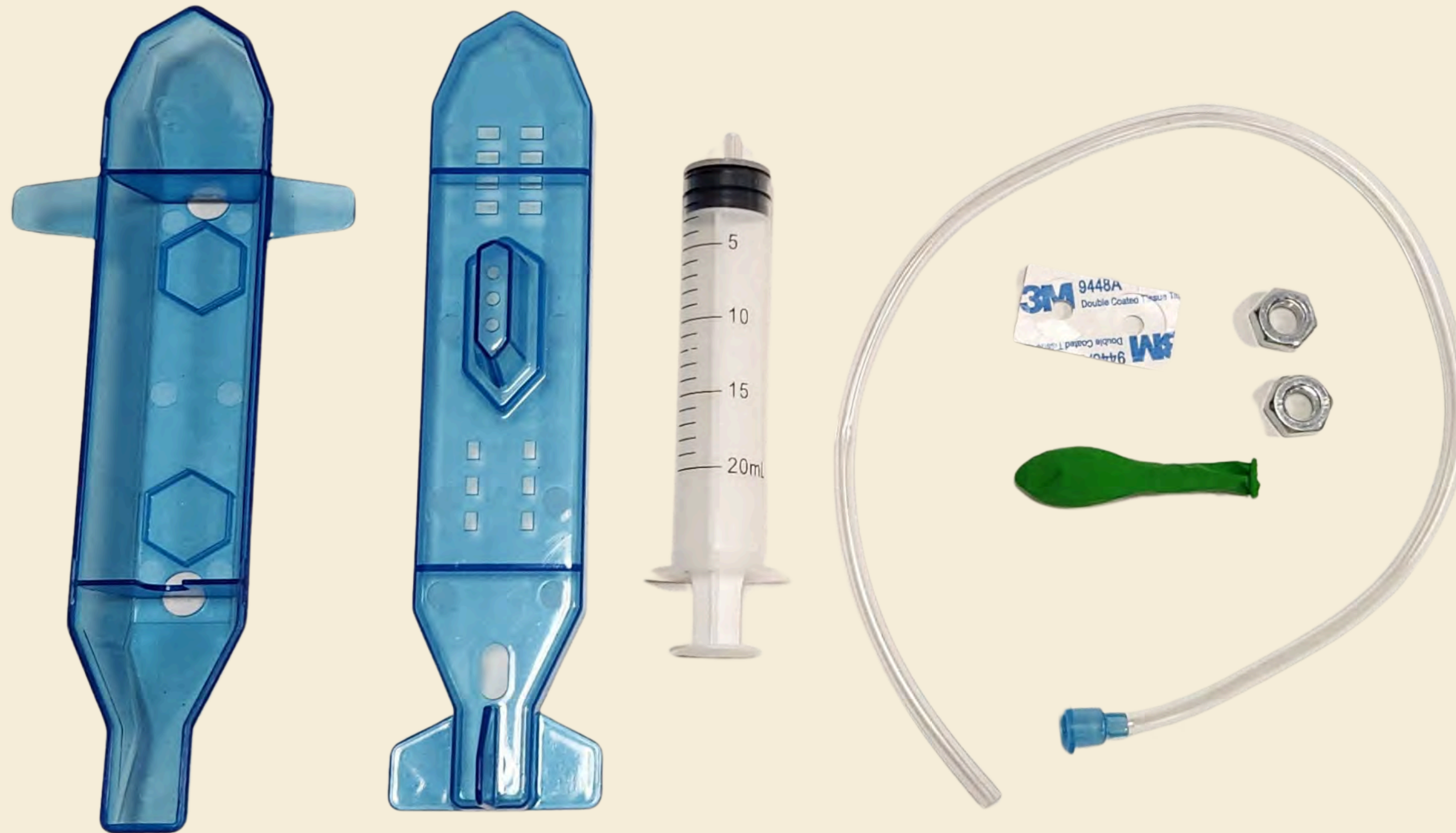
BUILD OUR OWN SUBMARINE MODEL

KEEP YOUR MODEL DRY!

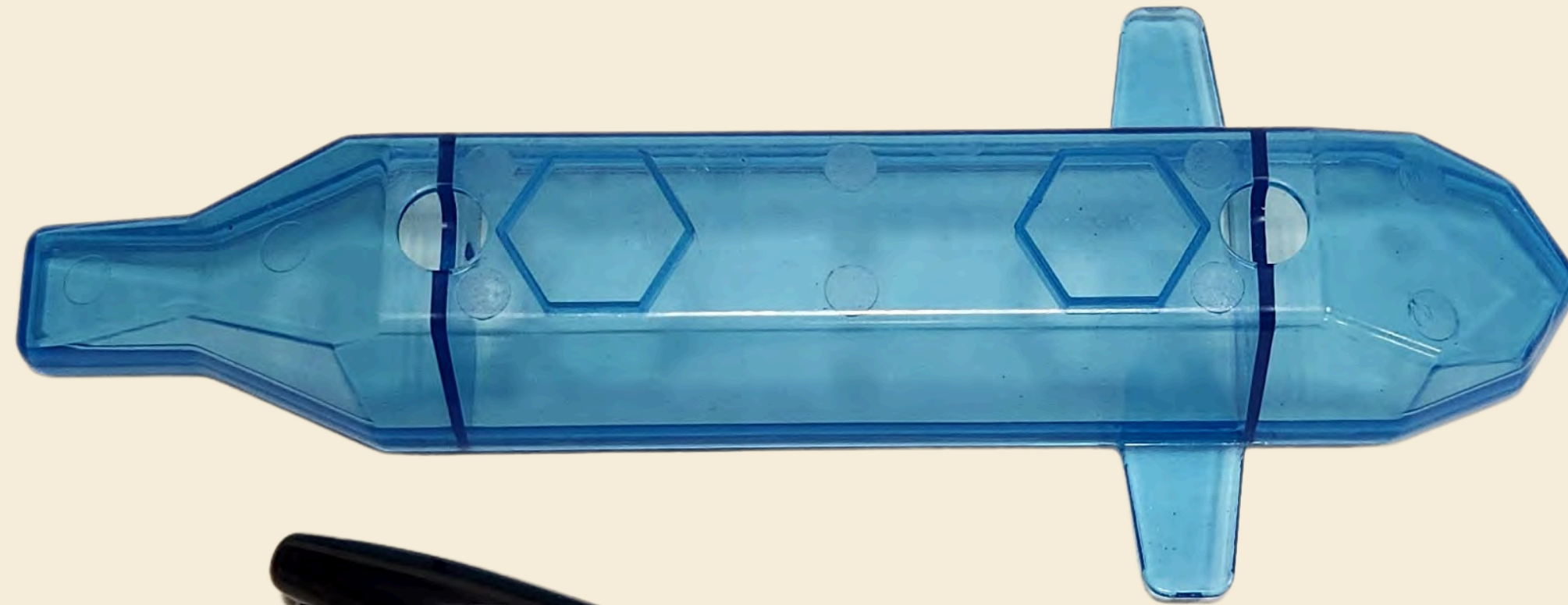
**TEST THE EXTRA SUBMARINE
MODELS IN THE WATER.**



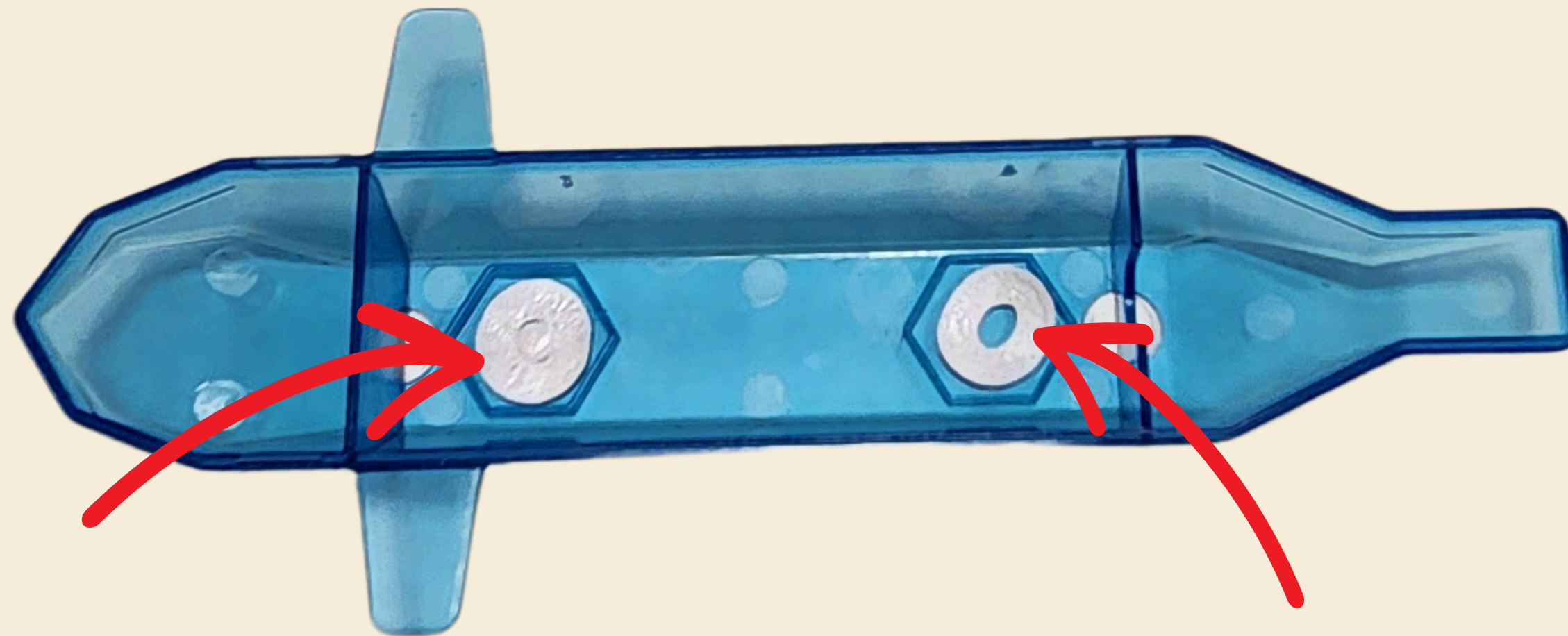
STEP 1 - CHECK MATERIALS



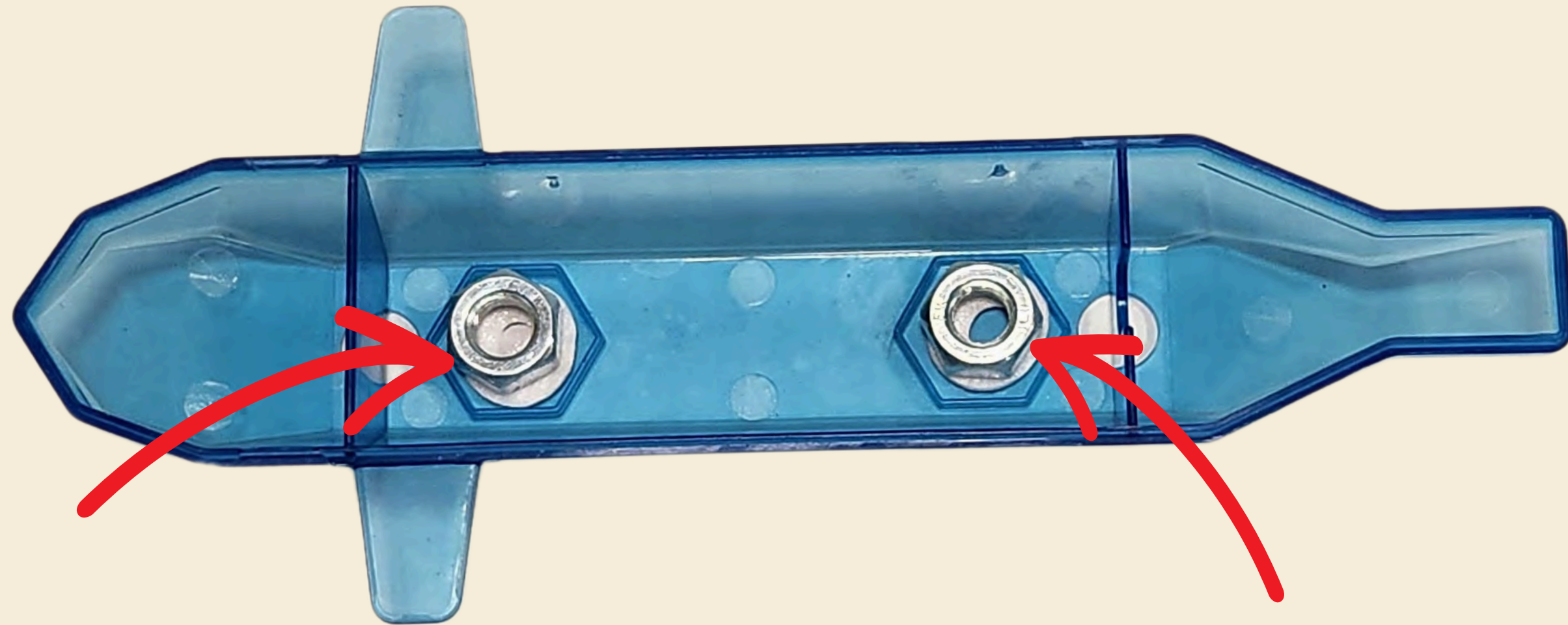
STEP 2 - LABEL THE BOTTOM OF THE BASE



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

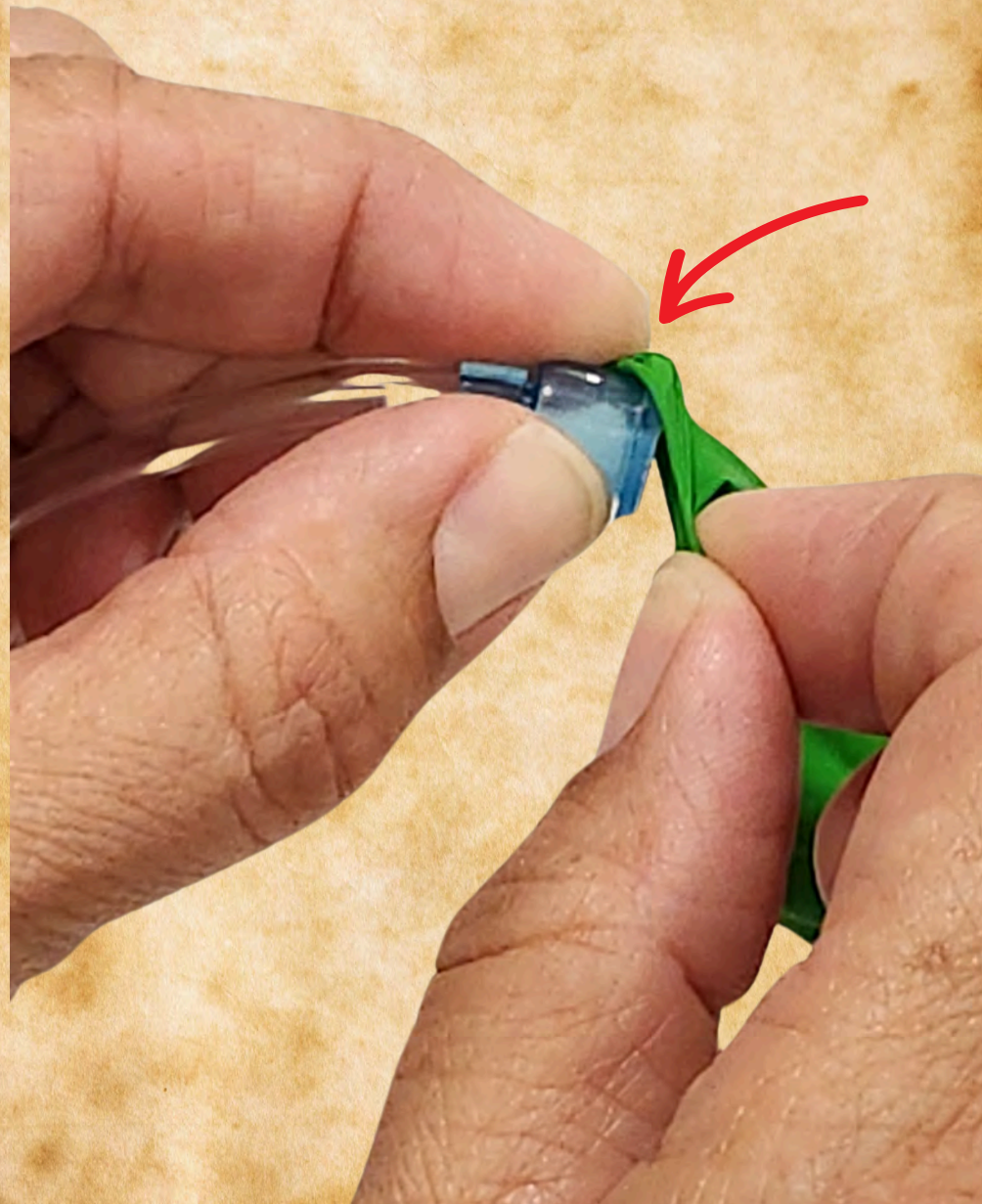


STEP 4 - PEEL THE OTHER SIDE OF EACH DOUBLE-SIDED TAPE AND PLACE THE METAL HEXAGON NUT ON TOP. PRESS DOWN FIRMLY.



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

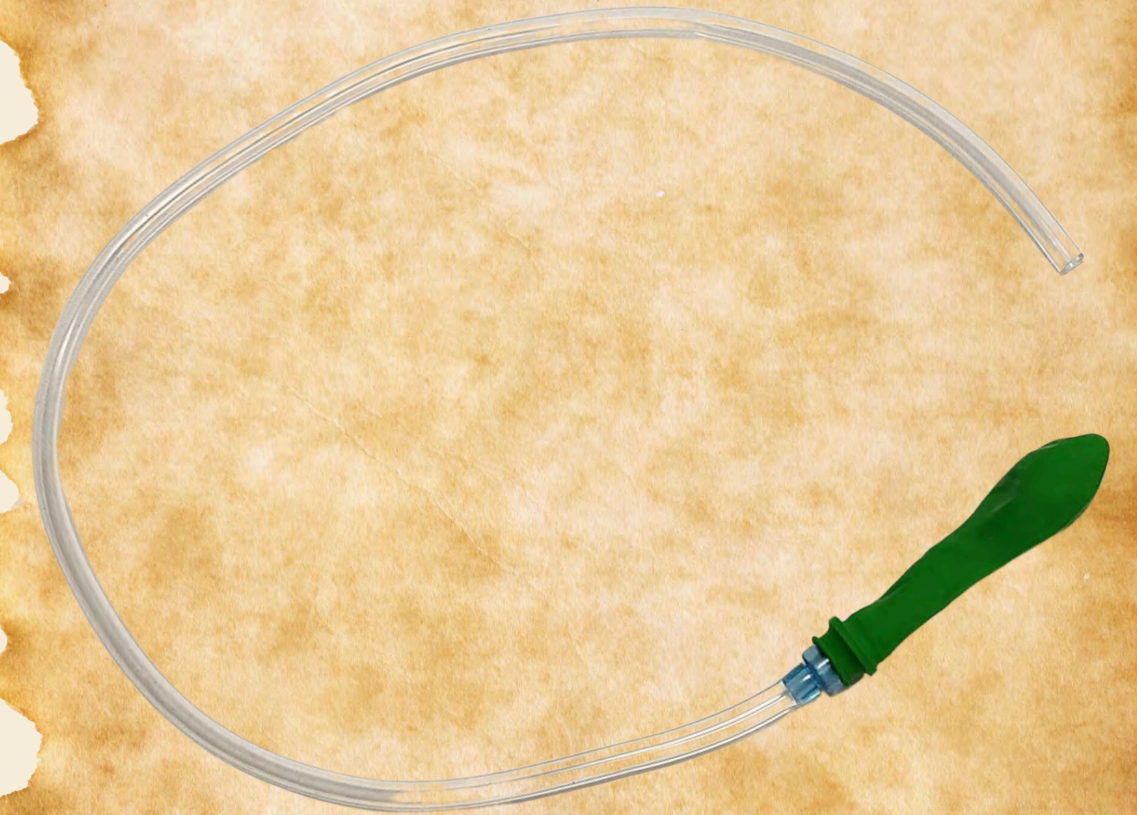
A: HOLD BALLOON IN PLACE ON ONE SIDE WITH INDEX FINGER



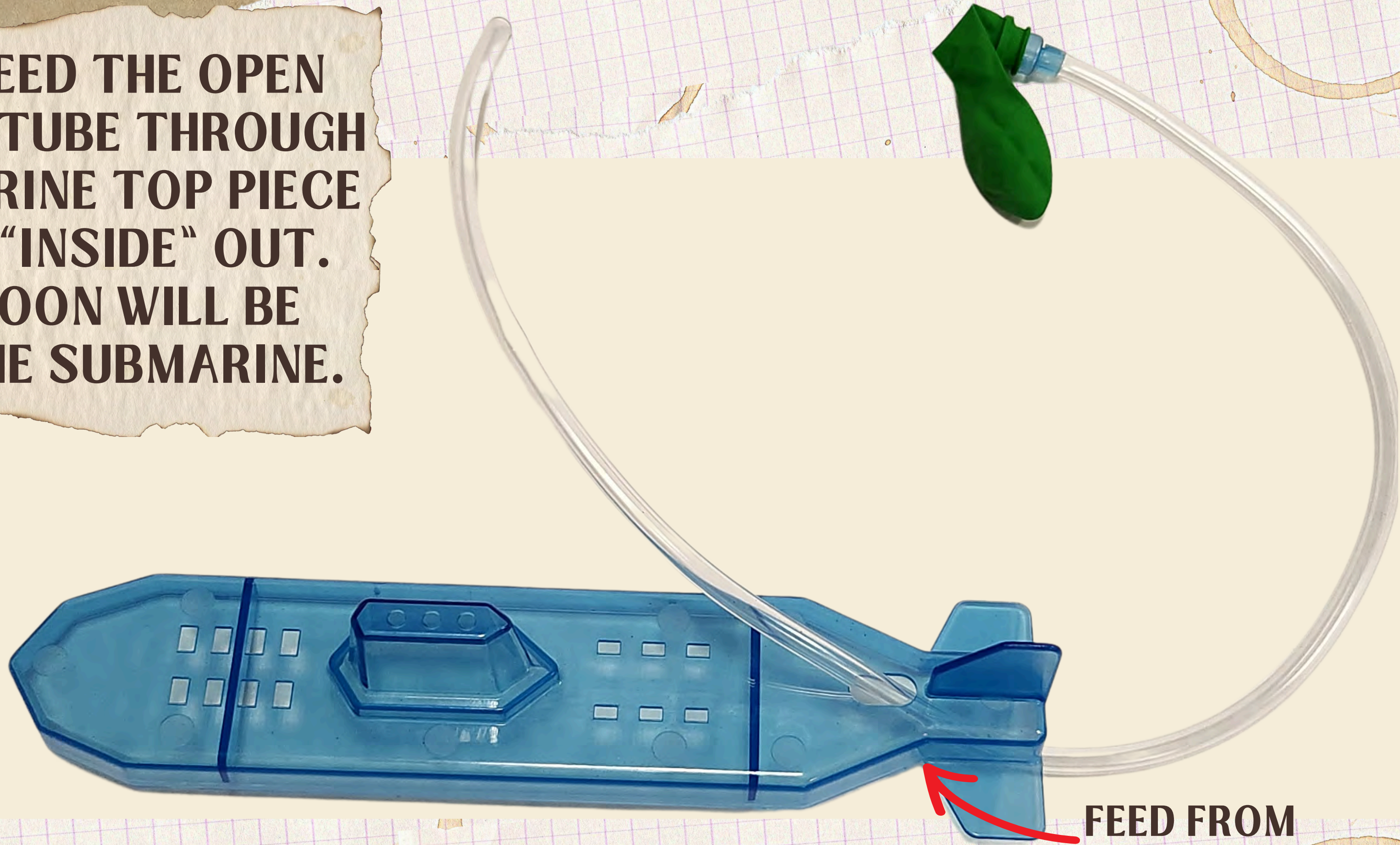
B: GENTLY PULL OPENING OF BALLOON ACROSS THE END OF THE TUBE TO THE OTHER SIDE



C: CAREFULLY ROLL THE BALLOON FURTHER ONTO THE TUBE

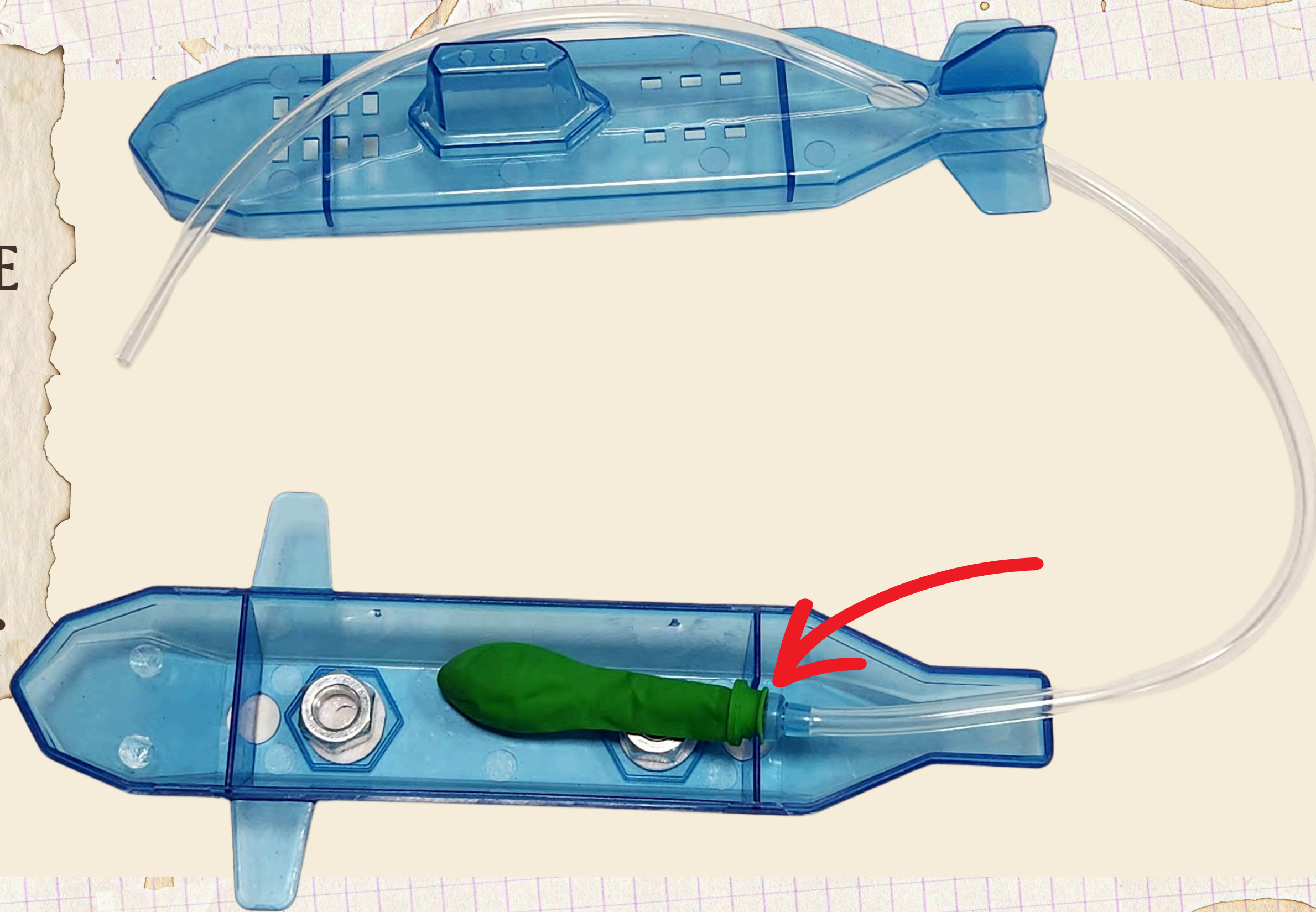


**STEP 6 - FEED THE OPEN
END OF THE TUBE THROUGH
THE SUBMARINE TOP PIECE
FROM THE "INSIDE" OUT.
THE BALLOON WILL BE
"INSIDE" THE SUBMARINE.**

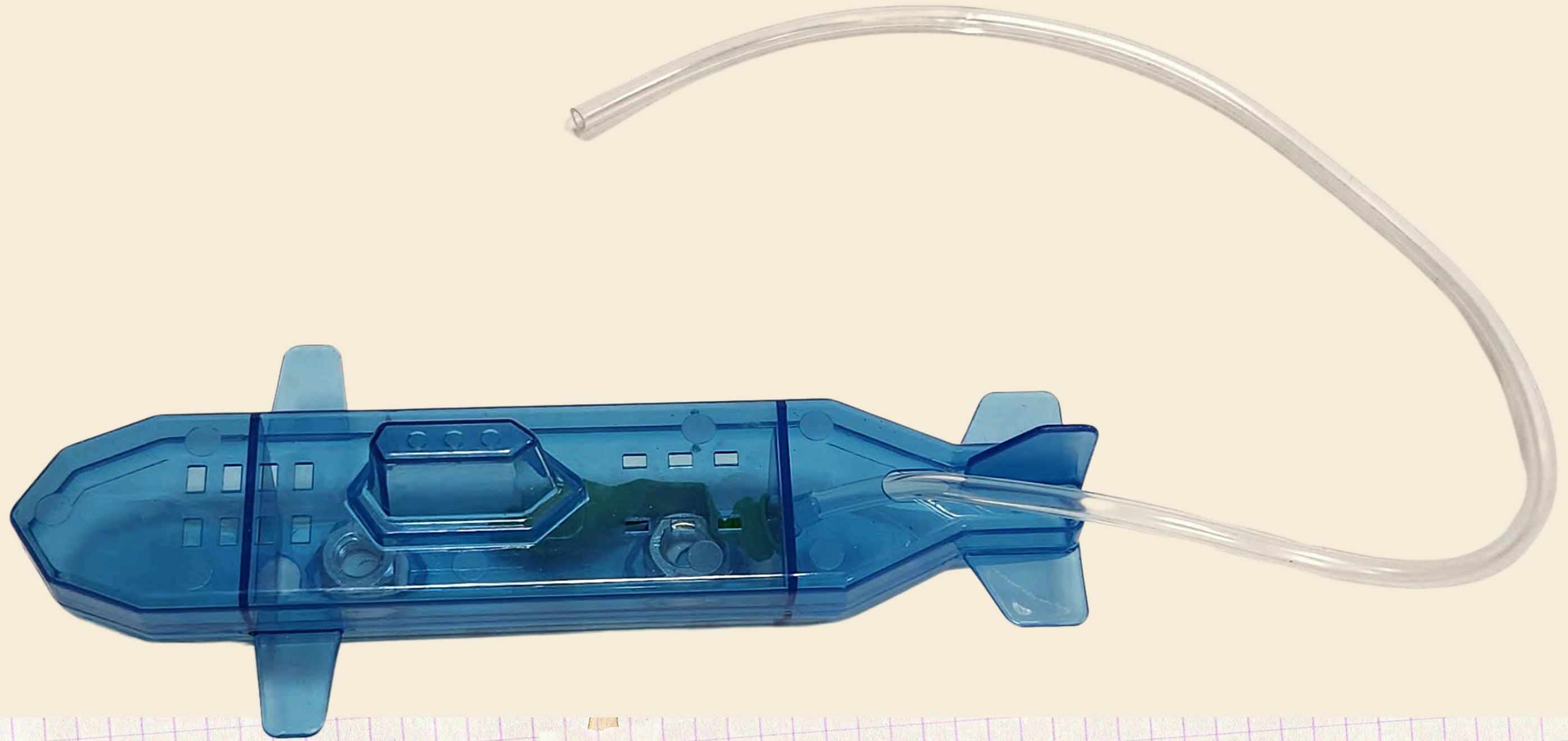


**FEED FROM
BOTTOM UP**

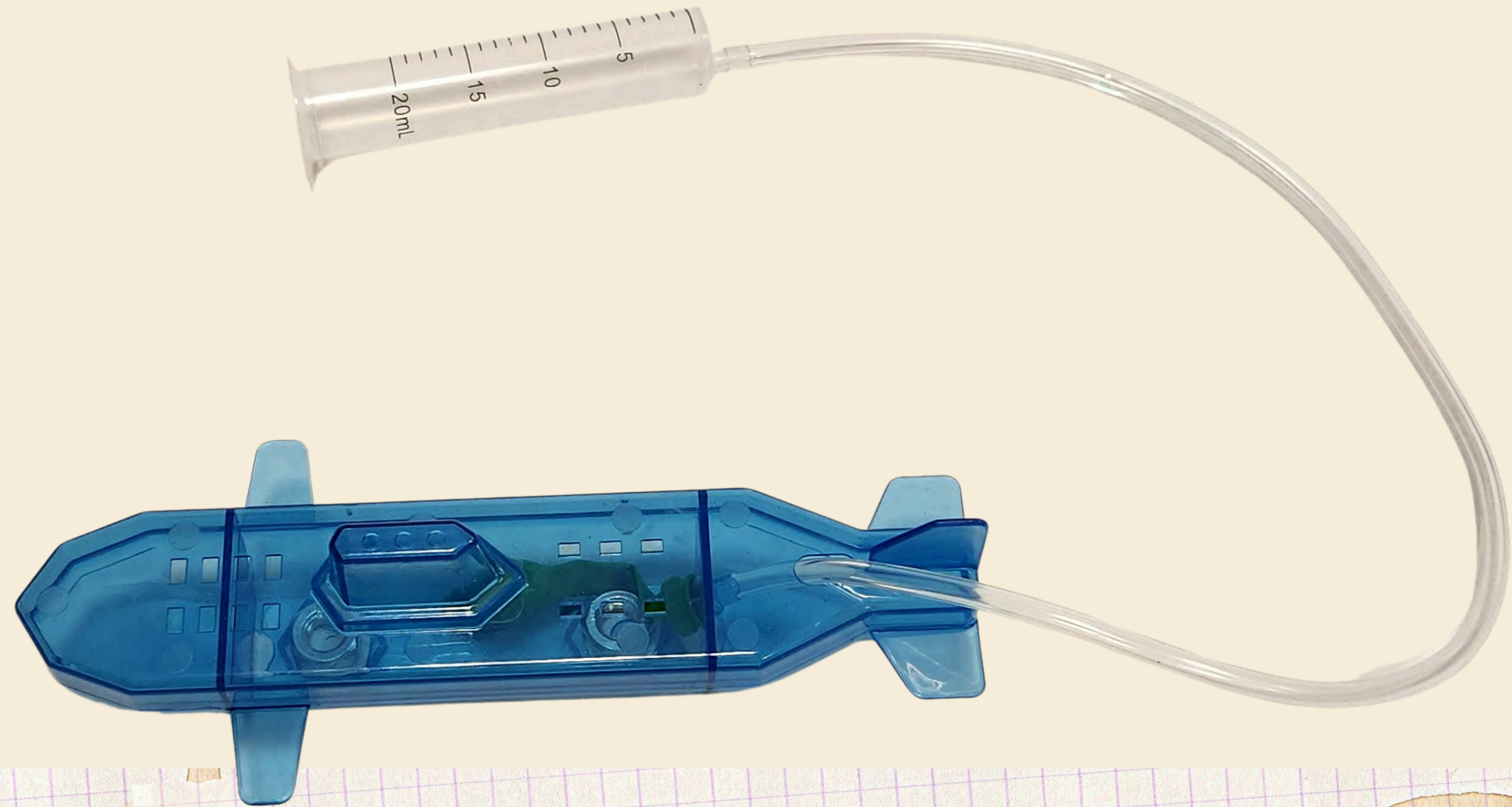
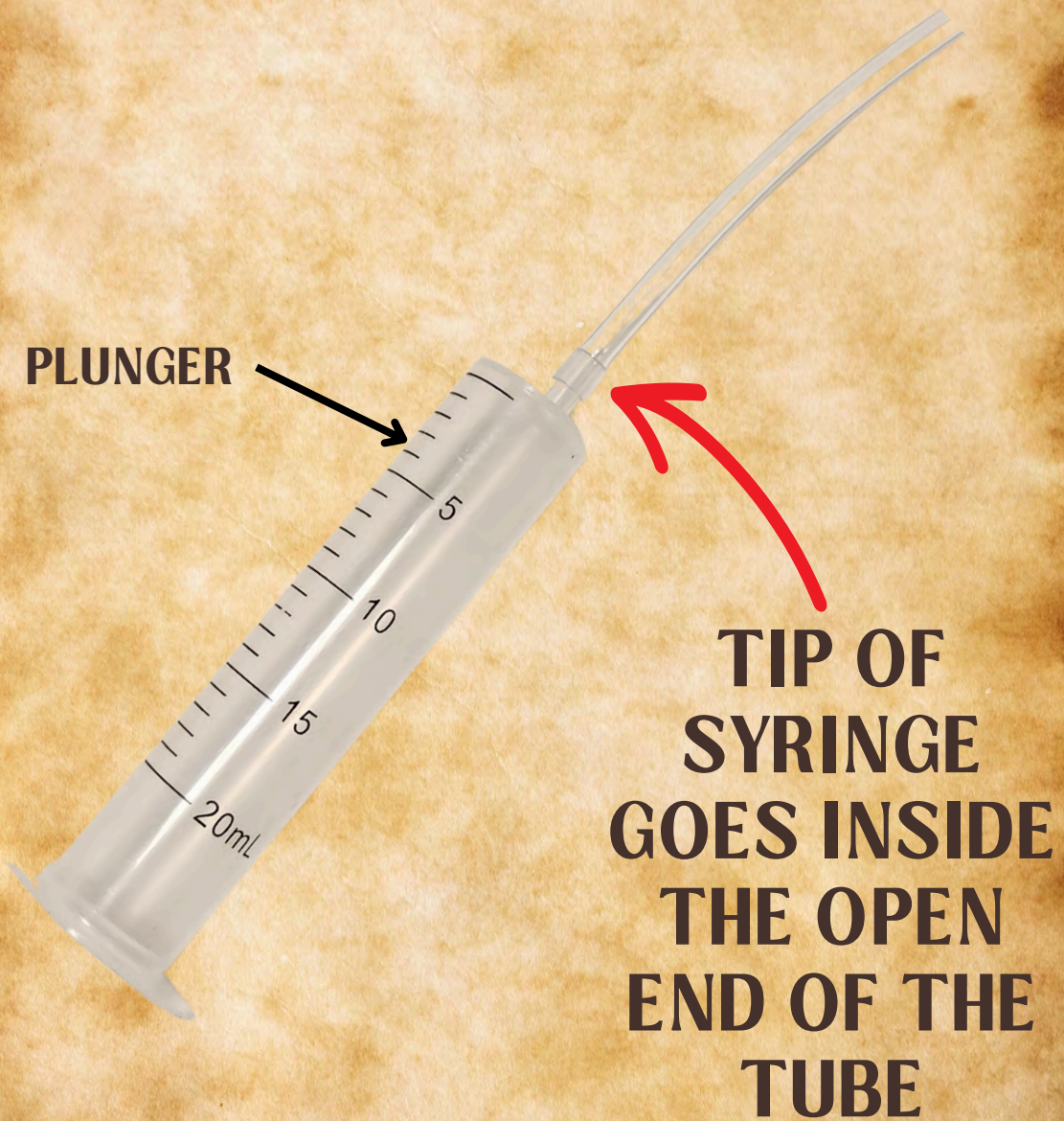
**STEP 7 - SLIDE THE
BALLOON END INTO THE
SPACE ON THE SUBMARINE
BASE - THE BALLOON
SHOULD BE LAYING
ACROSS THE BASE
POINTING TOWARDS THE
NOSE OF THE SUBMARINE.**



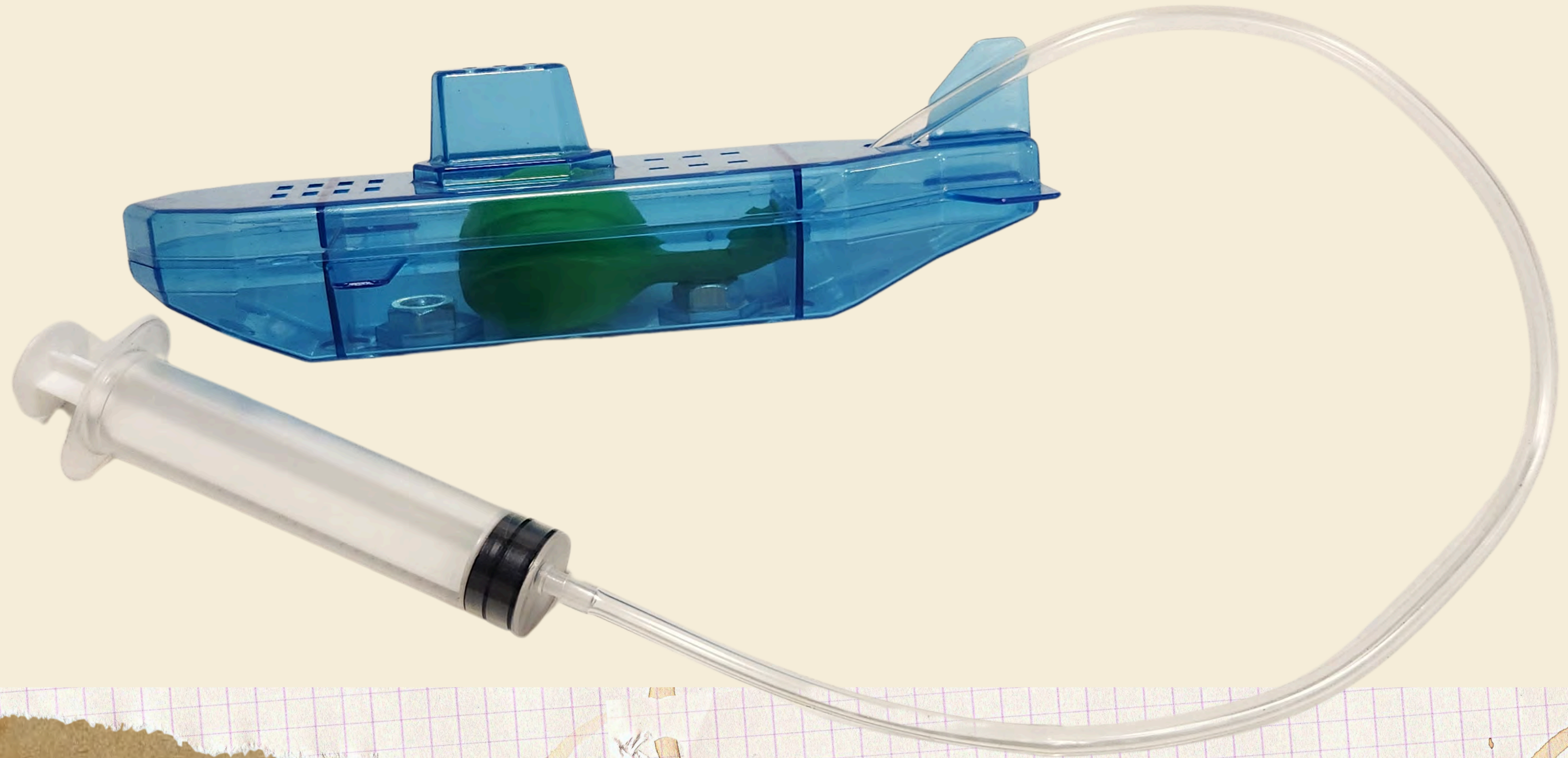
STEP 8 - CAREFULLY SLIDE THE SUBMARINE TOP DOWN THE TUBE TOWARDS THE BASE. MAKE SURE THE BALLOON STAYS IN PLACE BEFORE CLOSING THE SUBMARINE.

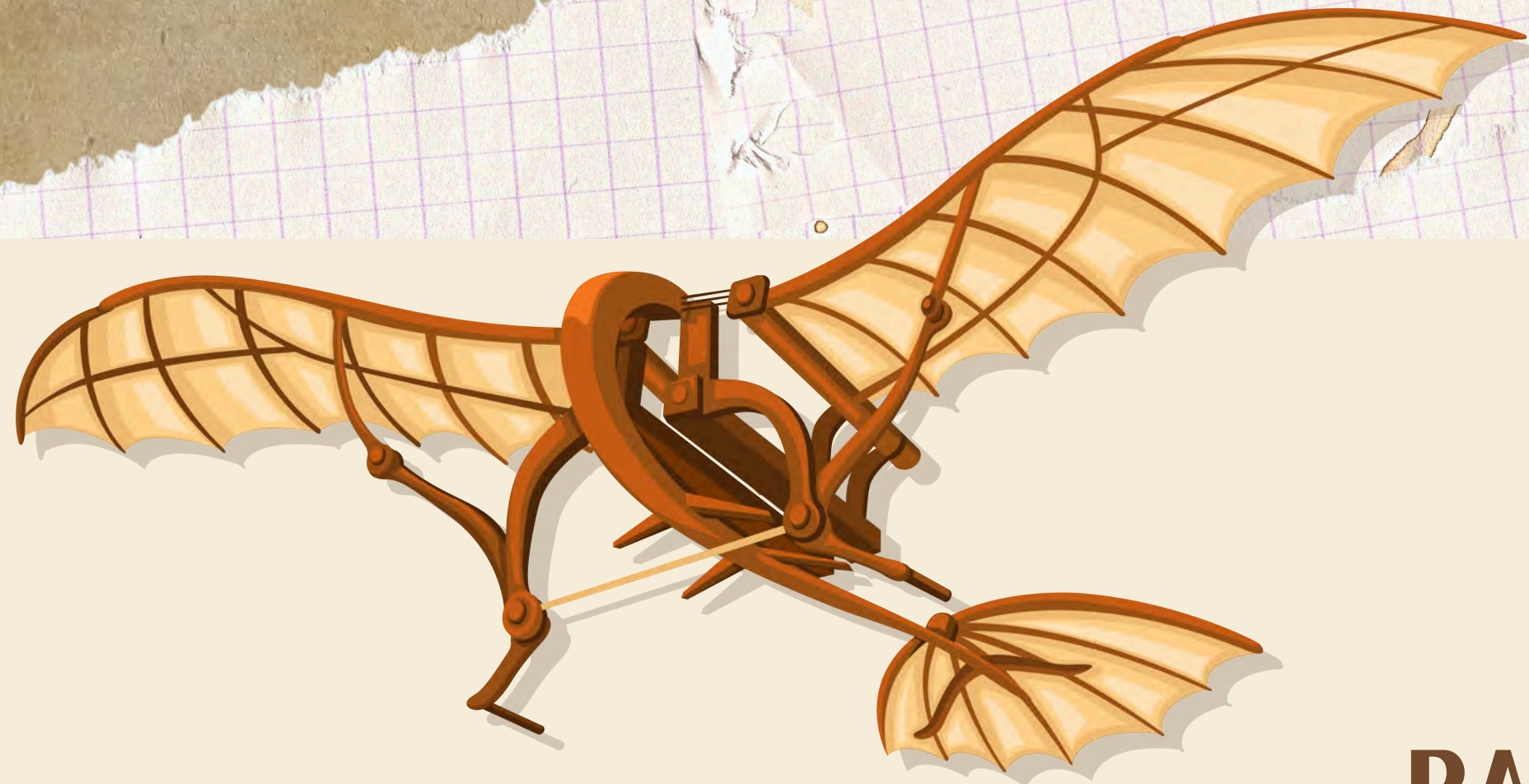


STEP 9 - REMOVE THE PLUNGER FROM THE SYRINGE AND SLIDE THE OPEN END OF THE PLASTIC TUBE ONTO THE TIP OF THE SYRINGE.



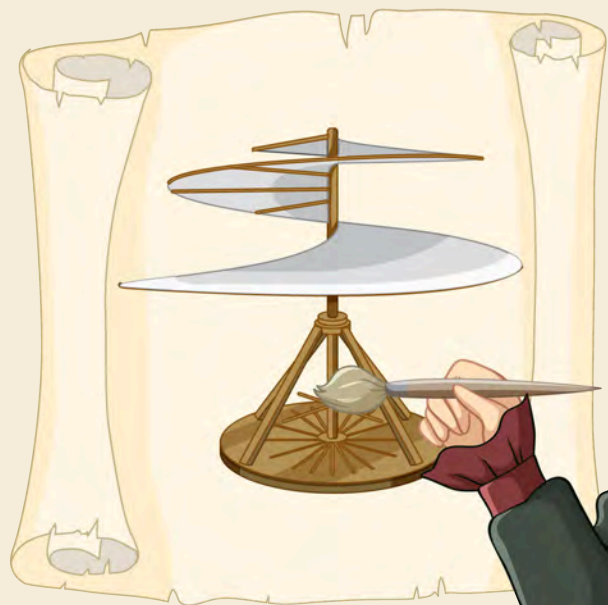
STEP 10 - PUT THE PLUNGER BACK INTO THE SYRINGE AND TEST THAT IT INFLATES THE BALLOON.



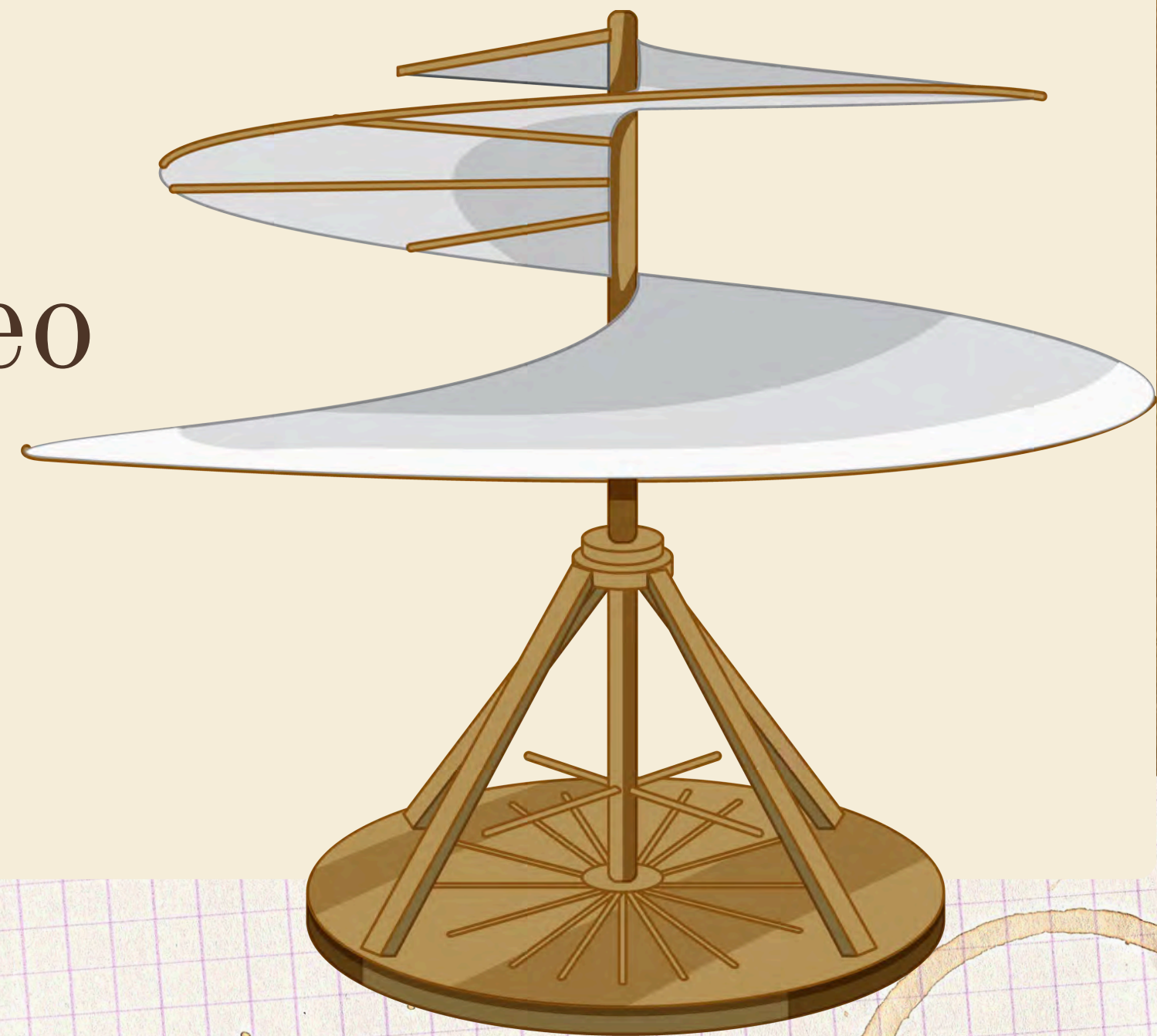


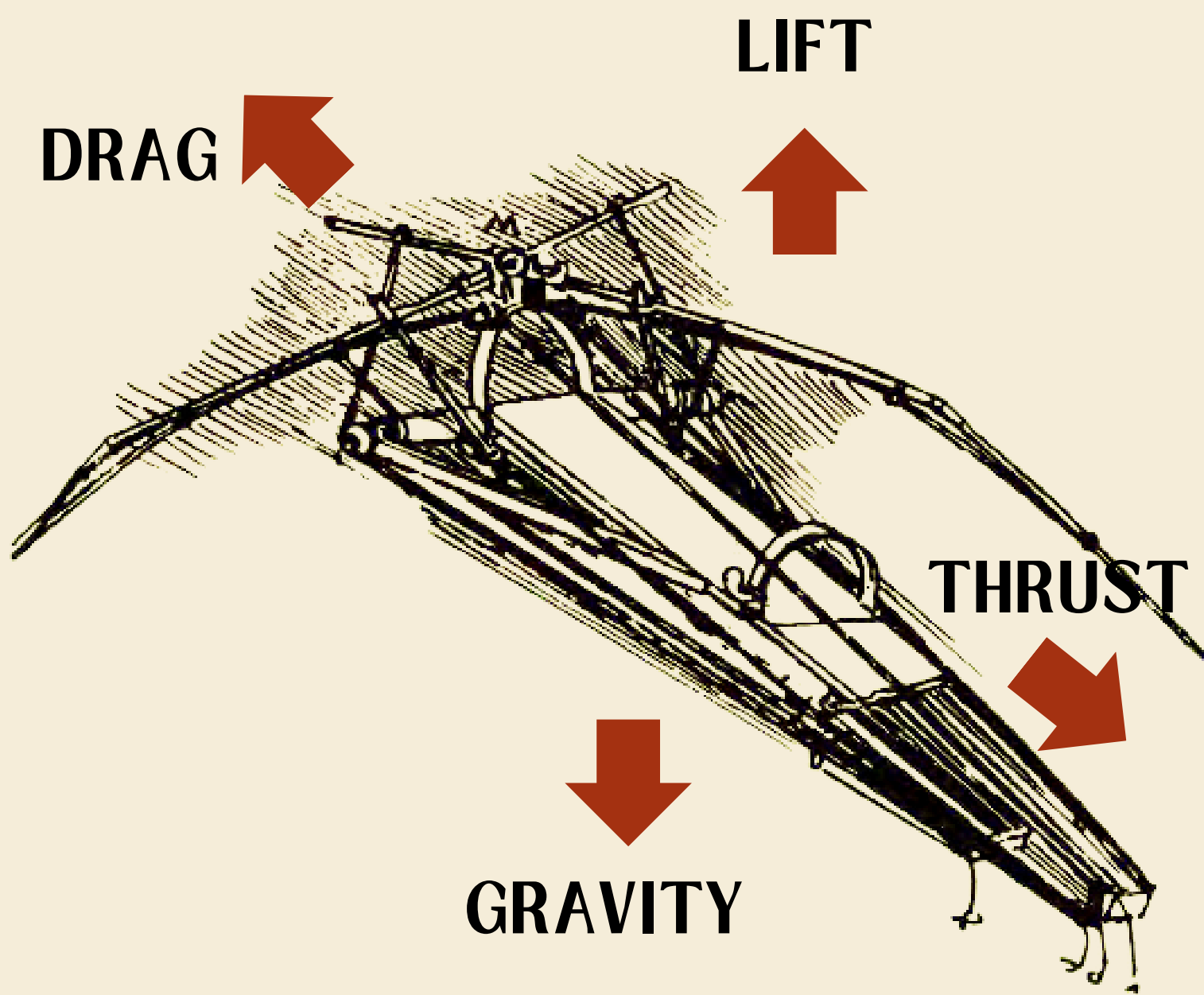
PART THREE:

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?

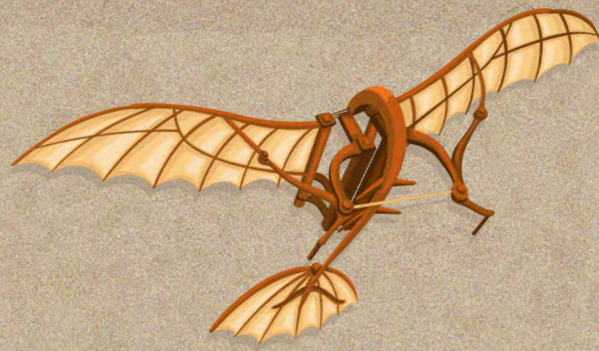


Table 4: Da Vinci's Flying Machines

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		

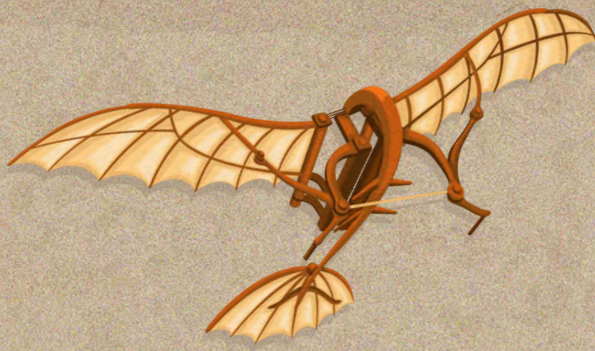
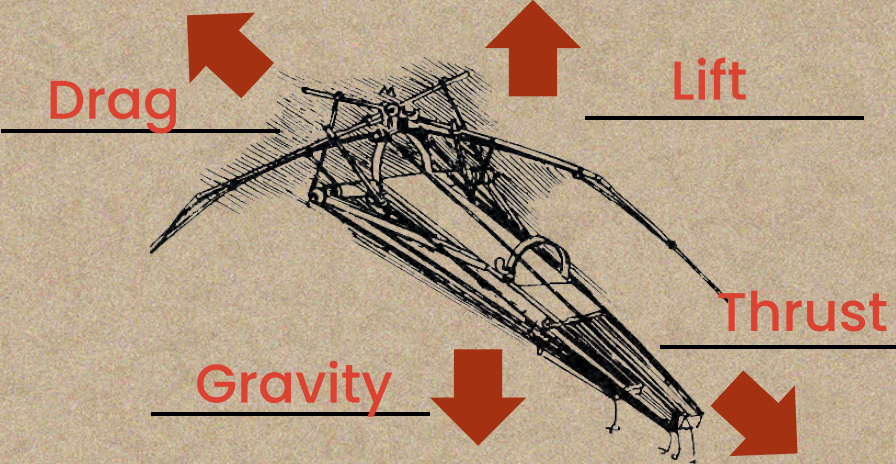


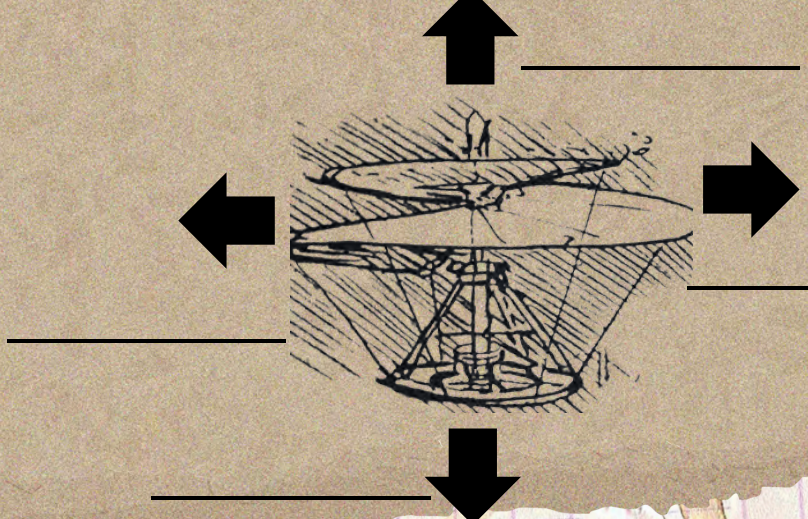
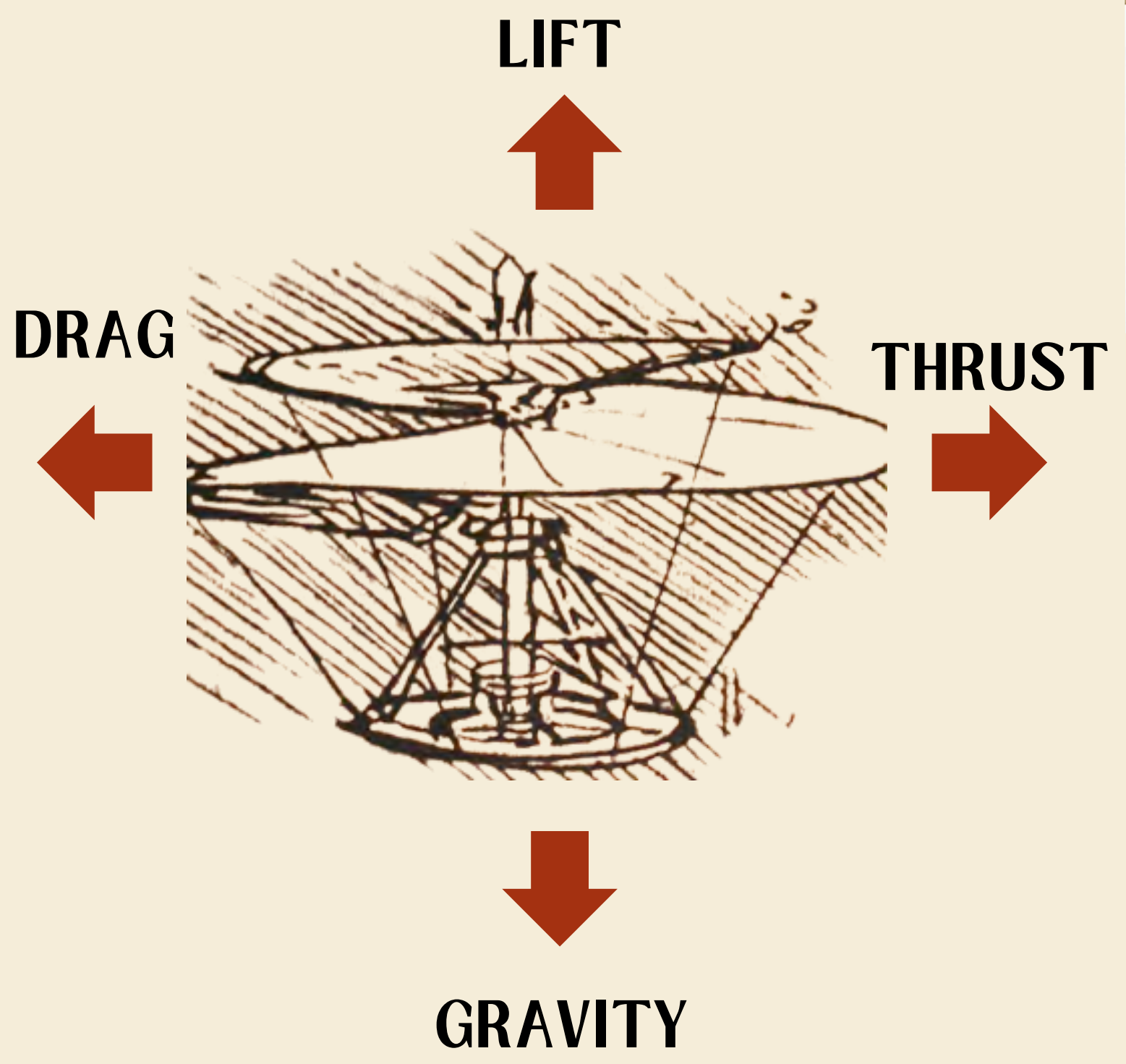


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Flying Machine	Label the diagram with the Opposing Forces of Flight	Will the machine actually fly? Why or why not? How is it similar to modern designs or animals?
Ornithopter		<p>No, it will not fly because the wings were not able to generate enough lift.</p>  
Aerial Screw		



INVESTIGATE DA VINCI'S FLYING MACHINES

Aerial Screw

Could it actually fly?

Is it similar to modern designs or animals?

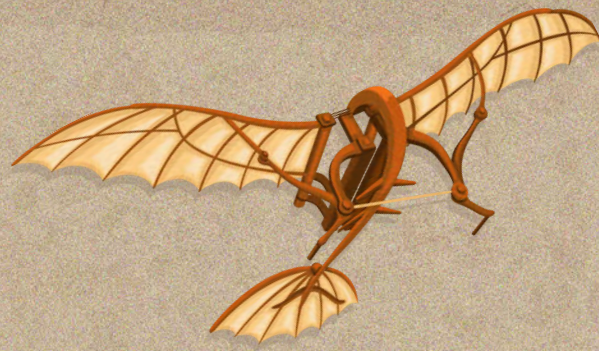
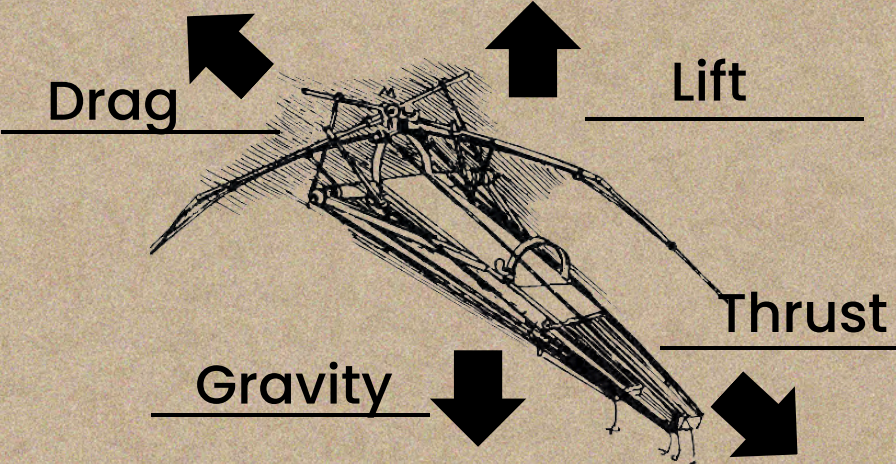
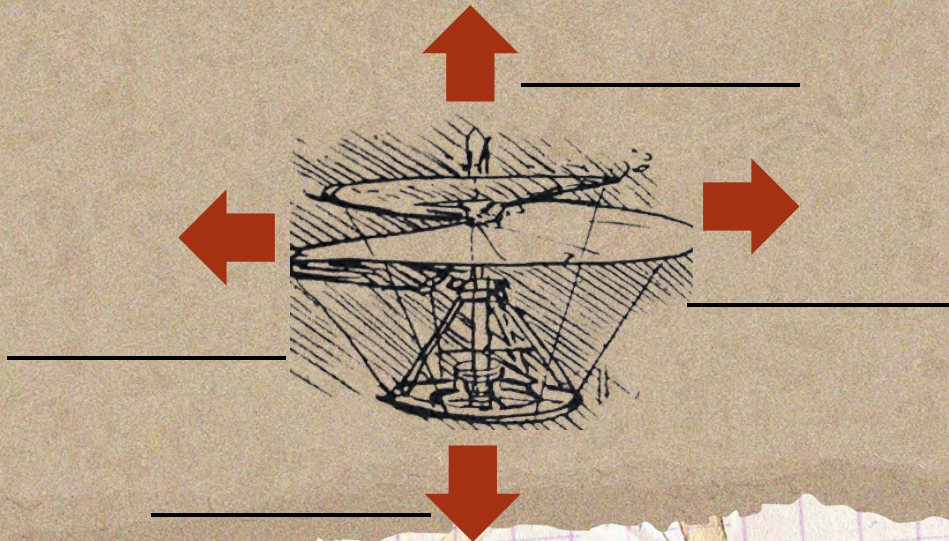


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Ornithopter		
Aerial Screw		

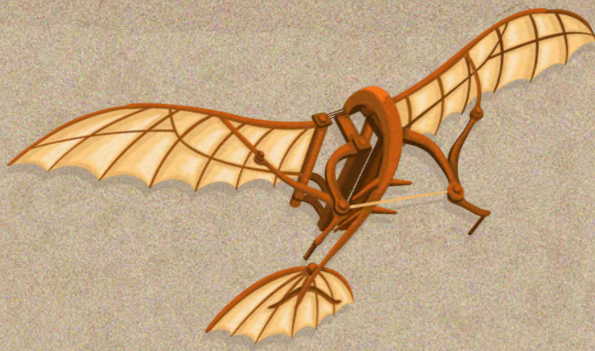
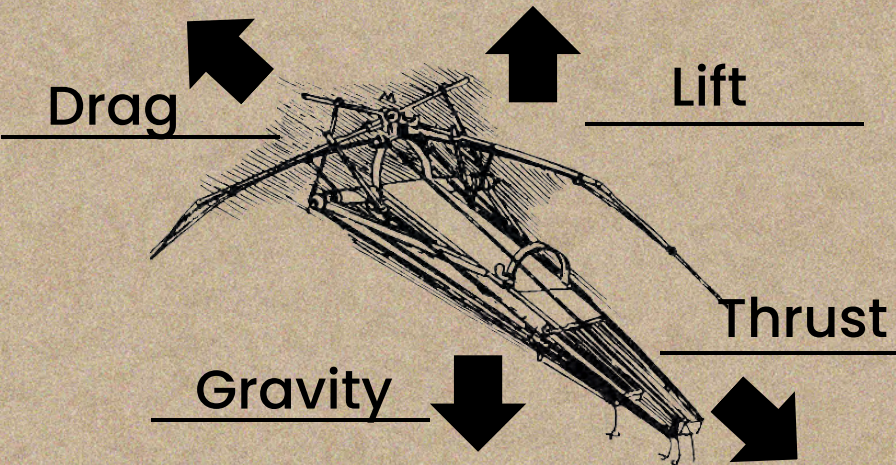


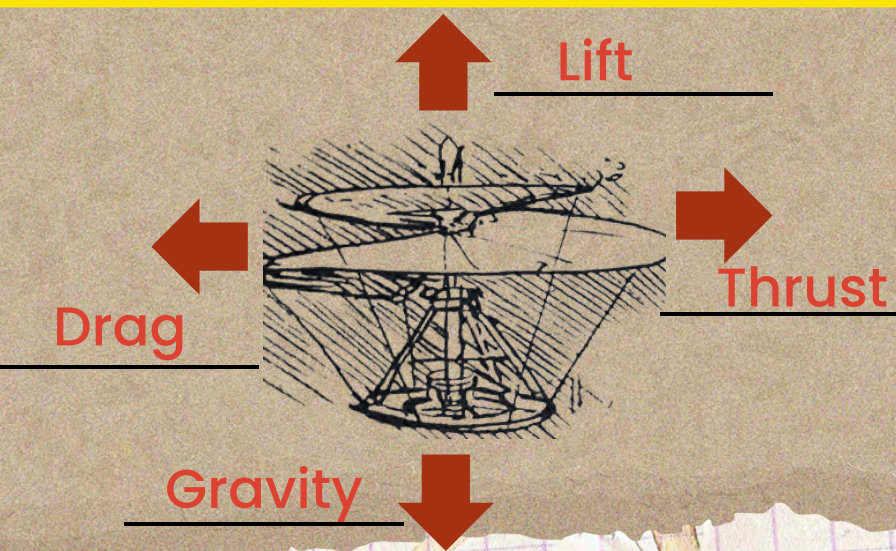




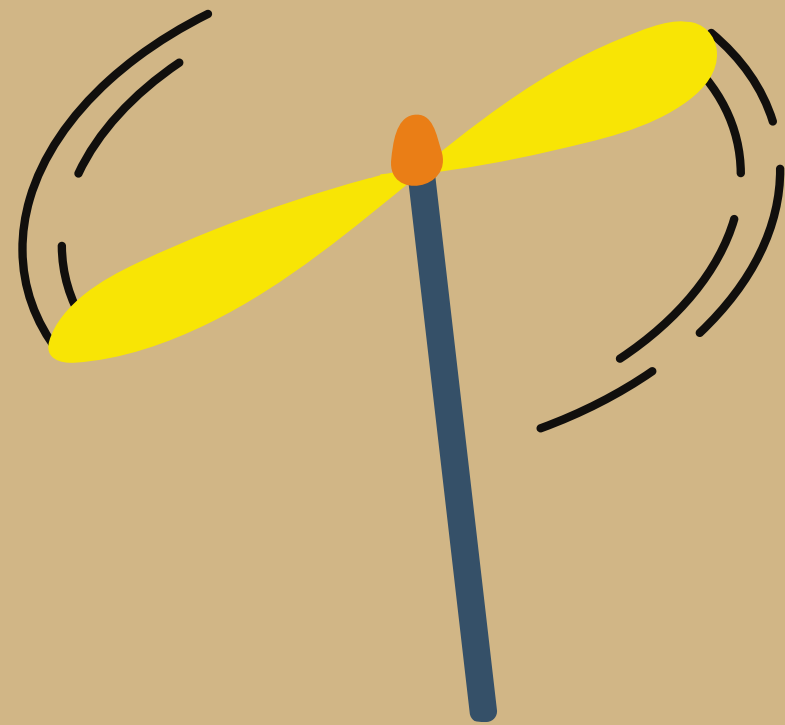
Table 4: Da Vinci's Flying Machines

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

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





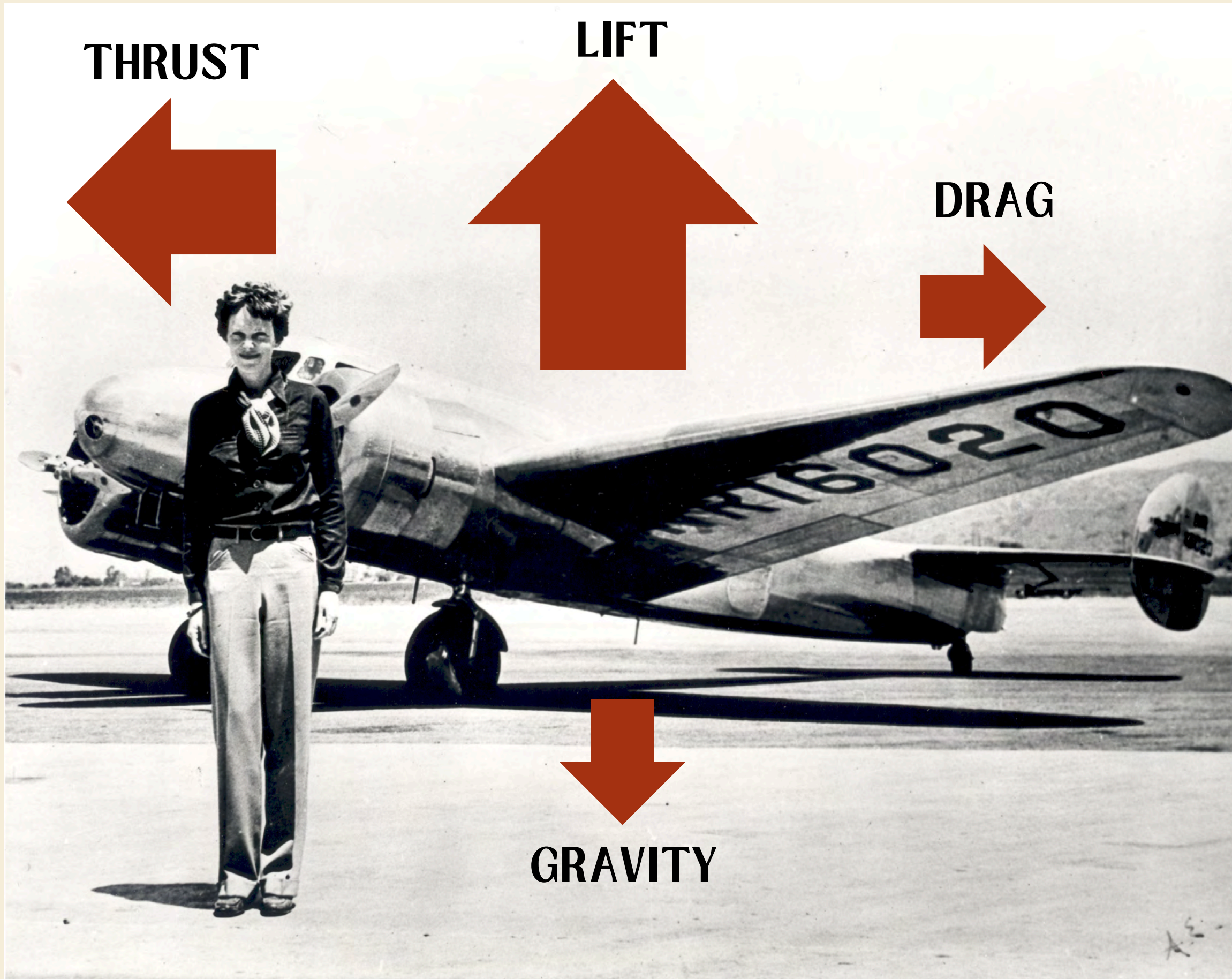
PART FOUR:

Amelia Earhart's Fantastic Forces of Flight



Amelia Earhart's
Fantastic Forces of Flight
Video





THRUST

LIFT

DRAG

GRAVITY

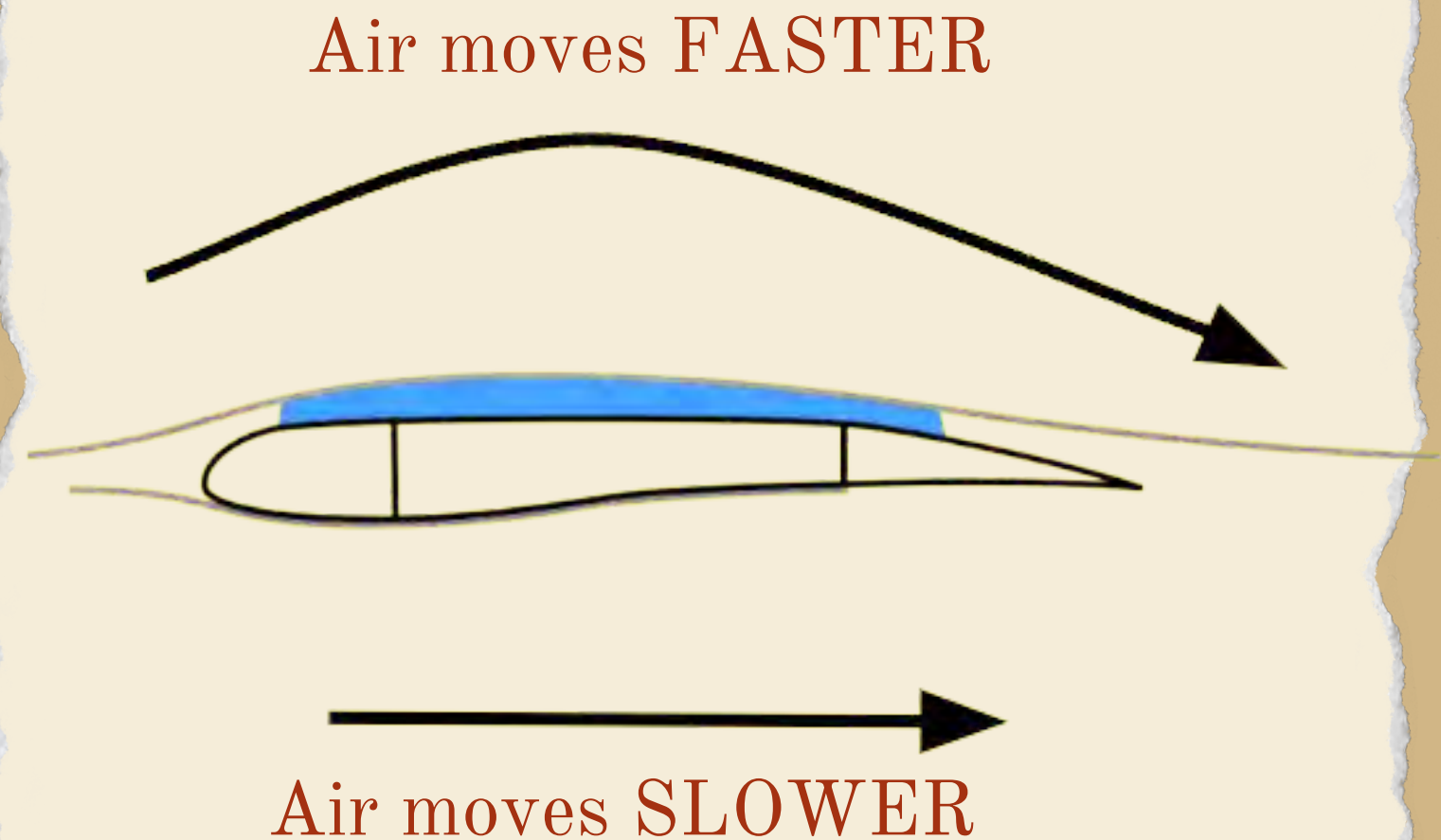
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AIRFOIL

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.

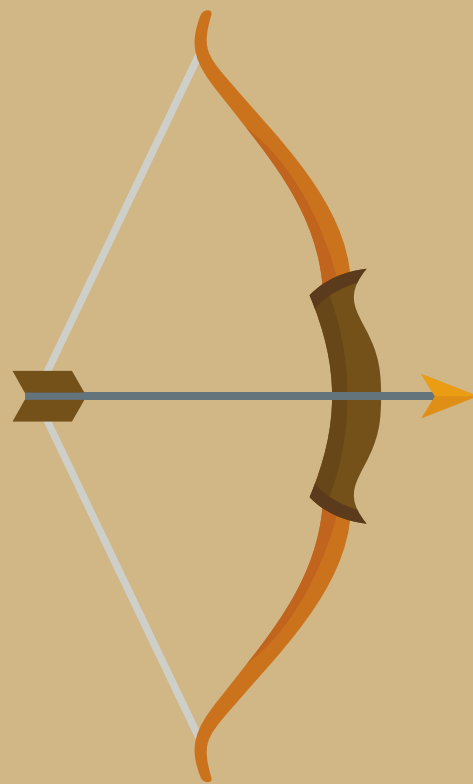


Table 5: Amelia Earhart's Fantastic Forces of Flight

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: <ul style="list-style-type: none"> • 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

