



# Theatre of Science Flight 1: Weight!

## Today we'll be hearing about:

What a force is and how it is measured

How to draw a force diagram

The relationship between lift and weight and what is needed for flight!

How the anatomy of birds and pterosaurs allows them to fly (and why humans can't!)

**To join in bring:** A deep bowl or pan 3/4 full of water (see-through best but any works fine), a small glass, some toilet roll.

If you enjoy these lessons, please consider chipping in £5 a month towards my wages! I'll send you Theatre of Science magazine, rainbow glasses, and all my gratitude. Search 'Theatre of Science Ko-fi' for details x

## Starters:

**Why can't humans fly without help?!**

(Choose as many as you like!)

- A: They're too heavy
- B: Their muscles aren't strong enough
- C: They don't have wings, just stringy little arms

**The rocket Saturn V took the first humans to the Moon, in 1969.. Why, soon after it took off, did bits fall off?!**

Do you know / any guesses?

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**How much of a 'push', in newtons, do you think an average car engine provides?**

Your estimate:

Answer:

**How about the Saturn V?**

Your estimate:

Answer:

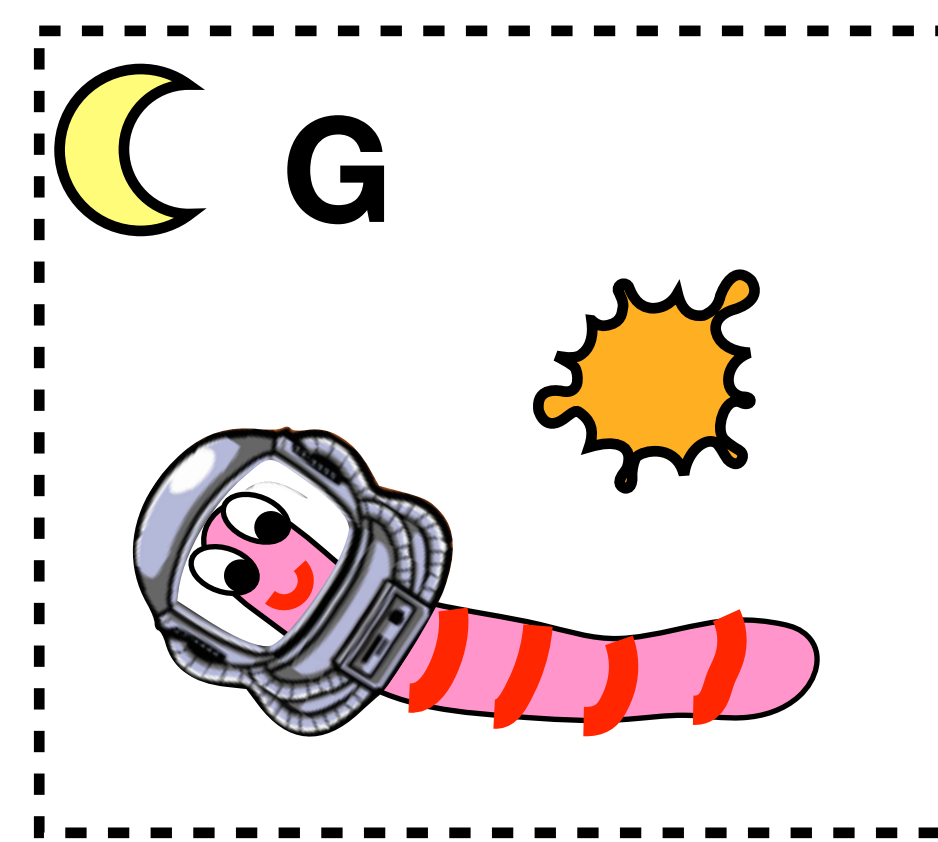
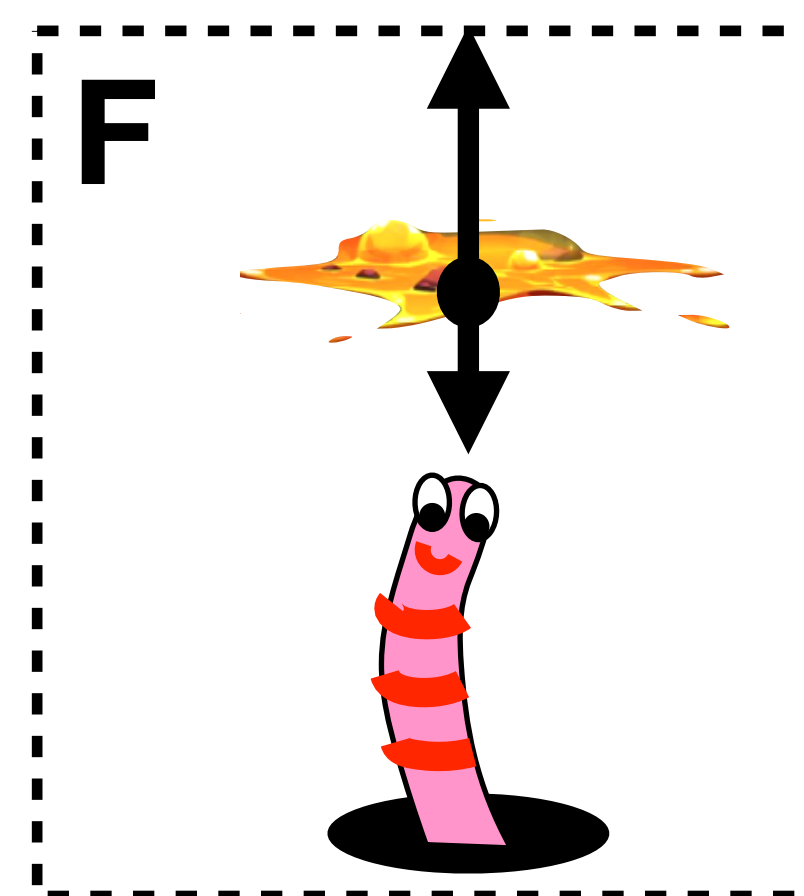
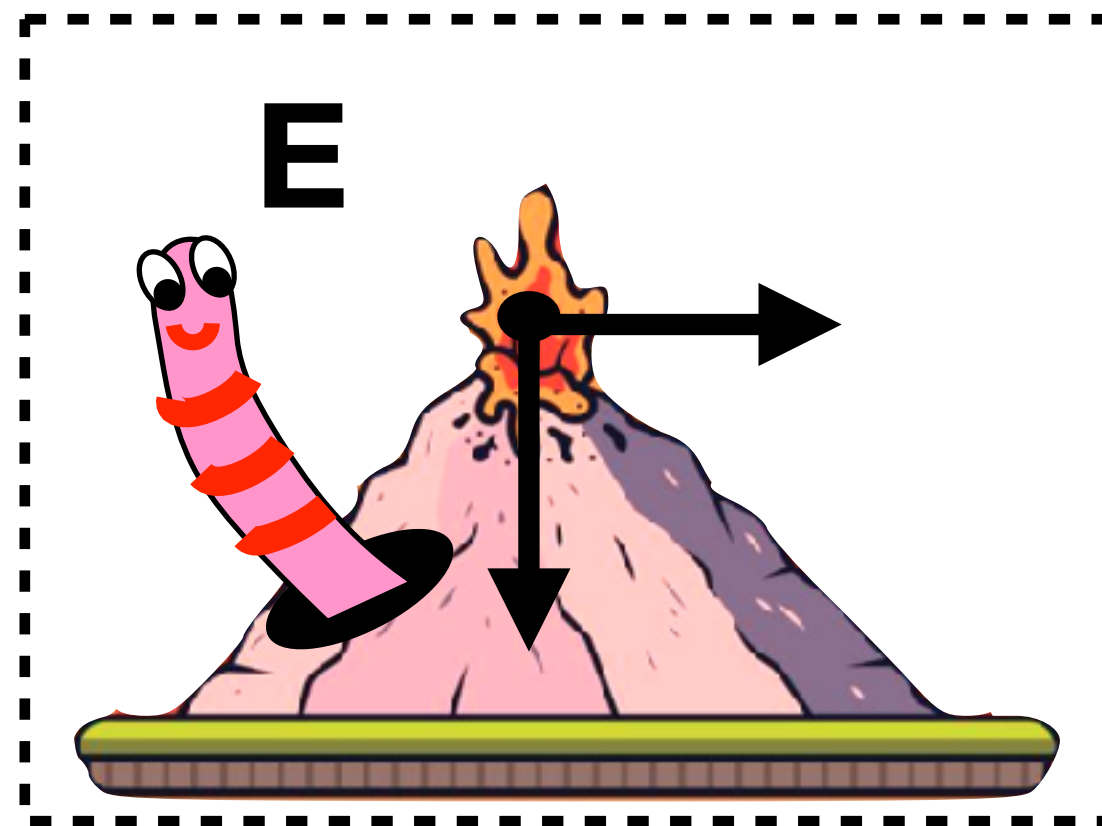
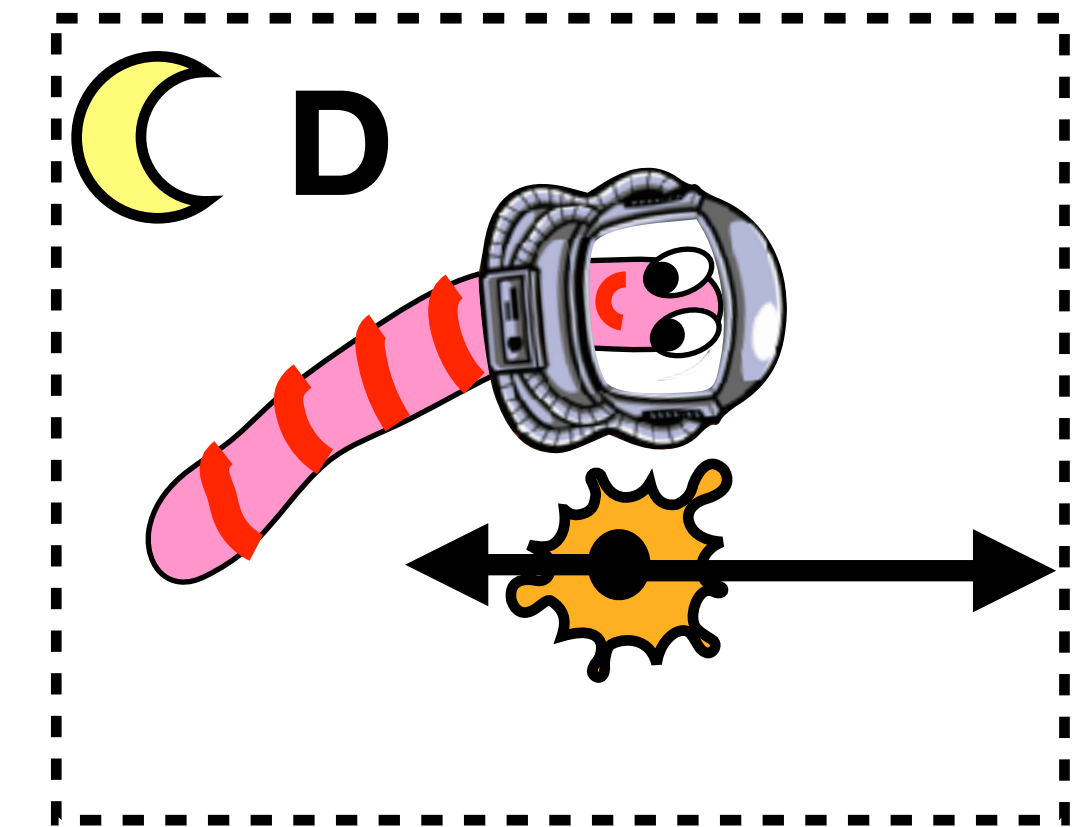
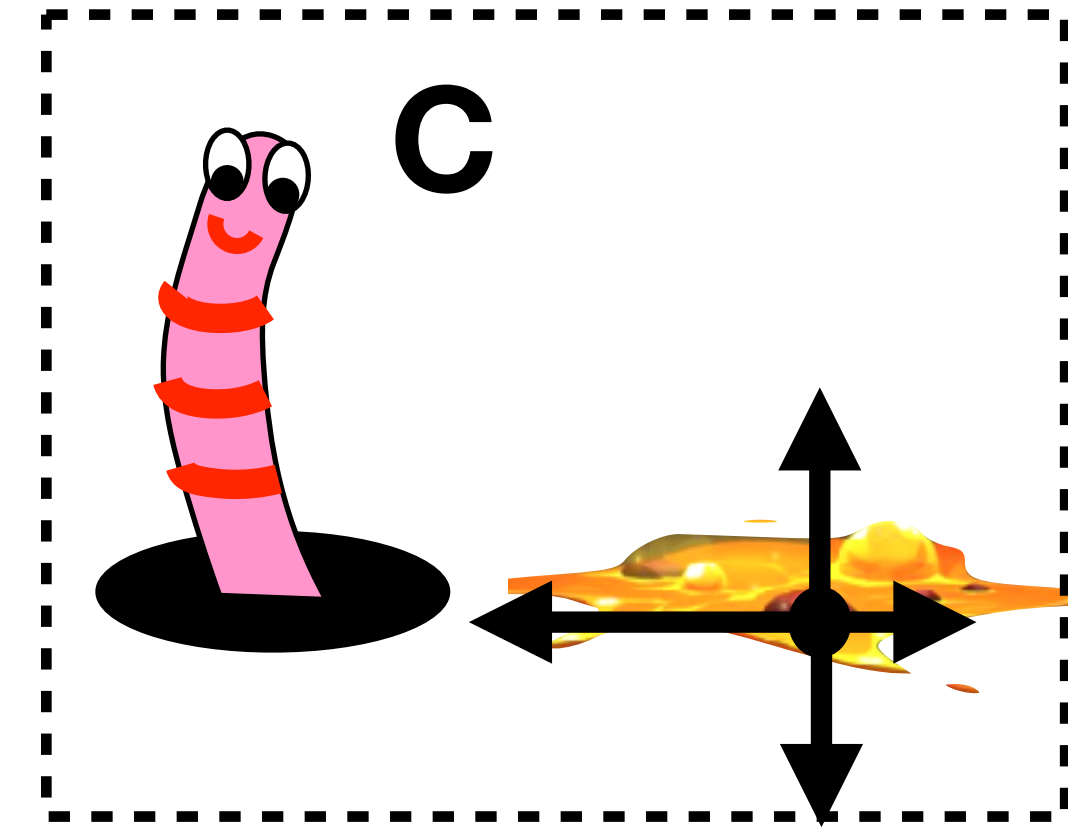
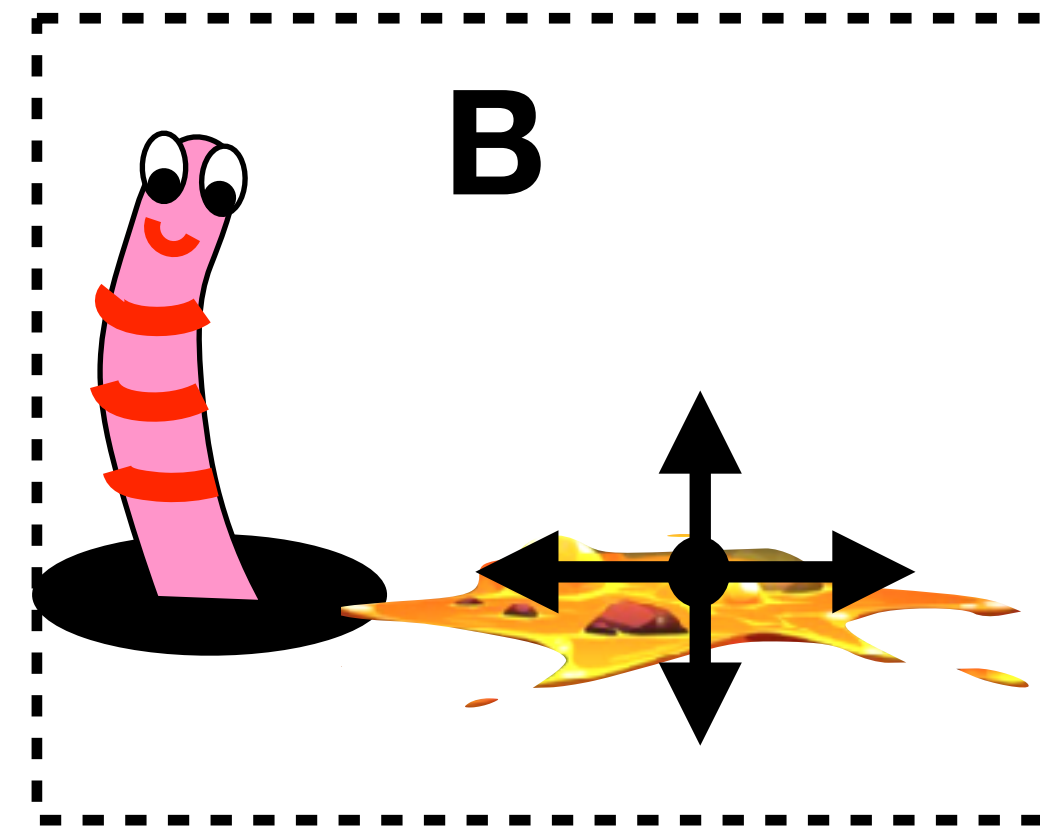
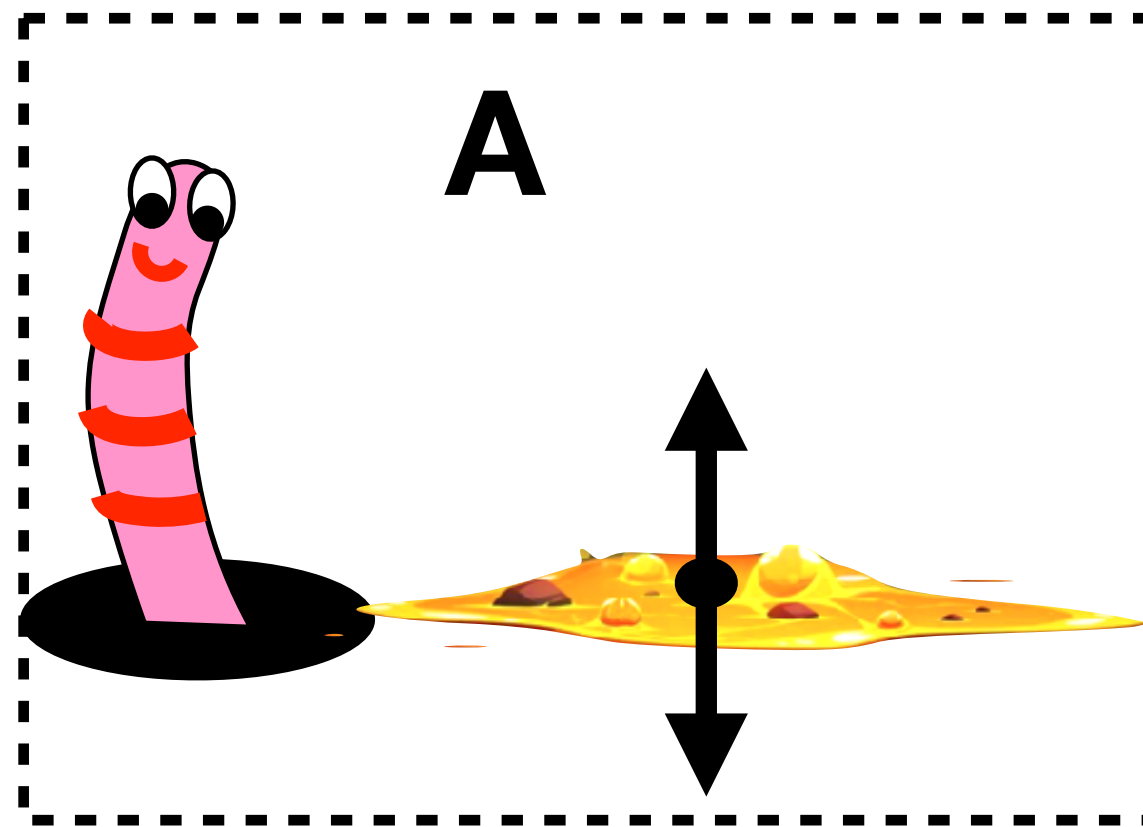
**And the latest NASA rocket?**

Your estimate:

Answer:



Wormy is hanging out near lava, when some of it starts moving! The forces acting on the lava are labeled with arrows. In each case, **draw an arrow to show where the lava is going, or write 'S' if the lava is staying still.** And say whether Wormy is safe or not!



Fill in the blanks:

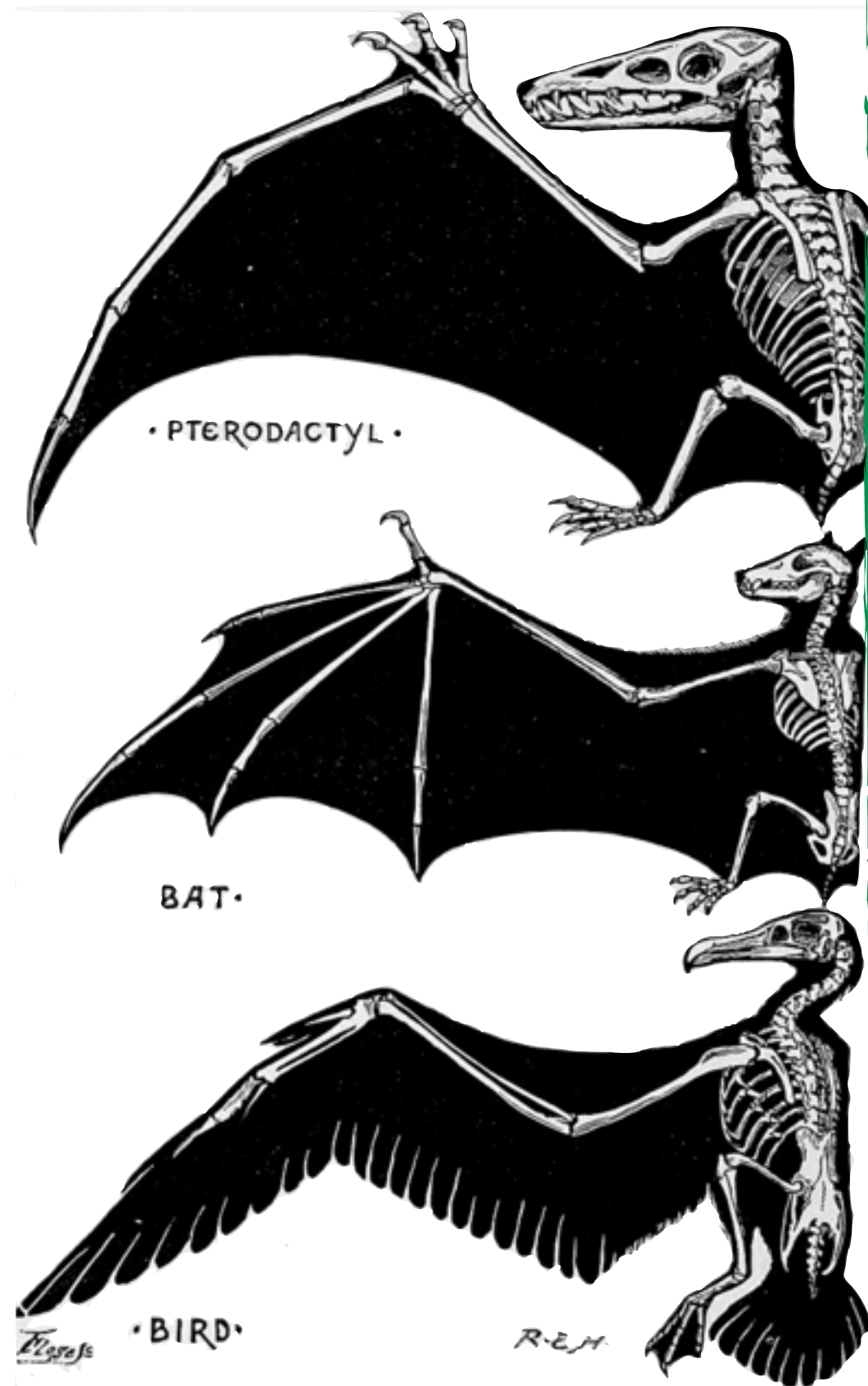
If an object is still,  
the  on it

must be

IF you come to my IGCSE physics lessons, or already know this stuff, imagine you don't have the info above and are just looking at the force diagrams. How else could the lava be moving in each case?



## Optional notes & doodles!



## Final Questions

1) Find the mistake on my can of butterbeans



2) Which of these would not be measured in newtons?

How hard a husky pulls a sled

How fast a child pushes a shopping trolley

How much effort it takes to peel the lid off Quorn scotch eggs.

3) A person starts a car.  
a) Are they moving forwards or backwards?



b) Draw on any force arrows that are missing

4) A rocket's engine provides it with 10 000N of upwards force. How much does the rocket weigh?

10 000N

Less than 10 000N

More than 10 000N



# Theatre of Science Flight 2: Buoyancy and balloons!

## Today we'll be hearing about:

What density means

How an object's density affects whether it sinks or floats

Why hot air balloons are the shape they are and why they fly

**To join in bring:** Large bowl of water, Lego bricks and cocktail stick (And if you have them! Two oranges, one peeled; full, see-through bottle of syrup/washing up liquid).

## Starter:

If you put Lego bricks in water, they float! What could you do to get them to sink? Use as many bricks you like, arranged however you like. You're just not allowed to attach anything else to them!

Try it and / OR write down what you think might work here:

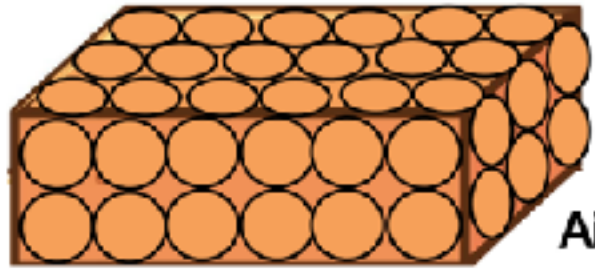
What does work? Why?!



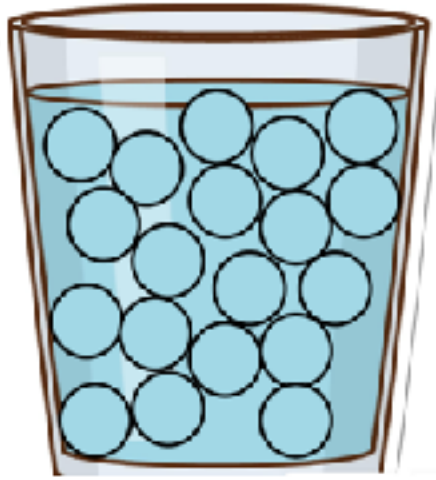


Density means how close together the particles in a thing are.

Bricks: particles tightly packed together. Very dense.



Water: particles a bit more spread out. Less dense.



Air: particles very spread out. Not very dense at all.

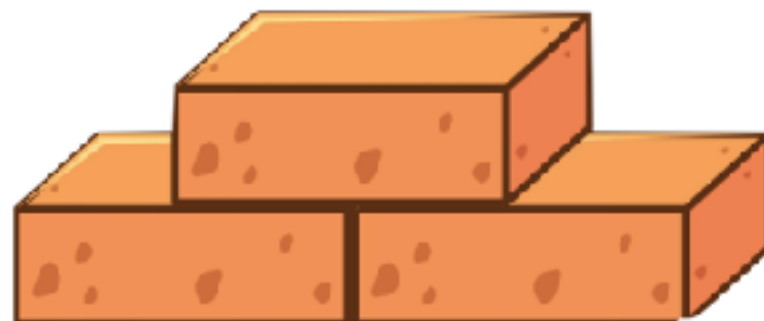


Which is denser?

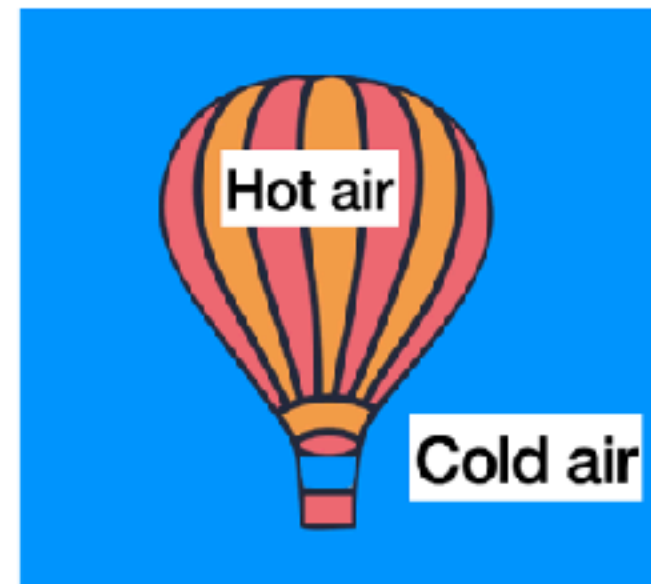
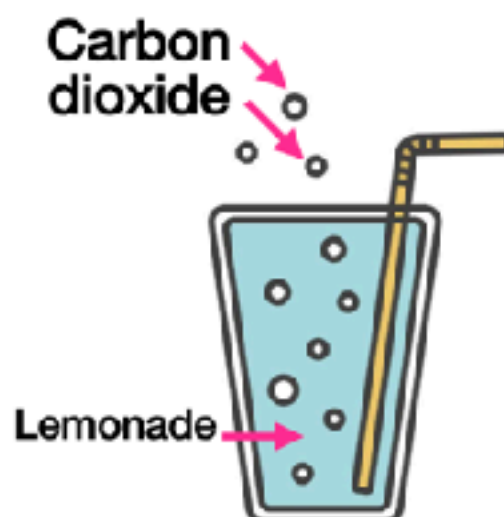
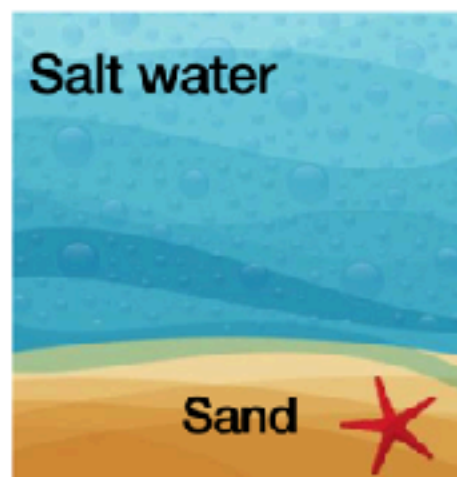
Single brick.



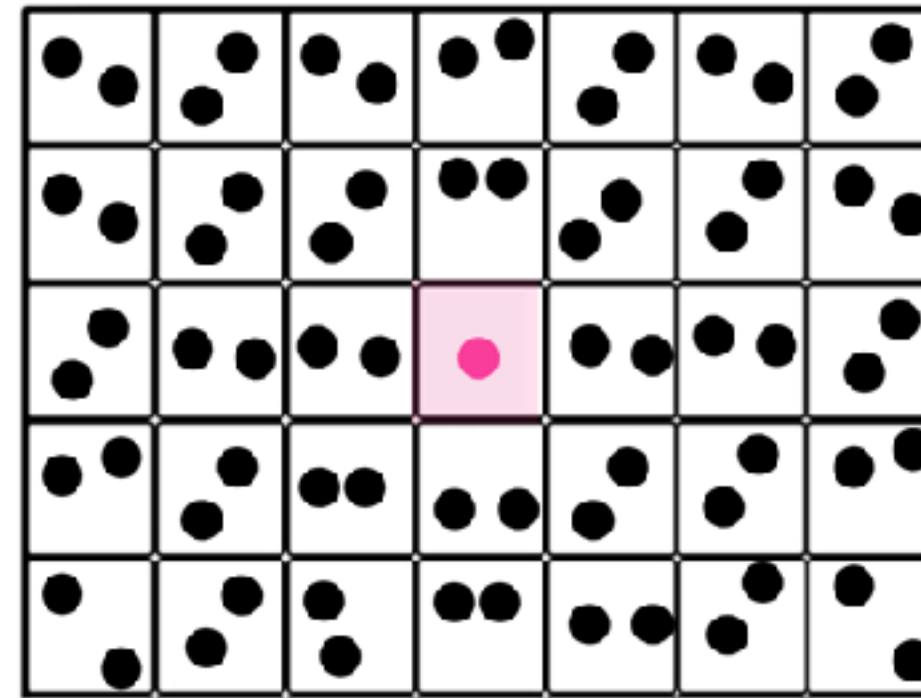
Brick wall



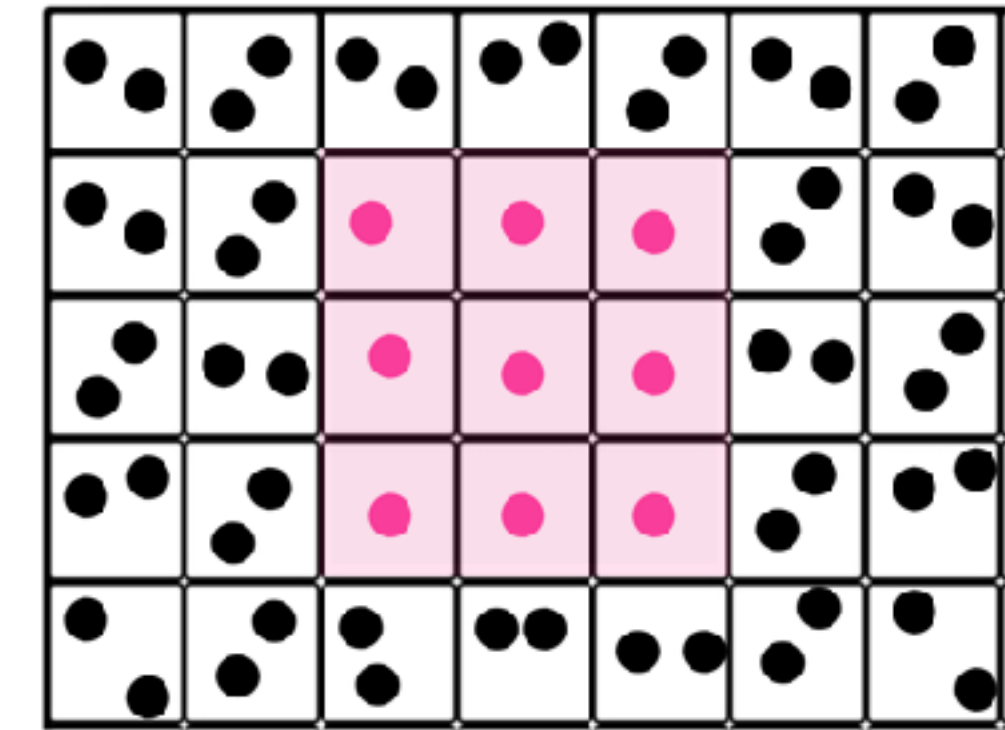
Things that are less dense float in things that are more dense. Circle the densest thing labelled in each picture.



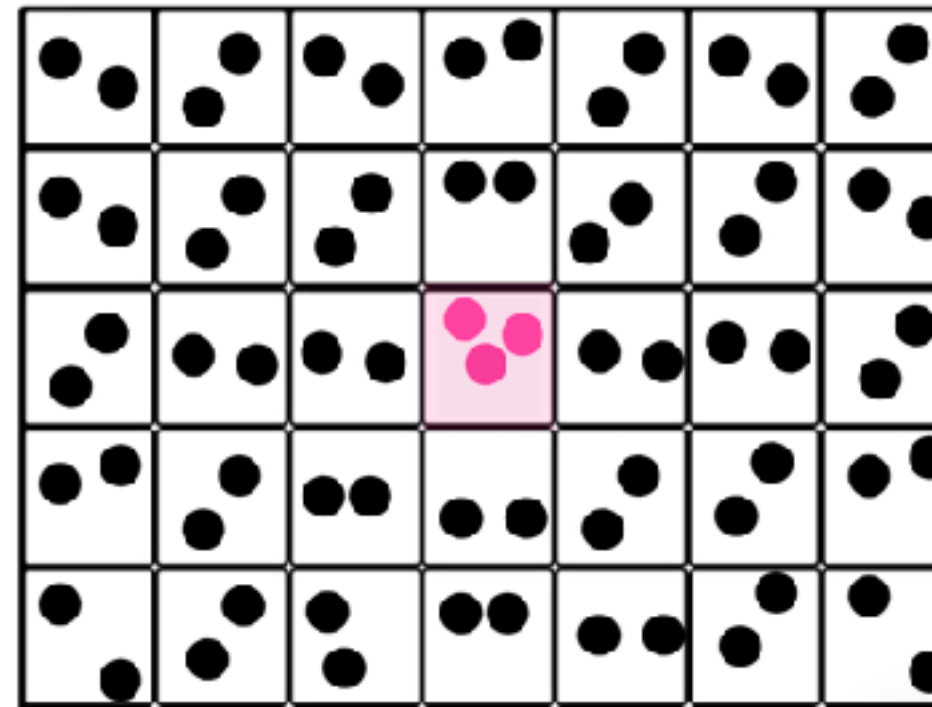
Will the pink object float or sink?



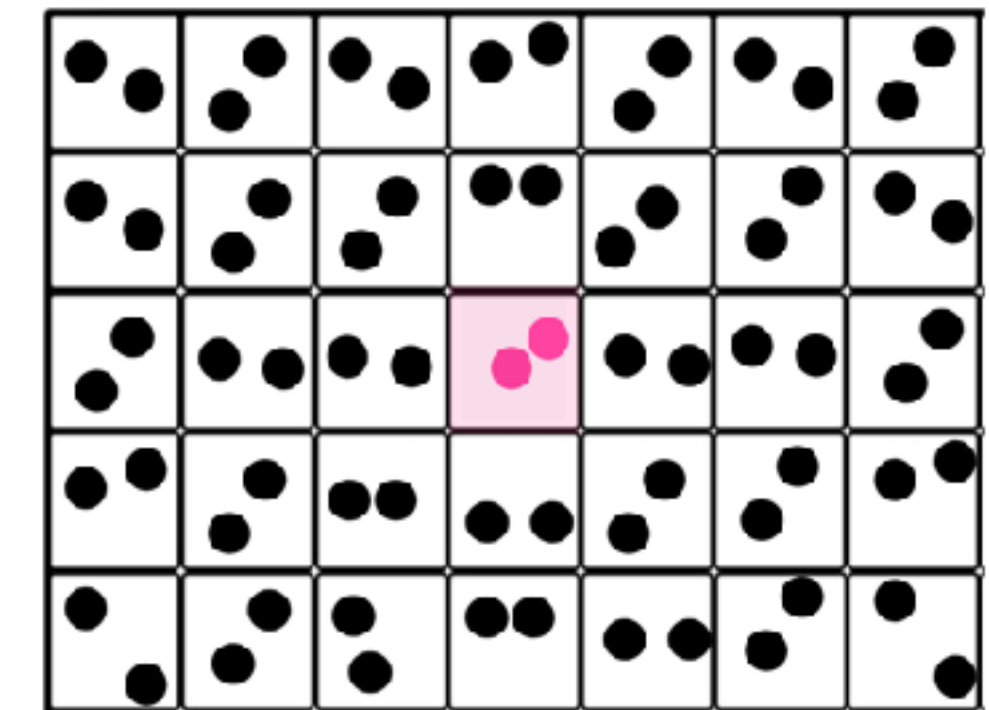
Float or sink?



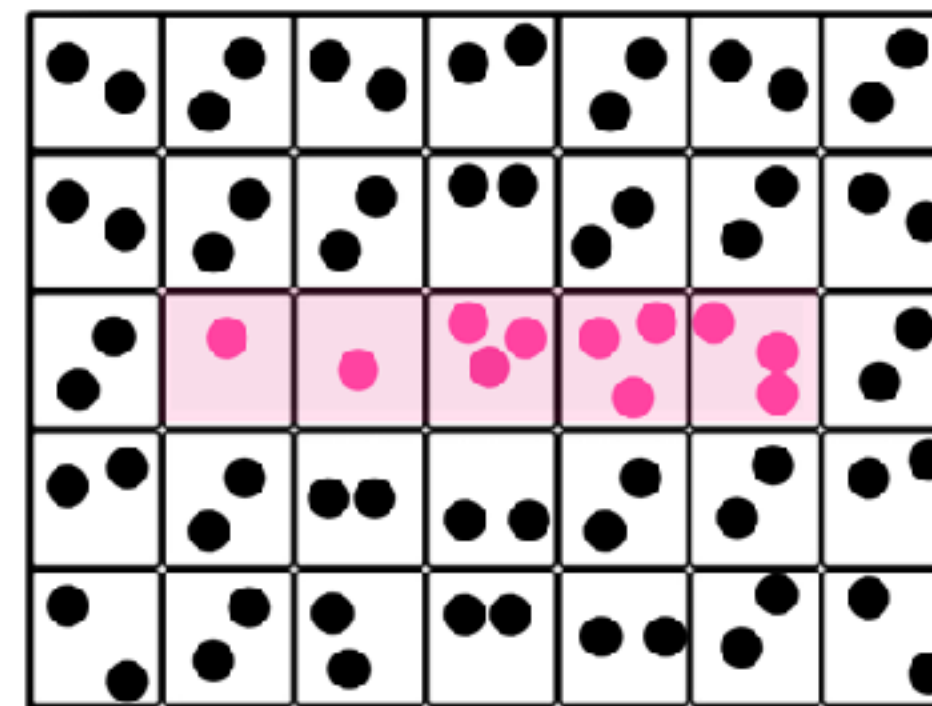
Float or sink?



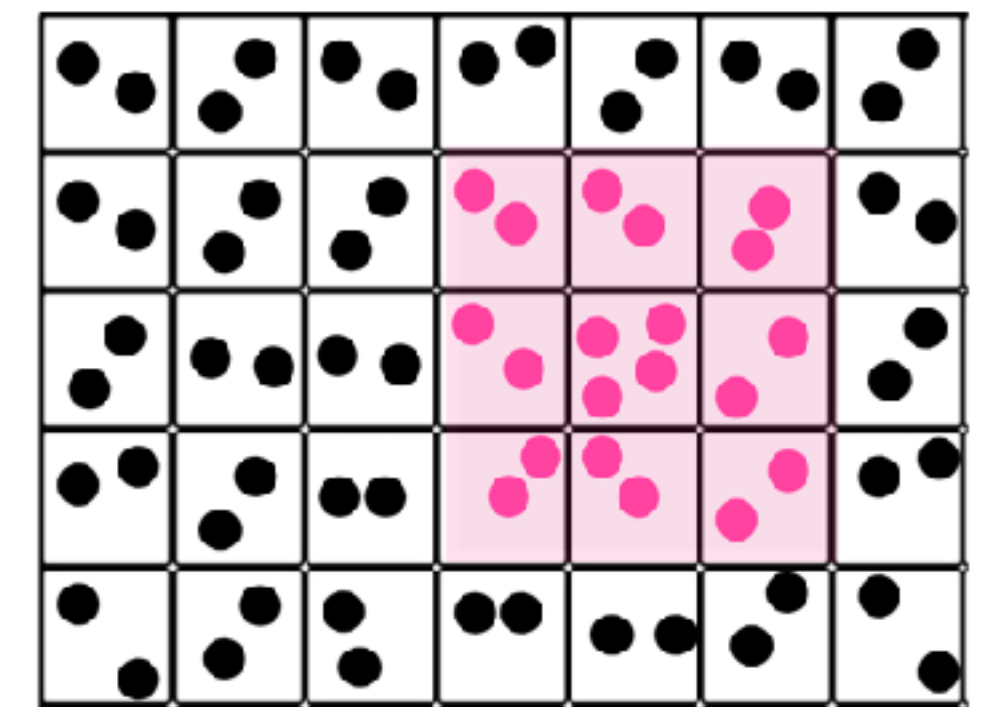
Float or sink?



Float or sink?



Float or sink?



Float or sink?



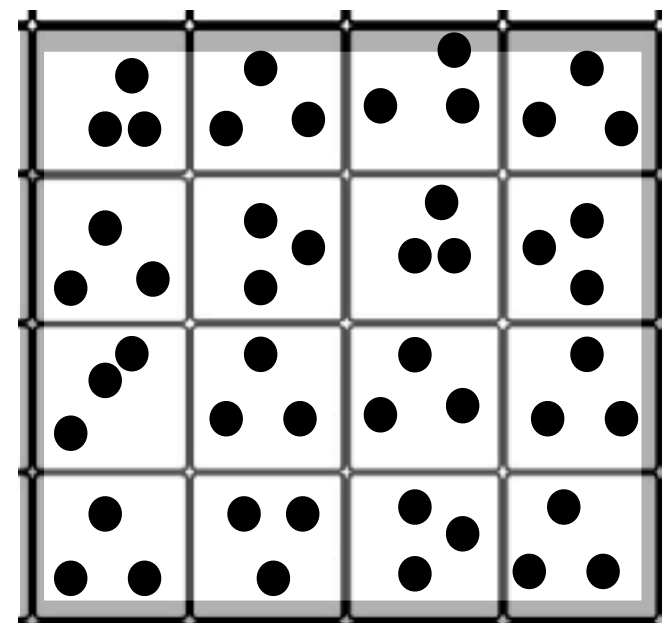
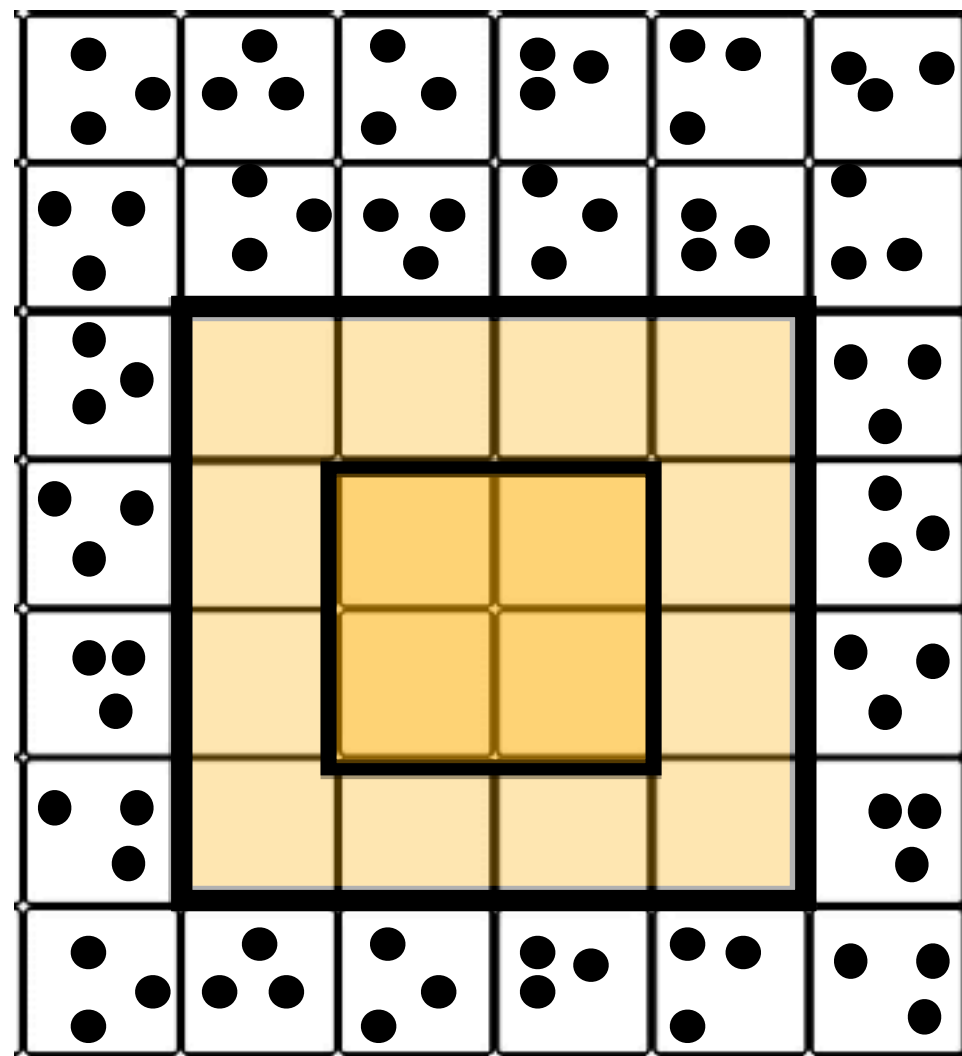
# Two oranges. One peeled, one not.

Which one is heavier?

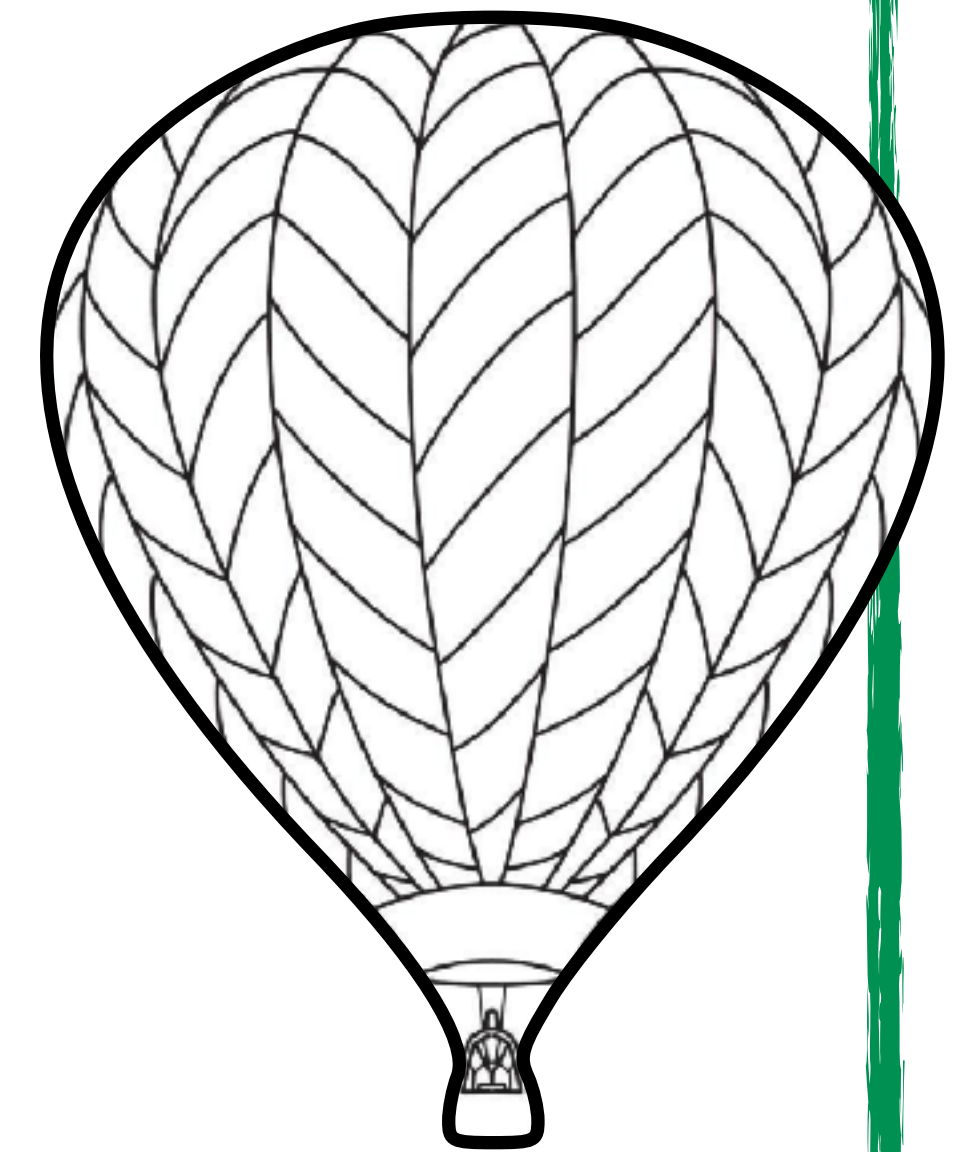
Which one will float?



Draw particles in the centre of the orange and on the orange peel to show what is happening!

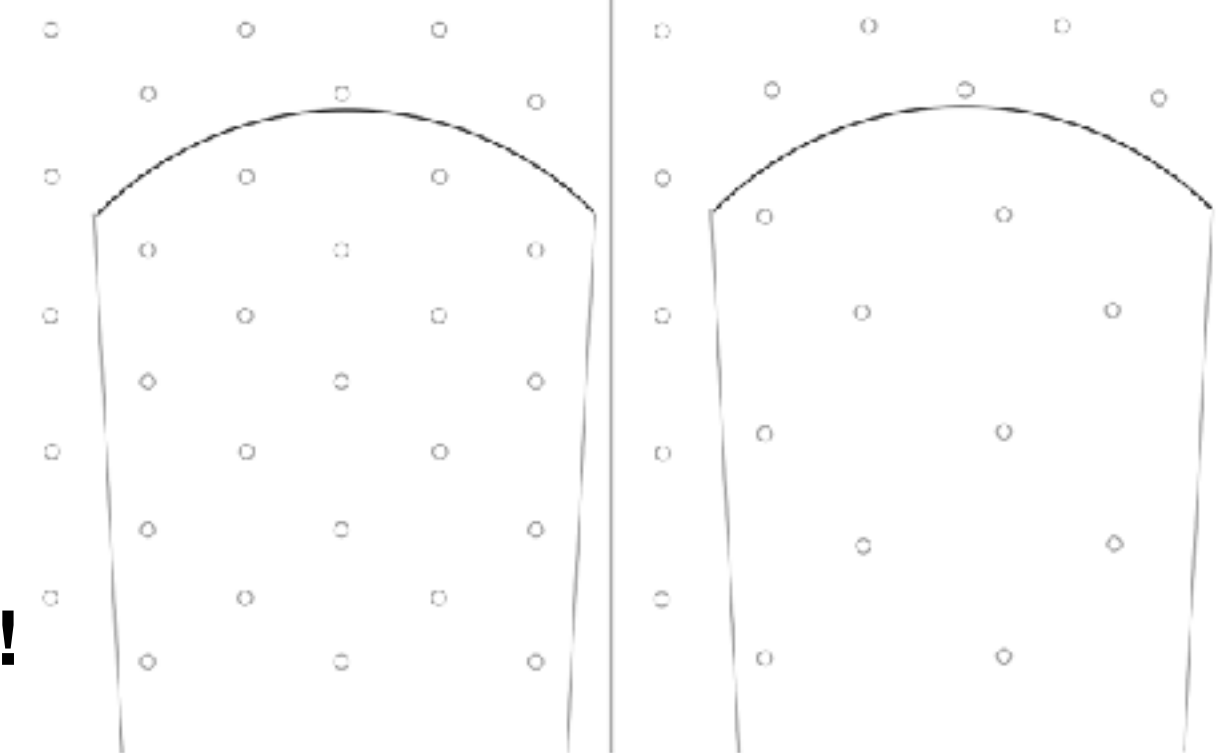


## Optional notes & doodles!



BEFORE HEATING

AFTER HEATING



What's happening in a hot air balloon!





# Theatre of Science Flight 3: Helicopters!

## Today we'll be hearing about:

The weather and atmospheric conditions that affect the flight of helicopters  
Basic features of helicopters that enable them to fly  
How helicopters can be adapted for flight on Mars!

**To join in bring:** A4 paper,  
card (cereal box is good!)  
scissors, sellotape.

**Starter:** WITHOUT LOOKING AT ANY PICTURES! Sketch a picture of a helicopter:



(I'm not wondering how good you are at art; I want to force you to really think about how much you know about helicopters already. It might be nothing! Sketch anyway! (I'm hoping you don't know loads because that's what this lesson's about!). What bits go where?!

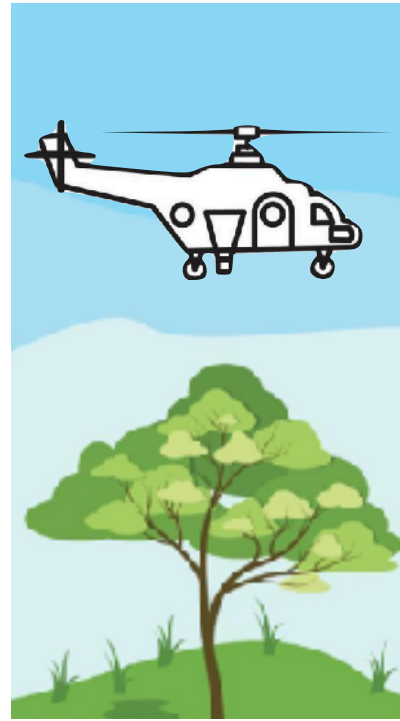
**Do helicopters have rotors or propellers? What's the difference?**



**Which of these would affect how much air pushed up on a helicopter? Circle an answer.**

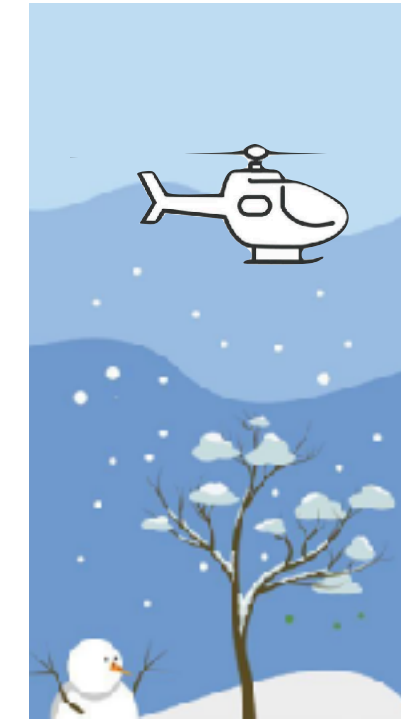
**If the air was warm**

- More lift
- Less lift
- No difference



**If the air was cold**

- More lift
- Less lift
- No difference



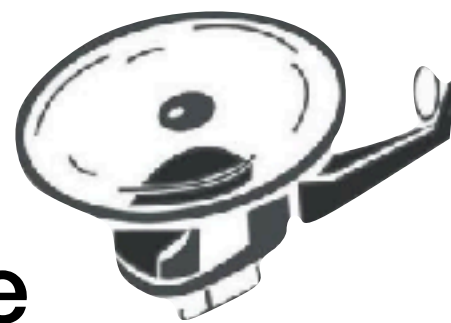
**If the helicopter was really high up**

- More lift
- Less lift
- No difference

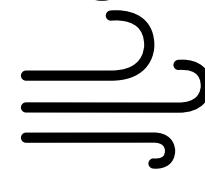


**If the rotor span faster**

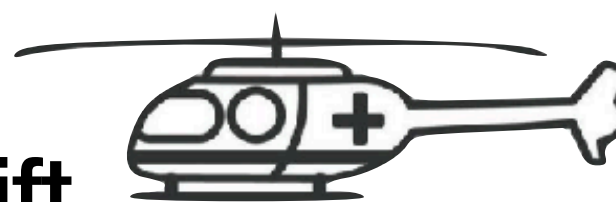
- More lift
- Less lift
- No difference



**If strong winds blew towards the helicopter**



- More lift
- Less lift
- No difference



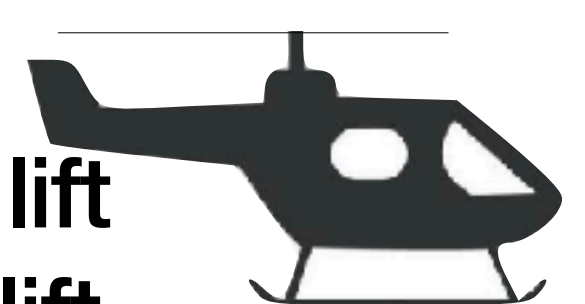
**If the helicopter was heavier**

- More lift
- Less lift
- No difference



**If the blades were thinner**

- More lift
- Less lift
- No difference







# Theatre of Science Flight 4: Gliders!

To join in bring:  
A4 paper

Today we'll be hearing about:

The difference between flying and gliding

Which animals have evolved to fly and which have evolved to glide

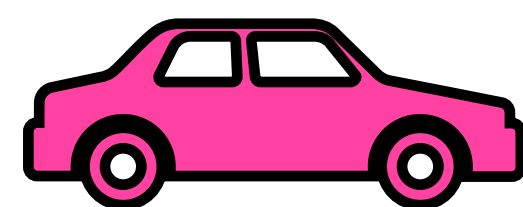
The forces acting on a gliding object and how they differ from those on a flying object

What soaring is and how it is used by humans and animals

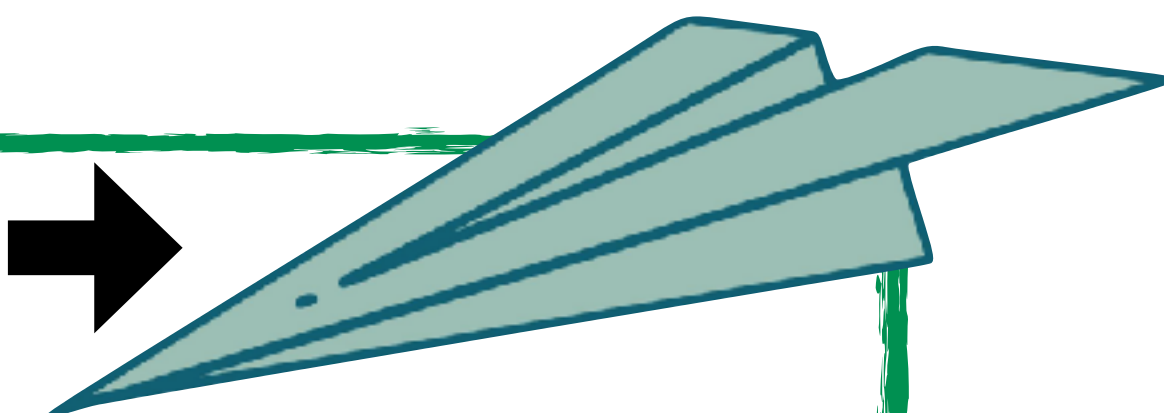
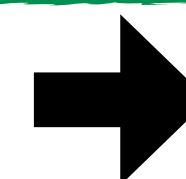
When you 'apply a force' to a pencil (push it!) why does it stop?




When an engine 'applies a force' to a car (gives it a push) why *doesn't* it stop?!



What is this?! Explain your answer as fully as you can!



If you'd like to contribute £5 a month towards my wages search 'Theatre of Science Kofi'! I'll send you nice things to say a huge thanks! I couldn't teach these lessons without that support x 



Activity 1: Can these animals fly?  
Put a small tick next to them if you think yes, and a cross if not!

Activity 2 (to be done **later!**)  
Circle whether you think the animal can fly or glide (or circle neither!).

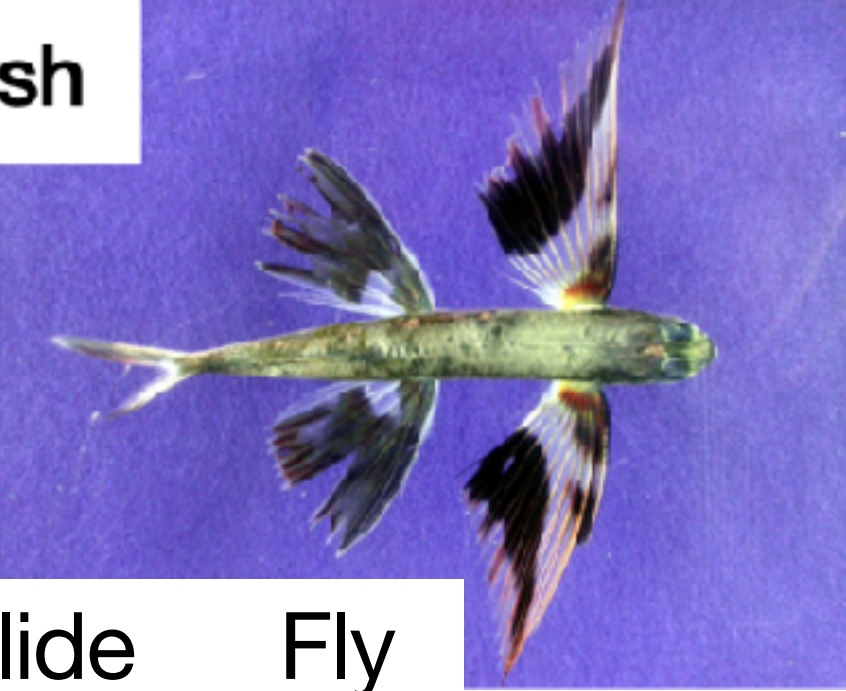
**Flying Squirrel**



Glide Fly

Image: Angie spuc via Wikimedia Commons. License: <https://creativecommons.org/licenses/by-sa/3.0/deed.en>

**Flying Fish**



Glide Fly

**Chickens**



Glide Fly


**Drago Lizard**



Glide Fly

Image: Psumuseum via Wikimedia Commons. License: <https://creativecommons.org/licenses/by-sa/3.0/deed.en>

**Paradise Flying Snake**



Glide Fly

Image: Alan Couch via Wikimedia Commons. License: <https://creativecommons.org/licenses/by/2.0/deed.en>

**Penguins**



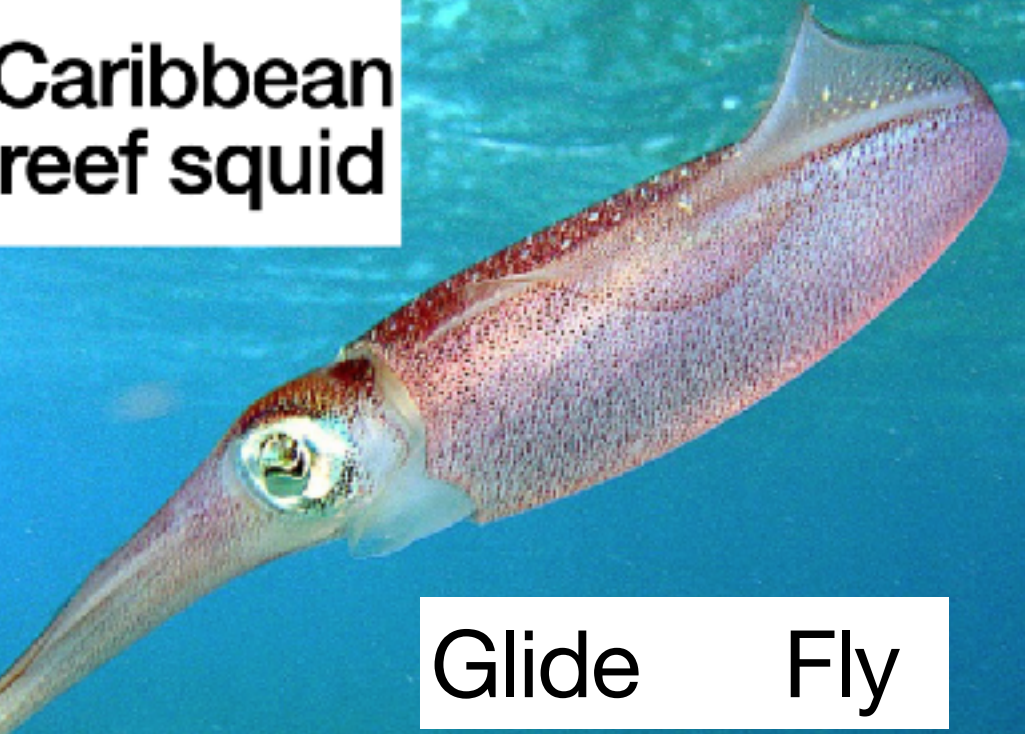
Glide Fly

**Baird's tapir**



Glide Fly

**Caribbean reef squid**



Glide Fly

**Flying frog**



Glide Fly

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**Bats**



Glide Fly

**Vultures**



Glide Fly



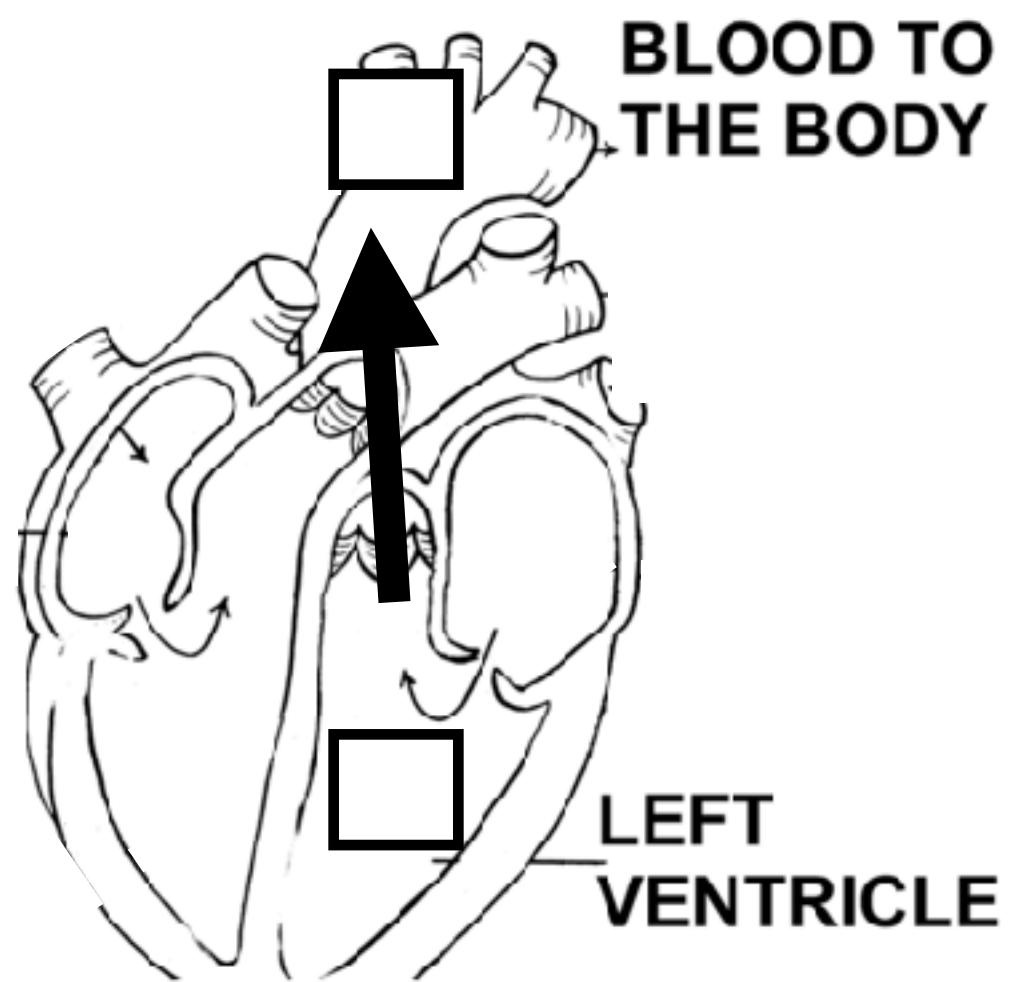


# Theatre of Science Flight 5: Wings!

To join in  
bring: A4  
paper, scissors,  
tall glass of  
water, spoon

Today we'll be hearing about:

- How pressure differences make things move
- What tornadoes and wings have in common!
- How the shape of an aeroplane wing creates differences in pressure
- Common misconceptions held about aeroplane wings



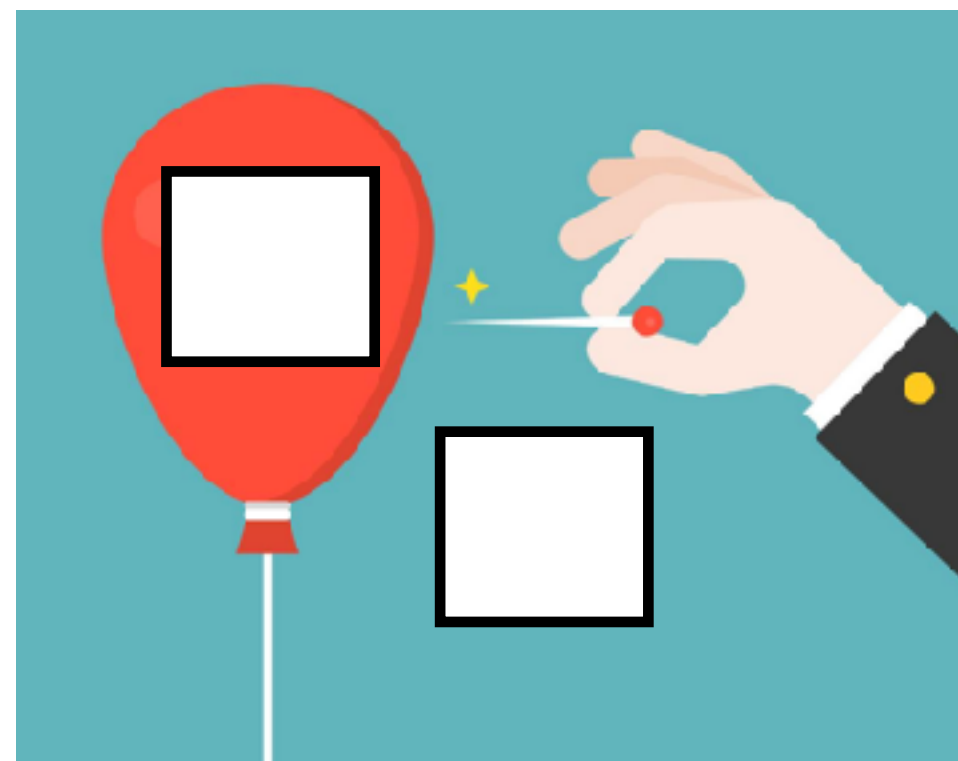
Blood moves from the left ventricle to the body. Write H and L in the right boxes to show whether the pressure is High or Low in each place.

For each situation...

Write 'H' where there's high pressure and 'L' where there's lower pressure. Draw arrows to show what direction the liquid or gas is about to move in!

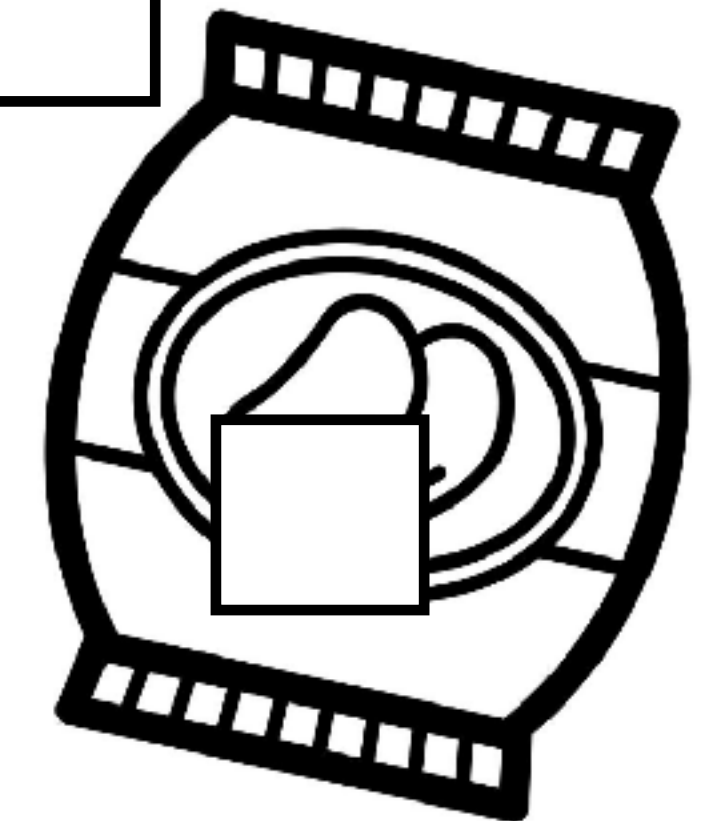
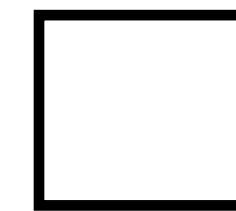
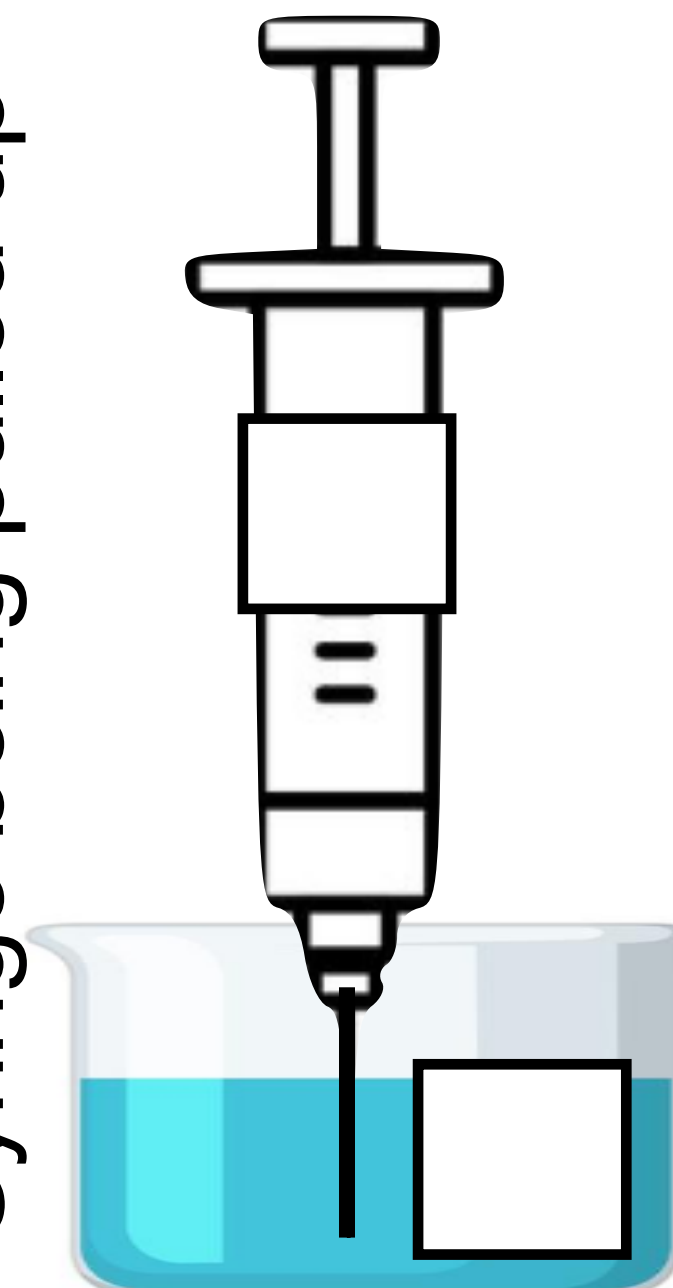


Taking the lid off a pop bottle



Pricking a balloon

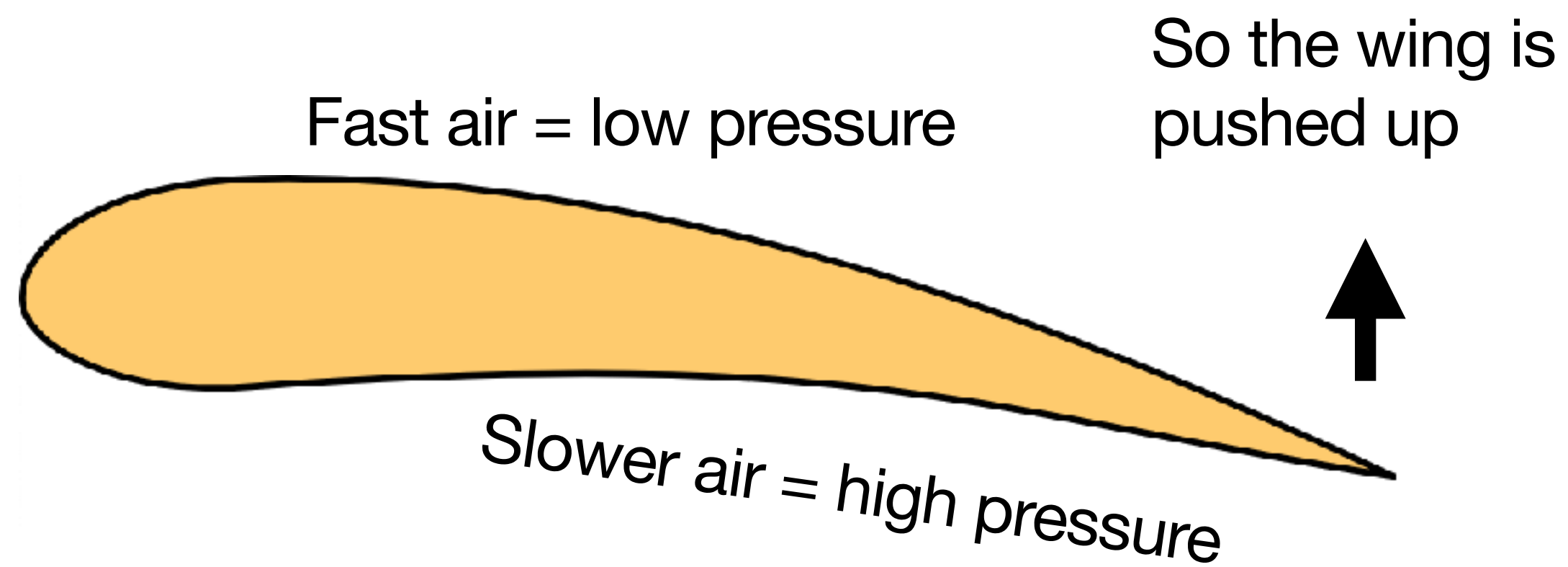
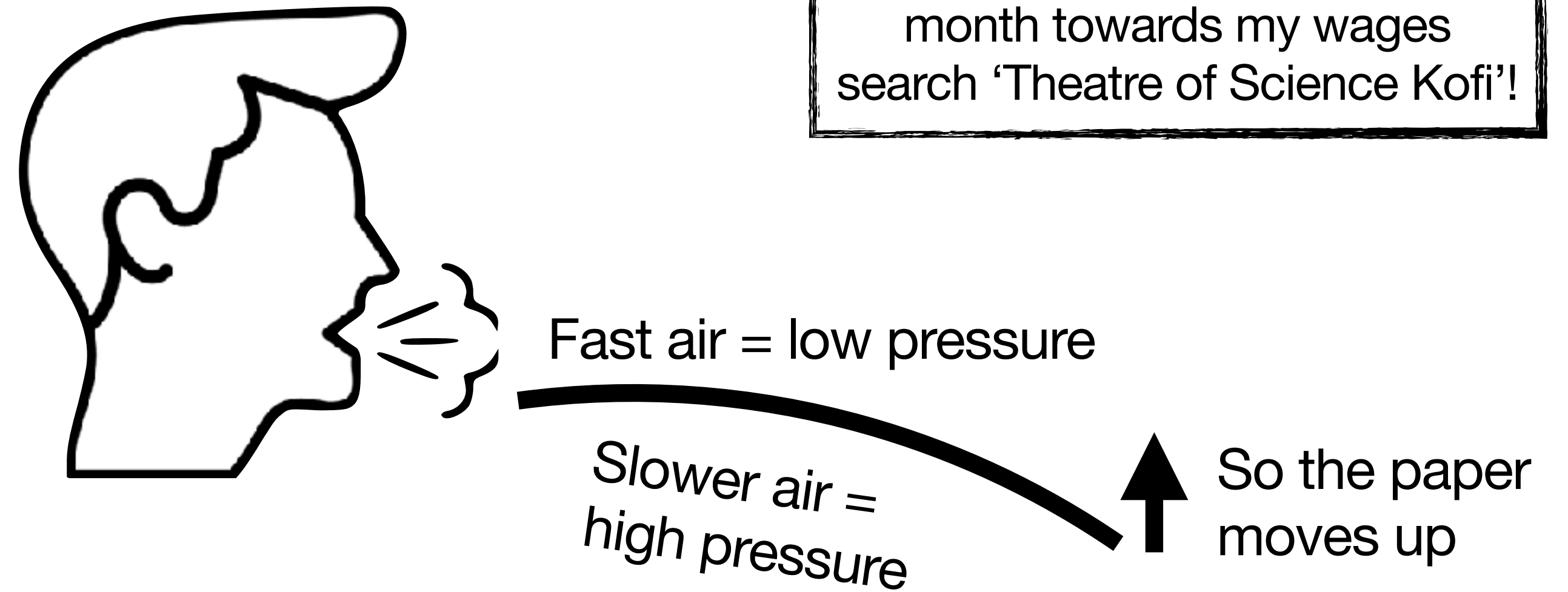
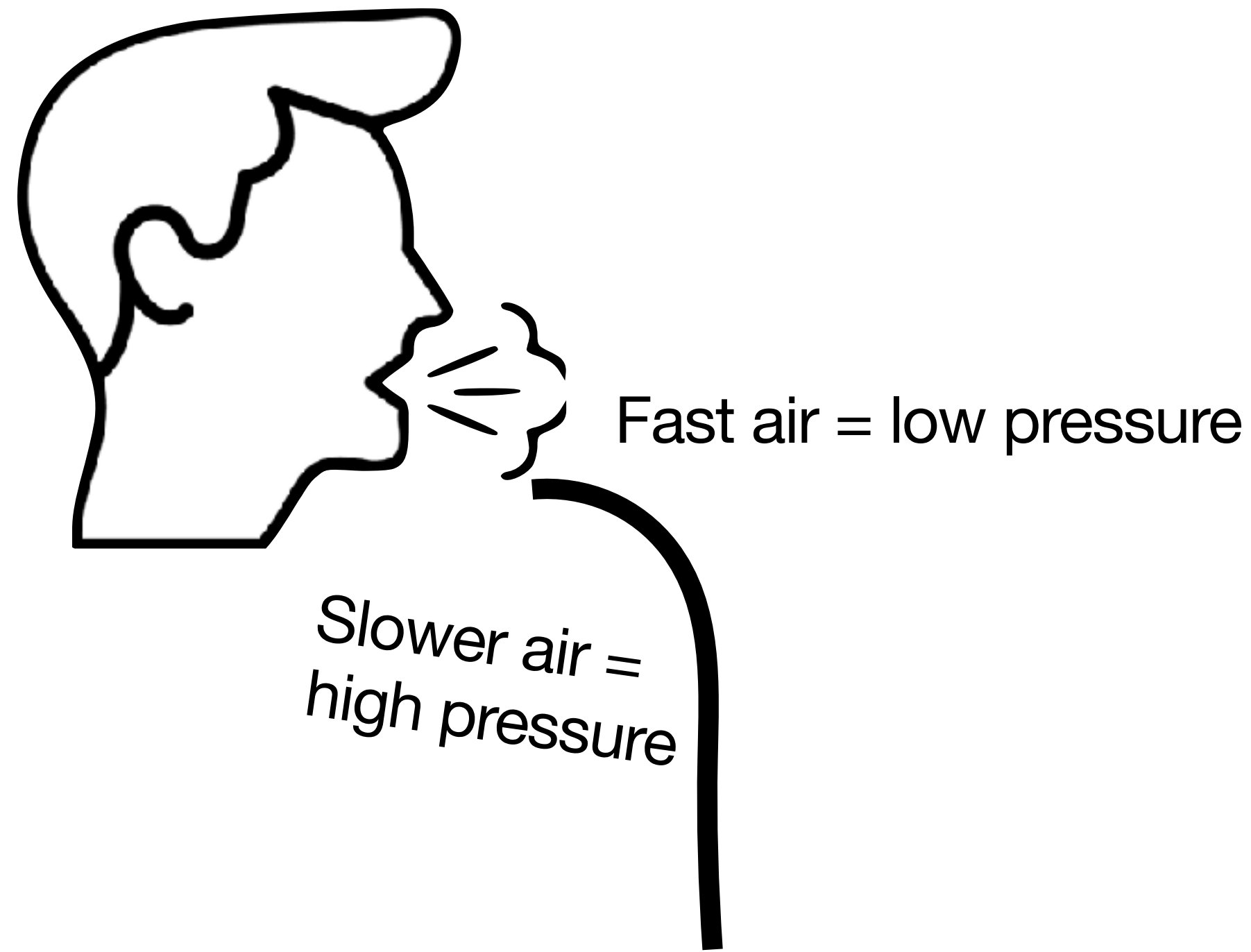
Syringe being pulled up



Crisp packet being squeezed

# How people think an aeroplane wing works!

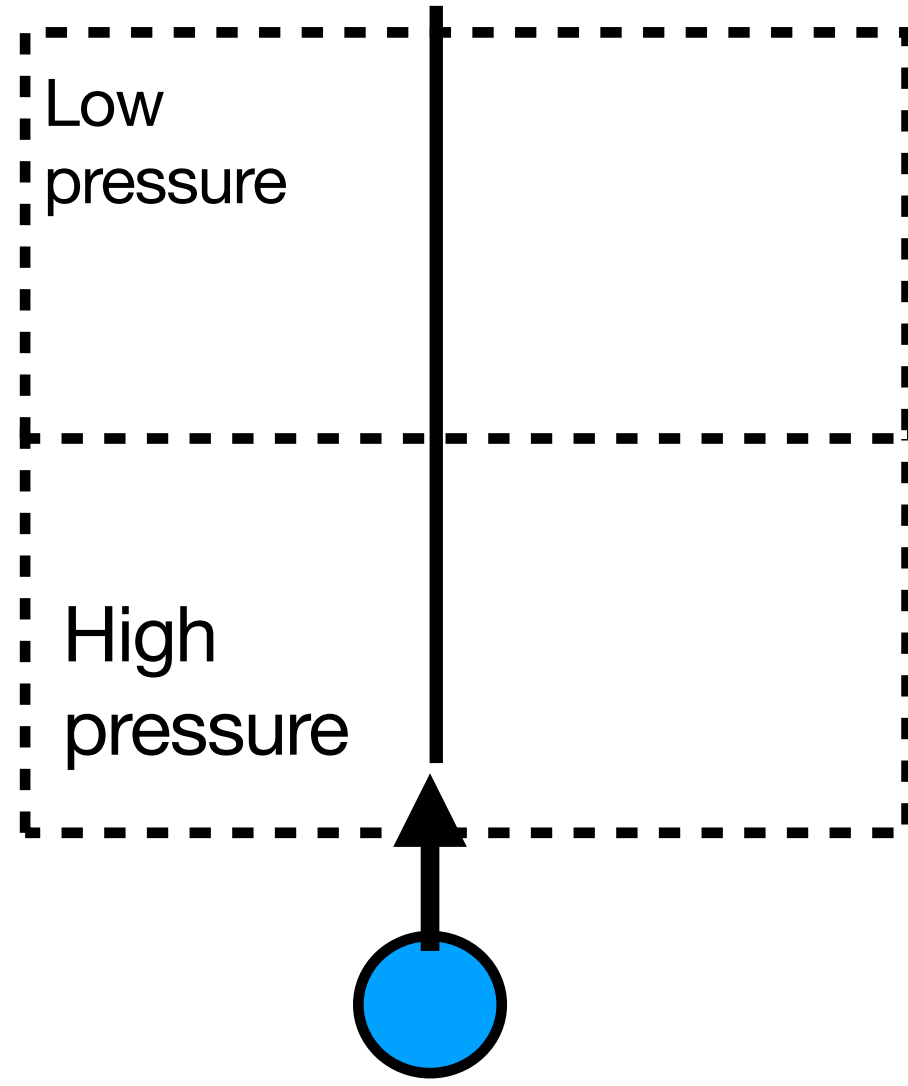
If you get Theatre of Science magazine, you're the reason I can do these lessons! Thank you!! like to contribute £5 a month towards my wages search 'Theatre of Science Kofi'!



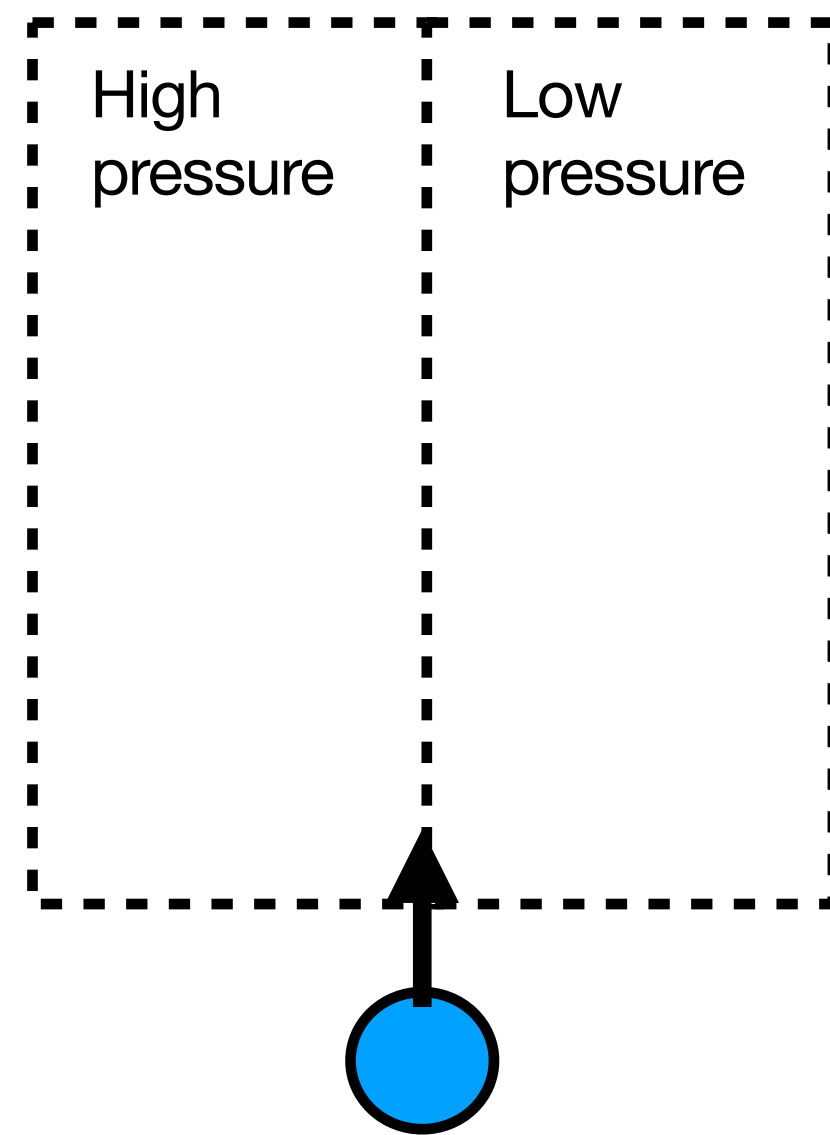
Challenge!!

What could you do with your strip of paper to prove it *isn't* the fast air making the paper go up?!

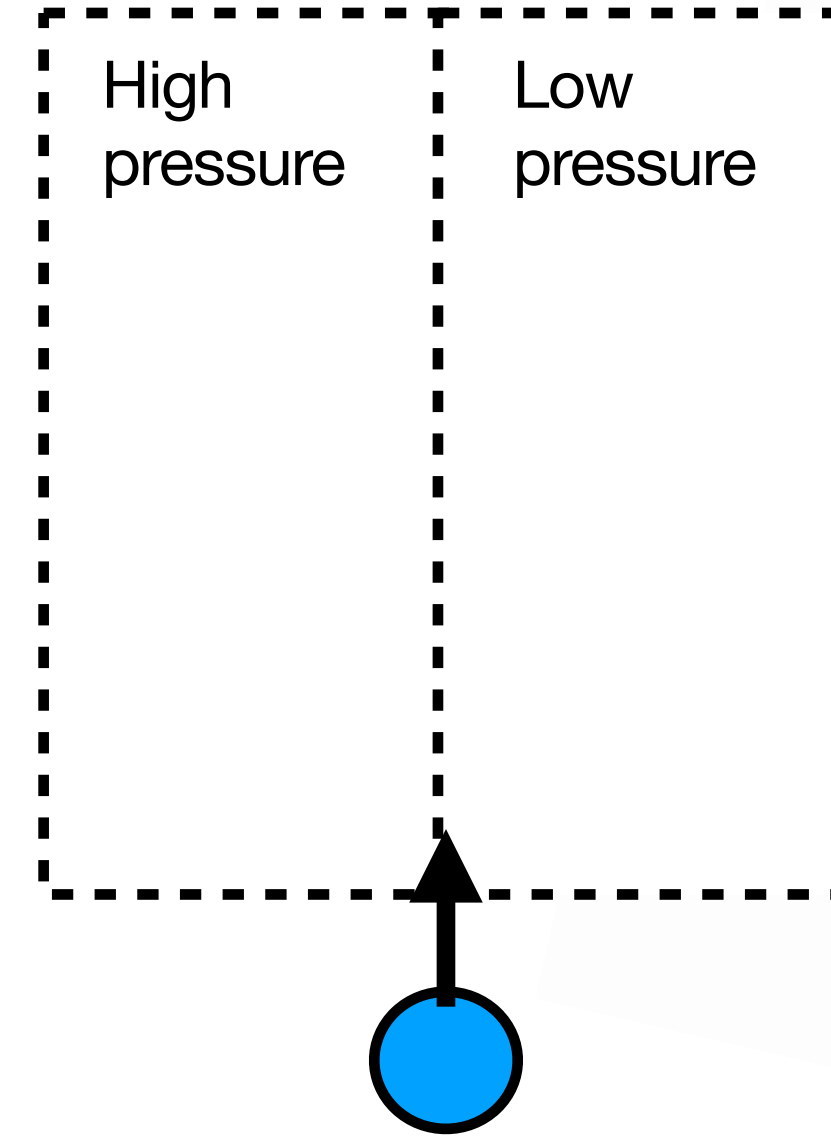




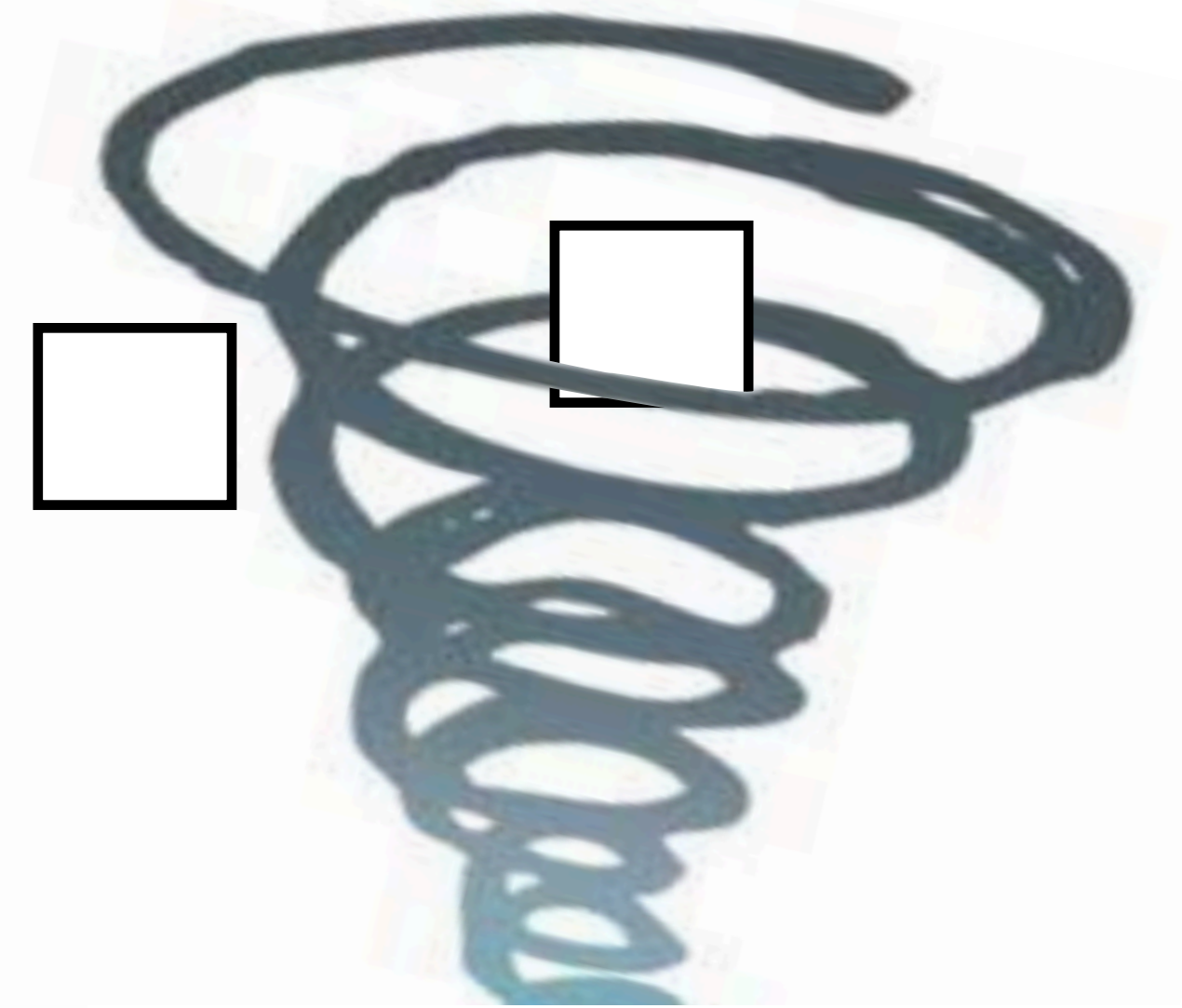
This blue air particle is moving forwards. When it gets to the square it will follow the path shown.



What path will this one take when it gets into the square?!

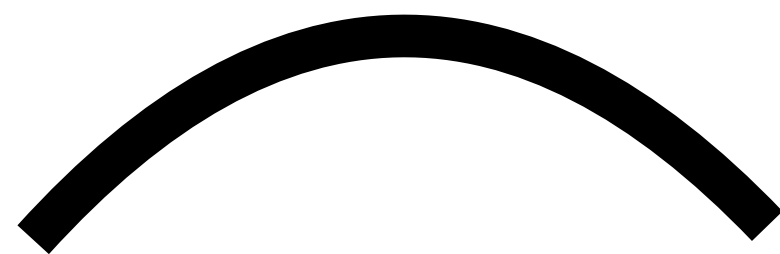


Draw the answer here when I show you!



Let's make a tornado and think about where the areas of high and low pressure are.

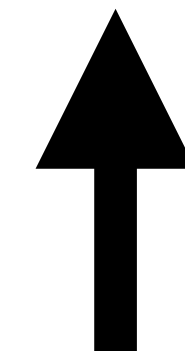
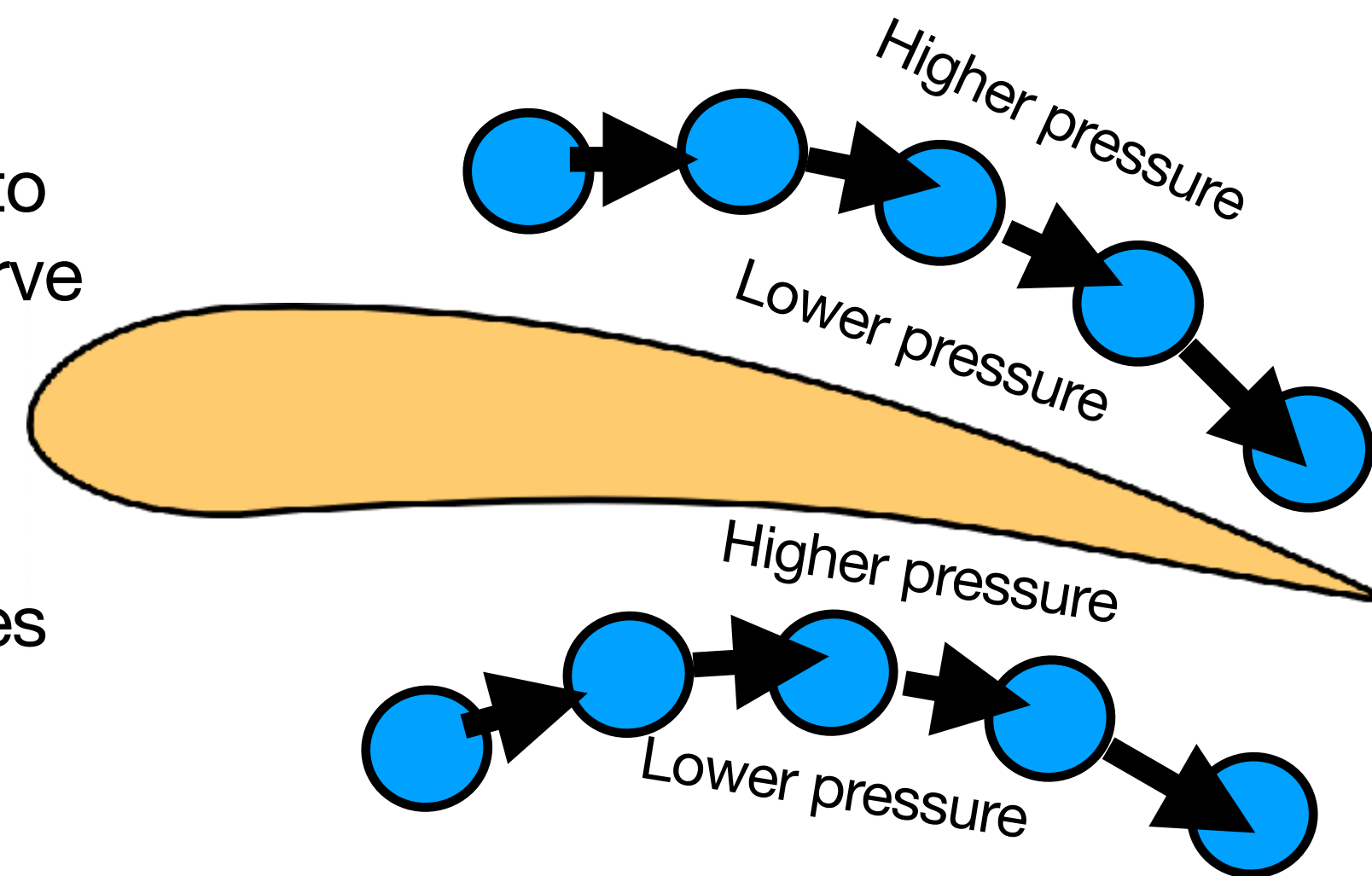
When air particles move in a curve, the outside of the curve is an area of higher pressure



And the inside is an area of lower pressure

1. Air forced to move in a curve

2. On both sides of the wing



So the wing is pushed up!



# Theatre of Science Flight 6: Aeroplanes!

To join in bring: Tall mug, fork and spoon (that you don't mind getting slightly bent!) matches, adult supervision if necessary.

## Today we'll be hearing about:

How aeroplanes store fuel and why and how they use less fuel Where an aeroplane's centre of gravity is.  
How centre of gravity affects an aeroplane's flight What parts of a plane are used for turning and stability

### Do you know the next line of this song?

"Autumn days when the grass is jewelled  
and the silk inside a chestnut shell. Jet  
planes meeting in the air to



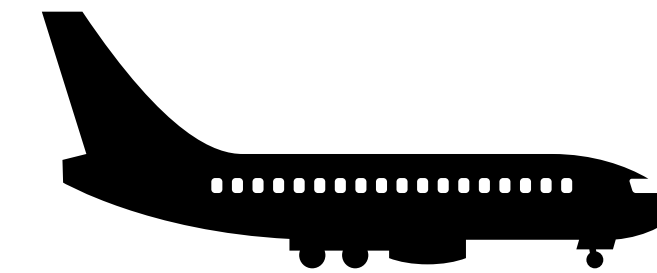
\_\_\_\_\_ ..."

(Planes carrying passengers  
don't do this, only military ones.)

If you're near an adult who went to a UK  
school in the 80s/90s ask them!

Estelle White was a British composer who died in 2011 aged 86. She wrote this hymn, *Autumn Days*, for a school that was under a flight path!  
It's sung in a lot of British Primary schools. A choir once walked out when asked to sing it because they didn't think aeroplanes should be mentioned in a religious song.

Draw arrows to show the **drag**, **weight**, **thrust** and **lift** acting on this moving plane.



### Use the four words in bold above to complete this sentence:

The \_\_\_\_\_ is caused by the engine. It makes air move over the wings which causes the \_\_\_\_\_. The \_\_\_\_\_ is caused by the passengers, baggage, fuel, etc! Less weight means less \_\_\_\_\_ is needed so less \_\_\_\_\_ is needed so the plane needs less fuel!



# Put a cross at your guess then draw a line to the right answer when I tell you!

Note: I don't want to sound harsh but I'm not interested whether you get the right answer! I'm interested in whether your brain's getting exercise. A comment like "I thought it would be (wrong answer) because" makes my heart glow rainbows much harder than the answer "I got 100%" because you've practised reasoning and problem solving. Those are skills you need. You don't need to know where the fuel is stored in a plane. Even if you end up being a pilot, they'll tell you again during training. OK, rant over.

1) Where is the fuel stored?

2) Where's the centre of gravity?

2) Where's the elevator?



4) Where's the rudder?

5) Where are the ailerons?  
Bonus: draw on the spoilers!



# Final questions! (Keep this page facedown until the end of the lesson please!)

Objects generate more lift (so fly better!) if they have thin wings. So why do aeroplanes have thick wings?!

- A: To make them more stable
- B: So fuel can be stored in them
- C: A and B.

What are the flaps in this picture?!

- A: Aerofoil
- B: Spoiler
- C: Aileron



Image: Olça Ernst via wikimedia commons. License: <https://creativecommons.org/licenses/by-sa/4.0/deed.en>

What of these might be used to turn an aeroplane?

- A: Spoiler
- B: Centre of gravity
- C: Rudder

Which is the correct label for the diagram?

- A: 1.Aileron 2.Elevator 3.Rudder
- B: 1.Aileron 2. Rudder 3.Elevator
- C: 1.Spoiler 2. Rudder 3.Elevator

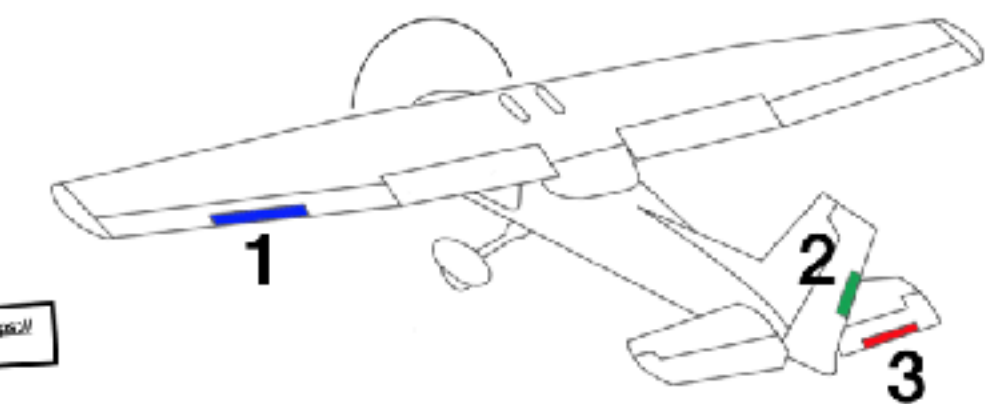
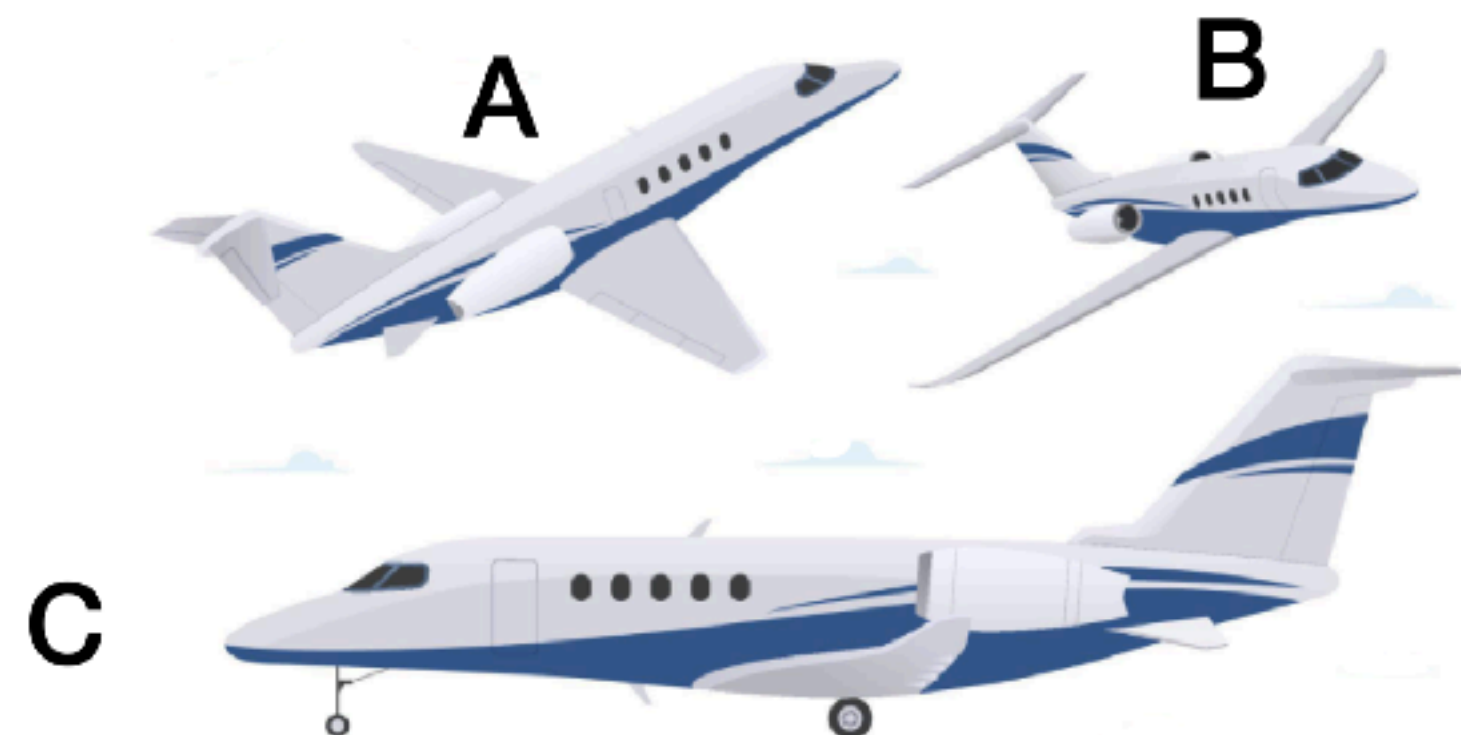


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Which of these aeroplanes is *banking*?



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# Theatre of Science Flight 7: Rockets!

To join in bring: Candle, way of lighting it, adult supervision if necessary.

1) Which of these needed a rocket launch to get into space? Select as many as you think.



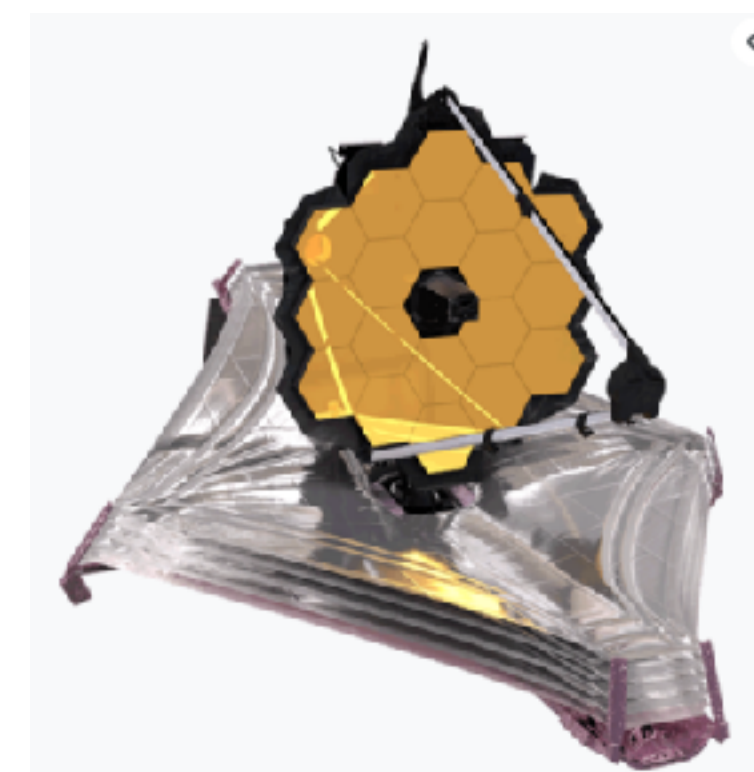
A robot on Mars (Mars Rover)



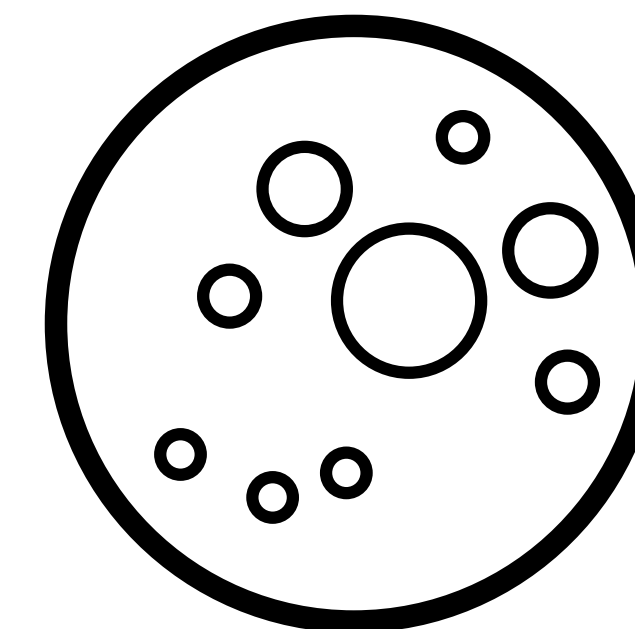
*Ingenuity*: The helicopter on Mars right now.



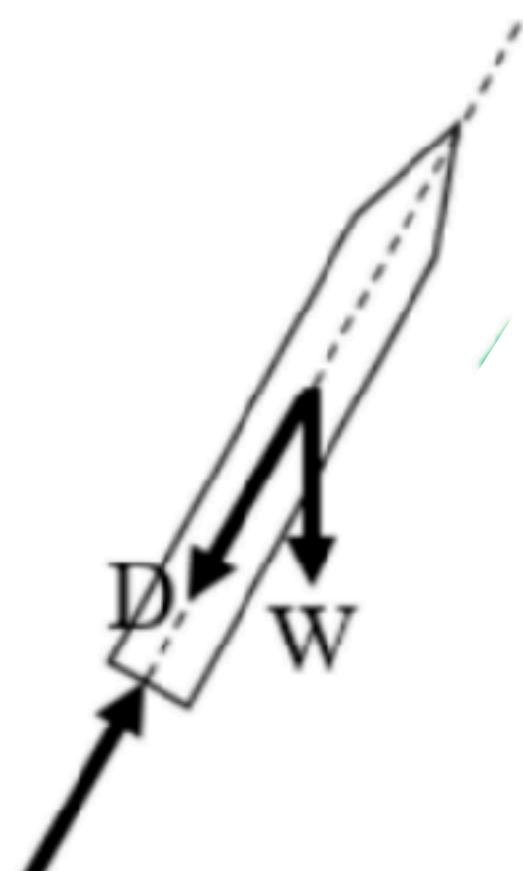
Alexei Leonov, the first person to walk in space.



The James Webb Telescope, orbiting the Sun 1 million miles away right as I write this!



The Moon



2) **One** of these diagrams has the drag, weight and thrust labelled correctly. Which one?  
Bonus challenge: try drawing an arrow showing which direction the lift is acting in!



What do fires need to burn?!

