# Le Chatelier's Principle

# Le Chatelier's Principle

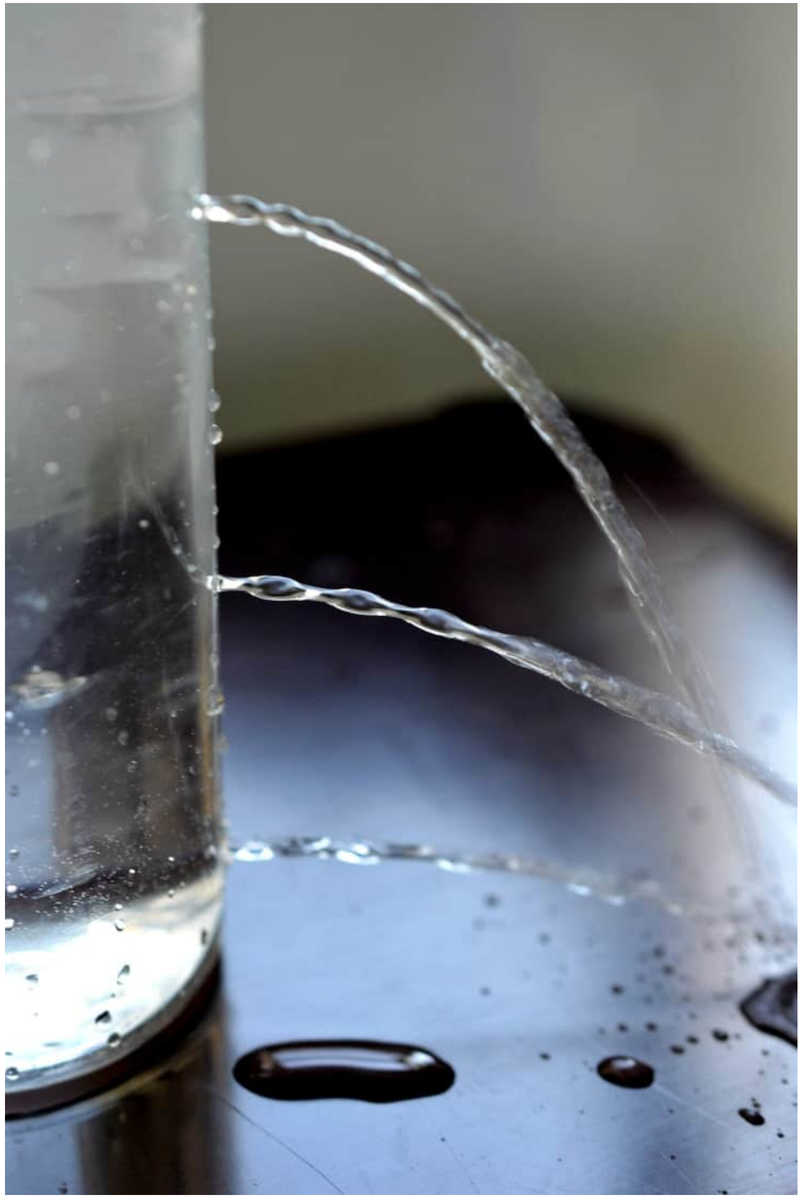
# first the key ideas

- Position of equilibrium
- Negative Feedback

# position of equilibrium

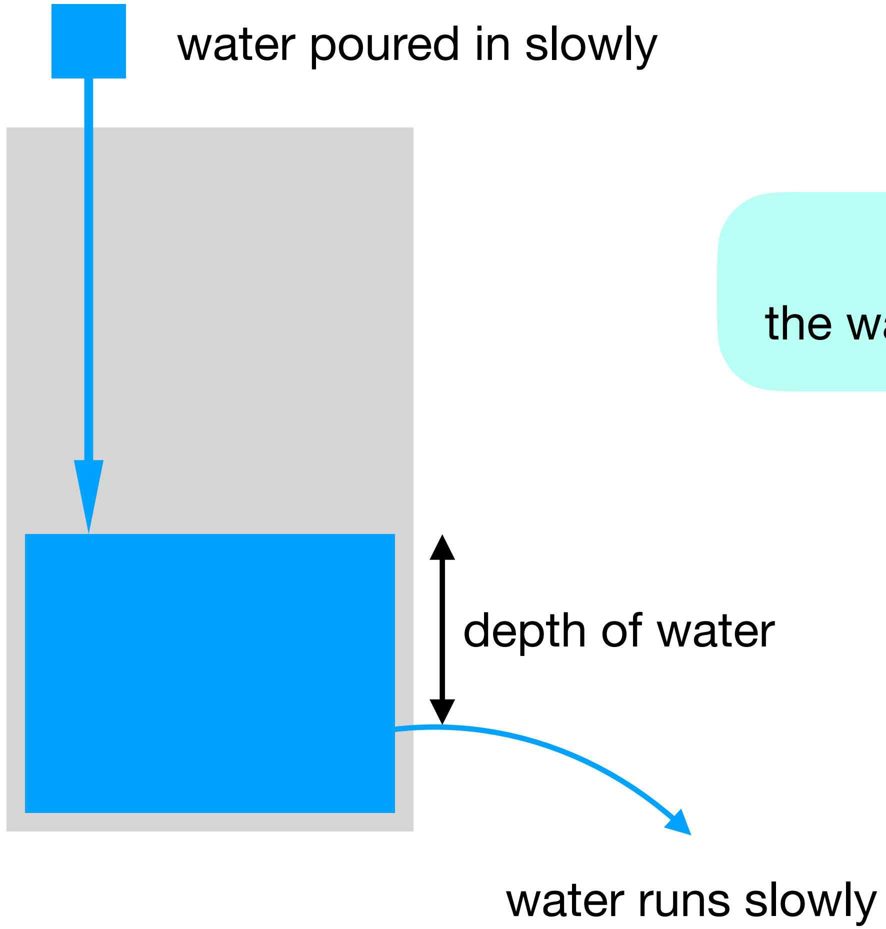
Notice that the water shoots out faster from the holes at the bottom?

That's because there's more pressure the deeper you go.



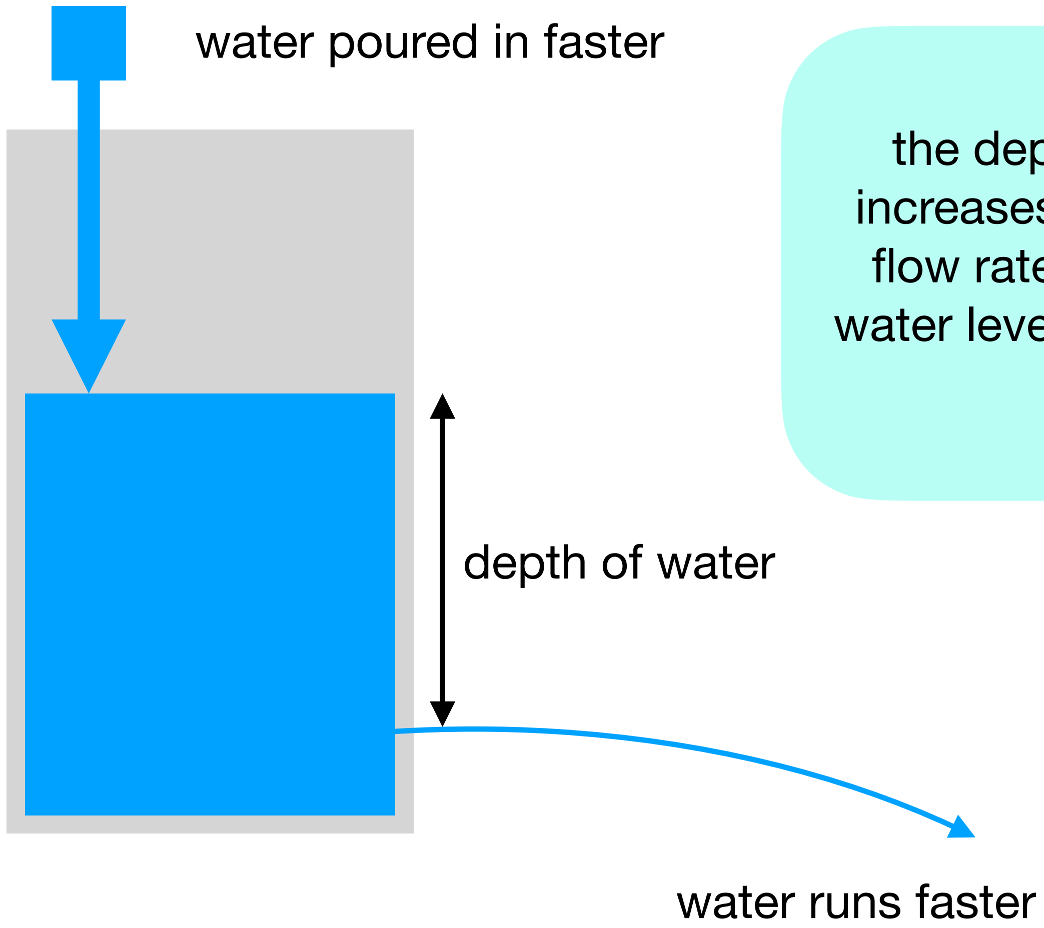
https://www.rookieparenting.com/waterpressure/

# position of equilibrium: the bucket experiment



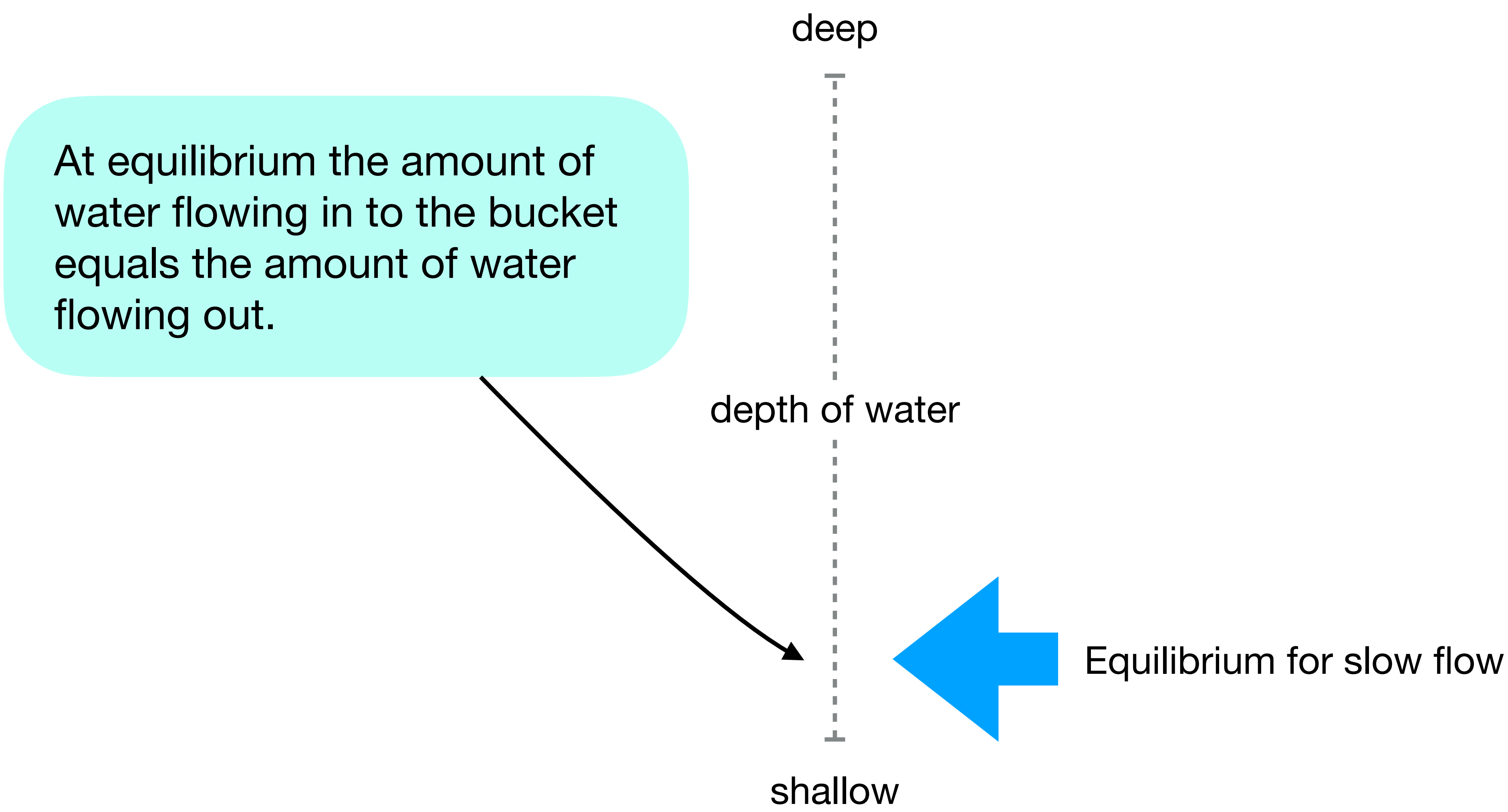

water in = water out
the water level is in equilibreum

# position of equilibrium: the bucket experiment

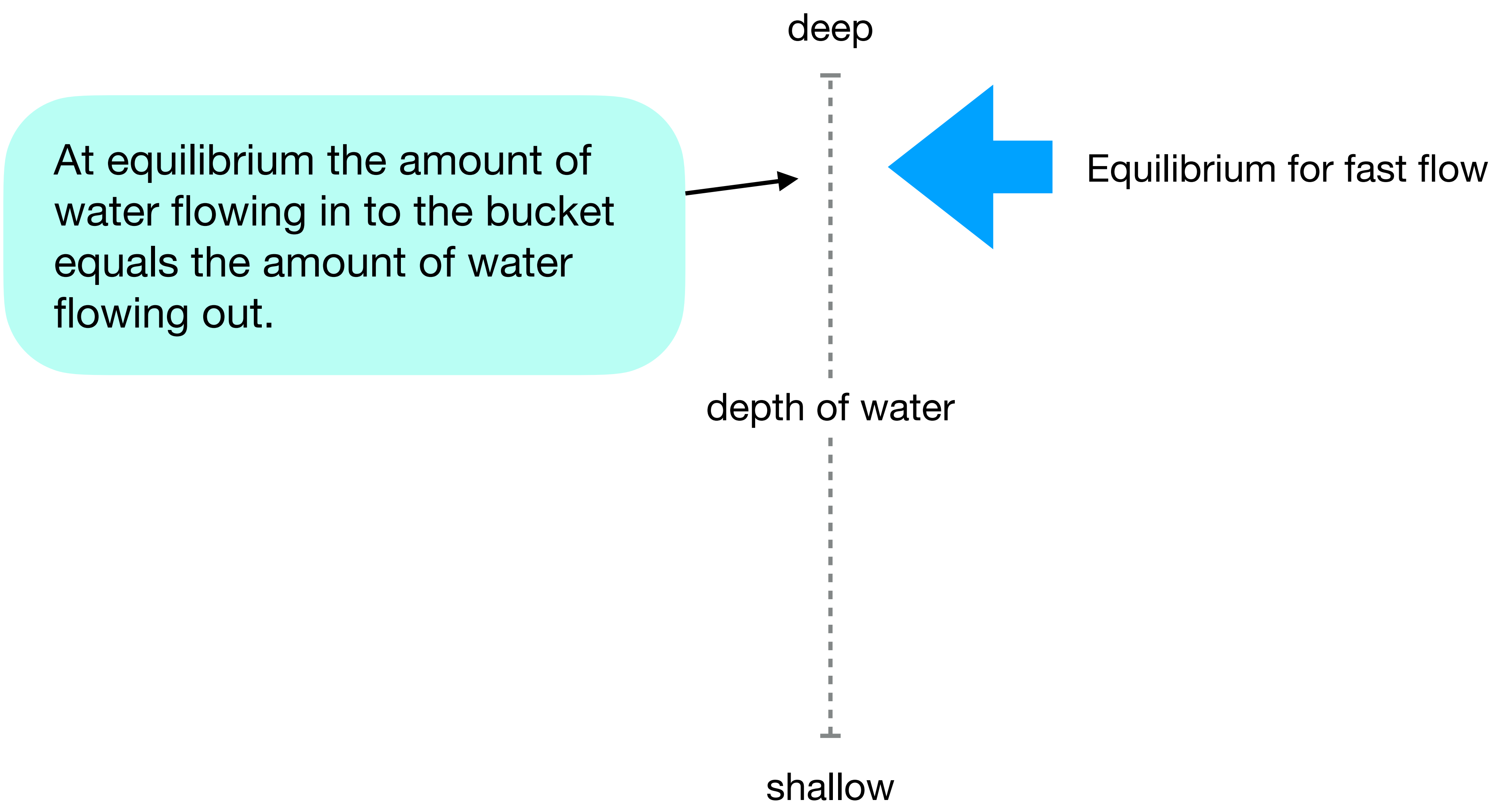



the depth of the water increases causing the out flow rate to rise until the water level is in equilibreum again

# position of equilibrium: the bucket experiment

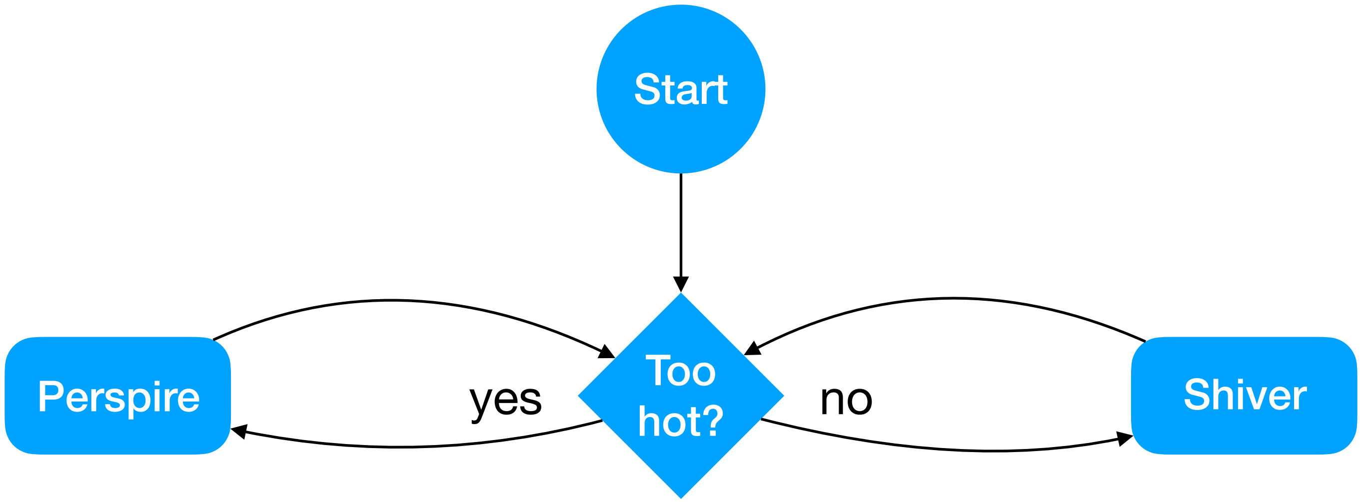


# position of equilibrium: the bucket experiment



# negative feedback

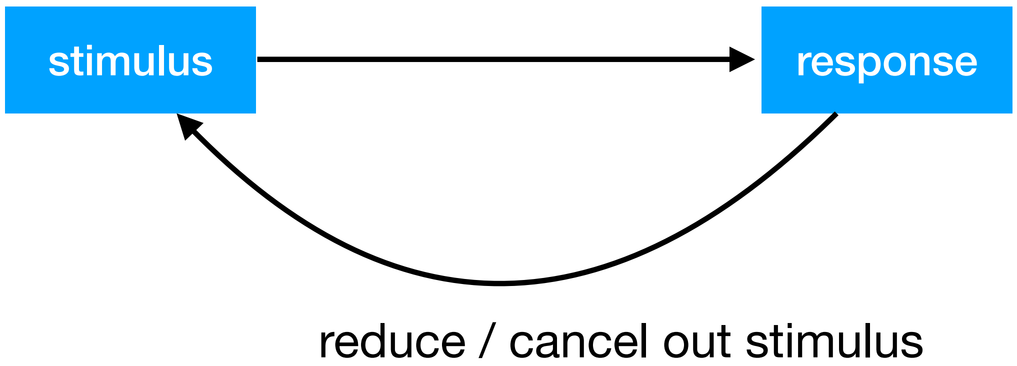
An example of negative feedback is how mammals regulate their temperature by perspiring.



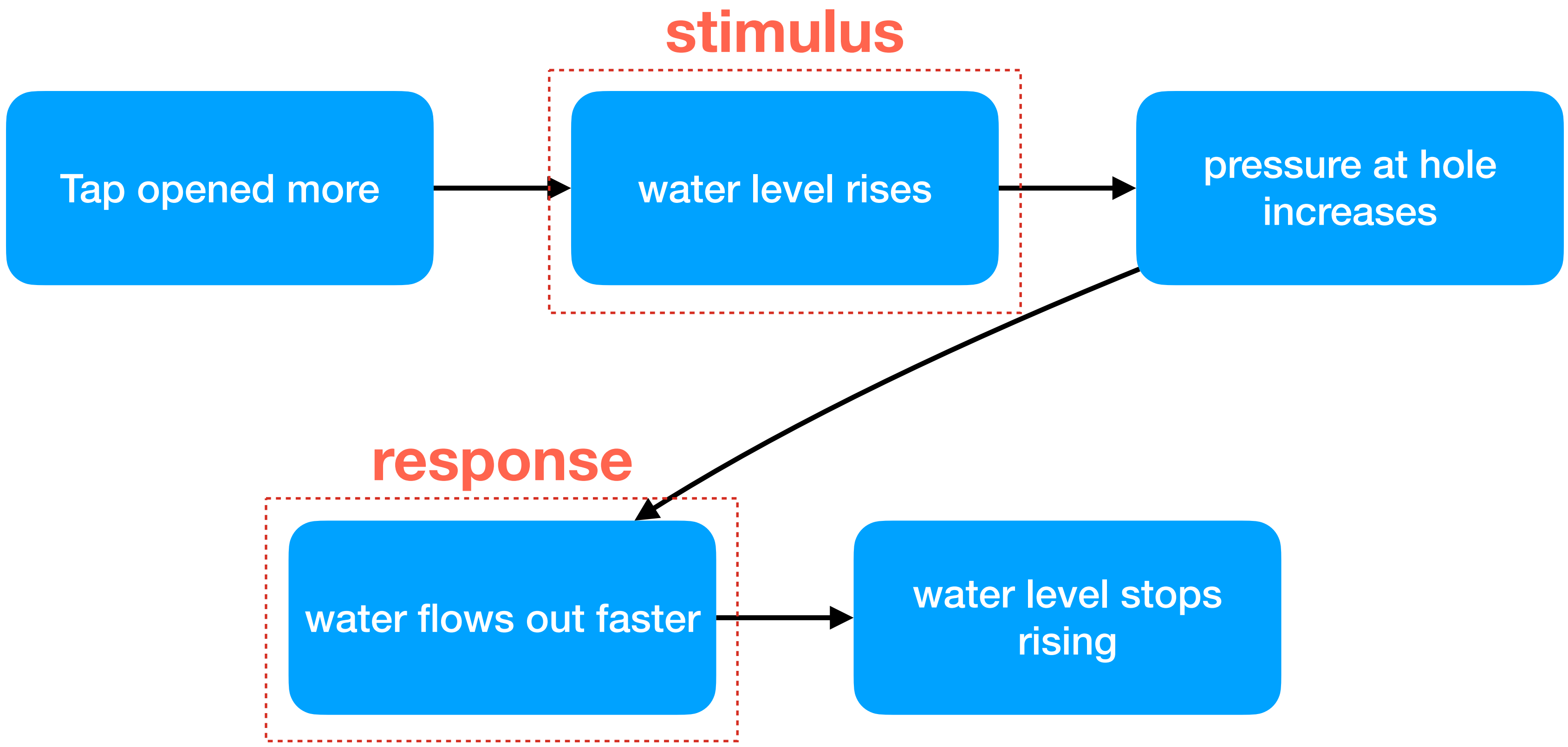
# negative feedback

- If a mammal’s temperature is too high it perspires which lowers its temperature.

- Likewise, shivering prevents a mammal’s temperature form dropping too low.



# negative feedback: the bucket experiment



# Le Chatelier’s Principle

When a system is changed it will alter its position of equilibrium to counteract that change.

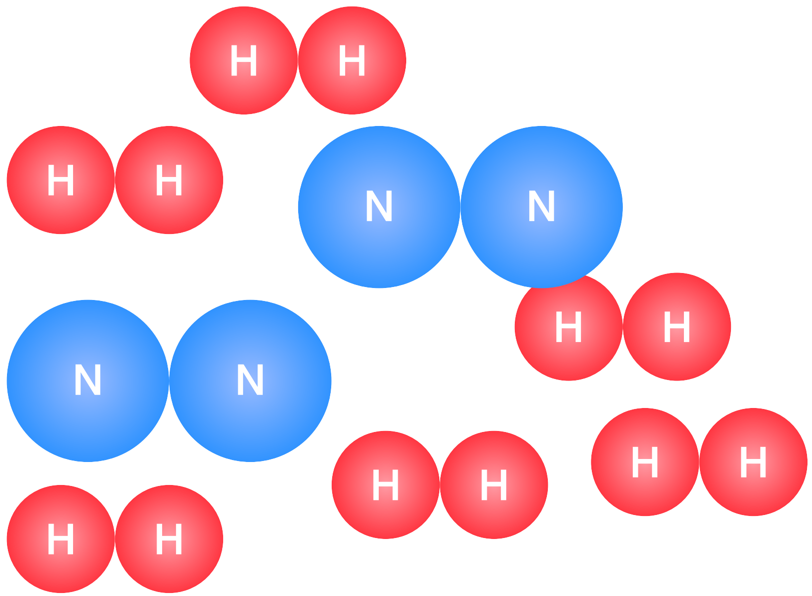
# application to chemistry: the Haber process

Ammonia is produced by this reversible reaction

$$3\,H_2 + N_2 \rightleftarrows 2\,NH_3$$

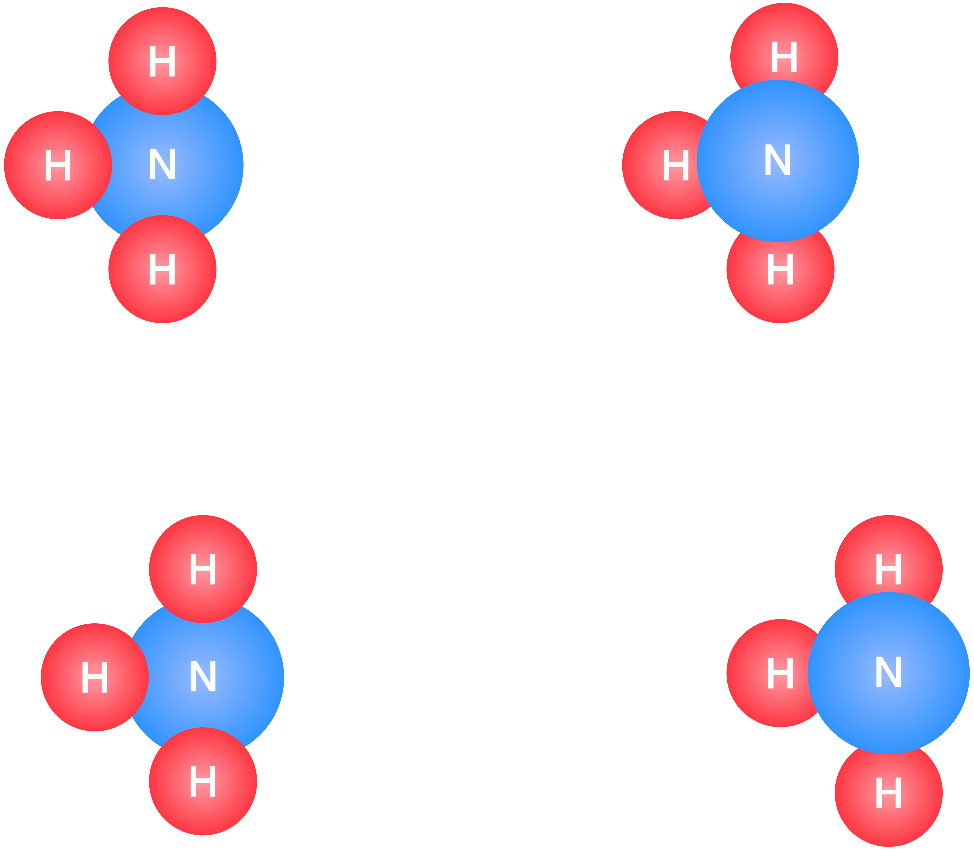
- On the left hand side of the equation are gasses, on the right hand side a liquid.
- The forward reaction (from left to right) is exothermic. The reverse reaction is endothermic.
- An equilibrium is reached with some of the gasses bonding to form ammonia, and some of the ammonia splitting to form gas.

$$3\,H_2 + N_2 \rightleftharpoons 2\,NH_3$$



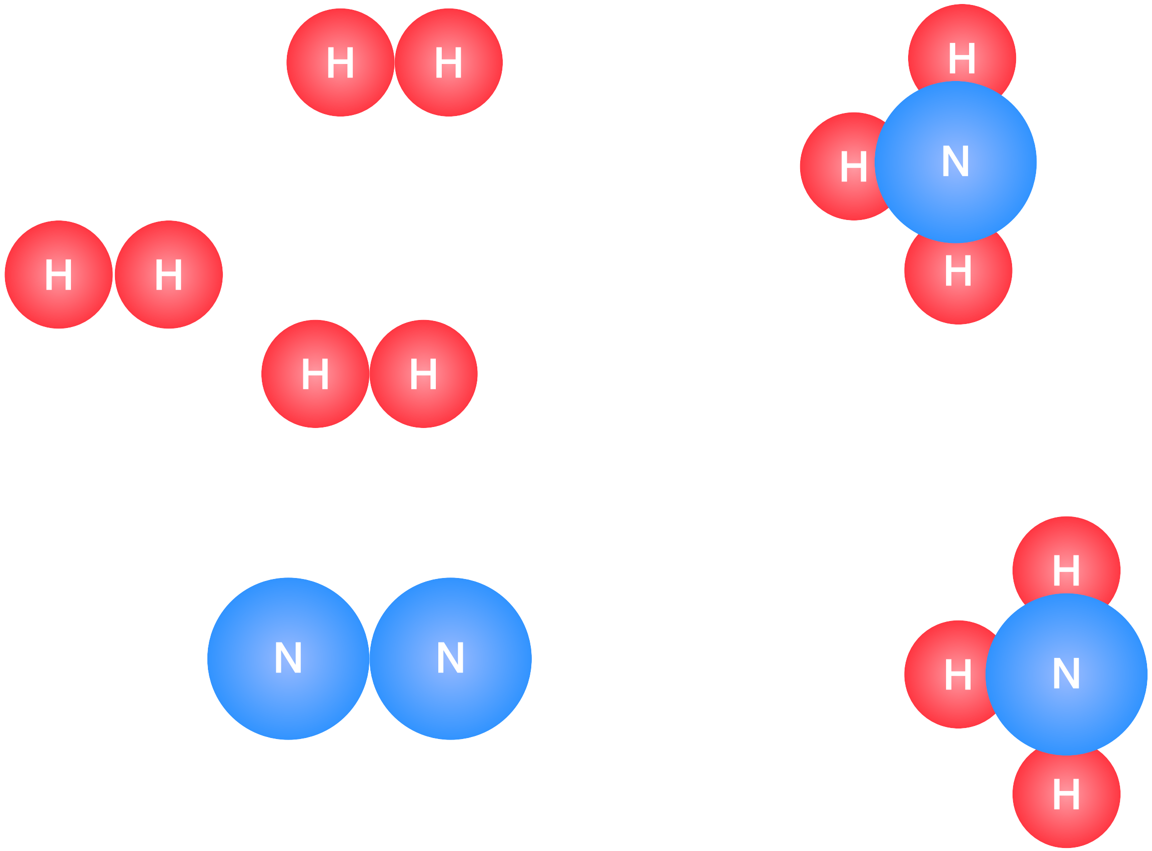

If we start with a mixture of Hydrogen and Nitrogen

$$3\,H_2 + N_2 \rightleftharpoons 2\,NH_3$$



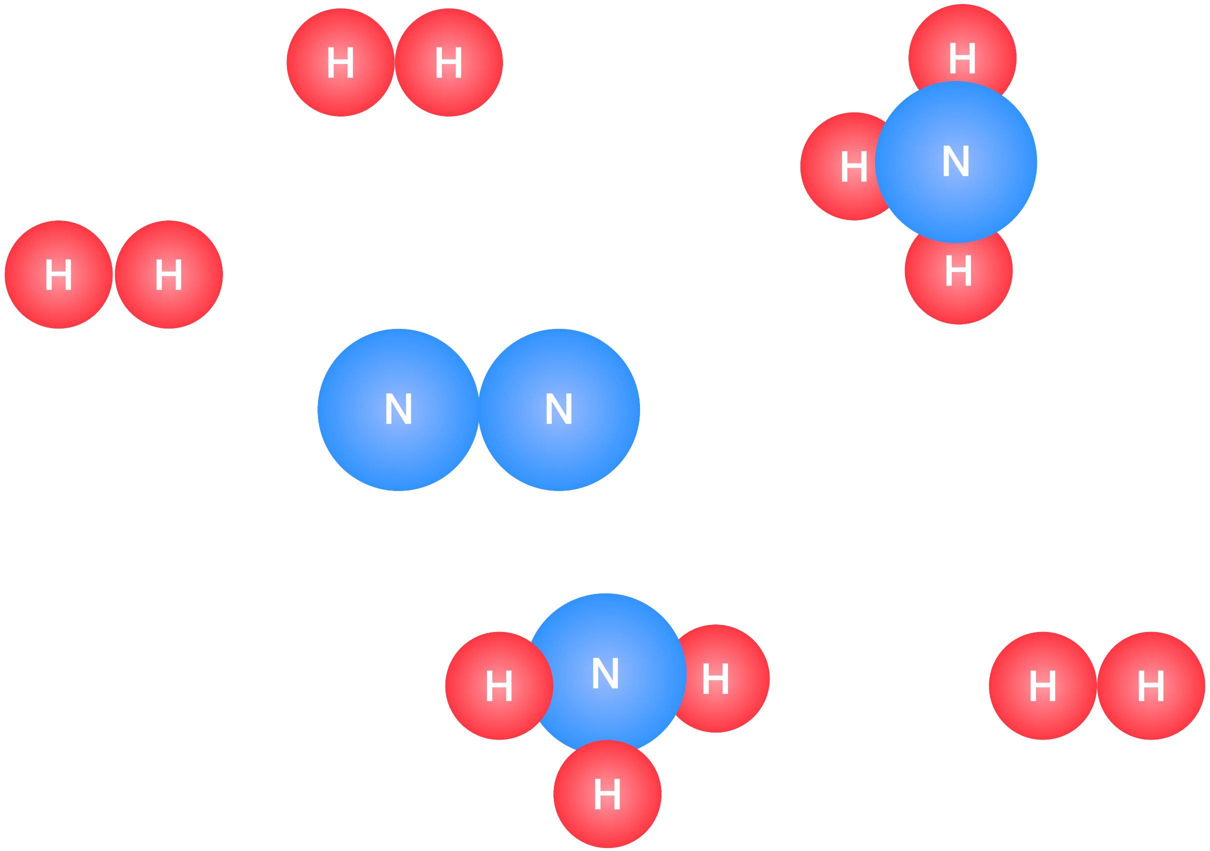

They can bond to form ammonia

$$3\,H_2 + N_2 \rightleftharpoons 2\,NH_3$$



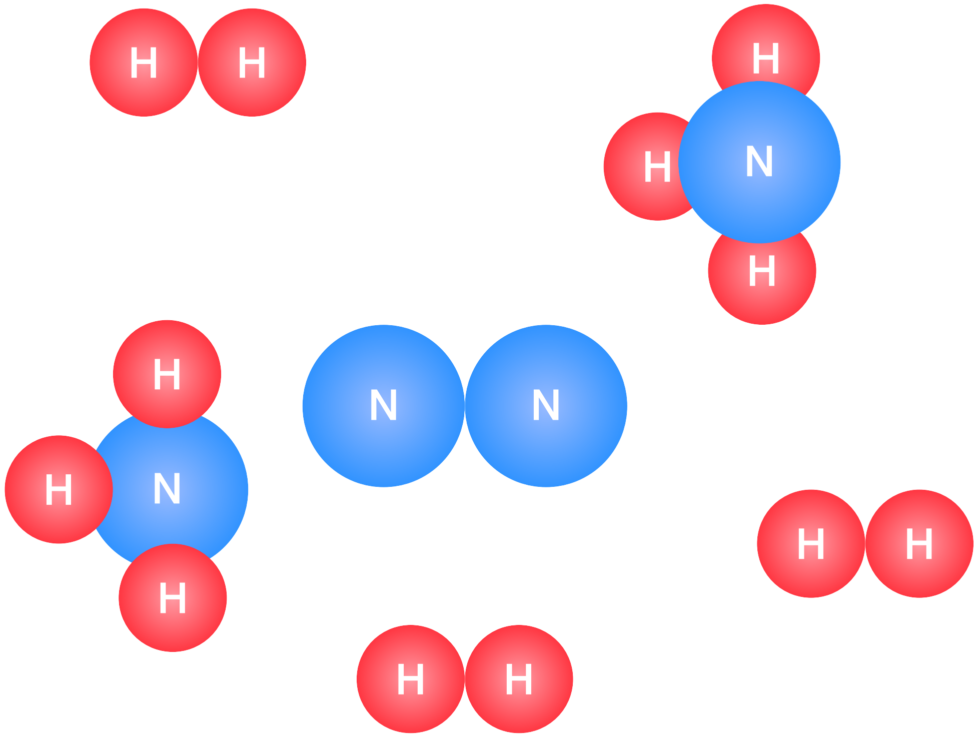

but ammonia can decompose back to Hydrogen and Nitrogen

$$3\,H_2 + N_2 \rightleftharpoons 2\,NH_3$$




And then react to form ammonia again

$$3\,H_2 + N_2 \rightleftharpoons 2\,NH_3$$

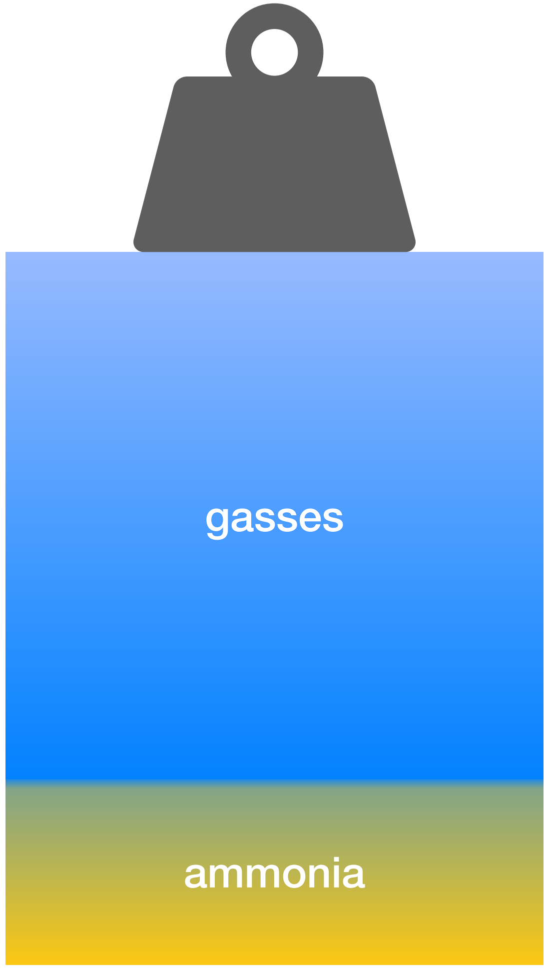



what determines the ratio of Hydrogen and Nitrogen to ammonia?

# application to chemistry: the Haber process

equilibreum at
low pressure

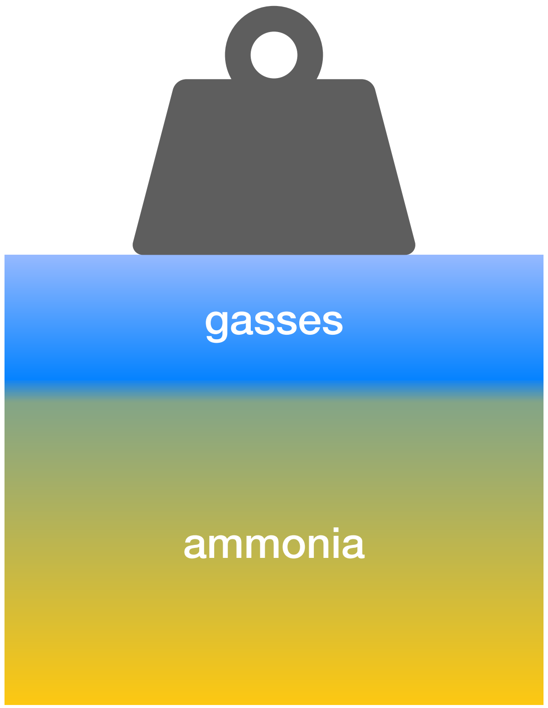
$$3\,H_2 + N_2 \rightleftharpoons 2\,NH_3$$



# application to chemistry: the Haber process

equilibreum at
high pressure

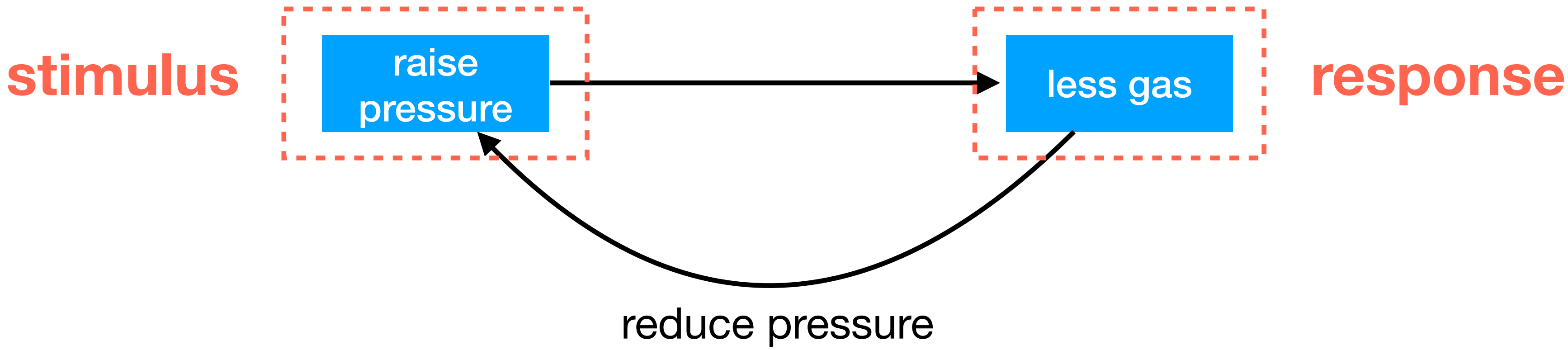
$$3\,H_2 + N_2 \rightleftharpoons 2\,NH_3$$



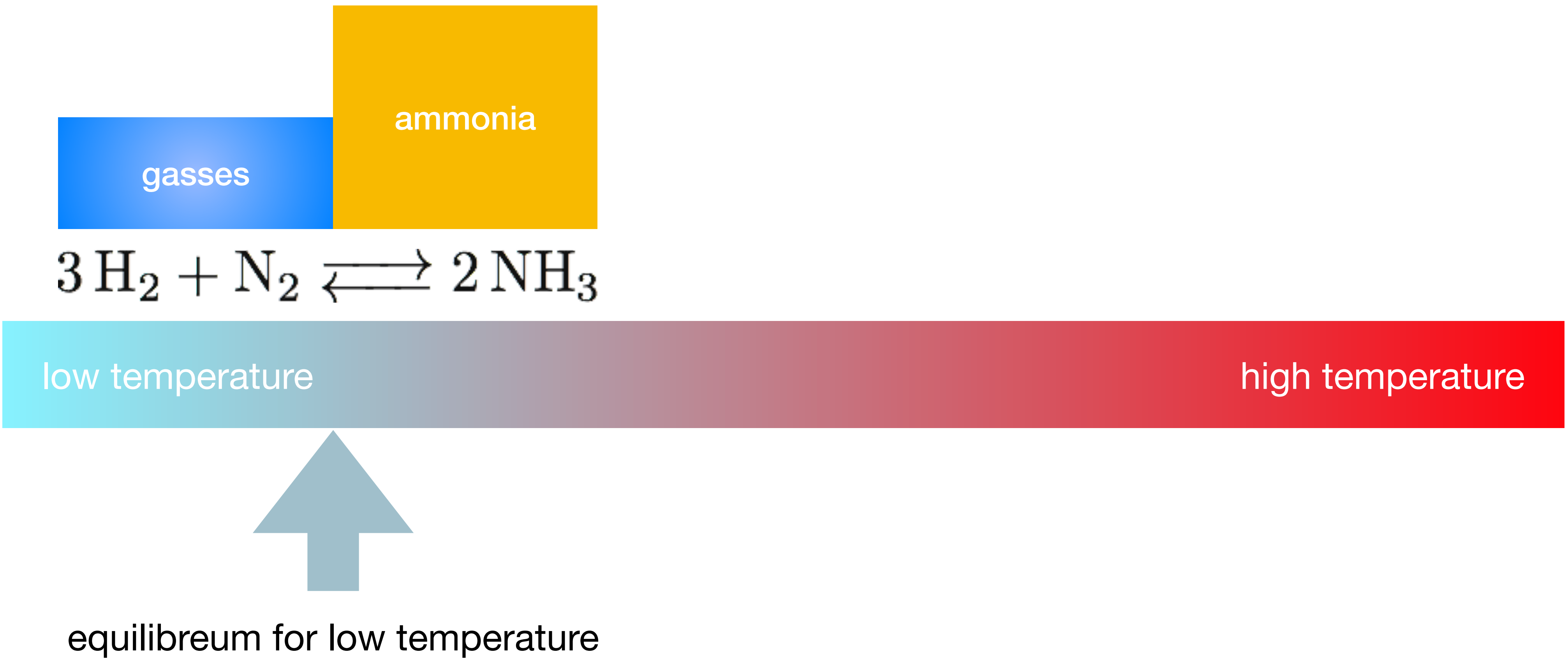
# Why the change in equilibrium position?

Q: Why is more ammonia produced at high pressures?

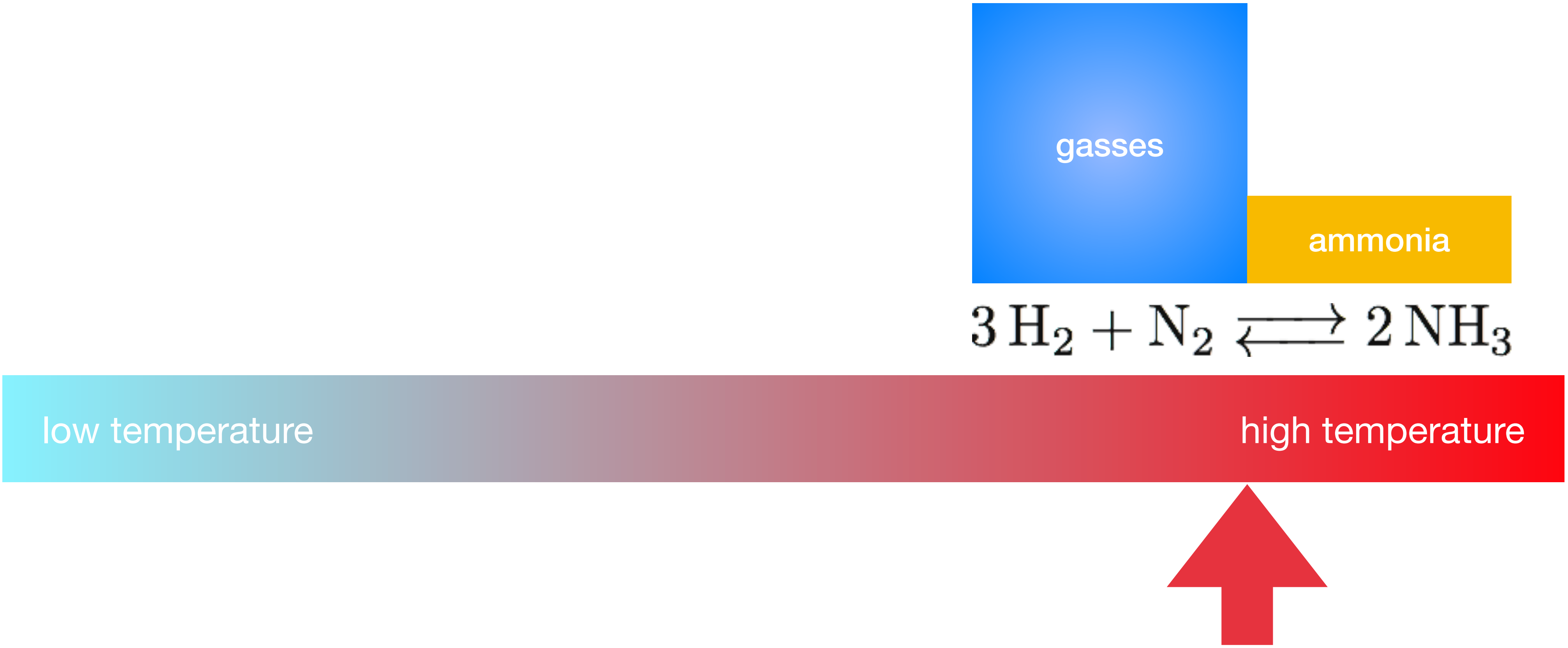
A: Gases take up more space than liquids so converting some gas to a liquid will reduce the overall pressure.



# application to chemistry:
# the Haber process



## application to chemistry:
## the Haber process

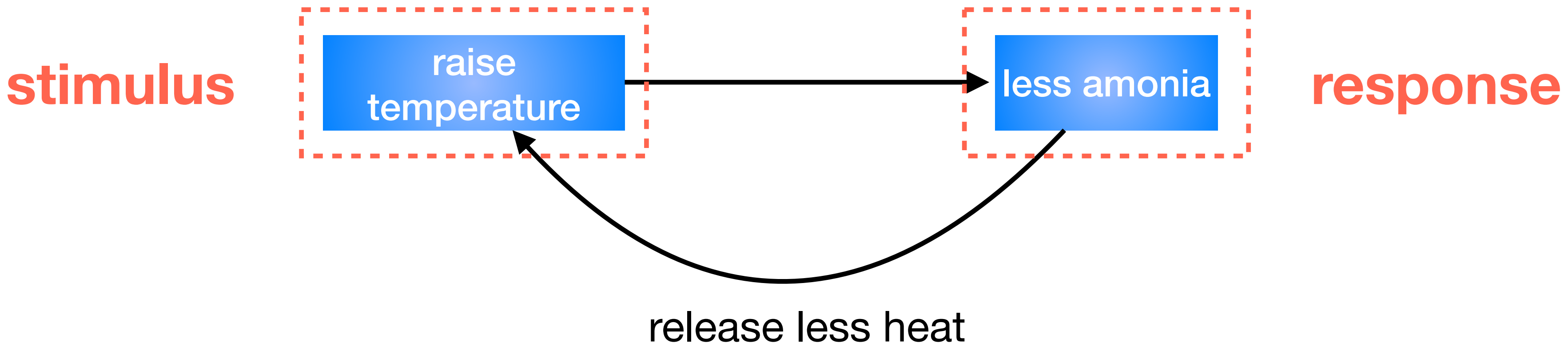



equilibreum for low temperature

# Why the change in equilibrium position?

Q: Why is less ammonia produced at higher temperatures?

A: because the reaction to produce ammonia is exothermic. To counteract the rise in temperature the system produces less ammonia and therefore less heat.



# Recap

Higher temperatures favour the exothermic reactants

exothermic

$$\boxed{3\,H_2 + N_2} \rightleftharpoons 2\,NH_3$$

endothermic

# Recap

Lower temperatures favour the endothermic reactants

exothermic

$$3\,H_2 + N_2 \rightleftharpoons \boxed{2\,NH_3}$$

endothermic

# Recap

Higher pressures favour less gas

4 mols of gas

0 mols of gas

$$3\,H_2 + N_2 \rightleftharpoons \boxed{2\,NH_3}$$

# Recap

Lower pressures favour more gas

4 mols of gas

0 mols of gas

$$\boxed{3\,H_2 + N_2} \rightleftharpoons 2\,NH_3$$