

Teach 3 steps to apply knowledge

Many students do badly at unfamiliar questions – AO2 at GCSE. They often dive straight in, choosing formula and writing answers without any plan.

Experts and the best students stand back and follow a 3-step approach, which we call Detect, Recall and Solve.

Teach this to your students and help them become aware of how to solve problems ('metacognition'). Over time they will improve at applying knowledge.

1. Choose one of the 3 sample problems (or a different one if you have the Practice Book)
2. After showing students the Example, get them to try a 'Your turn' question, writing down their thinking on the template.
3. Get students to compare their thinking with the steps in the Example, and write down ways they can improve.



3-steps to apply knowledge

Problem _____

Study the Example. Cover the page and try Your turn. Write down your thinking for each step:



Detect

Large dotted-line box for writing the Detect step.



Recall

Large dotted-line box for writing the Recall step.



Solve

Large dotted-line box for writing the Solve step.

Feedback

Compare your thinking in Detect, Recall and Solve with the Example's. Did you miss anything? What can you do differently to improve on this step? Write down feedback to yourself:



Detect



Recall



Solve

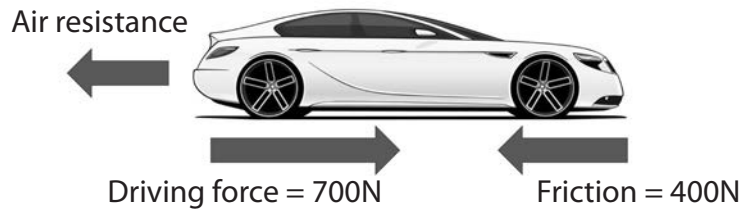
Large dotted-line box for writing feedback for each step.



Example

1.1 Find missing force

- 1 A car travels at constant speed. The diagram shows the forces on the car.



Calculate the force of air resistance.



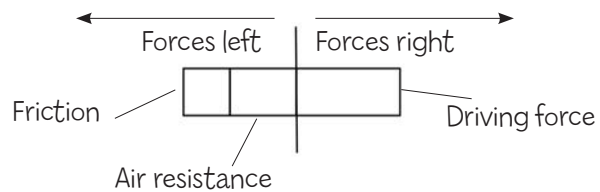
Detect

I know all the forces on the car except one. I have to calculate the missing force.



Recall

Constant speed (or at rest) means the forces are balanced. So,
Sum of forces in one direction = Sum of force in opposite direction.

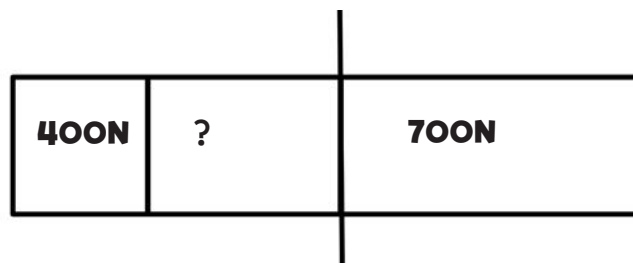


Why is this equation true?



Solve

Put the values from the question into the balanced forces diagram:



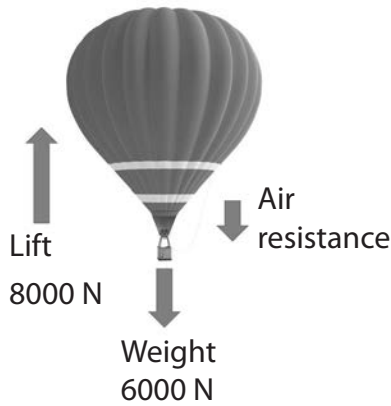
How did I work this out?

We can write this as an equation:

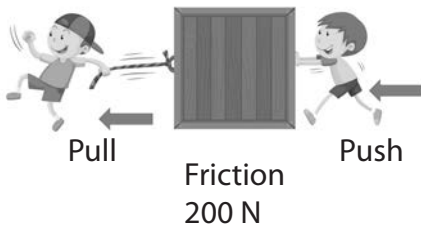
$$400\text{N} + \text{air resistance} = 700\text{ N}$$

$$\text{So, air resistance} = 700 - 400$$

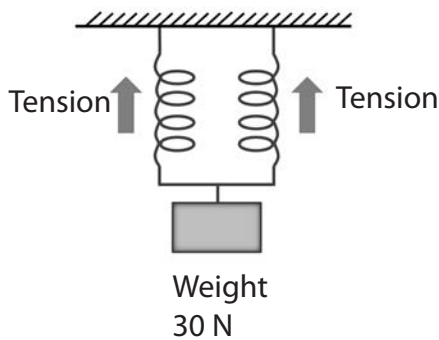
- 2** The hot air balloon is climbing at a steady speed. Calculate the air resistance.



- 3** Two boys pull and push a box with the same force. The box moves at a steady speed. Calculate the push and pull force.



- 4** The weight is supported by the tension in two identical springs. What is the tension in each spring?





Example

5.1 Chemical change evidence

- 1 Katie heated different substances to see if there was a chemical change. The table shows her observations.

Name of substance	Observations		
	Before heating (room temperature)	During heating	After cooling
i) Sodium hydrogen carbonate	White solid	Colourless gas and droplets of colourless liquid form	White solid
ii) Iron nitrate	Pale purple solid	Turns red-brown, brown gas forms	Brown-red solid
iii) Hydrogen peroxide	Colourless liquid	Bubbles form	Colourless liquid

For substances **i)**, **ii)** and **iii)**, explain whether there was a chemical change.



Detect

I need to think what the evidence is for a chemical change.

Why is this evidence?



Recall

In a chemical change, a new substance always forms.

The evidence for a new substance can be:

- Permanent colour change
- Fizzing or sign of a new gas
- Heat or light produced
- A precipitate (solid) forms if I mix two solutions.



Solve

i) Heating sodium hydrogen carbonate

- Permanent colour change
- Fizzing or sign of a new gas
- Heat or light produced



Chemical change

The droplets are likely to be water. A colourless gas and water droplets are both evidence for new substances.

ii) Heating iron nitrate

- Permanent colour change
- Fizzing or sign of a new gas
- Heat or light produced



Chemical change

A permanent colour change and brown gas are both evidence for new substances.

iii) Heating hydrogen peroxide solution

- Permanent colour change
- Fizzing or sign of a new gas
- Heat or light produced



Not sure

The bubbles could be a new gas, or due to boiling. There is no other evidence.

Why is the answer 'not sure'?



2 Alys mixed different solutions together. The table shows her observations.

	Solution 1	Solution 2	After mixing
i)	Silver nitrate (colourless)	Sodium chloride (colourless)	White precipitate forms
ii)	Copper sulfate (blue)	Dilute sulfuric acid (colourless)	The solution stays blue
iii)	Sodium hydrogen carbonate (colourless)	Hydrochloric acid (colourless)	Fizzing, leaving a colourless solution

For each experiment **i)**, **ii)** and **iii)**, explain whether there was a chemical change.

3 Jason added different substances to water. The table shows his observations.

Experiment	Substance	Before adding water	After adding to water
i)	Sodium metal	Silvery-grey metal	Fizzes, catches fire, solid disappears leaving a colourless solution
ii)	Sodium iodide	White solid	Solid disappears leaving a colourless solution
iii)	Iodine	Silvery-grey solid	A pale orange solution forms. Some solid remains

For each experiment **i)**, **ii)** and **iii)**, explain whether there was a chemical change.

4 Tomas mixed red and blue food colour in a glass of water. The water went purple. Tomas concluded there was a chemical change because it went a different colour. Do you think he was correct? Explain your answer.



Example

7.1 Functions of cell parts

- 1 The diagram shows a leaf infected with the tobacco mosaic virus (TMV).



Explain how destroying chloroplasts will affect the growth of the plant.



Detect

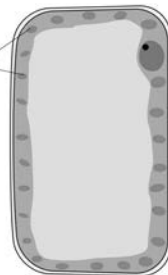
I need to think about the function of chloroplasts.

How is this cell part useful to the organism?



Recall

chloroplasts



1. Chloroplasts are green structures inside plant cells.
2. Their function is to carry out photosynthesis.
3. Photosynthesis is a process plants use to make food for themselves.
4. Growth is a life process. Organisms need food to grow.



Solve

IF TMV destroys some of the chloroplasts,
THEN there will be fewer chloroplasts.

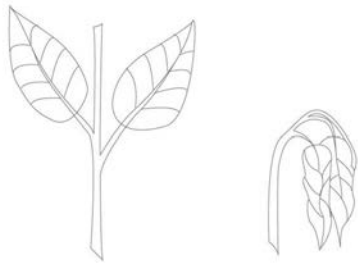
IF chloroplasts carry out photosynthesis
THEN fewer chloroplasts means less photosynthesis,

SO the plant will produce less food.
SO the plant will grow less.

OVERALL destroying chloroplasts will reduce the growth of the plant

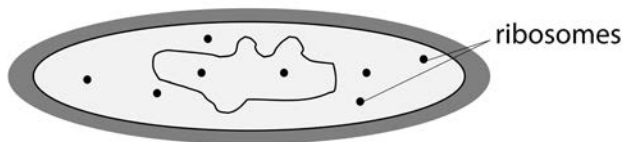
How does this cell part affect growth?

2



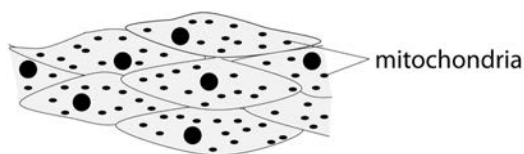
The diagram shows a plant wilting. This happens when plants cannot absorb enough water through their roots. Water moves out of the cell vacuole and the vacuole disappears. Explain why this causes the plant to wilt.

3



Antibiotics are drugs that kill bacteria. Some antibiotics stop ribosomes from working. Explain how this will kill a bacteria cell.

4



The diagram shows a group of muscle cells. Muscle cells have many more mitochondria than a typical animal cell. Explain why.