SANDWICH TECHNOLOGY SCHOOL

Physics A Level Transition work

Summer 2021

Within this transition guide you will find some key topics you have studied at GCSE. By revisiting them before you start your A Level course you will be giving yourself the best possible chance of success when term starts.

Welcome to A-level Physics!

Congratulations on choosing the best A-level subject!

The purpose of this work is to revise key concepts from GCSE so that you are as ready as possible for A-level Physics in September.

Please complete this work on separate sheets of paper and bring it with you to your first Physics lesson in September. We expect to see all three tasks attempted and self-marked.

There are three tasks. You should spend 1½ to 2 hours on each one. Complete as many of the questions as you can in this time. If you don't get to the end of the questions, that is fine as long as you have made the effort.

Task 1	Energy
Task 2	Electric circuits
Task 3	Resultant force

All the answers are in the back, so you can check your work yourself.

Other resources to help you prepare…

- GCSE revision guides - use these to revise key knowledge.
- CGP books 'Head Start to A-level Physics' and 'Essential Maths Skills for A-level Physics'. These cost about £5 each and will really help to bridge the gap between GCSE and A-level Physics.
- Take a look at information about the AQA Physics course to find out more about the course: https://www.aqa.org.uk/subjects/science/as-and-a-level/physics-7407-7408

<u>Keeping yourself entertained …</u>

YouTube Channels and Documentaries

Minute Physics youtube.com/user/minutephysics

Interesting short videos about lots of different aspects of Physics.

Sixty Symbols youtube.com/user/sixtysymbols

Videos about Physics and Astronomy with real experts

VSauce youtube.com/user/Vsauce

Not all Physics, but lots of interesting science!

Shock and Awe: The Story of Electricity youtu.be/Gtp51eZkwoI

An excellent three-part BBC documentary about the history of electricity.

Books

These books are all worth checking out. Some of them are easy reading, others are harder!

Richard Feynman	Surely You're Joking Mr Feynman
	Six Easy Pieces
	QED: The Strange Theory of Light and Matter
Stephen Hawking	A Brief History of Time
Carlo Rovelli	Seven Brief Lessons on Physics
James Gleick	Genius: The Life and Science of Richard Feynman
	Chaos: Making a New Science
Jon Butterworth	A Map of the Invisible
Brian Cox & Jeff Forshaw	Why does $E = mc^2$?
Randall Munroe (XKCD)	What if?
	Thing Explainer
	How to

A-level Physics Transition Work - Task 1 - Energy

These activities are to remind you of important ideas around **energy**.

You should use your GCSE revision materials or online sites such as BBC Bitesize to find out any facts that you need. Nothing here goes beyond GCSE level knowledge, but some of the questions are hard for GCSE level.

Activity 1 - Equations

Write word equations for all these quantities.

- work done by a force
- kinetic energy
- gravitational potential energy
- elastic potential energy
- thermal energy for a change of state
- thermal energy for a change of temperature

Activity 2 - Basic calculations

Remind yourself how to do simple calculations. Answers to the questions are in the back. There are also hints to suggest what you are doing wrong if you are making a common mistake.

1 Mass = 40 g Velocity = 20 m/s

Calculate the kinetic energy.

2 Mass = 2 kg Starting height = 10 cm Finishing height = 25 cm

Calculate the change in gravitational potential energy (for an object on Earth).

3 Spring constant = 200 N/m Extension = 40 mm

Calculate the elastic potential energy.

4 Specific latent heat of fusion = 500 000 J/kg Mass = 400 g

Calculate the thermal energy needed to melt the object.

5 Specific heat capacity = 500 J/kg/°C Mass = 3 kg
Start temperature = 12°C End temperature = 27°C

Calculate the thermal energy needed for this temperature increase.

6 Force = 40 GN Distance moved = 35 μm

Calculate the work done by the force.

7 Kinetic energy = 72 J Velocity = 6 m/s

Calculate the mass.

8 Kinetic energy = 392 J Mass = 16 kg

Calculate the velocity.

9 Elastic potential energy = 0.48 J Extension = 40 mm

Calculate the spring constant.

10 Change in gravitational potential energy = 24 mJ Mass = 30 g
Change in height = 40 cm

Calculate g.

11 Thermal energy for change of state = 2000 μJ Mass = 4 mg

Calculate the specific latent heat.

12 Specific heat capacity = 3000 J/kg/°C Mass = 12 kg
Thermal energy supplied = 180 kJ Start temperature = -7°C

Calculate the finishing temperature.

Activity 3 - Energy Conservation

1 Write down the principle of *conservation of energy*.

2 Write down the main changes in stored energy for each example. The first one has been done to show the level of detail needed.

(a) car braking *kinetic energy → thermal energy*

(b) car accelerating

(c) car driving up a hill

(d) gun firing a bullet

(e) bullet hitting a wooden block

(f) child stretching a spring

(g) spring firing a marble across a desk

(h) spring firing a marble upwards

(i) heating food in a gas oven

Activity 4 - Applying to real situations

For almost all these questions the method to get the answer is:

- Identify the starting and finishing energy stores.
- Write down the equations for these energy stores.
- Set the equations equal to each other.
- Substitute numbers and rearrange to find the missing value.

Example 1

A spring with spring constant 200 N/m is compressed by 3 cm. It is used to fire a ball of mass 12 g. Calculate the velocity of the ball as it leaves the spring.

Convert units	3 cm = 0.03 m 12 g = 0.012 kg
Energy conservation	Elastic potential before = Kinetic energy after $\frac{1}{2} k e^2 = \frac{1}{2} m v^2$
Substitute	$0.5 \times 200 \times 0.03^2 = 0.5 \times 0.012 \times v^2$
Tidy up	$0.09 = 0.006 v^2$
Rearrange	$v^2 = 0.09 \div 0.006 = 15$
Square root	$v = \sqrt{15}$ = 3.87 m/s (rounded to 3 s.f.)

Example 2

I rub a block of ice with sandpaper. The force of friction is 20 N and I move the sandpaper a total distance of 4 km while rubbing. The specific latent heat of fusion for ice is 334 kJ/kg. Calculate the mass of ice that could be melted this way.

Convert units	4 km = 4000 m 334 kJ/kg = 334 000 J/kg
Energy conservation	Work done by friction is transferred to thermal energy Work done by friction = Thermal energy for change of state Fd = mL
Substitute	$20 \times 4000 = m \times 334\,000$
Tidy up	$80\,000 = 334\,000\ m$
Rearrange	$m = 80\,000 \div 334\,000$ = 0.240 kg (rounded to 3 s.f.)

1 A carrot cannon fires a 0.4 kg carrot straight upwards at a velocity of 30 m/s.

Calculate the maximum height reached by the carrot.

2 A trampoline can be modelled as a spring with spring constant 15 000 N/m. A child of mass 40 kg compresses the trampoline by 40 cm.

Calculate the maximum height they could reach.

3 I fall of my chair. My mass is 90 kg and my chair is about 40 cm off the ground.

Estimate my impact speed.

4 A tennis ball has mass of about 60 g and impacts at a velocity of 60 m/s. It has an effective spring constant of 200 000 N/m.

Estimate how much the tennis ball squashes.

5 I put a real egg inside a slightly larger plastic egg. I then repeatedly drop it to try to raise the temperature of the egg and cook it. I need to raise the temperature of the egg by 90°C to cook it. Assume that the specific heat capacity of the egg is the same as water (4 200 J/kg/°C) and that it has a mass of 50 g. Also assume that all of the GPE given to the egg by lifting it is transferred to thermal energy in the egg when it lands.

Estimate the total height I would need to drop it from.

6 An asteroid of mass 2.0×10^{13} kg impacts the ocean at velocity 6 km/s. Assume that all of the energy is transferred to thermal energy. The specific latent heat of vaporisation of water is 2.3×10^{6} J/kg.

Calculate the mass of water that could potentially be evaporated.

7 The four brake discs on a car are made of iron (specific heat capacity 450 J/kg/°C) and each have a mass of about 10 kg. A car of mass 1600 kg is travelling at 30 m/s and brakes suddenly.

Estimate the maximum possible temperature rise of the brake discs.

8 This last question needs you to use **three** formulas.

A child of mass 40 kg is at the top of a slide. They are 2.5 m above the ground. They go down the slide. The average force of friction acting on them is 96 N and the length of the slide is 5.0 m.

Calculate their speed at the bottom of the slide.

<u>A-level Physics Transition Work - Task 2 - Electric Circuits</u>

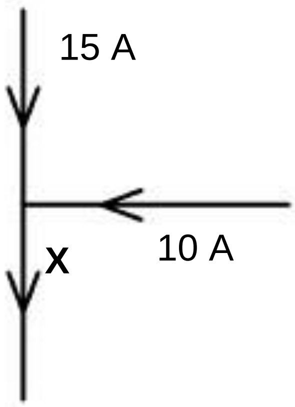
These activities are to remind you of important ideas around **electric circuits**.

You should use your GCSE revision materials or online sites such as BBC Bitesize to find out any facts that you need. Nothing here goes beyond GCSE level knowledge, but some of the questions are hard for GCSE level.

Activity 1 - Circuit rules

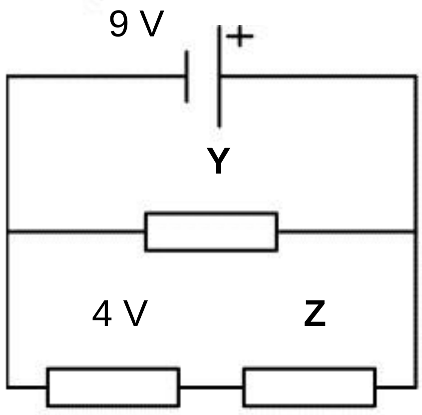
Currents at junctions

What is the rule for currents at junctions? Use it to work out the missing current **X** in the diagram.



Voltages around loops

What is the rule for voltages around loops? Use it to work out the two missing potential differences (voltages) **Y** and **Z** in the diagram.

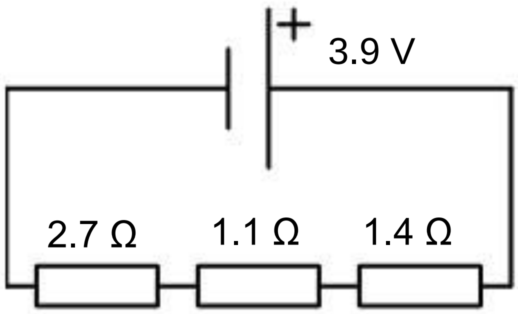


Resistance equation

What is the equation that links current (I), resistance (R) and potential difference (voltage) (V)? Use it to work out the current through a 20 Ω resistor connected to a 12 V cell.

Resistors in series

What is the rule for calculating the total resistance of several resistors in series? Use it to work out the total current in this circuit.



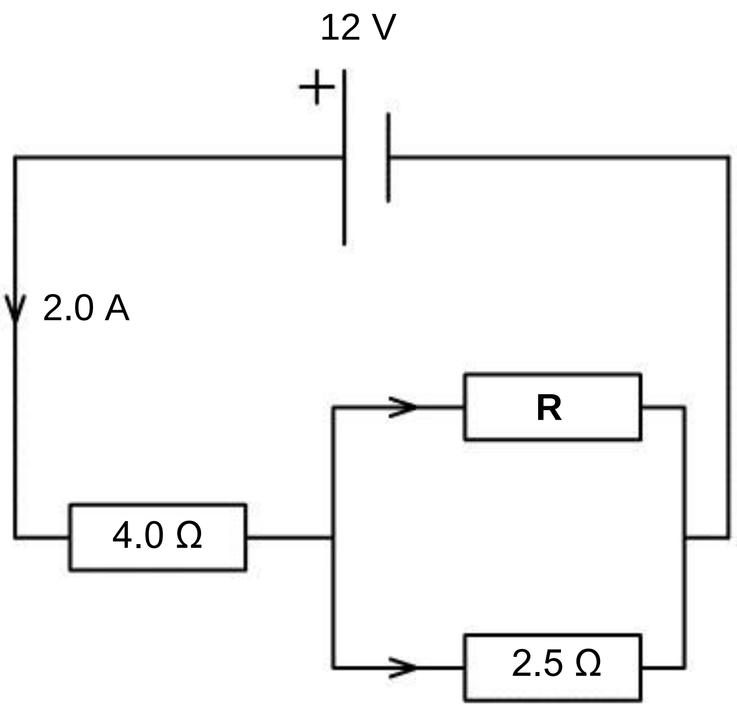
Activity 2 - Solving circuit problems

We can apply the circuit rules to solve circuit problems.

Carefully read through this example, then try some yourself.

<u>Example</u>

Calculate the resistance of the resistor **R** in the circuit shown below.



To solve this we just need to repeatedly apply the circuit rules:

- currents at junctions
- voltages around loops
- V = IR

Sometimes we can also use the rule for adding resistors in series. We don't need to (it is 'covered' by the other circuit rules) but it is often a useful shortcut.

<u>Step 1</u>

I am just going to repeatedly run through the list of rules and see if I can apply them to the circuit.

Current rule Is there a junction where I know all but one current?
No, so I can't apply this rule.

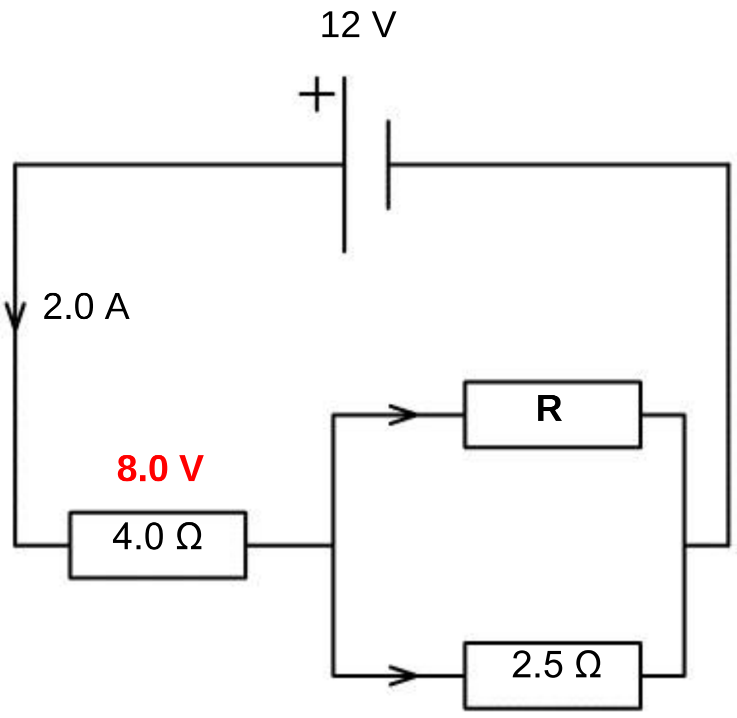
Voltage rule Is there a loop where I know all but one voltage?
No, so I can't apply this rule.

V = I R Is there a component where I know all but one of V, I and R?
Yes, I know that a current of 2.0 A flows through the 4.0 Ω resistor.

Calculating using V = IR gives me V = 2.0 × 4.0 = 8.0 V across the resistor.

Step 2

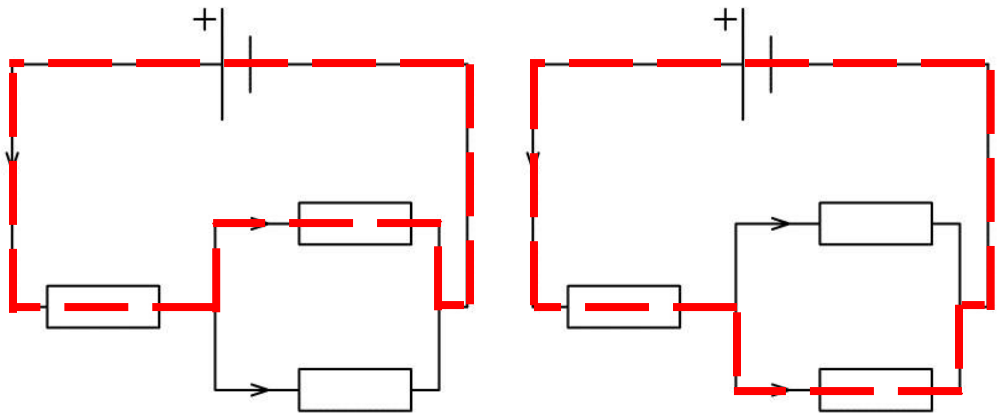
I have added my new information to the circuit diagram.



Now I am going to repeat the process…

Current rule Is there a junction where I know all but one current?
No, so I can't apply this rule.

Voltage rule Is there a loop where I know all but one voltage?
Yes, there are two loops where I know all but one voltage.



Looking at both loops:

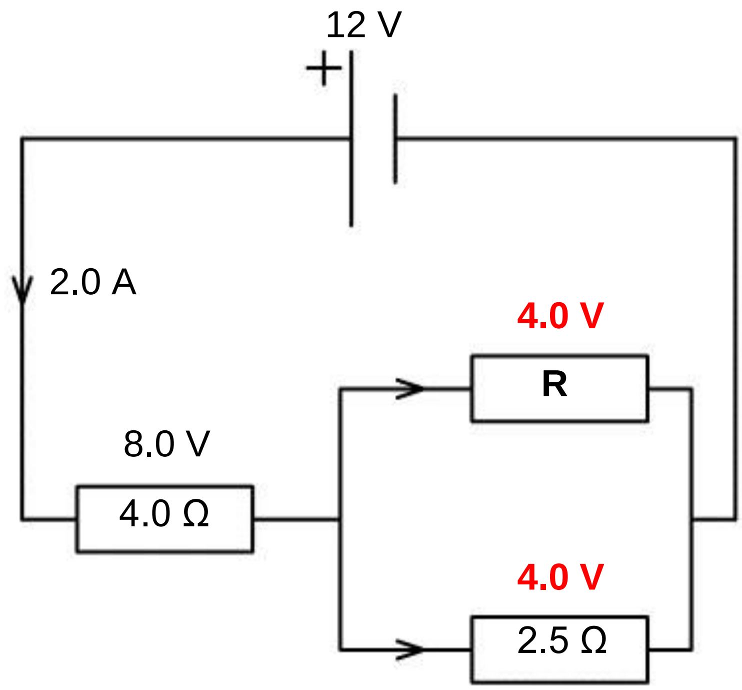
- The voltage (e.m.f.) of the cell is 12 V
- The voltage (p.d.) of the 4 Ω resistor is 8.0 V.

So, the voltages across the resistors in any loop must add up to 12 V. Therefore, the voltages across the 2.5 Ω resistor and across **R** must both be 4.0 V.

This is an example of a useful general rule - if two components are in parallel, they will have the same potential difference across them.

Step 3

Again, I have added my new information to the circuit diagram.



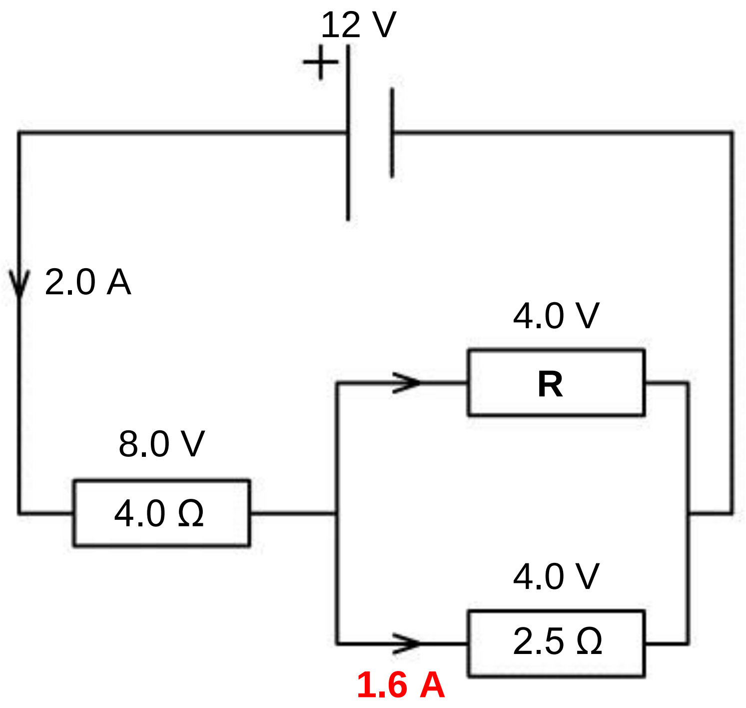
Once again, I am going to run through the circuit laws…

Current rule	Is there a junction where I know all but one current? *No, so I can't apply this rule.*
Voltage rule	Is there a loop where I know all but one voltage? *I know all the voltages, so this rule is useless!*
V = I R	Is there a component where I know all but one of V, I and R? *Yes, I know that the voltage across the 2.5 Ω resistor is 4.0 V.*

Calculating using V = IR gives me I = 4.0 ÷ 2.5 = 1.6 A.

Step 4

Add this new information and repeat…

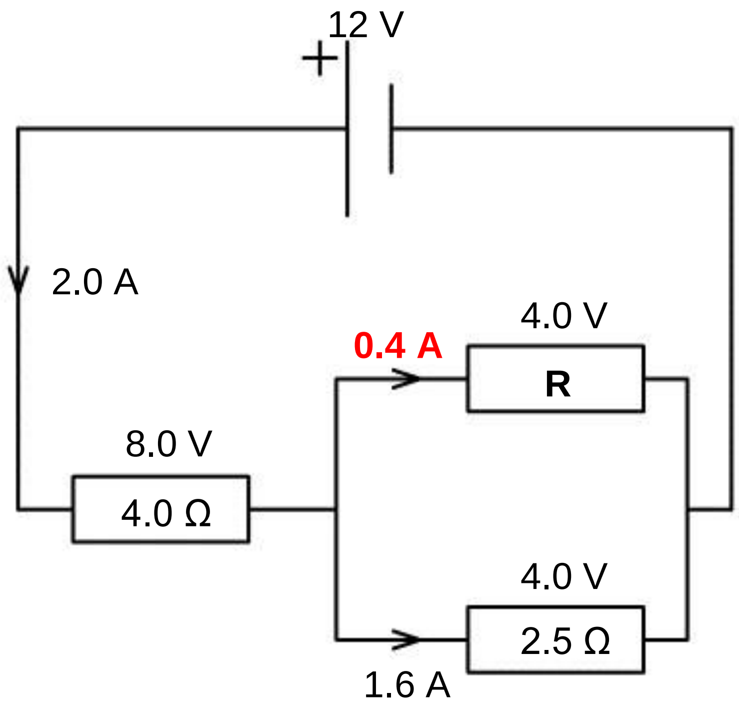


Current rule Is there a junction where I know all but one current?
Yes, the junction at the start of the parallel section.

There is 2.0 A arriving at this junction, and 1.6 A leaving through the 2.5 Ω resistor. That means there must be 0.4 A left over, passing through **R**.

Step 5

Add the new information…



Current rule Is there a junction where I know all but one current?
I know all the currents, so this rule is useless!

Voltage rule Is there a loop where I know all but one voltage?
I know all the voltages, so this rule is useless!

V = I R Is there a component where I know all but one of V, I and R?
Yes, I know the current and voltage for ***R****.*

Calculating using V = IR gives me R = 4.0 ÷ 0.4 = **10 Ω**.

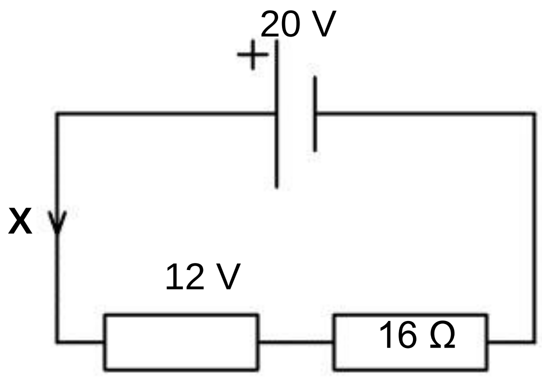
Summary

You should be able to solve any circuit you are given by applying this method. Just keep running through the circuit rules until you find one that you can apply.

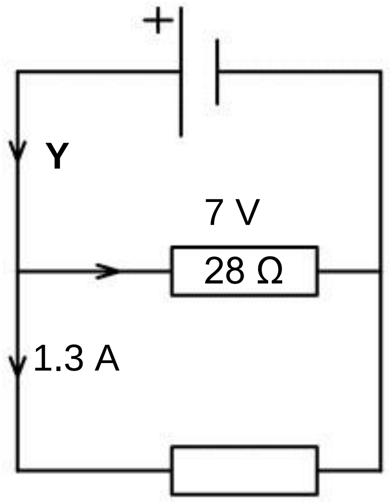
Once you get good at it you will be able to spot the next step without thinking about all of the rules.

Section 1 - Two-step problems

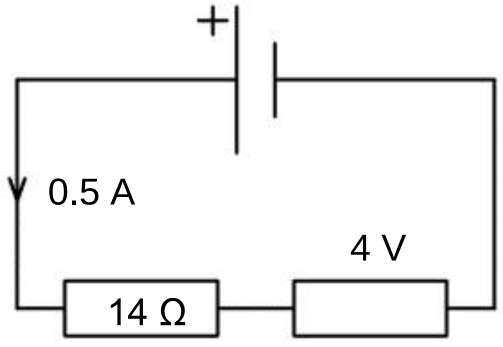
1 Calculate the current at **X**.



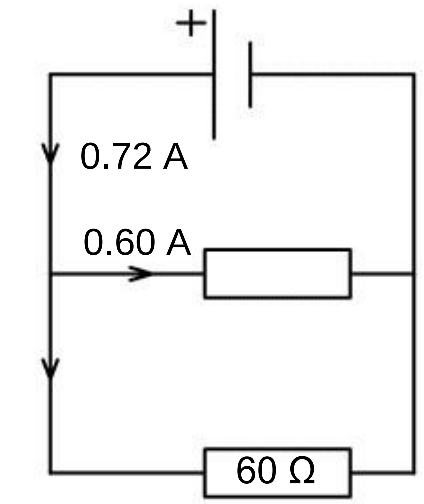
2 Calculate the current at **Y**.



3 Calculate the voltage (e.m.f.) of the cell.

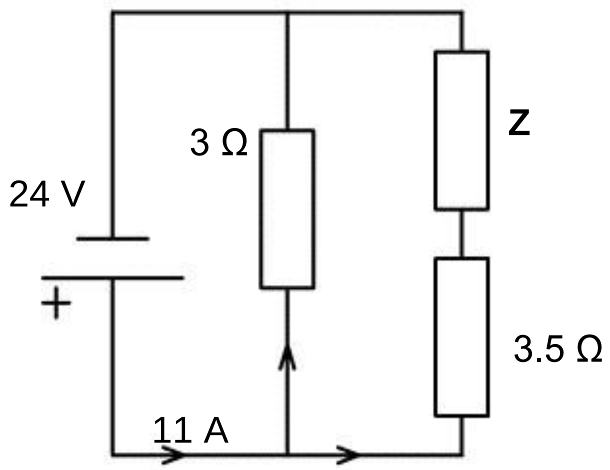


4 Calculate the voltage (p.d.) across the 60 Ω resistor.

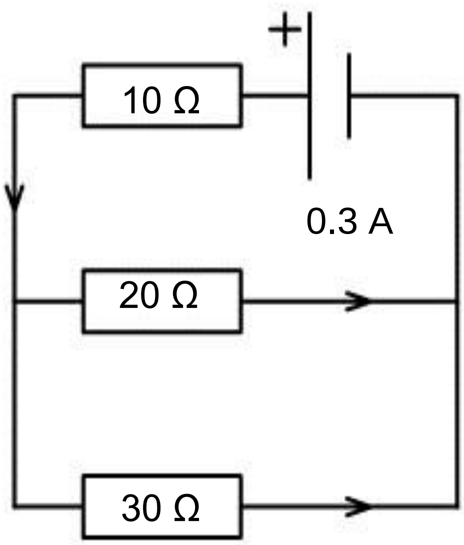


<u>Section 2 - Multi-step problems</u>

5 Calculate the resistance of the resistor **Z**.

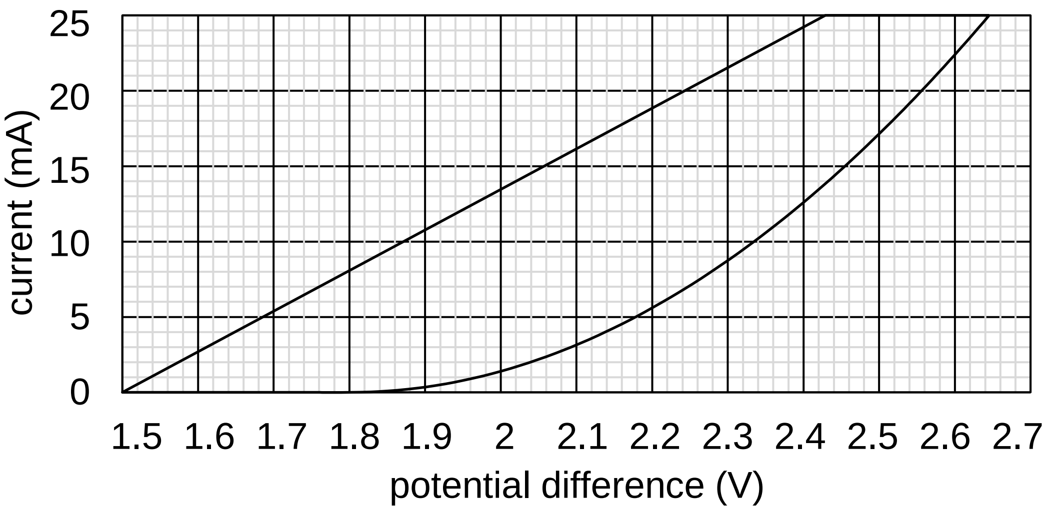


6 Calculate the voltage (e.m.f.) of the cell.

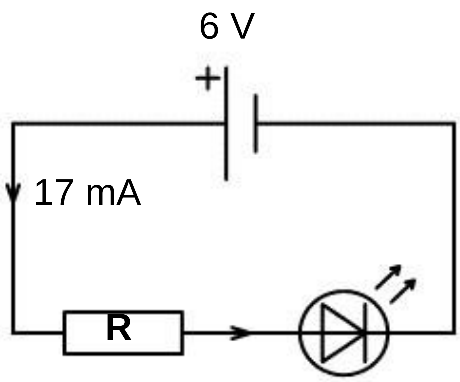


Section 3 - Challenge Question

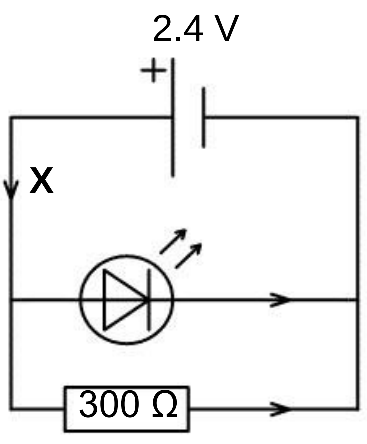
Light emitting diodes (LEDs) do not have constant resistance. For a particular LED, the relationship between potential difference and current is shown by this graph. You *cannot* use V = IR with a single value of R.



7 The LED is connected to this series circuit. Calculate the resistance **R**.



8 The LED is now connected to this parallel circuit. Calculate the current **X**.



A-level Physics Transition Work - Task 3 - Resultant forces

These activities are to remind you of important ideas around **resultant forces**.

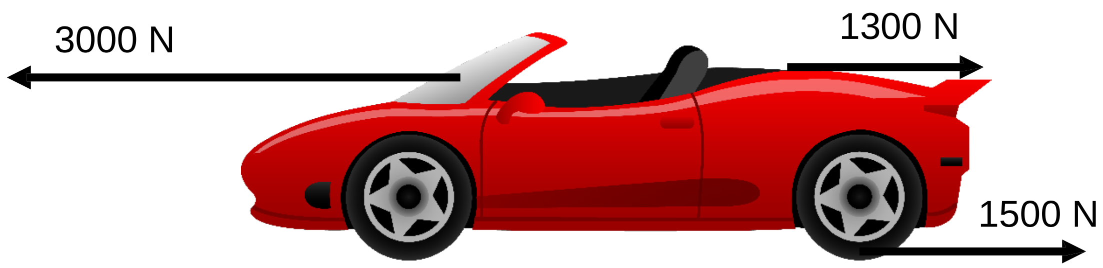
You should use your GCSE revision materials or online sites such as BBC Bitesize to find out any facts that you need. Nothing here goes beyond GCSE level knowledge, but some of the questions are hard for GCSE level.

Activity 1 - Parallel forces

Example

The car shown in the diagram has mass of 800 kg.

Calculate its acceleration



(Yes, I know there is no-one driving the car!)

The resultant force on the car is the sum of all the separate forces, taking into account their directions.

resultant force = 3000 - 1300 - 1500 = 200 N

To calculate the acceleration, we need to use the formula:

resultant force = mass × acceleration

$F = ma$

$a = F \div m = 200 \div 800 =$ **0.25 m/s^2**

It is **very important** that when you use $F = ma$, you use the **resultant** force.

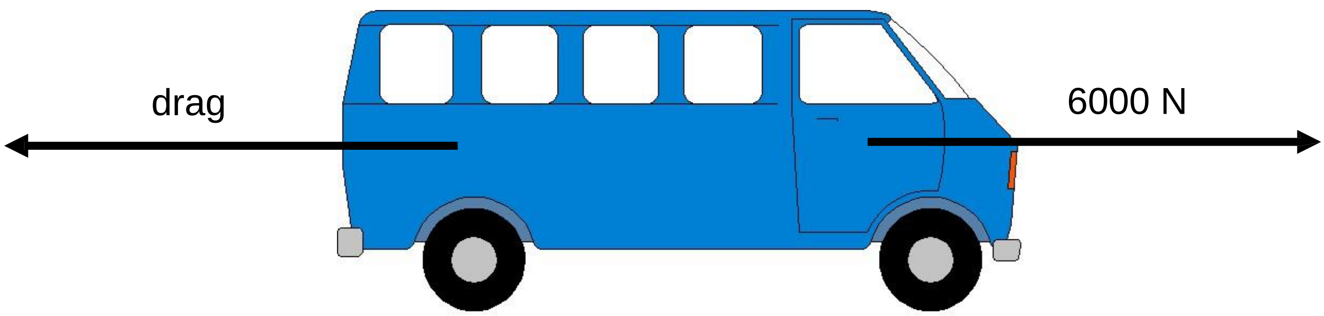
In some of the questions that follow you might also need to calculate weight:

weight = mass × g

At GCSE you will either have used g = 10 N/kg or g = 9.8 N/kg. At A-level we use a value of g = 9.81 N/kg.

1 The acceleration of the boat is 3 m/s^2. Calculate its mass.

2 The mass of the minibus is 3200 kg. Its acceleration is 0.8 m/s^2. Calculate the drag force.



3 The diagram shows an ostrich in a lift.

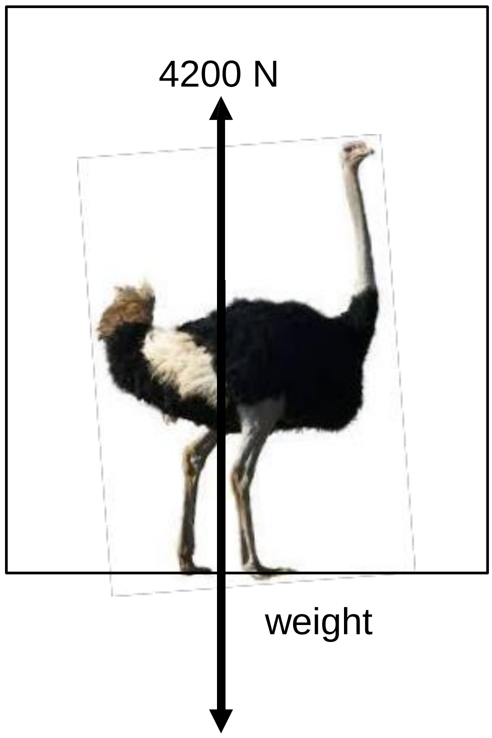
The mass of the ostrich is 300 kg.

The normal reaction force from the floor of the lift is 4200 N.

(a) Calculate the weight of the ostrich.

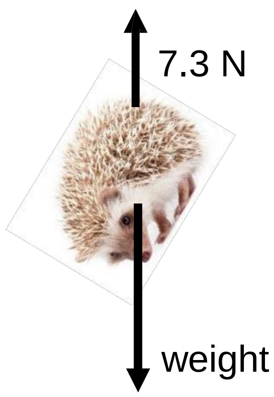
(b) Calculate the acceleration of the ostrich.

(c) Is the lift accelerating upwards or downwards?



4 The mass of the skydiving hedgehog is 1.2 kg.

Calculate its acceleration.

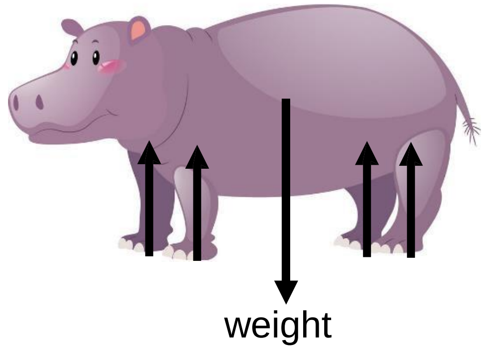


Challenge

5 The diagram shows 'Iron Hippo'. 'Iron Hippo' is a rhinoceros wearing a hippo-shaped metal suit with rocket boosters on each hoof.

Each rocket booster produces a force of 3.2 kN. This produces an upwards acceleration of 3.7 m/s^2.

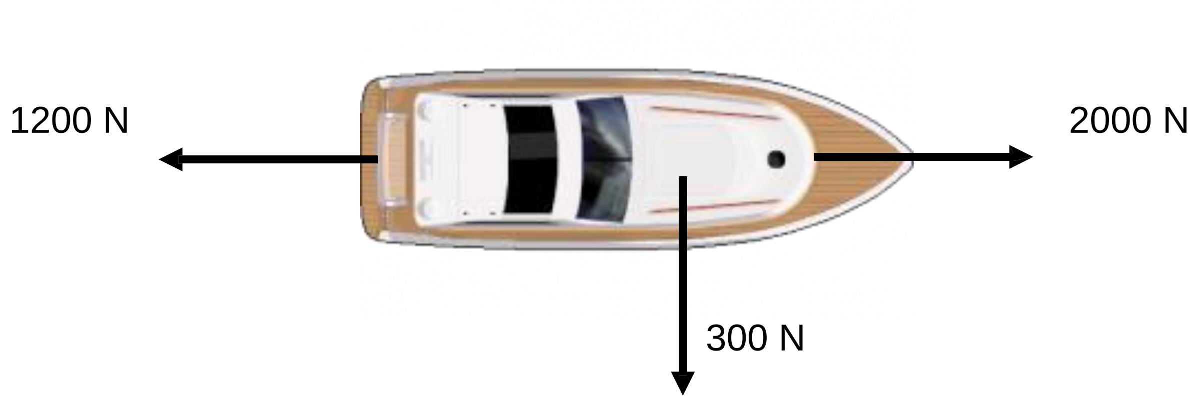
Use this information to calculate the mass of 'Iron Hippo'.



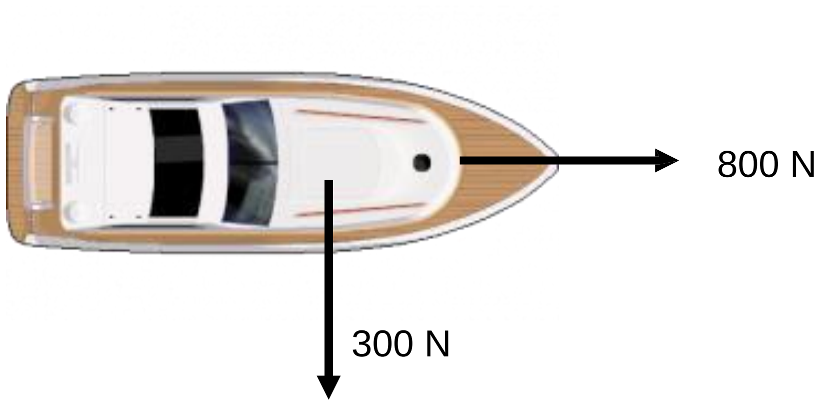
Activity 2 - Forces at right angles

<u>Example</u>

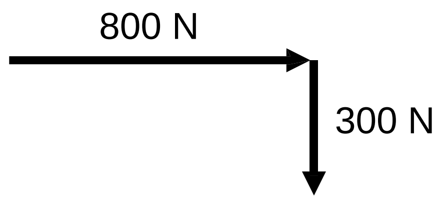
The diagram shows the force acting on a boat. The mass of the boat is 740 kg. Calculate the size of the acceleration of the boat.



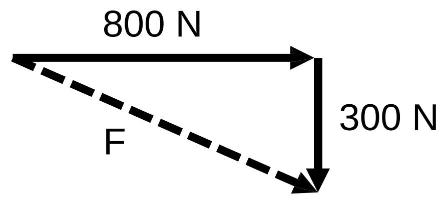
First, we simplify the problem by adding together the forward and backward forces, so we just have two forces at right angles.



Then, to add these together to find the resultant force, we need to use Pythagoras' theorem. First, put the two force vectors nose-to-tail.



Then join the 'tail' of the first force vector to the 'nose' of the second force vector. This is shown by the dashed arrow.



Then we need to find the length of this arrow.

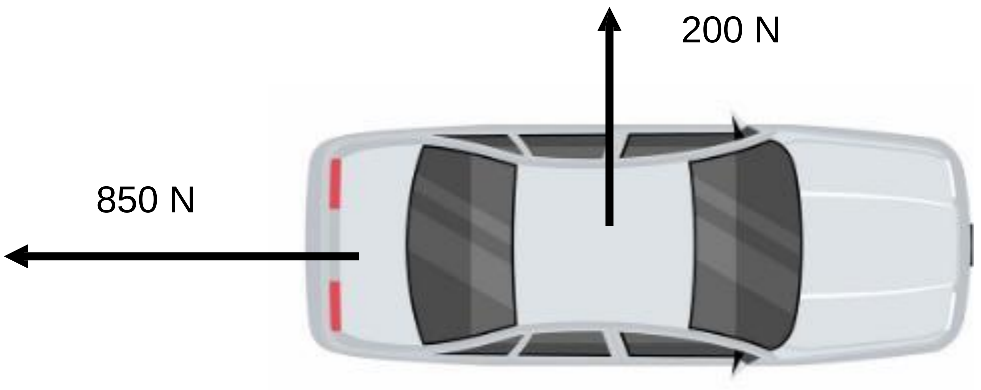
$$F^2 = 800^2 + 300^2 = 730\,000$$

$$F = \sqrt{730\,000} = 854.4 \text{ N}$$

This is the resultant force. Then just use F = ma as we did before:

$a = F \div m = 854.4 \div 740 =$ **<u>1.15 m/s²</u>**

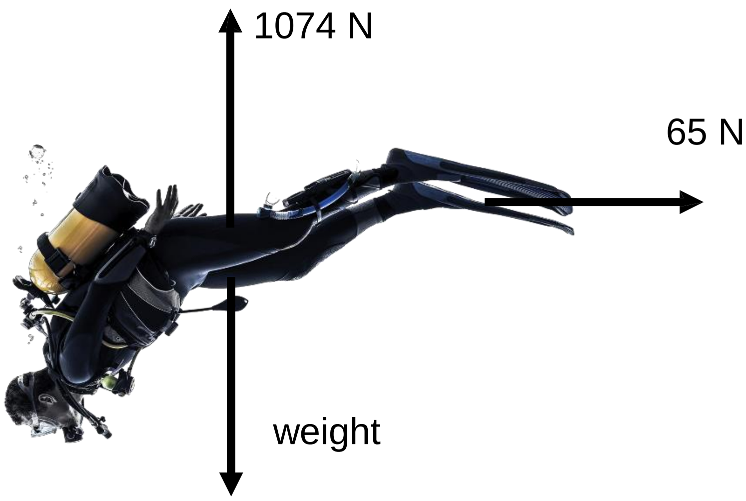
1 The mass of the car is 1140 kg. Calculate the size of its acceleration.



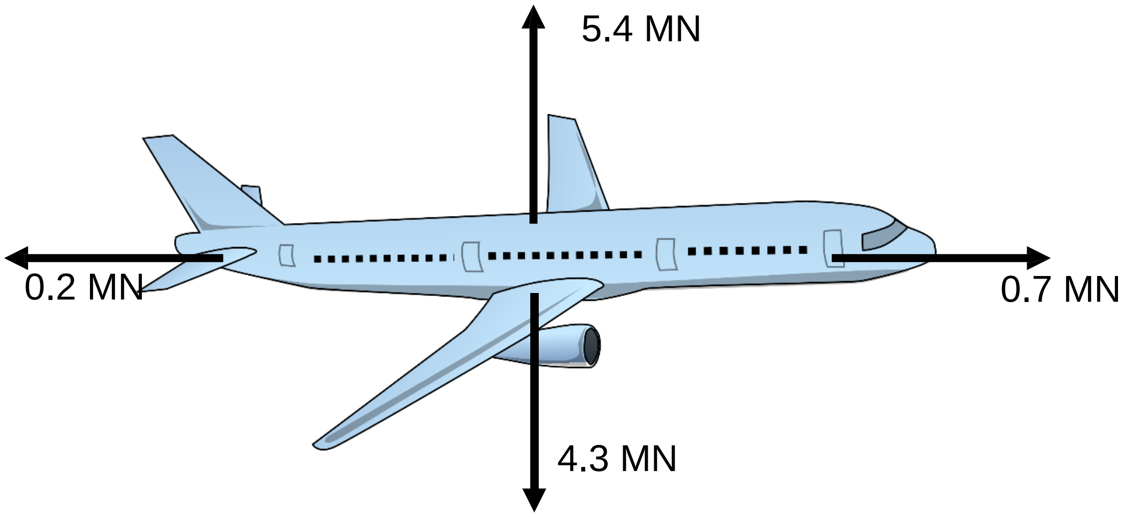
2 The mass of the diver, including all her equipment, is 115 kg.

(a) Calculate the weight.

(b) Calculate the size of the acceleration of the diver.



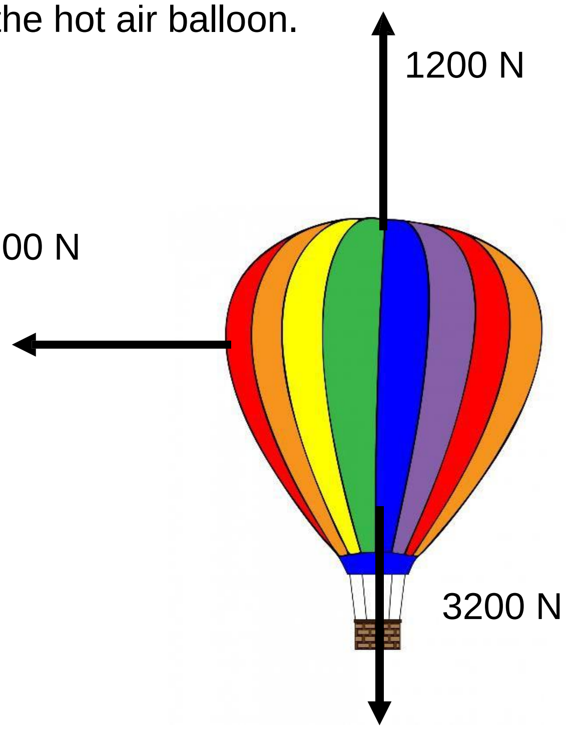
3 The diagram shows the forces on a jumbo jet.



(a) Use the weight to calculate the mass of the jumbo jet.

(b) Calculate the size of the acceleration of the jumbo jet.

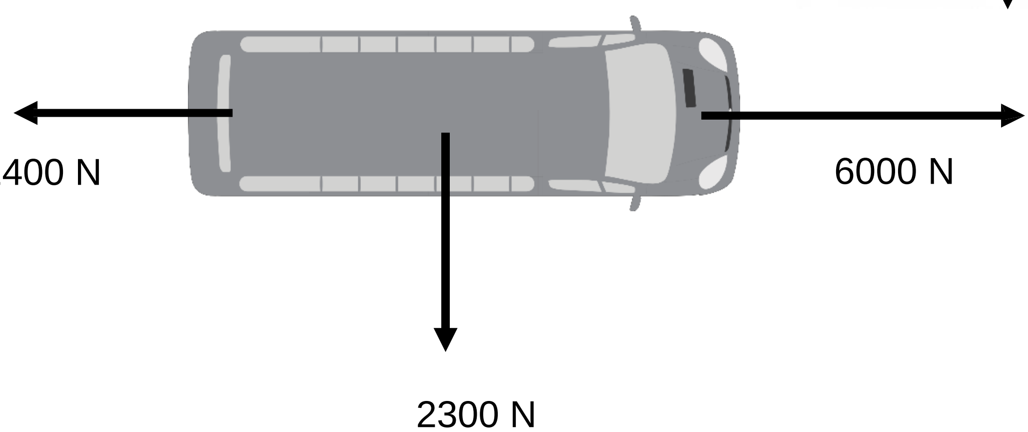
4 Calculate the size of the acceleration of the hot air balloon.



Challenge

5 The mass of the bus is 12 000 kg. The acceleration of the bus is 0.35 m/s^2.

Calculate the size of the drag force.



<u>Task 1 - Energy - ANSWERS</u>

Activity 2

Bold answers are correct. *Italic answers are wrong, with probable reasons.*

1 **8 J**
8000 J → You didn't convert 40 g into kg.
0.4 J → You forgot to square the velocity.
400 J → Both of those problems!

2 **2.94 J**
3 J → You used 10 for g, instead of 9.8. (At A-level we use 9.81.)
294.3 J → You didn't convert cm into m.
1.96 J or 4.9 J → You used one of the heights, instead of using the difference.

3 **0.16 J**
4 J → You forgot to square the extension.
160 000 J → You didn't convert mm to m.
16 J → You converted mm to m using the conversion factor for cm.
Anything beginning with 8 → You just multiplied the numbers as if finding the force using F = ke.

4 **200 000 J**
200 000 000 J → You didn't convert g into kg.

5 **22 500 J**
18000 J → You used the start temperature instead of the temperature change
40500 J → You used the end temperature instead of the temperature change

6 **1 400 000 J**
1400 J → You didn't convert GN to N or μm to m
14 followed by a different number of zeros → You did the unit conversions wrong!

7 **4 kg**
12 m/s → You just did 72 ÷ 6 (which is the wrong formula)
2 kg → You forgot about the ½ in the kinetic energy formula
24 kg → You forgot to square the velocity

8 **7 m/s**
24.5 m/s → You just did 392 ÷ 16 (which is the wrong formula)
4.95 m/s → You forgot about the ½ in the kinetic energy formula
3.0625 m/s → You squared the mass

9 **600 N/m**
6×10^{-4} N/m → You forgot to convert mm to m
300 N/m → You forgot about the ½ in the elastic potential energy formula
24 N/m → You forgot to square the extension

10 **2 N/kg**
2 with a different number of zeros → You didn't convert all of the units correctly.

11 **500 J/kg**
0.5 J/kg → Probably… you used 4 mg = 4 × 10^{-3} kg, which is incorrect. 4 mg is 4 × 10^{-3} g = 4 × 10^{-6} kg.

12 **-2°C**
9°C → You didn't notice the minus sign on the start temperature.
-6.995°C → You didn't convert 180 kJ into J.

Activity 3

1 *Total energy of a closed system is constant.*

2 **(a)** car braking *kinetic energy → thermal energy*

(b) car accelerating *chemical energy → kinetic energy*

(c) car driving up a hill *chemical energy → gravitational energy*

(d) gun firing a bullet *chemical energy → kinetic energy*

(e) bullet hitting a wooden block *kinetic energy → thermal energy*

(f) child stretching a spring *chemical energy → elastic energy*

(g) spring firing a marble across a desk elastic *energy → kinetic energy*

(h) spring firing a marble upwards *elastic energy → gravitational energy*

(i) heating food in a gas oven *chemical energy → thermal energy*

Activity 4 - Applying to real situations

1 46 m

2 3.1 m

3 2.8 m/s

4 3.3 cm

5 ~40 km

6 1.6 × 10^{14} kg

7 40°C

8 5.0 m/s

Task 2 - Electric Circuits - ANSWERS

Activity 1 - Circuit rules

Currents at junctions

The rule is that ‘currents add up at junctions’.

At A-level we call this *Kirchhoff’s 1st Law* and write it as:

sum of currents entering a junction = sum of currents leaving a junction

The junction in the example has a total of 25 A entering. Therefore the current **X**, which is leaving the junction is also **25 A**.

Voltages around loops

The rule is that ‘voltages add up around loops’.

At A-level we call the voltage across a component the *potential difference* and the voltage provided by a cell or other energy source the *e.m.f.*. Using these terms, we called the voltage rule *Kirchhoff’s 2nd Law* and write it as:

for a closed loop in a circuit, sum of e.m.f.s = sum of p.d.s

The e.m.f. in the example is 9V. So if we look at any loop that includes the cell, the total p.d. must also be 9 V. This means that the p.d. across **Y** is **9 V** and the p.d. across **Z** is **5 V**.

Resistance equation

potential difference = current × resistance

So, in the example, the current is 12 ÷ 20 = 0.6 A.

Resistors in series

The rule is that we just add the resistances together.

total resistance of resistors in series = sum of resistances

So, in the example, the total resistance is 2.7 + 1.1 + 1.4 = 5.2 Ω.

So the current is 3.9 ÷ 5.2 = 0.75 A.

Activity 2 - Circuit problems

1 Voltage across 16 Ω resistor is 20 - 12 = 8 V
Current through 16 Ω resistor, and therefore at **X**, is 8 ÷ 16 = **0.5 A**

2 Current through 28 Ω resistor is 7 ÷ 28 = 0.25 A
Current at **Y** is 1.3 + 0.25 = **1.55 A**

3 Voltage across 14 Ω resistor is 0.5 × 14 = 7.0 V
Voltage (e.m.f.) of cell is 7 + 4 = **11 V**

4 Current through 60 Ω resistor is 0.72 - 0.60 = 0.12 A
Voltage across 60 Ω resistor is 0.12 × 60 = **7.2 V**

5 Voltage across 3 Ω resistor is 24 V
Current through 3 Ω resistor is 24 ÷ 3 = 8 A
Current through 3.5 Ω resistor and through **Z** is 11 - 8 = 3 A
Voltage across 3.5 Ω resistor is 3 × 3.5 = 10.5 V
Voltage across **Z** is 24 - 10.5 = 13.5 V
Resistance of **Z** is 13.5 ÷ 3 = **4.5 V**

6 Voltage across 20 Ω resistor is 0.3 × 20 = 6 V
Voltage across 30 Ω resistor is also 6 V
Current through 30 Ω resistor is 6 ÷ 30 = 0.2 A
Current through 10 Ω resistor is 0.3 + 0.2 = 0.5 A
Voltage across 10 Ω resistor is 0.5 × 10 = 5 V
Voltage (e.m.f.) of cell is 6 + 5 = **11 V**

7 Current through LED is 17 mA
Read off from graph to find voltage across LED is 2.5 V
So voltage across **R** is 6 - 2.5 = 3.5 V
So resistance of **R** is 3.5 ÷ 0.017 = **206 Ω**

8 Voltage across LED is 2.4 V
Read off from graph to find current in LED is 12.5 mA
Voltage across resistor is 2.4 V
So current in resistor is 2.4 ÷ 300 = 8 mA
So current at **X** is 12.5 + 8 = **20.5 mA**

Task 3 - Resultant Forces - ANSWERS

Activity 1 - Parallel forces

1 resultant force = 5000 - 3500 = 1500 N forwards

$m = F \div a = 1500 \div 3 = 500$ kg

2 $F = ma = 3200 \times 0.8 = 2560$ N

resultant force = 6000 - D = 2560 → D = 6000 - 2560 = 3440 N

3 **(a)** $W = mg = 300 \times 9.81 = 2943$ N

(b) resultant force = 4200 - 2943 = 1257 N upwards

$a = F \div m = 1257 \div 300 = 4.19\ m/s^2$

(c) resultant force is upwards so the acceleration is also upwards

4 $W = mg = 1.2 \times 9.81 = 11.77$ N

resultant force = 11.77 - 7.3 = 4.47 N

$a = F \div m = 4.47 \div 1.2 = 3.73\ m/s^2$

5 upwards force = 3.2 kN × 4 = 3200 × 4 = 12 800 N

call the total thrust from the boosters T = 12 800 N

$F = ma \rightarrow T - W = ma \rightarrow T - mg = ma \rightarrow T = mg + ma \rightarrow T = m(g+a)$

$\rightarrow m = T \div (g+a) = 12\,800 \div (9.81 + 3.7) = 947$ kg

Activity 2 - Forces at right angles

1 $F = \sqrt{200^2 + 850^2} = 873.2$ N

$a = F \div m = 873.2 \div 1140 = 0.766$ m/s^2

2 **(a)** $W = mg = 115 \times 9.81 = 1128$ N

(b) total vertical force = 1128 - 1074 = 54 N

total horizontal force = 65 N

$F = \sqrt{54^2 + 65^2} = 84.5$

$a = F \div m = 84.5 \div 115 = 0.735$ m/s^2

3 **(a)** $W = 4.3$ MN $= 4.3 \times 10^6$ N

$m = W \div g = 4.3 \times 10^6 \div 9.81 = 4.38 \times 10^5$ kg

(b) total vertical force = 5.4 - 4.3 = 1.1 MN

total horizontal force = 0.7 MN - 0.2 MN = 0.5 MN

$F = \sqrt{1.1^2 + 0.5^2} = 1.21$ MN

$a = F \div m = (1.21 \times 10^6) \div (4.38 \times 10^5) = 2.76$ m/s^2

4 $m = W \div g = 3200 \div 9.81 = 326$ kg

total vertical force = 3200 - 1200 = 2000 N

total horizontal force = 900 N

$F = \sqrt{2000^2 + 900^2} = 2190$ N

$a = F \div m = 2190 \div 326 = 6.72$ m/s^2

5 $F = ma = 12\,000 \times 0.35 = 4200$ N

resultant force = 4200 N

total sideways force = 2300 N

total forward force = $\sqrt{4200^2 - 2300^2} = 3510$ N

total forward force = 6000N - drag force

→ drag force = 6000 - 3510 = 2490 N