RIDGEWOOD SCHOOL

AQA A-level Physics Y11- Y12 Transition task

Task 1: Read the information below and highlight annotate any key information or examples.

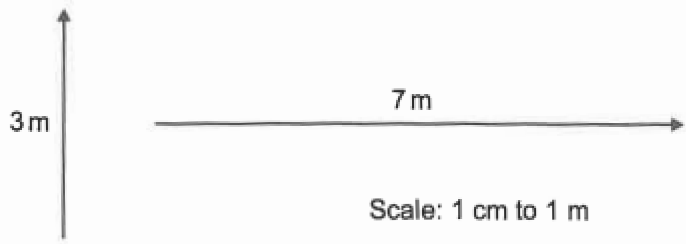
*You can use **Scale Drawings** to **Represent Displacement***

The simplest way to draw a vector is to draw an **arrow**. So for a displacement vector the **length** of the arrow tells you the **distance**, and the way the arrow **points** shows you the **direction**.

You can do this even for very large displacements so long as you **scale down**. Whenever you do a scale drawing, make sure you **state the scale** you are using.

EXAMPLE: Draw arrows to scale to represent a displacement of 3 metres upwards and a displacement of 7 metres to the right.

A displacement of 3 metres upwards could be represented by an arrow of length 3 centimetres. Using this same scale (1 cm to 1 m) a displacement of 7 metres to the right would be an arrow of length 7 centimetres.

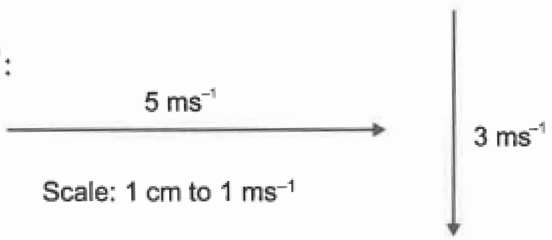


*You can also **Represent Velocities** with **Arrows***

Velocity is a **vector**, so you can **draw arrows** to show velocities too. This time, the **longer** the **arrow**, the **greater** the **speed** of the object. A typical scale might be 1 cm to 1 ms^{-1}.

EXAMPLE: Draw arrows to scale to represent velocities of 5 metres per second to the right and 3 metres per second downwards.

Draw the velocities like this with a scale of 1 cm to 1 ms^{-1}:



Task 2: Answer the questions below using the information above only for assistance.

1) Draw arrows representing the following displacements to the given scale:
   a) 12 m to the right (1 cm to 2 m)
   b) 110 miles at a bearing of 270^0 (1 cm to 20 miles)
2) Draw an arrow to represent each velocity to the given scale. Take north to be up the page.
   a) 60 ms^{-1} to the south-east (1 cm to 15 ms^{-1})
   b) 120 miles per hour to the west (1 cm to 30 miles per hour)

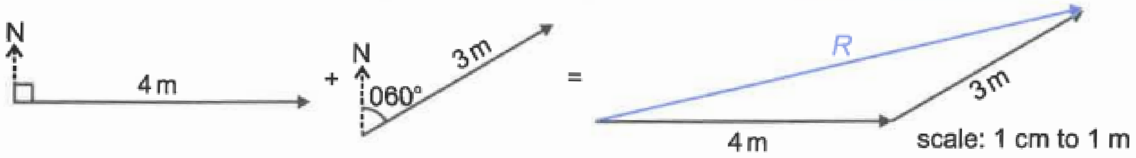
Task 3: Read the information below and highlight annotate any key information or examples.

You can use **Arrows** to **Add** or **Subtract Two Vectors...**

To **add** two velocity or displacement vectors, you **can't** simply add together the two distances as this doesn't account for the **different directions** of the vectors. What you do is:

1) **Draw** arrows representing the two vectors.
2) **Place** the arrows **one after the other** "tip-to-tail".
3) Draw a **third** arrow from start to finish. This is your **resultant vector**.

EXAMPLE: Add a displacement of 4 metres on a bearing of 090° to a displacement of 3 metres on a bearing of 060°. Use a scale of 1 cm to 1 m.



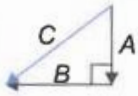
R is the **resultant** vector— it's the sum of the two displacements.
You can find the size of R by measuring the arrow and scaling up.
In this case it's 6.7 cm long which means the displacement is **6.7 m**.

To **subtract** vectors you need to **flip the direction** of the vector you are subtracting.
This **changes the sign** of the vector.
Adding the flipped vector is the **same** as **subtracting** the vector.

For example: 3 m → − 4 m → = 3 m → + ← (−4 m) = ← −1 m

...Or Use **Pythagoras** if the Vectors make a **Right Angle Triangle**

If two vectors, A and B, are at right angles to each other, you can also use Pythagoras' theorem to find the resultant. ➡ $A^2 + B^2 = C^2$

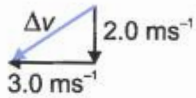


EXAMPLE: An object has an initial velocity of 3.0 ms^{-1} to the right, and a final velocity of 2.0 ms^{-1} down. Find the size of the change in velocity.

Change in velocity = Δv = final velocity – initial velocity.

First, flip the direction and change the sign of the vector that is being subtracted.

↓ 2.0 ms^{-1} − 3.0 ms^{-1} → = ↓ 2.0 ms^{-1} + ← 3.0 ms^{-1} =



$A^2 + B^2 = C^2$, so $C = \sqrt{A^2 + B^2} = \sqrt{2.0^2 + 3.0^2} = 3.605... =$ **3.6 ms^{-1} (to 2 s.f.)**

(This answer is rounded to 2 s.f. to match the data in the question — see page 1.)

Task 4: Answer the questions below using the information above only for assistance.

1) Find the size of the resultant of the following displacements by drawing the arrows "tip-to-tail".
   a) 5.0 m right and 4.0 m up.
   b) 15.0 miles south and 15.0 miles on a bearing of 045 ^{0}.
2) Initial velocity = 1 .0 ms^{-1} west and final velocity = 3.0 ms^{-1} north. Find the size of Δv.

Task 5: Read the information below and highlight annotate any key information or examples.

You can Split a **Vector** *into* **Horizontal** *and* **Vertical Components**

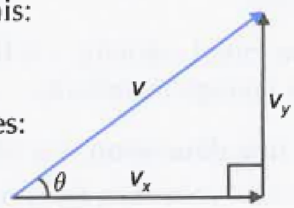
1) Vectors like **velocity** and **displacement** can be **split** into **components**.
2) This is basically the opposite of finding the resultant — you start from the resultant vector and split it into two separate vectors at **right angles** to each other.
3) Together these two components have the **same effect** as the **original** vector.
4) To find the components of a vector, v, you need to use **trigonometry**:

You get the **horizontal** component v_x like this:

$$\cos\theta = \frac{v_x}{v}$$

Rearranging this gives:

$$v_x = v\cos\theta$$



...and the **vertical** component v_y like this:

$$\sin\theta = \frac{v_y}{v}$$

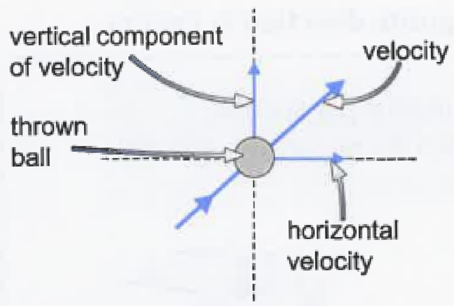
Rearranging this gives:

$$v_y = v\sin\theta$$

You can also **rearrange** these equations to find θ. E.g. if you know v_x and v then:

$$\theta = \cos^{-1}\left(\frac{v_x}{v}\right)$$

Resolving is dead useful because the two components of a vector **don't affect each other**. This means you can deal with the two directions **completely separately**.

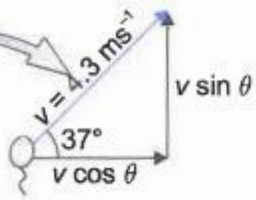


If you throw a ball diagonally up and to the right...

- Only the vertical component of the velocity is affected by gravity (see page 7).
- You can calculate the ball's vertical velocity (which will be affected by gravity).
- And you can calculate the ball's horizontal velocity (which won't be affected by gravity).

EXAMPLE: A helium balloon is floating away on the wind. It is travelling at 4.3 ms^{-1} at an angle of 37° to the horizontal. What are the vertical and horizontal components of its velocity?

It's useful to start off by drawing a diagram:



Horizontal velocity = $v_x = v\cos\theta = 4.3 \times \cos 37$
$= 3.434... =$ **3.4 ms^{-1} (to 2 s.f.)**

Vertical velocity = $v_y = v\sin\theta = 4.3 \times \sin 37$
$= 2.587... =$ **2.6 ms^{-1} (to 2 s.f.)**

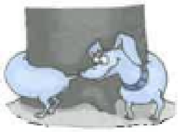
Task 6: Answer the questions below using the information above only for assistance.

1. A rugby ball is moving at 12 ms^{-1} at an angle of 68^0 to the horizontal. Find the horizontal and vertical components of the ball's velocity.
2. A plane is travelling at 98 ms^{-1} at a constant angle as it gains altitude. The horizontal velocity of the plane is 67 ms^{-1}. What is its angle of ascent?
3. A hot air balloon descends at a velocity of 5.9 ms^{-1} at an angle of 23 ^{0} to the horizontal. How long does it take the balloon to descend 150 m?

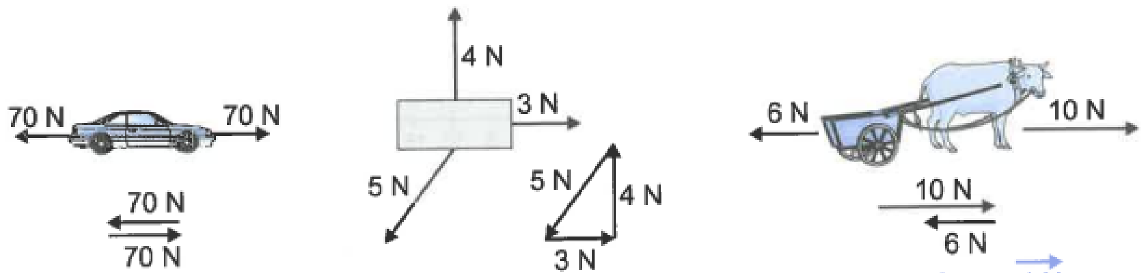
Task 7: Read the information below and highlight annotate any key information or examples.

The Resultant Force is the Sum of All the Forces

1) Force is a **vector**, just like displacement or velocity.
2) When **more than one force** acts on a body, you can **add them together** in just the same way as you add displacements or velocities.
3) You find the **resultant force** by putting the arrows "tip-to-tail".
4) If the resultant force is **zero**, the forces are **balanced**.
5) If there's a resultant force, the forces are **unbalanced** and there's a **net force** on the object.



EXAMPLE: Find the resultant force on each object below and decide if the forces are balanced or unbalanced.



Resultant force = 0 N
Balanced

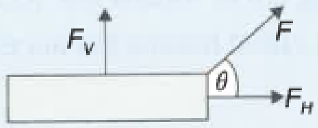
Resultant force = 0 N
Balanced

Resultant force: 4 N →
Unbalanced

You can Resolve Forces just like Other Vectors

1) Forces can be in **any direction**, so they're not always at right angles to each other. This is sometimes a bit **awkward** for **calculations**.
2) To make an 'awkward' force easier to deal with, you can think of it as **two separate forces**, acting at **right angles** to **each other**.

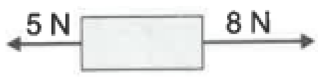
The force F has exactly the same effect as the horizontal and vertical forces, F_H and F_V.
Use these formulas when resolving forces:

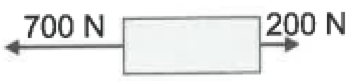


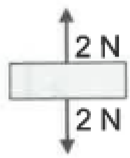
$$F_H = F\cos\theta \text{ and } F_V = F\sin\theta$$

Task 8: Answer the questions below using the information above only for assistance.

1) Work out the resultant forces on these objects. Are the forces are balanced or unbalanced?

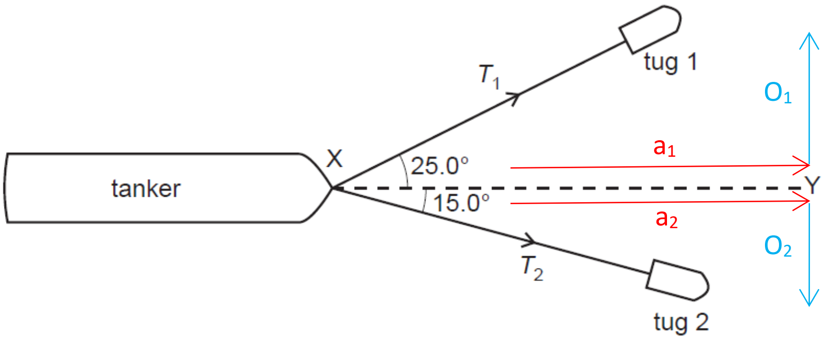
a) 

b) 

c) 

2) The engine of a plane provides a force of 920 N at an angle of 12 ^{0} above the horizontal. What is the horizontal component of the force?
3) A kite surfer is pulled along a beach by a force of 150 N at an angle of 78 ^{0} above the horizontal. What is the vertical component of the force?

Task 9: Attempt the question below using all the information covered.



T_1 applies a force of 550N and T_2 force of 445N to the tanker.

Ignore any effect of air/water resistance.

a) Calculate the resultant force.

b) Calculate the angle from horizontal this force acts from

Task 10: Without any further calculations state if there is an alternative way of checking your answers to "a" & "b". If so explain how you would go about it.

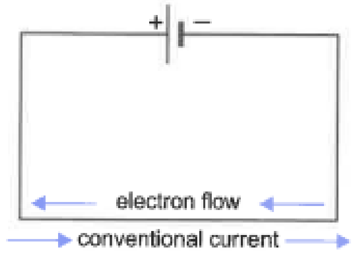
Task 11: Ensure that you are up to date with key vocabulary for the start of the course. Do this by filling in the definition section for each row.

Key term or word	Definition
Scalar quantity	
Vector Quantity	
Contact Force	
Non-contact Force	
Equilibrium	
Resultant Forces	
Power	
Newton’s 1st law	
Newton’s 2nd law	
Newton’s 3rd law	
Momentum	
Density	
Elastic Behaviour	
Plastic Behaviour	
Limit of Proportionality	

Task 12: Read the information below and highlight annotate any key information or examples.

Electric Current *— the* ***Rate of Flow*** *of* ***Charge*** *Around a* ***Circuit***

1) In a circuit, **negatively-charged electrons** flow from the **negative** end of a battery to the **positive** end.
2) This flow of charge is called an **electric current**.
3) However, you can also think of current as a flow of **positive charge** in the **other direction**, from **positive** to **negative**. This is called **conventional current**.



The electric current at a point in the wire is defined as:

$$\textbf{current} \text{ (in amperes, A)} = \frac{\text{the } \textbf{amount of charge} \text{ passing the point (in coulombs, C)}}{\text{the } \textbf{time it takes} \text{ for the charge to pass (in seconds, s)}}$$

Or, in symbols: $I = \frac{Q}{t}$

EXAMPLE: 585 C of charge passes a point in a circuit in 45.0 s. What is the current at this point?

$I = \frac{Q}{t}$, so $I = \frac{585}{45.0} = \mathbf{13.0\ A}$

Potential Difference *(Voltage) — the* ***Energy Per Unit Charge***

1) In all circuits, energy is **transferred** from the power supply to the **components**.
2) The **power supply** does **work** on the **charged particles**, which **carry** this energy **around** the circuit.
3) The potential difference **across a component** is defined as the **work done** (or energy transferred) **per coulomb** of charge moved through the component.

$$\textbf{Potential difference across component} \text{ (in volts, V)} = \frac{\textbf{work done} \text{ (in joules, J)}}{\textbf{charge moved} \text{ (in coulombs, C)}}$$

In symbols: $V = \frac{W}{Q}$

EXAMPLE: A component does 10.8 J of work for every 2.70 C that passes through it. What is the potential difference across the component?

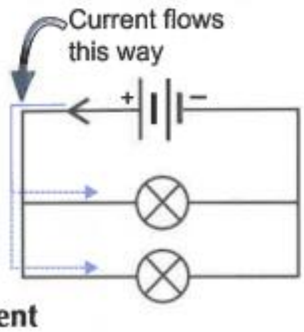
$V = \frac{W}{Q}$, so $V = \frac{10.8}{2.70} = \mathbf{4.00\ V}$

Task 13: Answer the questions below using the information above only for assistance.

1) How long does it take to transfer 12 C of charge if the average current is 3.0 A?
2) The potential difference across a bulb is 1 .5 V.
   How much work is done to pass 9.2 C through the bulb?
3) A motor runs for 275 seconds and does 9540 J of work. If the current in the circuit is 3.80 A, what is the potential difference across the motor?

Task 14: Read the information below and highlight annotate any key information or examples.

Charge is *Always Conserved* in Circuits

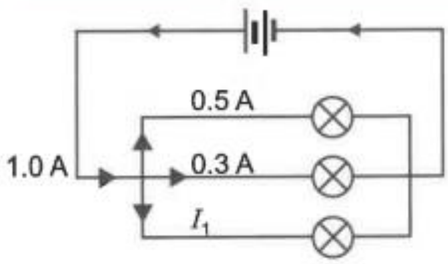


1) As **charge flows** through a circuit, it **doesn't** get **used up** or **lost**.
2) You can easily build a circuit in which the electric current can be **split** between **two wires** — two lamps connected in **parallel** is a good example.
3) Because charge is **conserved** in circuits, whatever charge flows **into** a junction will flow **out** again.
4) Since **current** is **rate of flow of charge**, it follows that whatever **current flows into** a junction is the **same** as the **current flowing out** of it.

   the **sum** of the **currents going into the junction** = the **sum** of the **currents going out**

   This is **Kirchhoff's first law**. It means that the current is the **same** everywhere in a **series circuit**, and is **shared between the branches** of a **parallel circuit**.
5) N.B. — current arrows on circuit diagrams normally show the direction of flow of **conventional current** (see p.25).

EXAMPLE: Use Kirchoff's first law to find the unknown current I_1.



Sum of currents in = sum of currents out

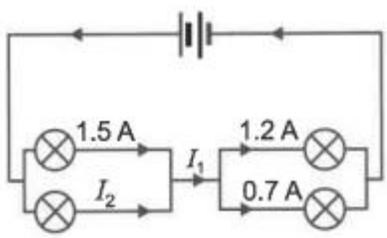
$1.0 = 0.5 + 0.3 + I_1$

$1.0 = 0.8 + I_1$

$I_1 = 1.0 - 0.8$

$I_1 = \mathbf{0.2\ A}$

EXAMPLE: Calculate the missing currents, I_1 and I_2, in this circuit.



Looking at the junction immediately after I_1:

$I_1 = 1.2 + 0.7$

$I_1 = \mathbf{1.9\ A}$

And looking at the junction immediately before I_1:

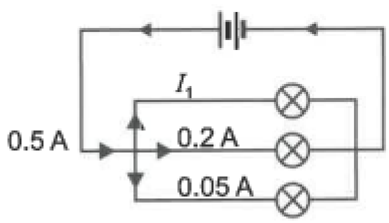
$1.5 + I_2 = 1.9$

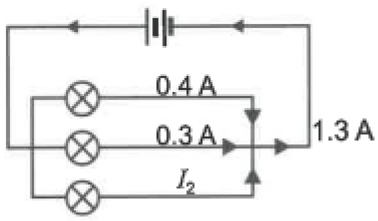
$I_2 = 1.9 - 1.5$

$I_2 = \mathbf{0.4\ A}$

Task 15: Answer the questions below using the information above only for assistance.

1) Work out the values for I_1 & I_2.





Task 16: Read the information below and highlight annotate any key information or examples

Energy is **Always Conserved** in **Circuits**

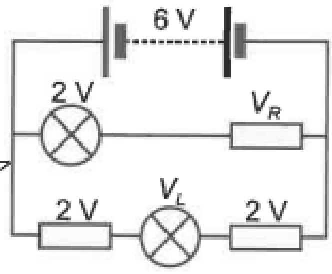
1) Energy is **given** to **charged particles** by the **power supply** and **taken off them** by the **components** in the circuit.
2) Since energy is **conserved**, the **amount** of energy one coulomb of charge loses when going around the circuit must be **equal to** the energy it's **given** by the power supply.
3) This must be true **regardless** of the **route** the charge takes around the circuit. This means that:

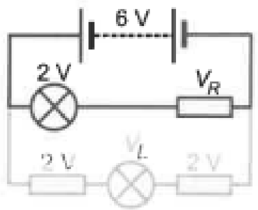
For any **closed loop** in a circuit, the **sum** of the **potential differences** across the components **equals** the **potential difference** of the **power supply**.

This **Kirchhoff's second law.** It means that:

- In a **series circuit**, the potential difference of the power supply is split between all the components.
- In a **parallel circuit**, each **loop** has the same potential difference as the power supply.

EXAMPLE: Use Kirchoff's second law to calculate the potential differences across the resistor, V_R, and the lamp, V_L, in the circuit shown on the right.



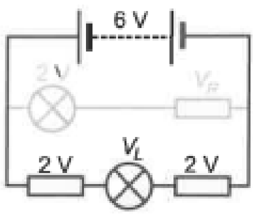


First look at just the top loop:

p.d. of power supply = sum of p.d.s of components in top loop

$6 = 2 + V_R$

So $V_R = 6 - 2 = \mathbf{4\ V}$



Now look at just the outside loop:

p.d. of power supply = sum of p.d.s of components in outside loop

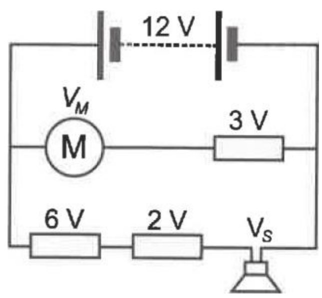
$6 = 2 + V_L + 2$

So $V_L = 6 - 2 - 2 = \mathbf{2\ V}$

Task 17: Answer the questions below using the information above only for assistance.

1) For the circuit on the right, calculate:
   a) the voltage across the motor, VM
   b) the voltage across the loudspeaker, Vs.

2) A third loop containing two filament lamps is added to the circuit in parallel with the first two loops. What is the sum of the voltages of the two filament lamps?



Task 18: Attempt the question below using all the information covered.

1) Work out the voltage of the other cell.
2) Work out the current if the total resistance of the circuit is 4Ω
3) Calculate the resistance of each individual bulb.
4) If you built this circuit how you would you be able to tell which bulb was which; without taking measurements?