AQA Trilogy Science

SAMUEL WARD ACADEMY TRUST

Paper 1 Physics topics

- Energy and energy resources
  - Conservation and dissipation of energy
  - Energy transfer by heating
  - Energy resources
- Particles at work
  - Electric circuits
  - Electricity in the home
  - Molecules and matter
  - Radioactivity

Paper 2 Physics topics

- Forces in action
  - Forces in balance
  - Motion
  - Forces and motion
- Waves and electromagnetism
  - Wave properties
  - Electromagnetic waves
  - Electromagnetism

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Trilogy P1: Conservation and dissipation of energy

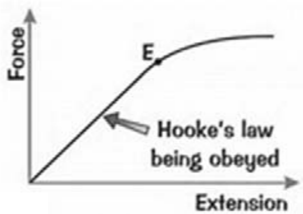
Part of: Energy

Knowledge Organiser

Key points to learn

1. Energy stores [J]	Chemical energy
	Kinetic energy
	Gravitational potential energy
	Elastic potential energy
2. Chemical energy [J]	Transferred during chemical reactions eg fuels, foods, or in batteries
3. Kinetic energy [J]	All moving objects have it
	k.e = 0.5 x mass x (speed)^2 E_k = ½ x m x v^2 [J] [kg] [m/s]
4 Gravitational potential energy [J]	Stored in an object lifted up
	g.p.e = mass x g x height E_p = m x g x h [J] [kg] [N/kg] [m]
5. Elastic potential energy [J]	Energy stored in a springy object
	e.p.e = 0.5 x spring constant x (extension)^2 E_e = ½ x k x e^2 [J] [N/m] [m] *(You are given this equation)*
6. Energy can be transferred by…	Heating (thermal energy always flows from hot to cold objects)
	An electrical current flowing
	A force moving an object
	Radiation eg light
7. Useful energy [J]	Energy transferred to the place and in the form we need it
8. Wasted energy [J]	Not useful. Eventually transferred to surroundings

Key points to learn

9. Work done [J]	Equal to the energy transferred
	When a force moves an object
	Work done = Force x distance moved W = F x s [J] [N] [m]
10. Energy flow diagram	Show energy transfers eg for a torch lamp:
	Chemical → Light + Heat
11. Conservation of energy	Energy cannot be created or destroyed It can only be transferred usefully, stored or dissipated
12. Dissipated energy [J]	Wasted energy, usually spread to the surroundings as heat
13. Hooke's Law and k the spring constant	The extension of a spring is proportional to the force on it
	The gradient of this graph is known as k, the spring constant. 
14. Efficiency	Proportion of input energy transferred to useful energy. 100% means no wasted energy. Efficiency = useful energy ÷ total input energy
15. Power [W]	Energy [J] transferred in 1 second.
	Power [W] = Energy [J] ÷ time [s]
16. Wasted power [W]	Total power in – useful power out

Big picture (Physics Paper 1)

- Energy and energy resources
  - **Conservation and dissipation of energy**
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  - Energy resources
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Background

Energy is the capacity of something to make something happen.
The Universe and everything in it is constantly changing energy from one form into another.

Maths skills

You should be able to recall, use and rearrange all the equations on this page except number 5.

g is Earth's acceleration due to gravity. It has a constant value of approximately 9.8m/s^2

You need to remember the units for each quantity. They are in [ ] next to equations.

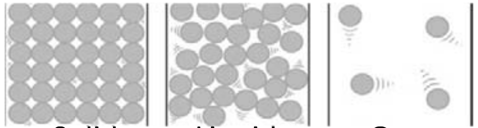
You should be able to calculate the gradient of a Force – extension graph.

Trilogy P2: Energy transfer by heating

Part of: Energy

Knowledge Organiser

Key points to learn

1. States of matter	
2. Solid	Particles held together in fixed positions by strong forces. Least energetic state of matter
3. Liquid	Particles move at random and are in contact with each other. More energy than solids, less than gas
4. Gas	Particles move randomly and are far apart. Weak forces of attraction. Most energetic
5. Vacuum	No particles at all. Space is a vacuum
6. Metals	Have free electrons which makes them good conductors
7. Non-metals	Have fixed electrons which makes them good insulators
8. Conductor	Is good at carrying heat energy or electrical energy
9. Thermal conductivity	A measure of how good something is at conducting
10. Insulator	A poor conductor
11. Friction	Two surfaces rubbing together
	Causes energy to be transferred as heat
	Can be reduced by using a lubricant
12. Lubricant	Fluid (eg oil) that smooths contact points between surfaces

Key points to learn

13. More energy loss from a building	If walls are thin
	If walls have high thermal conductivity
	Big temperature difference between inside and outside
14. Reduce heat loss by	Using material with low thermal conductivity ie an insulator
	Make insulator thicker
15. Specific heat capacity, c [J/kg°C]	Amount of energy needed to change temperature of 1kg by 1°C
	$\Delta E = mc\Delta\theta$ *(You are given this equation)* • ΔE: Change in energy [J] • m: mass of object • c: *specific heat capacity* • $\Delta\theta$: change in temperature [°C]
	Objects with high specific heat capacity take a long time to heat up and cool down. They are good at storing heat energy
16. Loft insulation	Fibreglass which traps air which is a good insulator
17. Cavity wall insulation	Traps air pockets in gaps which is a good insulator
18. Double glazing	Traps air in gaps between glass which is a good insulator
19. Foil behind radiator	Reflects heat away from wall back into room

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Background

Not wasting heat energy in your home is important for the environment and for your finances. This topic will help you make more informed decisions so that you can save even more.

Maths skills

You should be able to use the specific heat capacity equation to find energy change and the specific heat capacity when given all other variables. Rearranging to make c the subject:

$$c = \frac{\Delta E}{m\Delta\theta}$$

Key points to learn

1.Fuel	Substance that we burn to release heat energy
	Stores chemical energy
2. Fossil fuels	Coal, oil and gas
	Remains of ancient organisms. Millions of years to form
	Are non-renewable
	Release carbon dioxide when burnt
3. Non-renewable	Are used quicker than they are made. So will run out
4. Renewable fuels	Made quicker than they are used. Will not run out
	These energy sources are renewable: • Biofuel • Wind and Wave • Geothermal • Hydroelectric and Tidal • Solar
5. Biofuel	Fuel made from living organisms eg vegetable oil, ethanol, wood
	Are considered carbon-neutral because CO_2 released is balanced by amount taken in by photosynthesis
	Reliable – can even be used fossil fuel power stations
	Reduces land available for food growth
	Renewable
6. Burning fuels	Releases carbon dioxide which contributes to the greenhouse effect and global warming

Key points to learn

7. Decommission	Take apart and make safe at the end of its life
8. Wind and wave power	Kinetic energy of the air/water turns turbines
	Unreliable as both need wind
	Renewable
9. Geothermal power	Use heat energy from deep underground instead of fuel
	Not available everywhere
	Renewable
10. Hydroelectric and Tidal power	Water stored high up in dams then released to spin a turbine
	Very quick start-up time
	Can destroy habitats for animals
	Renewable
11. Solar power	Use light or heat energy from the Sun
	Unreliable as needs sun
	Renewable
12. Nuclear fuel	Energy stored in nucleus as nuclear energy. Uranium or Plutonium
	Heat release in reactor core
	High energy yield
	Very slow start-up time as potentially dangerous
	Fuel and waste is radioactive
	Very expensive to set up and decommission

Trilogy P3: Energy Resources

Part of: Energy

Knowledge Organiser

Big picture (Physics Paper 1)

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Background

It is hard to imagine a World without electricity. It reaches into every aspect of our lives. But where do we get the energy to make it from? Will they run out? Have we got a backup plan?

Additional

To make electricity, we usually spin a turbine which we then attach to a generator. Making that turbine spin, is the problem…

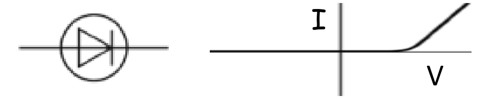
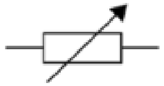
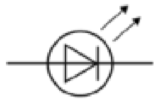
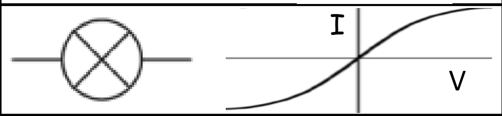
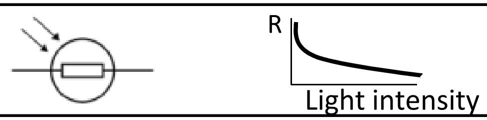
The most common way is by burning fuels to boil water, then shooting the steam at the turbine. But there are issues with this, as you will find out.

Trilogy P4: Electric circuits

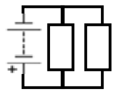
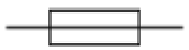
Part of: Electricity

Knowledge Organiser

Key points to learn

1. Diode	
	Current only flows one way. Very high resistance in other direction
2. Resistor (Ohmic conductor)	
	Resistance stays constant. Current proportional to pd
3. Variable resistor	Resistance can be set by a human. Used in dimmer switches 
4. LED	A diode that gives off light 
5. Lamp	
	Resistance increases as the temperature increases
6. Thermistor	
	Resistance decreases as the temperature increases
	Used in thermostats
7. LDR	
	Resistance decreases as the light intensity increases (gets brighter)
	Used in automatic lights

Key points to learn

8. Cell and battery	Provides the potential difference (pd) and energy for a circuit. 
9. Current, I	Rate of flow of electrical charge. Measured in Amps (A)
10. Charge, Q	Measured in Coulombs (C)
11. Potential difference, V	pd. Energy transferred per unit charge. Measured in Volts (V)
12. Resistance R	Ability to slow current. Measured in Ohms (Ω)
13. Series circuit	Current has only one route
	Current is the same all the way around. Potential difference is shared across components
	Resistances are added together
14. Parallel circuit	Current has different paths it could take 
	Current is shared through each branch. Potential difference is the same across each branch
	Total resistance is lower than the smallest single resistor
15. Voltmeter	Measures pd across a component 
16. Ammeter	Measures current through a component 
17. Fuse	Resistor that melts if current is too high 

Big picture (Physics Paper 1)

- Energy and energy resources
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  - Electricity in the home
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Background

Electrical power fills the modern world with light and sound, information and entertainment, remote sensing and control. Its use was identified and explored by scientists of the 19th century but it becomes more important every day.

Maths skills

- **Q = I x t**
  Charge = Current x time
  [C] [A] [s]
- **V = I x R**
  Potential difference = Current x Resistance
  [V] [A] [Ω]

(You need to be able to remember and use these)

Trilogy P5: Electricity in the home

Part of: Electricity

Knowledge Organiser

Big picture (Physics Paper 1)

- Energy and energy resources
  - Conservation and dissipation of energy
  - Energy transfer by heating
  - Energy resources
- Particles at work
  - Electric circuits
  - **Electricity in the home**
  - Molecules and matter
  - Radioactivity

Background

We use electricity in all aspects of modern life. But how is it moved from power stations to our homes and then to our devices? This topic answers that question as well as investigating how power companies measure our electricity usage.

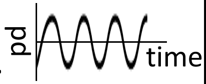
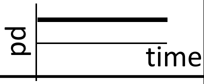
Maths skills

- E = P x t
  Work done = Power x time
  [J] [W] [s]
  [kWh] [kW] [hr]

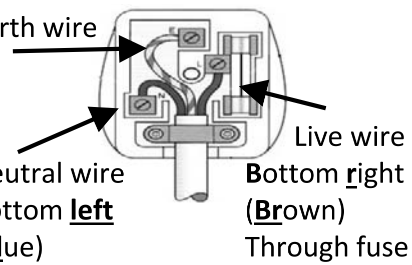
(You need to remember and be able to use all of the equations on this sheet.)

- E = Q x V
  Work done = Charge flow x potential difference
  [J] [C] [V]

Key points to learn

1. ac	Alternating current Found in mains
	Has an alternating potential difference (voltage) negative to positive. 
2. dc	Direct current Found in batteries 
	Has a constant potential difference (voltage)
3. UK mains	AC supply of 230Volts and frequency of 50Hz
4. Power, P	Energy [J] transferred in one second. Measured in Watts (W)
5. Potential difference, V	Also known as voltage. Measured in volts (V)
6. Energy transferred, E	Depends on the power of the appliance and the time it is on for. Also called work done
7. Energy transfer diagram	Energy input → Useful energy + Wasted energy
8. Work done, E	Energy transferred when current flows in a circuit
9. National grid	System of cables and transformers
10. Step-up transformer	Increase potential difference so that less heat energy is wasted
11. Step-down transformer	Decrease potential difference to make electric more easily used

Key points to learn

12. Current, I	Measured in Amps (A)
13. Resistance, R	Measured in ohms (Ω)
14. Live wire	Brown. Connects to fuse
	Carries the alternating potential difference from the supply
	About 230V
15. Neutral wire	Blue wire
	Completes the circuit
	Around 0V
16. Earth wire	Green and yellow striped wire
	Carries current safely to Earth if there is a fault
	Normally 0V
17.Electrical plug	Made of plastic as it is a good insulator
	

- P = V x I
  power = potential difference × current
  [W] [V] [A]
- P = I^2 × R
  power = $current^2$ × resistance
  [W] [A] [Ω]

Trilogy P6: Molecules and matter

Part of: Particle model of matter

Knowledge Organiser

Big picture (Physics Paper 1)

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Background

The particle model is widely used to predict the behaviour of solids, liquids and gases. It helps us to design vehicles from submarines to spacecraft. It even explains why it is difficult to make a good cup of tea high up a mountain!

Maths skills

$$density = \frac{mass}{Volume}$$

[kg/m³] $\rho = \frac{m}{V}$ $\frac{[kg]}{[m^3]}$

(You need to remember this.)

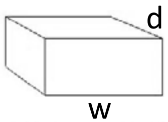
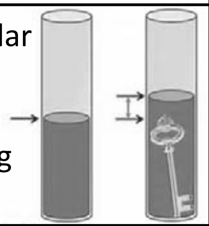
Latent heat: $Energy = \text{mass x specific latent heat}$

$$E = m \times L$$

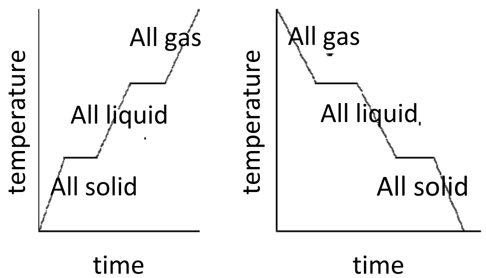
[J] [kg] [J/kg]

(You are given this)

Key points to learn

1. Mass, m	Amount of matter in something. Measured in kg
2. Volume, V	Amount of space something takes up. Measured in m³
	Volume of a cuboid = w x d x h 
	Volume of an irregular object can be found by dropping in a liquid and measuring displacement 
3. Density, ρ	Mass per unit volume. Measured in kg/m³
	$density = \frac{mass}{volume}$
4. Floating	An object that has a lower density than the fluid will float
5. Sinking	An object that has a higher density than the fluid will sink
6 Evaporation	Happens at any temperature
7 Sublimation	Solid turns straight into gas
8. Solid	Particles held together in fixed positions by strong forces. Least energetic state of matter
9. Liquid	Particles move at random and are in contact with each other. More energy than solids, less than gas
10. Gas	Particles move randomly and are far apart. Weak forces of attraction. Most energetic.

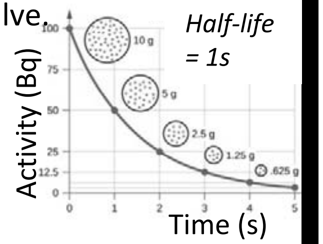
Key points to learn

11. Melting point	Temperature when solid turns into liquid. Same as freezing point
12. Boiling point	Temperature when liquid turns into gas. Same as condensation point
13. Condensation point	Temperature when gas turns into liquid. Same as boiling point
14. Freezing point	Temperature when liquid turns into solid. Same as melting point
15. Latent heat	Energy transferred when a substance changes state but temperature doesn't change
16. Specific latent heat of fusion	Energy needed to melt 1kg of solid into liquid
17. Specific latent heat of vaporisation	Energy needed to boil 1kg of liquid into gas
18. At state changes…	Temperature and kinetic energy of particles stays constant
	Internal energy increases due to an increase in potential energy as particles move further apart
19. Heating and cooling curves	
20. Gas pressure	Caused by particles hitting surfaces. Increases when temperature increases

Key points to learn

1. Radioactive decay	Unstable nuclei emitting a type of radiation (α, β , γ or neutron)
2. Random event	You cannot predict or change when decay might happen
3. Ionising	The ability to charge atoms
4. Alpha particle (α)	Two neutrons and two protons. The same as a helium nucleus
	Stopped by paper or skin
$^{4}_{2}He$	Range of a couple of cm in air
	Highly ionising: has charge of +2
	Parent atom mass drops by 4 and atomic number drops by 2
5. Beta particle (β)	A high speed electron made when a neutron turns into a proton
	Stopped by thin aluminium
$^{0}_{-1}e$	Range of up to one metre
	Mid ionising: has charge of -1
	Parent atom mass remains same and atomic number rises by 1
6. Gamma ray (γ)	An electromagnetic wave
	Stopped by thick lead
$^{0}_{0}\gamma$	Unlimited range
	Low ionising: has no charge
	Parent atom mass and atomic number remains same
7. Neutron (n)	Neutron ejected from the nucleus

Key points to learn

8. Activity	Rate of unstable nuclei decay. Measured in Becquerel (Bq)
9. Irradiated	Exposed to radiation but does not become radioactive
10. Radioactive contamination	Unwanted presence of radioactive material
11 Geiger counter	Nuclear radiation detector
12. Half-life	Time it takes for the radioactive nuclei to halve. Or, the time it takes for the activity to halve. 
13. Nuclear model of the atom	Very small, radius of ≈$1x10^{-10}$m Most of mass in the nucleus. Number of electrons = protons
14. Mass number	Number of neutrons + protons
15. Atomic number	Number of protons $^{4}_{2}He$
16. Isotope	Same number of protons different number of neutrons
17. Ion	Atom where number of protons is not equal to electrons (+'ve or –'ve)
18. Plum pudding atom model	Early model: ball of positive charge with electrons stuck in it
19. Bohr Model	Idea that electrons have to be at certain distances from nucleus
20. Chadwick	Discovered neutrons

Trilogy P7: Radioactivity

Part of: Atomic Structure

Knowledge Organiser

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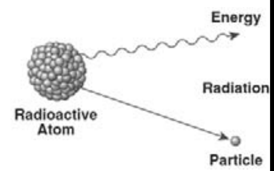
Background

Researched by Henri Becquerel and Marie Curie around 1900 it remains mysterious and frightening.



Maths skills

- *Nuclear decay equations:* Balance top and bottom numbers on RHS and LHS.
  $$^{226}_{88}\mathrm{Ra} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{222}_{86}\mathrm{Rn}$$
- *Finding Half-life using a graph*
  Find how long It takes until you have half what you started with