Key

relative atomic mass **atomic symbol** name atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112 – 116 have been reported but not fully authenticated						

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

Trilogy P1: Conservation and dissipation of energy

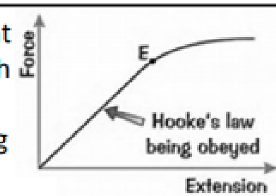
Collins revision guide: Energy

Knowledge Organiser

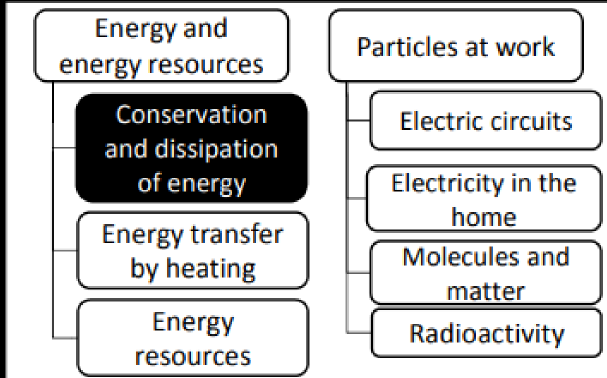
Key points to learn

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
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)



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.

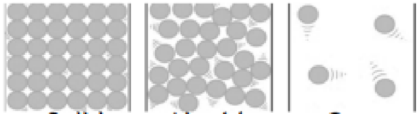
You should be able to calculate the gradient of a Force – extension graph.

Trilogy P2: Energy transfer by heating

Collins revision guide: Energy

Knowledge Organiser

Key points to learn

1. States of matter	 Solid Liquid Gas
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
	$E = mc\ \theta$ *(You are given this equation)* • E: Change in energy [J] • m: mass of object • *c: specific heat capacity* • θ: 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

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

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:

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

Trilogy P3: Energy Resources

Collins revision guide: Energy

Knowledge Organiser

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

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

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…

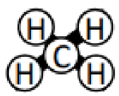
The most common way is by burning fuels to boil water, then shooting the steam at the turbine. But there are issues with this, as you will find out.

Trilogy C4: Chemical calculations

Collins rev. guide: Quantitative chemistry

Knowledge Organiser

Key points to learn

1. Atom	Smallest part of an element that can exist
	Hydrogen atoms (4H) 
2. Molecule	Two or more atoms chemically bonded
	Hydrogen molecule (H_2)  Water molecule (H_2O) 
3. Element	Only one type or atom present. Can be single atoms or molecules
	Both examples of the Nitrogen element (N_2)  (N) 
4. Compound	Two or more different elements chemically bonded
	Carbon dioxide (CO_2)  Methane (CH_4) 
5. Mass number	Number of neutrons + protons ⇨ $^{11}_{5}B$ (*6 Neutrons + 5 Protons*)
6. Atomic number	Number of protons ⇨ (*5 Protons*)
7. Relative Atomic Mass	A_r The mass number of an atom. Eg A_r of O is 16 and H is 1
8. Relative Formula Mass	M_r The mass of all the atoms of a molecule added together. Eg M_r of H_2O is (2 x 1) + 16 = 18
9. Mole	An amount where either the A_r or M_r is written in grams. Eg one mole of water has a mass of 18g
10. Solute	Solid that has been dissolved

Key points to learn

11. Isotope	Same number of protons different number of neutrons
12. Numbers in reaction equations	Big numbers in front of a chemical tell us how many molecules/atoms of that chemical there are
13. Balancing equations	The number of atoms in the reactants must equal the number of atoms in the products
	Steps to balance an equation 1) $Mg + O_2 \rightarrow MgO$ *Needs another O on product side* 2) $Mg + O_2 \rightarrow$ **2**MgO *Only add big numbers in front* *Now needs more Mg on reactants* 3) **2**$Mg + O_2 \rightarrow 2MgO$ *Only add big numbers in front*
	The table you will have drawn to help Mg: ~~1~~ 2 → ~~1~~ 2 O: 2 → ~~1~~ 2
14. Chemical reaction	Reactants → Products *'turn into'*
15 Conservation of mass	In a chemical reaction the total mass of reactants = total mass of products
16 If mass seems to be lost/gained	Conservation of mass always applies but sometimes the mass of a gas being used/made is missed
17. Concentration	The mass of solute in a given volume of solution
	Concentration [g/dm³] = mass of solute [g] / volume of solution [dm³]
18. Solution	Liquid containing dissolved solute

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - **Chemical calculations**
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes

Background

Want to make enough pancakes for everyone? Then you need to know quantities. Chemical reactions are the same (cooking is a chemical reaction!). This topic explores in more detail.

Maths skills

Steps to balance an equation:

1. Write down the symbols of each element then count how many are on each side of the equation
2. Leave Hydrogen and Oxygen till last if it's complicated
3. Start with an element that appears in the least molecules first (usually a metal)
4. Only add big numbers to the left of each chemical. You can't change molecules

Trilogy C8: Rates and equilibrium

Collins revision guide: The rate and extent of chemical change

Knowledge Organiser

Key points to learn

1. Chemical reaction	Reactants → Products *'turn into'*
2. Reactants	Ingredients in a chemical reaction
3. Products	The chemicals that are produced
Conservation of mass 4	In a chemical reaction the total mass of reactants = total mass of products
5. Rate	How quickly something happens. Usually measured per second
6. Rate of reaction	How fast reactants turn into products
7. Measuring rate of reaction	1. Measure decrease in mass of a reaction if a gas is given off
	2. Increase in volume of gas given off. Catch gas given off
	3. Decrease in light passing through a solution
8. Calculating rate of reaction	The steepness of the line at any point on a reaction vs time graph.
	The steeper the line on the reaction vs time graph, the faster the reaction
9. Increasing temperature	Increases speed and energy of particles
10. Concentration	Amount of a substance per defined volume units of mol/dm^3
11. Pressure	Force applied per unit area [N/m^2]
12 Endothermic	Reaction that absorbs in energy
13 Exothermic	Reaction that releases heat energy
14 Equilibrium	Concentrations remain constant

Key points to learn

15. Collision theory	Reactions occur when particles collide with enough energy
16. Activation energy	Minimum energy needed in a collision for a reaction to occur
17. Increasing rate of reaction	1. Either need more particle collisions or more energetic collisions
	2. Increase surface area to volume ratio: greater rate of collisions
	3. Increase concentration: more particles, greater rate of collisions
	4. Increase pressure: particles closer, greater rate of collisions
	5. Increase temperature: greater rate of collisions each with more energy
	6. Use of a catalyst: reduce activation energy required for a reaction to happen
18. Catalyst	A substance that helps a reaction take place but is not used up itself
	In industry the increase rates of reaction and reduce energy cost
19. Reversible reactions	A reaction where the products will turn back into the products
	Reactants ⇌ Products
	eg hydrated copper sulfate ⇌ Anhydrous copper sulfate + water

Big picture (Chemistry Paper 2)

- Rates, equilibrium and organic chemistry
  - **Rates and equilibrium**
  - Crude oil and fuels
- Analysis and the Earth's resources
  - Chemical analysis
  - The Earth's atmosphere
  - The Earth's resources

Background

In your body there are lots of reactions taking place all the time. Reactions are also important in industry to make products to sell for money. How do we measure or accelerate these reactions up? This topic finds out.

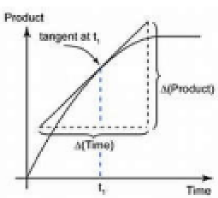
Additional

Look back at Trilogy C7: Energy Changes for more on endothermic, exothermic and activation energy.

Maths skills

Finding the steepness (gradient) of a curved line at a point using a tangent.

Gradient = rise ÷ run



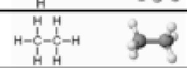
Rate of reaction = Δ(Product) ÷ Δ(time)

Trilogy C9: Crude Oil and Fuels

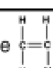
Collins rev guide: Organic Chemistry

Knowledge Organiser

Key points to learn

1. Mixture	Not pure. Different compounds / elements not chemically bonded
2. Hydrocarbon	Compound containing only hydrogen and carbon eg CH_4
3. Crude oil	Fossil fuel mixture of hydrocarbons
4. Distillation	Separating liquid from a mixture by evaporation and condensation
5. Compound	Two or more different elements chemically bonded
6. Molecule	Two or more atoms chemically bonded
7. Fractions	Hydrocarbons with similar boiling points separated from crude oil
8. Alk**ane**s	Hydrocarbon with only single covalent bonds eg C–C
	Known as saturated hydrocarbons
	Methane (CH_4) 
	Ethane (C_2H_6) 
	Propane (C_3H_8) 
	Butane (C_4H_{10}) 
9. Boiling point	Temperature liquid turns to gas. (Long hydrocarbons have higher)
10. Volatility	How easily it evaporates (Long hydrocarbons have lower)
11. Flammability	How easily it lights and burns (Long hydrocarbons have lower)

Key points to learn

12. Viscosity	The resistance of a liquid to flowing or pouring. (Long hydrocarbons have higher)
13. Fractional distillation	Separating liquids from a mixture by boiling then condensing at different temperatures
14. Burning hydrocarbons	Hydrocarbon + Oxygen → Water + Carbon Dioxide
	eg $CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$
15. Oxidised	Oxygen added or electrons lost
16.Test for CO_2	Turns limewater cloudy
17. Incomplete combustion	When a fuel burns with insufficient oxygen. Produces toxic Carbon Monoxide (CO)
18. Cracking	Breaking large alkanes into smaller, more useful ones
19. Thermal decomposition	Breaking down a compound by heating it
20. Catalyst	Chemical which speeds up a reaction without being used itself
21. Alk**ene**s	Hydrocarbon with a double covalent bond eg C=C
	Known as unsaturated hydrocarbons
	Has twice as many H as C atoms
	eg Ethene  Propene 
22. Testing for alkenes	Unsaturated hydrocarbons turn bromine water colourless

Big picture (Chemistry Paper 2)

- Rates, equilibrium and organic chemistry
  - Rates and equilibrium
  - **Crude oil and fuels**
- Analysis and the Earth's resources
  - Chemical analysis
  - The Earth's atmosphere
  - The Earth's resources

Background

Fossil fuels are non-renewable which means they are running out. But why is oil so useful? This topic explores that very question.

Additional

Remember that non-metals bond by covalent bonding (sharing electrons) and that Carbon is in group 4 so needs 4 electrons to fill its outer shell.

Maths skills

Balancing equations:

Number of atoms on reactant side = Number of atoms on product side

Alkane general formula: C_nH_{2n+2}

Alkene general formula: C_nH_{2n}