Year 10 Triple Science Physics Paper 1 Checklist

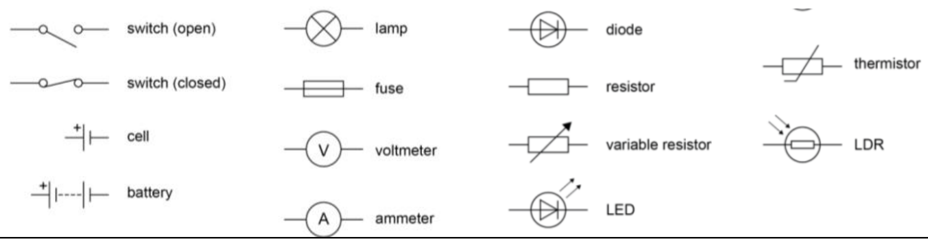
Energy

By the end of this topic you should know and understand:
• A **system** is an object or group of objects
• When a system changes, the energy stored in that system changes as well
• The following are the different stores of energy: **chemical, kinetic, gravitational potential, elastic potential, thermal, magnetic, electrostatic, nuclear**
• Energy can be transferred usefully, stored or **dissipated**, but cannot be created or destroyed.
• Where energy is transferred in a closed system, there is no net change in the total energy.
• All energy transfers have some energy dissipated so that it is stored in less useful ways.
• Energy is transferred via one of the following pathways: **heating, electrical, radiation** or **mechanical.**
• Energy that is not transferred usefully is said to be wasted
• Unwanted energy transfers can be reduced through **lubrication** or **insulation**
• Energy for humans comes from the food that we eat
• Different people have different energy requirements
• **Anomalies** – a result that does not fit the pattern
• **Control** – it may, in addition to the independent variable, affect the outcome of the investigation and should therefore be kept constant
• **Dependent** – the value is measured for each change in the independent variable
• **Independent** – values are changed or selected by the investigator
• **Accurate** – a measurement is considered accurate if it is judged to be close to the true value
• **Precise** – precise measurements are ones in which there is very little spread around the mean value.
• **Resolution** – the smallest change in the quantity being measured by a measuring instrument.
• **Uncertainty**- the interval within which the true value can be expected to lie
• **Random error** – cause readings to be spread about the true value, due to results varying in an unpredictable way. They cannot be corrected. They can be reduced by taking more measurements and calculating a mean
• **Systematic error** – cause readings to differ from the same amount each time. They cannot be dealt with by repeats.
• **Reproducible** – the same results can be obtained if the investigation is repeated by another person
• **Repeatable** – the same results are obtained if the investigation is repeated by the same investigator using the same method
• The energy in food can be transferred from the chemical store to the thermal store by burning.
• Energy can be lost to the surroundings
• When a force causes an object to move through a distance, work is done on the object
• **Work done** (energy used to move the object) is measured in Joules (J)
• Work done can be calculated using the equation: Work done (J) = Force (N) x displacement (m) [W = F x s]
• One **joule** of work is done when a force of one newton causes a displacement of one metre.
• **Power** is defined as the rate at which energy is transferred or the rate at which work is done
• Power = energy transferred/time; Power = work done/time
• An energy transfer of 1 joule per second is equation to a power of 1 watt
• Efficiency is a measure of how good a device is at changing energy (or power) from one form to another
• **Efficiency** can be calculated using the equation: Efficiency = useful energy out/total energy in Or Efficiency = useful power out/total power in
• Efficiency can be turned into a percentage by multiplying it by 100.
• The kinetic energy of a moving object can be calculated using the equation: Kinetic energy = 0.5 x mass x (speed)^2 [E_k = ½ m v^2] Where E_k in J, m in kg, v in m/s
• The amount of gravitational potential energy gained by an object raised above ground level can be calculated using the equation: g.p.e. = mass x gravitational field strength x height [E_p = mgh] Where E_p is in Joules, m in kg, g in N/kg and h in metres
• The amount of elastic potential energy stored in a stretched spring can be calculated using the equation: Elastic potential energy = 0.5 x spring constant x (extension)^2 [E_e = ½ k e^2] Where E_e in J, k in N/m and e in m
• During heat transfer, energy always moves from hot to cold
• Heat can be transferred through 3 process; **conduction** (mostly in solids), **convection** (in liquids and gases) and **radiation** (EM radiation that can travel through a **vacuum**)
• **Thermal conductivity** (in units of W/m^{o}C) tells you how well a material conducts heat. The higher the thermal conductivity of a material, the higher the rate of energy transfer by conduction across the material
• The thicker the material, the lower the thermal conductivity, thus a thicker wall on a house will conduct less heat away.
• **Infrared** radiation is radiation of shorter wavelength than red light
• An object emits infrared radiation when it cools.
• A perfect **black body** is an object which absorbs all of the radiation incident on it. It does not reflect or transmit any radiation
• A body at a constant temperature is absorbing radiation at the same rate as it is emitting radiation
• Putting the same amount of heat energy into some materials gives a bigger temperature rise than in other materials due to **specific heat capacity** • The specific heat capacity (c) is the amount of energy needed to increase the temperature of 1 kg of a substance by 1^{o}C

•	Energy can be calculated using the equation: ΔE = mcΔθ. Where: ΔE = change in energy (J), m = mass (kg), c = specific heat capacity (J/kg^{o}C), Δθ = change in temperature (^{o}C)
•	In a house, heat is lost through the walls, windows, roof and floor
•	Drafts can enter a house through gaps in doors/windows and lose heat through convection currents
•	Heat loss is bad because using energy to heat a house costs money
•	We can reduce heat loss from a house using draft excluders, loft insulation, double glazing, carpets or cavity wall insulation
•	The main energy resources available for use on Earth include: fossil fuels, nuclear fuel, **biofuel**, wind, **hydroelectricity**, **geothermal**, the tides, the Sun and water waves
•	A **renewable** resource is one that is replenished as it is used
•	The uses of energy resources include transport, electricity generation and heating
•	**Fossil fuels** are formed from plant and animal matter under pressure and heat for millions of years. They are reliable. They produce greenhouse gases and are not renewable, they will run out.
•	Nuclear fuel relies on energy being released when large, unstable radioactive atoms split. It does not release greenhouse gases, and releases a lot more energy compared to other energy types. Radioactive waste is difficult to store safely, and the power stations are expensive to build.
•	Solar energy relies on energy from the sun which is captures by solar panels and is converted into electricity. It allows houses to have their own energy supply, but they can be expensive and rely on sunny weather.
•	Wind turbines turn wind into electricity. They can be used on their own but are often in groups on wind farms. Some people object to wind farms, arguing that it spoils the countryside. They rely on windy weather.
•	The movement of tides can drive turbines. A tidal barrage is built across estuaries, forcing water through the gaps. These are useful on islands with large coastal areas, and have the potential to generate a lot of electricity. They can be expensive to build and can have a negative impact on wildlife.
•	Wave power uses the movement of sea water to drive a turbine. Again, they are useful for islands. They are more likely to be small, local operations. They can be expensive and might be opposed by environmental groups.
•	Geothermal uses the natural heat of the Earth. Steam can be used for heating or to power turbines. These can be expensive to set up and only work in areas of volcanic activity
•	Hydroelectric power uses the movement of water through rivers, lakes and dams. This helps to create water reserves as well as energy supplies. They are expensive and can cause flooding of the surrounding areas
•	Biomass/biofuels use the chemical energy stored in organic materials that is released when burned. They are carbon neutral. They are only renewable if the crops are replanted.
•	The UK uses a combination of all energy types to meet energy demand in the future.
•	Burning fossil fuels releases **greenhouse gases**, which cause global warming
•	Burning coal can also release sulfur dioxide which leads to acid rain, and carbon particulates which causes global dimming
•	Carbon capture is likely to be needed in the future to trap the CO_2 gases that are released when fossil fuels are burned.

Electricity

•	Circuit components are represented by the following standard symbols.



•	For electrical charge to flow through a closed circuit the circuit must include a source of potential difference.
•	Electric current is a flow of electrical charge. The size of the electric current is the rate of flow of electrical charge.
•	Charge flow, current and time are linked by the equation: charge flow = current x time (Q=It)
•	A current has the same value at any point in a single closed loop.
•	Potential difference is measured in volts and is measured with a voltmeter connected in parallel.
•	Potential difference is a measure of energy transferred between two points in a circuit.
•	The current through a component depends on both the resistance of the component and the potential difference across the component.
•	The greater the resistance of the component the smaller the current for a given potential difference across the component.
•	Potential difference = current x resistance (V = IR)
•	The resistance of a wire depends on temperature; the higher the temperature the higher the resistance
•	The longer the wire the higher the resistance.
•	The thinner the wire the higher the resistance
•	For some resistors, resistance remains constant regardless of the current (at a constant temperature). This is called an ohmic conductor.
•	For other resistors, resistance is not constant when changing current. This is called a non-ohmic conductor.

• The resistance of components such as lamps, diodes, thermistors and LDRs is not constant, it changes with the current through the component.
• The resistance of a filament lamp increases as the temperature of the filament increases.
• The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction.
• The resistance of a thermistor decreases as the temperature increases.
• Thermistors can be used in thermostats
• The resistance of an LDR decreases as light intensity increases.
• LDRs can be used in circuits to switch lights on when it gets dark
• Components connected in series have the same current through each component
• The total potential difference of the power supply is shared between the components in series
• The total resistance of the components in the circuit is the sum of the resistance of each component ($R_{total} = R_1 + R_2 + R_3$...)
• The potential difference of each component connected in parallel is the same
• The total current through the whole circuit is the sum of the currents through the separate components
• The total resistance of multiple resistors is less than the resistance of the smallest individual resistor.
• Power transferred in a circuit is related to potential difference and current, and to the energy changes over time.
• Power = potential difference x current (P = VI)
• Power = (current)^2 x resistance ($P=I^2 \times R$)
• Every day appliances are designed to bring about energy transfers.
• The amount of energy an appliance transfers depends on how long it is switched on for and the power of the appliance
• Work is done when charge flows in a circuit
• The amount of energy transferred by electrical work is calculated using the equation: Energy = power x time (E = Pt)
• It can also be calculated by: energy = charge flow x potential difference (E =QV)
• Direct current flows in one direction
• Alternating current flows in both directions.
• Mains electricity is an ac supply
• In the UK, domestic energy supply has a frequency of 50Hz and is about 230V
• Most electrical appliances are connected to the mains using three-core cable
• The live wire is brown and carries the alternating potential difference from the supply. It can be dangerous even when the switch is open. • The neutral wire is blue and completes the circuit.
• The earth wire is green and yellow stripes. It is a safety mechanism that stops the appliance becoming live.
• The potential difference between the live wire and the earth wire (0V) is about 230V.
• The neutral wire is at, or close to, earth potential (0V)
• The earth wire is at 0V and only carries a current if there is a fault.
• The fuse is designed to melt if too high a current flows through, to prevent fires.
• A correct amp rating of fuse must be used for an appliance.
• Efficiency = (output power/input power) x 100
• The national grid is a system of cables and transformers linking power stations to consumers
• Step-up transformers are used to increase the potential difference from the power station to the transmission cables.
• This reduces the current which reduces heat loss, making the transmission more efficient.
• Step-down transformers are used to decrease the potential difference to a safer level for domestic use
• A charged object creates an electric field around itself.
• The electric field is strongest close to the charged object. The further away from the charged object the weaker the field
• A second charged object placed in the field experiences a force. The force gets stronger as the distance between the objects decreases.
• When certain insulating materials are rubbed against each other they become electrically charged.
• Negatively charged electrons are rubbed off one material and on to another
• The material that gains electrons becomes negatively charged. The material that loses electrons is left with an equal positive charge
• When two electrically charged objects are brought close together they exert a force on each other.
• Two objects of the same charge repel. Two objects of opposite charge attract.
• Attraction and repulsion between two charged objects are examples of non-contact forces.

Particle Model of Matter

By the end of this unit you should know and understand:
• The density of a material is defined by the equation *density=mass/volume* [ρ=m/v]
• Volume of an irregular solid can be determined using a eureka can and measuring cylinder, using water displacement.
• Particles in a solid vibrate around a fixed point
• Particles in a liquid move over each other whilst remaining in contact. They move to take the shape of their container.
• Particles in a gas move rapidly and randomly, and are spread over a large area. They move to fill the container they are in.
• Changes of state are physical changes which differ from chemical changes because the material recovers its original properties if the change is reversed

•	When substances change state (melt, freeze, boil, evaporate, condense or sublimate) mass is conserved
•	The melting point of a substance is the temperature at which it changes from a solid to a liquid and vice versa
•	The melting and boiling point of a pure substance are fixed
•	Evaporation can happen at any temperature, and it happens at the surface of the substance
•	Boiling only happens at the boiling point, and occurs throughout the liquid.
•	Internal energy is the total kinetic energy and potential energy of all the particles (atoms and molecules) that make up a system
•	Heating changes the energy stored within the system by increasing the energy of the particles that make up the system. This either raises the temperature of the system or produces a change of state.
•	If the temperature of the system increases, the increase in temperature depends on the mass of the substance heated, the type of material and the energy input to the system
•	Change in thermal energy = mass x specific heat capacity x temperature change
•	The specific heat capacity of a substance in the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.
•	The energy needed for a substance to change state is called latent heat. When a change of state occurs, the energy supplied changes the energy stored (internal energy) but not the temperature
•	The specific latent heat of a substance is the amount of energy required to change the state of one kilogram of the substance with no change in temperature
•	Energy for a change of state = mass x specific latent heat [E=mL]
•	Specific latent heat of fusion is the change of state from solid to liquid
•	Specific latent heat of vaporisation is the change of state from liquid to vapour
•	The molecules of a gas are in constant random motion so they store kinetic energy.
•	The temperature of the gas is related to the average kinetic energy of the molecules. The higher the temperature, the more kinetic energy they have, so they move faster on average.
•	Changing the temperature of a gas held at constant volume, changes the pressure exerted by the gas
•	Pressure from a gas is caused by particles colliding with the container walls.
•	When the temperature increases the particles hit the container walls more frequently and with more force, and thus increase the pressure.
•	A gas can be compressed or expanded by pressure changes. The pressure produces a force at right angles to the wall of the gas container
•	If the volume of gas decreases the pressure will increase if the temperature remains constant.
•	For a fixed mass of gas held at a constant temperature *pressure x volume=constant [pV=constant]*
•	Work is the transfer of energy by a force
•	Doing work on a gas increases the internal energy of the gas and can cause an increase in the temperature of the gas

Atomic Structure

•	Atoms are very small, having a radius of about 1×10^{-10} metres
•	An atom has a positively charged nucleus made of protons and neutrons surrounded by negatively charged electrons
•	The radius of a nucleus is less than 1/10000 of the radius of an atom.
•	Most of the mass of an atom is concentrated in the nucleus
•	The electrons are arranged at different distances from the nucleus (energy levels)
•	The electron arrangement may change with the absorption of electromagnetic radiation (move to a higher energy level or further from the nucleus) or by the emission of electromagnetic radiation
•	In an atom the number of electrons is equal to the number of protons
•	Atoms have no overall electrical charge
•	All atoms of a particular element have the same number of protons This is called its atomic number
•	The total number of protons and neutrons in an atom is called its mass number
•	Atoms of the same element can have different numbers of neutrons; these atoms are called isotopes of the element
•	Ions are formed if an atom loses or gains electrons.
•	New experimental evidence may lead to a scientific model being changed or replaced
•	Before the discovery of the electron, atoms were thought to be tiny spheres that could not be divided
•	The discovery of the electron led to the plum pudding model of the atom. This suggested that the atom is a ball of positive charge with negative electrons embedded in it
•	The results from the alpha particle scattering experiment led to the conclusion that the mass of an atom was concentrated at the centre and that the nucleus was charged.
•	Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances. The theoretical calculations of Bohr agreed with experimental observations
•	Later experiments led to the idea that the positive charge of any nucleus could be subdivided into a whole number of smaller particles, with each particle having the same amount of positive charge. These were called protons.
•	The experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus. This was about 20 years after the nucleus became an accepted scientific idea.

- Some atomic nuclei are unstable.
- The nucleus gives out radiation as it changes to become stable.
- This process is random and is called radioactive decay.
- Activity is measured in becquerels (Bq) and is the rate at which a source of unstable nuclei decays
- Count rate is the number of decays recorded each second by a detector (for example the Geiger-Muller tube)
- Nuclear radiation may be alpha, beta or gamma.
- An alpha particle consists of two neutrons and two protons. It is the same as a helium nucleus.
- Alpha radiation is highly ionising but is the least penetrating type of radiation. It is absorbed by a thin sheet of paper and travels 5cm in air.
- A beta particle is a high speed electron ejected from the nucleus as a neutron turns into a proton
- Beta radiation is less ionising than alpha radiation, but is more penetrating. It will be stopped by a thin sheet of aluminium and travels 1m in air.
- A gamma ray is a type of electromagnetic radiation from the nucleus.
- Gamma rays are highly penetrating but have a low ionising power. It is stopped by 3-5cm of lead, or 1m of concrete. It can travel an unlimited distance in air.
- Radiation has many uses. Each use has its own advantages and disadvantages, and sources have to be selected carefully to be safe
- Nuclear equations are used to represent radioactive decay
- In a nuclear equation an alpha particle may be represented by the symbol: $^{4}_{2}He$
- A beta particle may be represented by: $^{0}_{-1}e$
- The emission of different types of nuclear radiation may cause a change in the mass and/or the charge of the nucleus
- An example of alpha decay causing both the mass and charge of the nucleus to decrease is: $^{219}_{86}$radon → $^{215}_{84}$polonium + $^{4}_{2}He$
- An example of beta decay is: $^{14}_{6}$carbon → $^{14}_{7}$nitrogen + $^{0}_{-1}e$
- The emission of a gamma ray does not cause the mass or the charge of the nucleus to change
- Radioactive decay is random
- The half life of a radioactive isotope is the time it takes for the number of nuclei of the isotope in a sample to halve, or the time it takes for the count rate or activity from a sample containing the isotope to fall to half its initial level.
- Radioactive contamination is the unwanted presence of materials containing radioactive atoms on other materials
- The hazard from contamination is due to the decay of the contaminating atoms
- The type of radiation emitted affects the level of hazard
- Irradiation is the process of exposing an object to nuclear radiation. The irradiated object does not become radioactive.
- It is important for the findings of studies into the effects of radiation on humans to be published and shared with other scientists so that the findings can be checked by peer review
- Background radiation is around us all of the time
- It comes from natural sources such as rocks and cosmic rays from space, and from man-made sources such as the fallout from nuclear weapons testing and nuclear accidents
- The level of background radiation and radiation dose may be affected by occupation and/or location
- Radiation dose is measure in sieverts (Sv)
- Radioactive isotopes have a very wide range of half life values
- Hazards associated with radioactive material differs according to the half life involved
- A longer half life may mean a greater hazard – it takes longer for the radioactive isotope to decay.
- Nuclear radiations are used in medicine for the exploration of internal organs and to control or destruct unwanted tissue.
- Nuclear fission is the splitting of a large and unstable nucleus such as uranium or plutonium
- Spontaneous fission is rate. Usually, for fission to occur, the unstable nucleus must first absorb a neutron
- The nucleus undergoing fission splits into two smaller nuclei, roughly in equal size, and emits two or three neutrons plus gamma rays.
- Energy is released by the fission reaction
- All of the fission products have kinetic energy
- The neutrons may go on to start a chain reaction
- The chain reaction is controlled in a nuclear reactor to control the energy released.
- The explosion caused by a nuclear weapon is caused by an uncontrolled chain reaction
- Nuclear fusion is the joining of two light nuclei to form a heavier nucleus.
- In this process some of the mass may be converted into the energy of radiation