Year 11 AQA GCSE Physics Revision Booklet

Paper 1

Particle model of matter	😀	😐	😟

Density of materials - know
- the density of a material is defined by the equation: density = mass/volume - ρ = m/V
- density, ρ, is measured in kilograms per metre cubed, kg/m^3
- mass, m, is measured in kilograms, kg
- volume, V, is measured in metres cubed, m^3
- How to explain the differences in density between the different states of matter in terms of the arrangement of atoms or molecules.
- How to explain differences in density between the different states
- How to describe practical methods to measure the density of regular and irregular solids and a liquid.

The three states of matter – know
- The states of matter are solid, liquid and gas and how to recognise and draw simple diagrams to model the difference in arrangement of particles between solids, liquids and gases.
- The names of the changes of state (Melting, freezing, boiling, evaporating, condensing, sublimation)
- How to use melting and boiling point data to decide the state of a substance

Changes of state
- Students should be able to describe how and that when substances change state (melt, freeze, boil, evaporate, condense or sublimate) and that mass is conserved.
- Changes of state are physical changes which differ from chemical changes

Internal Energy
- Internal energy is stored inside a system by the particles that make up the system. It is the total kinetic energy and potential energy of all the particles
- 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.

Temperature changes in a system and specific heat capacity
- 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.
- The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.
- The following equation applies
- change in thermal energy = mass× specific heat capacity x temp change.
- change in thermal energy is measure in joules, J, mass, m, in kilograms, kg
- specific heat capacity, c, is measured in joules per kilogram per degree Celsius, J/kg °C
- temperature change, Δθ, is measured in degrees Celsius, °C.

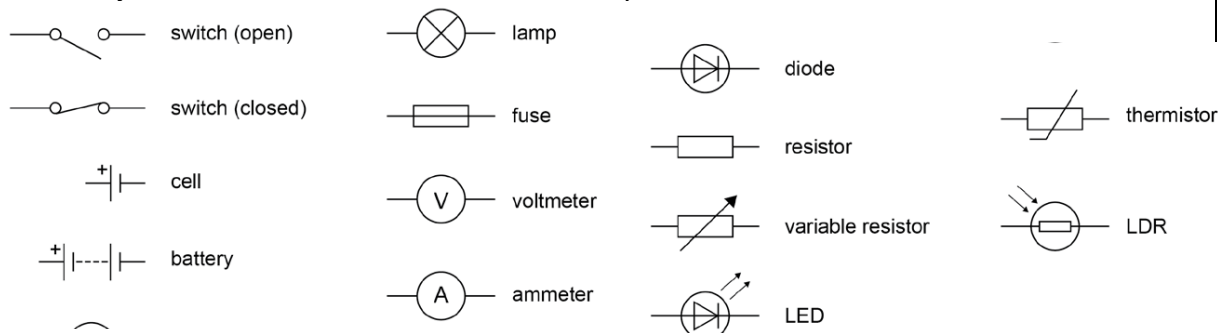| Particle model of matter continued	☺	😐	☹
Changes of heat and specific latent heat • Latent heat is the energy needed for a substance to change state. • When a change of state occurs, the energy supplied changes the energy stored (internal energy) but not the temperature. • The specific latent heat 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 × specific heat capacity x latent heat • energy, E, is measured in joules, J; mass, m is measured in kilograms, kg • specific latent heat, L, is measured in joules per kilogram, J/kg • 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 • Be able to interpret heating and cooling graphs that include changes of state. • Be able to distinguish between specific heat capacity (a change in temperature is involved) and specific latent heat (a change of state is involved at constant temperature).			
Particle motion in gases • The molecules of a gas are in constant random motion. The temperature of the gas is related to the average kinetic energy of the molecules. • Changing the temperature of a gas, held at constant volume, changes the pressure exerted by the gas. • Be able to explain how the motion of the molecules in a gas is related to both its temperature and its pressure • Be able to explain qualitatively the relation between the temperature of a gas and its pressure at constant volume.			
Pressure in gases • A gas can be compressed or expanded by pressure changes. The pressure produces a net force at right angles to the wall of the gas container • Be able to use the particle model to explain how increasing the volume in which a gas is contained, at constant temperature, can lead to a decrease in pressure. • For a fixed mass of gas held at a constant temperature: pressure × volume = constant • pV=constant ($p_1V_1 = p_2V_2$) • pressure, p, is measured in pascals, Pa; volume, V, is measured in metres cubed, m^3 • Be able to calculate the change in the pressure of a gas or the volume of a gas (a fixed mass held at constant temperature) when either the pressure or volume is changed.			
Increasing the pressure of a gas • 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. • Be able to explain how, in a given situation e.g. a bicycle pump, doing work on an enclosed gas leads to an increase in the temperature of the gas.			

Atomic Structure and Radioactivity	☺	😐	☹

Models of the atom – know:
- Plum pudding model of the atom and Rutherford and Marsden's alpha experiments, being able to explain why the evidence from the scattering experiment led to a change in the atomic model.
- Be able to explain the difference between the plum pudding and nuclear model of the atom.
- Niels Bohr's adaptation of the Rutherford model
- That Chadwick's experiments showed the existence of neutrons in the nucleus.
- Atoms are very small, having a radius of about 1×10^{-10} metres with a positively charged nucleus surrounded by negatively charged electrons.
- The radius of a nucleus is less than 1/10 000 (about 1×10^{-14} m).of the radius of an atom.
- That most of the mass of an atom is concentrated in the nucleus.
- The electrons are arranged at different distances from the nucleus (different energy levels). The electron arrangements may change with the absorption of electromagnetic radiation (move further from the nucleus; a higher energy level) or by the emission of electromagnetic radiation (move closer to the nucleus; a lower energy level).
- The electrical charges and relative masses of protons, neutrons and electrons.
- How to calculate the number of protons, electrons and neutrons in an atom or ion given the atomic number and mass number
- What an isotope is – an atom with different numbers of neutrons but the same number of protons.
- Atoms turn into positive ions if they lose one or more outer electron(s).

Radioactive decay and nuclear radiation
- Radioactive decay is a random process where an unstable nuclei becomes more stable.
- Activity is the rate at which a source of unstable nuclei decays and is measured in Becquerel (Bq)
- Count-rate is the number of decays recorded per second by a detector/Geiger-Muller tube.
- The nuclear radiation emitted may be a) an alpha particle (α) – this consists of two neutrons and two protons which is the same as a helium nucleus, b) a beta particle (β) – a high speed electron ejected from the nucleus as a neutron turns into a proton, c) a gamma ray (γ) – electromagnetic radiation from the nucleus or d) a neutron (n).
- Know the penetration of alpha particles, beta particles and gamma rays through materials, their range in air and ionising power.
- Be able to apply your knowledge to the uses of radiation and evaluate the best sources of radiation to use in a given situation

Nuclear Equations
- To be able to use the names and symbols of common nuclei and particles to write balanced nuclear equations that show single alpha (α) and beta (β) decay. This is limited to balancing the atomic numbers and mass numbers. Nuclear equations are used to represent radioactive decay. For example:

$$^{219}_{86}\text{radon} \longrightarrow {}^{215}_{84}\text{polonium} + {}^{4}_{2}\text{He}$$

$$^{14}_{6}\text{carbon} \longrightarrow {}^{14}_{7}\text{nitrogen} + {}^{0}_{-1}\text{e}$$

Atomic Structure and Radioactivity continued	:)	:|	:(

Radioactive Decay – know:
- That Radioactive decay is random and that 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 to fall to half its initial level.
- How to determine the half-life of a radioactive isotope from given information.
- How to calculate the net decline, expressed as a ratio, in a radioactive emission after a given number of half-lives.
- That radioactive isotopes have a very wide range of half-life values.
- The hazards associated with a radioactive material depends on the half-life.

Radioactive Contamination - know
- That radioactive contamination is the unwanted presence of radioactive atoms with the hazard being the due to the decay of the contaminating atoms.
- The type of radiation emitted affects the level of hazard.
- Irradiation is when an object is exposed to radiation, but does not become radioactive.
- How to compare the hazards associated with contamination and irradiation.
- The precautions to protect against hazards from radioactive sources.
- Recognise the importance for the findings of studies into the effects of radiation on humans to be published and shared so that the findings can be checked by peer review.

Background radiation - know
- Background radiation is around us all of the time. It comes from natural sources such as rocks and cosmic rays from space, 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 measured in sieverts (Sv) - 1000 millisieverts (mSv) = 1 sievert (Sv)

Uses of radiation
- Know that nuclear radiations are used in medicine for the exploration of internal organs and control or destruction of unwanted tissue.
- Be able to describe and evaluate the uses of nuclear radiations for exploration of internal organs, and for control or destruction of unwanted tissue
- Be able to evaluate the perceived risks of using nuclear radiations when given data and consequences

Nuclear Fission –know that:
- Nuclear fission is the splitting of a large unstable nucleus (e.g. uranium or plutonium).
- Spontaneous fission is rare, for it to occur the unstable nucleus a neutron is absorbed.
- The nucleus undergoing fission splits into two smaller nuclei, roughly equal in 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 and the neutrons may go on to start a chain reaction where the reaction is controlled in a reactor with controlled energy release. The explosion of a nuclear weapon is caused by an uncontrolled chain reaction.
- How to draw/interpret diagrams representing nuclear fission/ chain reaction.

Nuclear Fusion – know that:
- 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.

Electricity			

Circuit Symbols - You should know the circuit symbols below:

switch (open)   lamp   diode

switch (closed)   fuse   thermistor

cell   resistor

+   voltmeter   variable resistor   LDR

battery   ammeter   LED


Electrical charge and current
- 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
- $Q = It$
- Charge flow Q, in coulombs, C, current I, in amperes, A (Amps is ok), time, t in seconds s.
- A current has the same value at any point in a single closed loop.

Current, Resistance and Potential Difference
- The current (I) through a component depends on both the resistance (R) of the component and the potential difference (V) across the component.
- The greater the resistance of the component the smaller the current for a given potential difference (p.d.) across the component.
- Current, potential difference or resistance can be calculated using the equation:
- Potential difference = current x resistance
- $V = I\,R$
- Potential difference (V) in volts V, current (I) in Amps A and resistance (R) in ohms Ω.
- Be able to draw a suitable circuit diagram and explain how to complete a practical to investigate the factors affecting the resistance of an electrical circuit. Including the effect of the length of wire at constant temperature and combinations of resistors in series and parallel.

Resistors
- be able to explain that, for some resistors, the value of R remains constant but that in others it can change as the current changes.
- The current through an ohmic conductor (at a constant temperature) is directly proportional to the potential difference across the resistor. This means that the resistance remains constant as the current changes.
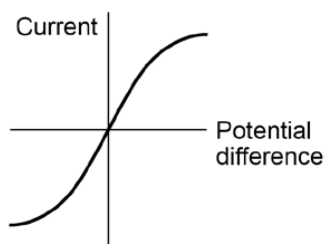
Current

Potential difference
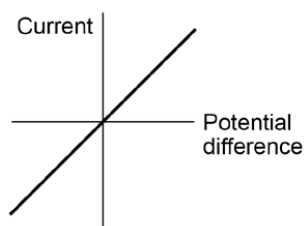
- The resistance of components such as lamps, diodes, thermistors and LDRs is not constant; it changes with the current through the component.

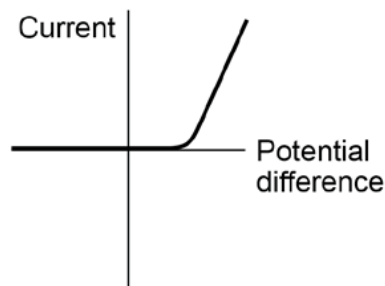| Electricity - continued	:)	:|	:(

Resistance

- The resistance of a filament lamp increases as the temperature of the filament increases.

Current

Potential
difference

- The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction.

Current

Potential
difference

- Know the resistance of a thermistor decreases as the temperature increases.
- Know some applications of thermistors in circuits e.g. a thermostat
- Know the resistance of an LDR decreases as light intensity increases.
- Know the application of LDRs e.g. switching lights on when it gets dark.
- Be able to explain the design and use of a circuit to measure the resistance of a component (e.g. filament lamp, diode, resistor at constant temperature) by measuring the current through, and potential difference across the component including the graphs that should be drawn and information that can be obtained from the graph.
- Draw appropriate circuit diagrams using correct circuit symbols.
- Be able to use graphs to explore whether circuit elements are linear or non-linear and relate the curves produced to their function and properties.
- Explain an experiment to investigate the relationship between the resistance of a thermistor and temperature and the resistance of an LDR and light intensity.

Series and parallel circuits – know:

- That there are two ways of joining electrical components, in series and in parallel and that some circuits include both series and parallel parts.
- That for components connected in series there is the same current through each component, the total potential difference of the power supply is shared between the components, the total resistance of two components is the sum of the resistance of each component.
- $R_{total} = R_1 + R_2$ - resistance, R, is measured in ohms, Ω
- For components connected in parallel: the potential difference across each component is the same, the total current through the whole circuit is the sum of the currents through the separate components (branches), the total resistance of two resistors in parallel is less than the resistance of the smallest individual resistor.
- How to use circuit diagrams to construct and check series and parallel circuits that include a variety of common circuit components, describe the difference between series and parallel circuits, explain qualitatively why adding resistors in series increases the total resistance whilst adding resistors in parallel decreases the total resistance

Electricity - continued	:)	:|	:(
Series and parallel circuits - continued • How to explain the design and use of dc series circuits for measurement and testing purposes • How to calculate the currents, potential differences and resistances in dc series circuits • How to solve problems for circuits which include resistors in series using the concept of equivalent resistance.			
Domestic uses and safety **Direct and alternating potential difference – know** • Mains electricity is an ac supply In the UK the supply has a frequency of 50Hz and is about 230V • Explain the difference between a direct (one direction only) and alternating (constantly changing direction) potential difference.			
Mains electricity – know • Most electrical appliances are connected to the mains using three-core cable • The insulation covering each wire is colour coded for easy identification. (live wire – brown, neutral wire – blue, earth wire – green and yellow stripes) • The live wire carries the alternating p.d. from the supply so can be dangerous even when a switch in the mains circuit is open. • The neutral wire completes the circuit. • The earth wire is a safety wire to stop the appliance becoming live • To explain the dangers of providing any connection between the live and earth. • The p.d. between the live wire and earth 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.			
Energy Transfers, Power – know • Explain how the power transfer in any circuit device is related to the potential difference across it and the current through it, and to the energy changes over time: • Power = potential difference x current $P = IV$ • Power = (current)^2 x Resistance $P = I^2R$ Power P in Watts, W p.d. V in volts, V Current I, in amps, A Resistance R, in ohms Ω			
Energy transfers in everyday appliances • Everyday electrical appliances are designed to bring about energy transfers. • The amount of energy an appliance transfers depends on how long the appliance is switched on for and the power of the appliance. • Describe how different domestic appliances transfer energy from batteries or ac mains to the kinetic energy of electric motors or the energy of heating devices. • Work is done when charge flows in a circuit. • The amount of energy transferred by electrical work can be calculated using the equation: • Energy transferred = power x time $E = Pt$ • Energy transferred = charge flow x potential difference $E = QV$			

Electricity - continued	😀	😐	🙁
Energy transfers in everyday appliances • Energy transferred = current x p.d. x time *E = VIt* Energy transferred E in joules J Power P in watts W Time t, in seconds, s Charge flow Q in coulombs Potential difference V in volts V Current I in amps A • Explain how the power of a circuit device is related to the p.d across it and the current through it • Explain how the power of a circuit device is related to the energy transferred over a given time. Describe, with examples, the relationship between the power ratings for domestic electrical appliances and the changes in stored energy when they are in use.			
The National Grid • The National grid is a system of cables and transformers linking power stations to consumers. • Electrical power is transferred from power stations to consumers using the National grid. • Step up transformers are used to increase the potential difference from the power station to the transmission cables then step-down transformers are used to decrease, to a much lower value, the potential difference for domestic use. • Explain why the National Grid system is an efficient way to transfer energy.			
Static Electricity – know • That when certain insulating materials are rubbed against each other they become electrically charged. Know how this happens in relation to the movement of negatively charged electrons and be able to describe the production of static electricity and sparking. • What happens when electrically charged objects are brought close together and that this depends on their charge • That attraction and repulsion between two charged objects are examples of a non-contact force and describe evidence (examples) of this.			
Electric Fields – know that • A charged object creates an electric field around itself. The electric field is strongest close to the charged object and diminishes with distance from the charged object. • A second charged object placed in the field experiences a force. The force gets stronger as the distance between the objects decreases. • How to draw the electric field pattern for an isolated charged sphere, explain the concept of an electric field, explain how the concept of an electric field helps to explain the noncontact force between charged objects as well as other electrostatic phenomena such as sparking.			

Energy	😀	😐	🙁
Energy stores and systems • A system is an object or group of objects. • There are changes in the way energy is stored when a system changes • Describe all the changes involved in the way energy is stored when a system changes for common situations. For example: • An object projected upwards, • A moving object hitting an obstacle • An object accelerated by a constant force • A vehicle slowing down • Bringing water to a boil in an electric kettle. • Be able to calculate changes in energy involved when a system is changed by heating, work done by force, work done when current flows • Use calculations to show on a commons scale how the overall energy in a system is re-distributed when the system is changed (e.g. Sankey diagram)			
Changes in Energy • Be able to calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level. • The kinetic energy of a moving object can be calculated using the equation: • *Kinetic Energy = 0.5 x mass x (speed)^2* $E_k = \frac{1}{2} mv^2$ Kinetic energy E_k in joules, J Mass, m in kilograms, kg Speed, v, in metres per second, m/s • 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* $E_e = \frac{1}{2} ke^2$ (assuming the limit of proportionality has not been exceeded) Elastic potential energy in joules, J Spring constant k, in newtons per metre, N/m Extension, e, in metres, m • *Gravitational Potential Energy = Maxx x gravitational field strength x height* $E_p = m g h$ Gravitational potential energy, E_p, in joules, J Mass, m, in kilograms, kg Gravitational field strength, g, in newtons per kilogram, N/kg (in any calculation the value of the gravitational field strength (g) will be given.) Height, h, in metres, m			
Energy changes in systems • The amount of energy stored in or released from a system as its temperature changes can be calculated using the equation (which will be given in the physics equation sheet): • *Change in thermal energy = mass x specific heat capacity x temperature change* $\Delta E = m c \Delta\vartheta$ Change in thermal energy, ΔE, in joules, J Mass, m, in kilograms, kg Specific heat capacity, c in joules per kilogram per degree Celsius, J/(kg^{o}C) Temperature change, $\Delta\theta$, in degrees Celsius, ^{o}C • The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.			

Energy - continued	☺	😐	☹
Energy changes in systems - continued • Be able to explain the required practical to determine the specific heat capacity of one (or more) materials by linking the decrease of one energy store (or work done) to the increase in temperature and subsequent increase in thermal energy stored. For example the gain in thermal energy by a known mass of water will equal the loss in thermal energy of a known mass of metal, this can be used to determine the specific heat capacity of the metal.			
Power • Power is defined as the rate at which energy is transferred or the rate at which work is done. • *Power = energy transferred/time (this equation must be recalled)* • *P = E/t* • *Power = work done / time (this equation must be recalled)* • *P = W/t* Power, P, in watts, W Energy transferred, E, in joules, J Time, t, in seconds, s Work done, W, in joules, J • An energy transfer of 1 joule per second is equal to a power of 1 watt. • Be able to give examples that illustrate the definition of power e.g. comparing two electric motors that both lift the same weight through the same height but one does it faster than the other.			
Conservation and dissipation of energy – Energy transfers in a system • Energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed. • Be able to describe with examples where there are energy transfers in a closed system, that there is no net change to the total energy. • Be able to describe, with examples, how in all system changes energy is dissipated, so that it is stored in less useful ways. This energy is often described as being 'wasted'. • Explain ways of reducing unwanted energy transfers, for example through lubrication and the use of thermal insulation. • The higher the thermal conductivity of a material the higher the rate of energy transfer by conduction across the material. The different thermal conductivity of metals can be shown by sticking drawing pins onto a strip of metal using wax, heating one end of the strip and monitoring the time for pins to drop (when heating several different metals at once) • Be able to describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls. • Required practical to investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties of a material.			
Efficiency • The energy efficiency for any energy transfer can be calculated using the equation: • *Efficiency = useful output energy transfer / total input energy transfer (learn this)* • Efficiency may also be calculated using the equation: • *Efficiency = useful power output/total power input* • Be able to use efficiency values as either a percentage or a decimal • Describe ways to increase the efficiency of an intended energy transfer.			
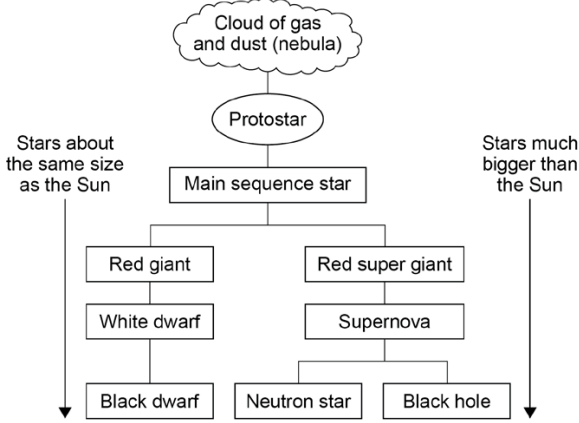
Energy - continued			
	🙂	😐	🙁
National and Global Energy Resources • The main energy resources available for use on Earth include: Fossil fuels (coal, oil and gas), nuclear fuel, bio-fuel, wind, hydro-electricity, geothermal, the tides, the Sun and water waves. • A renewable energy resources is one that is being (or can be) replenished as it is used. • The uses of energy resources include transport, electricity generation and heating. • Be able to describe the main energy sources available • Distinguish between energy resources that are renewable and energy resources that are non-renewable • Compare ways that different energy resources are used, the uses to include transport, electricity generation and heating • To understand why some energy resources are more reliable than others. • Describe the environmental impact arising from the use of different energy resources • Explain patterns and trends in the use of energy resources. • Be able to consider environmental issues that may arise from the use of different energy resources. • Show that science has the ability to identify environmental issues arising from the use of energy resources but not always the power to deal with the issues because of political, social, ethical or economic considerations.			

Paper 2

Questions in Paper 2 may draw on an understanding of energy changes and transfers due to heating, mechanical and electrical work and the concept of energy conservation from the Energy Topic and Electricity Topic

Space Physics	😃	😐	🙁
Our solar system – know • The planets and the dwarf planets that orbit around the Sun including the order. • That natural satellites, the moons that orbit planets, are also part of the solar system. • That our solar system is a small part of the Milky Way galaxy. • That the Sun was formed from a cloud of dust and gas (nebula) pulled together by gravitational attraction. • How to explain the start of a star's life cycle, the dust and gas were drawn together by gravity causing fusion reactions, that fusion reactions led to an equilibrium between the gravitational collapse of a star and the expansion of a star due to fusion energy.			
Life cycle of a star – know that • A star goes through a life cycle. The life cycle is determined by the size of the star. • How to describe the life cycle of a star, the size of the Sun and the life cycle of a star much more massive than the Sun. • That fusion processes in stars produce all of the naturally occurring elements. Elements heavier than iron are produced in a supernova. • The explosion of a massive star (supernova) distributes the elements throughout the universe. • How to explain how fusion processes lead to the formation of new elements. 			
Orbital motion, natural and artificial satellites – know that • Gravity provides the force that allows planets and satellites (both natural and artificial) to maintain their circular orbits. • Describe similarities and distinctions between the planets, their moons and artificial satellites. • Explain qualitatively that for circular orbits, the force of gravity can lead to changing velocity but unchanged speed • For a stable orbit, the radius must change if the speed changes.			
Red-shift – know that • There is an observed increase in wavelength of light from most distant galaxies. The further away the galaxy, the faster they are moving and the bigger the observed increase in wavelength. This effect is called red-shift. • The observed red-shift provides evidence that space itself (the universe) is expanding and supports the Big Bang Theory. • The Big Bang Theory suggests the universe began from a very small region that was extremely hot and dense.			

Space Physics - continued	😀	😐	🙁
Red-shift – continued • Since 1998 onwards, observations of supernovae suggest that distant galaxies are receding ever faster. • Explain qualitatively the red shift of light from galaxies that are receding • Explain the change of each galaxy's speed with distance is evidence of an expanding universe • Explain how red-shift provides evidence for the Big Bang model • Explain how scientists are able to use observations to arrive at theories such as the Big Bang Theory. • Explain that there is still much about the universe that is not understood for example dark mass and dark energy.			

Waves	😀	😐	🙁
Transverse and longitudinal waves • Be able to describe the difference between longitudinal and transverse waves including examples of each (e.g. ripples / light for transverse & sound (compression waves) for longitudinal. • Describe evidence that, for both ripples on a water surface and sound waves in air, it is not the wave and not the water or air itself that travels.			
Properties of waves • Be able to describe wave motion in terms of their amplitude, wavelength, frequency and period. • Amplitude – maximum displacement of a point on a wave away from its undisturbed position. • Wavelength – distance from a point on one wave to the equivalent point on the adjacent wave. • Frequency – number of waves passing a point each second. • *Period – 1/frequency [T= 1/f](equation on the physics equation sheet)* • Period, T, in seconds, s • Frequency, f, in hertz, Hz • The wave speed is the speed at which the energy is transferred (or the wave moves) through the medium. All waves obey the wave equation: • *Wave speed – frequency x wavelength [v=f λ] (learn this equation)* • Wave speed, v, in metres per second, m/s • Frequency f, in hertz, Hz, Wavelength, λ, in metres, m • Be able to identify amplitude and wavelength from given diagrams • Describe a method to measure the speed of sound waves in air and describe a method to measure the speed of ripples on a water surface. • Be able to show how changes in velocity, frequency and wavelength, in transmission of sound waves from one medium to another are inter-related. • Required practical – be able to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements.			
Reflection of waves • Be able to construct ray diagrams to illustrate the reflection of a wave at a surface • Be able to describe the effects of reflection, transmission and absorption of waves at material interfaces • Required practical – investigate the reflection of light by different types of surfaces and the refraction of light by different substances.			

Waves continued	😀	😐	🙁
Sound waves			

Sound waves
- Sound waves can travel through solids causing vibrations in the solid.
- Within the ear, sound waves cause the ear drum and other parts to vibrate which causes the sensation of sound. The conversion of sound waves to vibrations of solids works over a limited frequency range. This restricts the limits of human hearing.
- Explain why the conversion of sound waves to vibrations only works over a limited frequency range
- Know the range of normal human hearing is from 20Hz to 20kHz

Waves for detection and exploration
- Be able to explain in qualitative terms, how the differences in velocity, absorption and reflection between different types of wave in solids and liquids can be used both for detection and exploration of structures which are hidden from direct observation.
- Ultrasound – frequency higher than upper limit of human hearing. Ultrasound is partially reflected when it meets a boundary between two different media. The time taken for reflections to reach a detector can be used to determine how far away such a boundary is. Ultrasound can therefore be used for both medical and industrial imaging.
- Seismic waves are produced by earthquakes. P-waves are longitudinal, seismic waves. P- waves travel at different speeds in solids and liquids. S-waves are transverse, s-waves cannot travel through a liquid. P-waves and S-waves provide evidence for the structure and size of the Earth's core. The study of seismic waves produced new evidence leading to discoveries about parts of the earth which are not directly observable.
- Echo sounding, using high frequency sound waves is used to detect objects in deep water and measure depth

Electromagnetic waves – Types
- EM waves are transverse waves that transfer energy from the source of the waves to an absorber.
- EM waves form a continuous spectrum and all travel at the same velocity through a vacuum or air.
- Waves are grouped in terms of wavelength and frequency. From long to short wavelength (low to high frequency) the groups are:
- Radiowaves, microwaves, infrared, visible light, ultraviolet, x-rays, gamma rays.
- Our eyes detect only visible light
- Be able to give examples that illustrate the transfer of energy by electromagnetic waves. E.g. heating effect of sunlight – IR radiation

Properties of electromagnetic waves
- Different substances may absorb, transmit, refract or reflect EM waves in ways that vary with wavelength.
- Some effects e.g. refraction, are due to the difference in velocity of the waves in different substances.
- Be able to construct ray diagrams to illustrate the refraction of a wave at the boundary between two media.
- Be able to use wave front diagrams to explain refraction in terms of the change of speed that happens when a wave travels from one medium to a different medium.
- Required practical – investigate how the amount of IR radiation absorbed or radiated by a surface depends on the nature of that surface
- Radio waves can be produced by oscillations in electrical circuits.
- When radio waves are absorbed they may create an alternating current with the same frequency as the radio wave itself, so radio waves can themselves induce oscillations in an electrical circuit.
- Changes in atoms and the nuclei of atoms can result in electromagnetic waves being

generated or absorbed over a wide frequency range. Gamma rays originate from changes in the nucleus of an atom.
- UV, X-rays and gamma rays can have hazardous effects on human body tissue. Effects depend on the type and size of the dose. Radiation dose (in Sieverts – you will be given the unit) is a measure of the risk of harm resulting from an exposure of the body to the radiation. UV can cause skin to age prematurely and increase the risk of skin cancer. X-rays and gamma rays are ionising radiation that can cause the mutation of genes and cancer.
- Be able to draw conclusions from given data about the risks and consequences of exposure to radiation.

Uses and applications of EM waves
- Be able to quote examples and give brief explanations why each type of EM wave is suitable for the practical application.
- Radio waves – television and radio
- Microwaves – satellite communications, cooking food.
- Infrared – Electrical heaters, cooking food, infrared cameras
- Visible light – fibre optic communications
- Ultraviolet – energy efficient lamps, sun tanning
- X-rays and gamma rays – medical imaging and treatments.

Lenses
- Be able to explain how lenses form an image by refracting light.
- Draw ray diagrams to illustrate similarities and differences between convex and concave lenses.
- Be able to identify and describe (or draw on a diagram) the principal focus (where parallel rays of light are brought to a focus) and the focal length.
- Recall that the image produced by a convex lens can be either real or virtual but the image produced by a concave lens is always virtual.
- The magnification produced by a lens can be calculated using the equation:
- *Magnification – image height / object height (this equation is on the Physics equation sheet)*
- Magnification is a ratio and has no units.
- Image height **and** object height should both be measured in the same unit either both in mm or both in cm.

In ray diagrams a convex lens will be represented by:

A concave lens will be represented by:

- You should be able to describe an experiment to investigate the magnification produced by a range of convex lenses.

Visible light
- Be able to describe and explain specular and diffuse reflection
- Each colour within the visible light spectrum has its own narrow band of wavelength and frequency.
- Colour filters work by absorbing certain wavelengths (and colour) and transmitting other wavelengths (and colour).
- The colour of an opaque object is determined by which wavelengths are more strongly reflected. Wavelengths not reflected are absorbed. If all wavelengths are reflected equally object looks white, if all wavelengths are absorbed, object appears black.
- Be able to describe the above and explain the effect of viewing objects through filters.

Black body radiation – emission and absorption of IR radiation			
• All bodies (objects), no matter what temperature, emit and absorb infrared radiation. The hotter the body, the more infrared radiation it radiates in a given time. • A perfect black body is an object that absorbs all of the radiation incident on it. A black body does not reflect or transmit any radiation. Since a good absorber is also a good emitter, a perfect black body would be the best possible emitter.			
Perfect black bodies and radiation • Be able to explain that all bodies emit radiation • That the intensity and distribution of any emission depends on the temperature of the body. • Be able to explain how the temperature is related to the balance between incoming radiation absorbed and radiation emitted, using everyday examples which illustrate this balance and the example of the factors which determine the temperature of the Earth. • Use information or draw/interpret diagrams to show how radiation affects the temperature of the Earth's surface and atmosphere.			

Forces and their interactions	☺	😐	☹
Scalar and vector quantities: • Scalar quantities have magnitude only. • Vector quantities have magnitude and associated direction. • A vector may be represented by an arrow. The length of the arrow represents the magnitude and the direction of the arrow the direction of the vector quantity.			
Contact and non-contact forces • A force is a push or pull that acts on an object due to the interaction with another object. All forces between objects are either: • Contact forces (physically touching eg friction, air resistance, tension and normal contact force) • Non-contact forces (physically separated eg gravitational, electrostatic and magnetic forces) • Forces are vector quantities • Make sure you can describe the interaction between pairs of objects which produce a force on each object, the forces to be represented as vectors.			
Gravity • Weight is the force acting on an object due to gravity. The force of gravity close to the earth is due to the gravitational field around the Earth. • The weight of an object depends on the gravitational field strength at the point where the object is. • Weight = mass x gravitational field strength (Learn and recall this equation) • $W = mg$ (g=9.8N/kg – this will be given to you) • The weight of an object may be considered to act at a single point referred to as the object's 'centre of mass'. • Weight and mass are directly proportional. $W \alpha m$ (the symbol α means 'proportional to' here) • Weight is measured using a calibrated spring-balance (newton meter)			
Resultant Forces • A number of forces acting on a point can be replaced with a single force that has the same effect as all the original forces acting together. This single force is called the resultant force. • You need to be able to calculate the resultant of two forces acting in a straight line. • You need to be able to resolve a single force into two components acting at right angles			

to each other by scale diagram (you can use trigonometry and Pythagoras but be careful to read the question carefully they may want to see a scale diagram) • Draw free body diagrams and use them to describe examples where several forces lead to a resultant force on an object including balanced forces where the resultant force is zero. • Use vector diagrams to illustrate resolution of forces, equilibrium situationa sn determine the resultant of two forces at right angles including both magnitude and direction (Scale drawings only)			
Work done and Energy transfer. • Work is done when a force acts on an object causing it to more through a distance. • Work = force x distance (learn and recall this equation). • W = F s • 1Joule of work is done when a force of one newton causes a displacement of 1 metre. • Make sure you can describe the energy transfer involved when work is done. • Convert between newton-metres Nm and Joules (1Nm = 1J) • Work done against frictional forces acting on an object causes a rise in the temperature of the object.			
Forces and Elasticity • Give examples of the forces involved in stretching, bending or compressing an object. • Explain why, to change the shape of an object more than one force has to be applied (limited to stationary objects only) • Describe the difference between elastic deformation and inelastic deformation caused by stretching forces. • The extension of an elastic object, such as a spring, is directly proportional to the force applied, provided that the limit of proportionality is not exceeded. • Force = spring constant x extension • F = ke (learn and recall this equation) • Make sure you can describe the difference between linear and non-linear relationship between force and extension and use the linear case to calculate a spring constant • The equation is valid for compression of an elastic object where e is the compression in this case rather than extension. • A force stretching a spring does work and this elastic potential energy is stored in the spring. Provided the spring is not elastically deformed, the work done on the spring and the elastic potential energy stored are equal. • Be able to interpret data from an investigation of the relationship between force and extension. • Calculate work done in stretching (or compressing) a spring (up to the limit of proportionality) using the equation: • Ee = ½ ke2 • Elastic potential energy = ½ x spring constant x (extension)2 (You will be given this equation) **Required Practical 6 – investigating the relationship between force and extension for a spring**			
Moments, levers and gears • Moment of a force = force x perpendicular distance between force and pivot(learn and recall this equation) • Moment measured in Nm • For equilibrium the total clockwise moment equals the total anti-clockwise moment. • A simple lever and a simple gear system can both be used to transmit the rotational effects of forces. • Make sure you can explain how levers and gears transmit the rotational effects of forces.			

Pressure and pressure differences in fluids • Pressure in a fluid (liquid or gas) causes a force normal (at right angles) to any surface). • Pressure at the surface of a fluid = force / area (learn and recall this) • P = F/A • Pressure is measured in Pascals Pa. • Pressure due to a column of liquid = density of fluid x height of column x gravitational field strength. • P = ρgh (this equation is given to you) • Explain why in a liquid the pressure at a point increases with the height of the column of liquid above that point and with the density of the liquid. • Be able to calculate the differences in pressure at different depths in a liquid. • A partially (or totally) submerged object experiences a greater pressure on the bottom surface than on the top surface. This creates a resultant force upwards. This force is called upthrust. • Be able to describe the factors which influence floating and sinking.			
Atmospheric pressure • Describe a simple model of the Earth's atmosphere and of atmospheric pressure. • Explain why atmospheric pressure varies with height above a surface. • (Air molecules colliding with a surface create atmospheric pressure. The number of air molecules (and so the weight of air) above a surface decreases as the height of the surface above ground level increases) so as height increases there is always less air above a surface than there is at a lower height. Therefore atmospheric pressure decreases with increase in height**.			
Forces and Motion • Distance and displacement • Distance is scalar, is a measure of how far an object moves and does not involved direction. • Displacement is vector, is measured in a straight line from the start point to the finish point and is the distance between the points and the direction of that straight line.			
Speed • Speed is scalar and does not involve direction. • Speed is rarely constant • Typical average speeds walking: 1.5m/s; running: 3.0 m/s; cycling : 6.0m/s. • Learn typical speeds for different types of transportation systems. • Speed of sound and wind also vary • Be able to make measurements of distance and time then calculate speeds of objects. • Speed = distance /time (learn and recall this equation) • Speed is measured in m/s • Make sure you can calculate average speed for non-uniform motion (i.e. where the speed is changing (total distance / total time taken = average speed)			
Velocity • Velocity is speed in a given direction – vector • Be able to explain with examples that motion in a circle involves constant speed but changing velocity.			
Distance – time relationship • Distance time graphs give the following information: • Speed of object – calculated from the gradient of distance –time graph. • If object is accelerating, distance time graph will be curved and so speed at any time is calculated using the gradient of the tangent to the line at that point. • Make sure you can draw distance time graphs from measurements and extract and interpret lines and slopes of distance time graphs.			

Acceleration • Average acceleration = change in velocity / time taken • a = (v-u)/t (learn and recall this equation • acceleration is measured in m/s2 • Be able to estimate the magnitude of everyday accelerations • Acceleration can be calculated from the gradient of a velocity time graph. • The displacement of an object is calculated from the area under a velocity-time graph. • Make sure you can draw v-t graphs from measurements and interpret lines and slopes to determine acceleleration. • Interpret enclosed areas in v-t graphs to determine distance (or displacement) travelled. • Measure area under a v-t graph by counting the squares. • For uniform acceleration • (final velocity)2-(initial velocity)2 = 2 x acceleration x displacement • v2 – u2 = 2as (be able to use this equation it will be given to you on the sheet) • Near the earth's surface any object falling freely under gravity has an acceleration of about 9.8m/s2 • An object falling through a fluid initially accelerates due to the force of gravity. Eventually the resultant force will be zero and the object will move at its terminal velocity. • Make sure you can draw and interpret v-t graphs for objects that reach terminal velocity including interpreting the changing motion in terms of the forces acting.			
Newton's First Law • If the resultant force on an object is zero and: • The object is stationary it will remain stationary • The object is moving the object will continue to move at the same speed and in the same direction i.e. with the same velocity. • A vehicle travelling at constant speed has balanced forces (resistive and driving forces are equal but in opposite directions). • If the velocity (speed and/or direction) is changing then an resultant force must be acting on the object. • The tendency of objects to continue in their state of rest or of uniform motion is called inertia.			
Newton's Second Law • The acceleration of an object is proportional to the resultant force acting on the object and inversely proportional to the mass of the object. • Resultant force = mass x acceleration • F = ma • Inertial mass is a measure of how difficult it is to change the velocity of an object • Inertial mass is the ratio of force over acceleration F/a • Be able to estimate the speed, accelerations and forces involved in large accelerations for everyday road transport. • Recognise and use the symbol ~ for an approximate value or answer. **Required practical activity 7 – investigate the effect of varying the force on the acceleration of an object of constant mass and the effect of varying the mass of an object on the acceleration produced by constant force.**			
Newton's Third Law • Whenever two objects interact, the forces they exert on each other are equal and opposite. • Be able to apply this law to examples of equilibrium situations (e.g. a book on a shelf, a car on the road, a balloon propelled toy car (backward motion of air out of balloon produces equal but opposite force on car propelling it forward)			
Stopping Distance:			

- Stopping distance = thinking distance + braking distance
- Thinking distance = distance travelled during the driver's reaction time.
- Braking distance = distanced travelled while the brakes are applied until the car stops.
- For a given braking force, the greater the speed the greater the stopping distance.
- Estimate how the distance for a vehicle to make an emergency stop varies over a range of speeds typical for that vehicle.
- Interpret graphs relating speed to stopping distance for a range of vehicles.

Reaction time:
- Reaction time varies between people. Typical values range from 0.2 – 0.9s
- Reaction time increased by: tiredness, drugs, alcohol and distractions.
- Explain methods to measure human reaction time and recall typical results.
- Interpret and evaluate measurements from simple methods to measure the different reaction times of students.
- Evaluate the effect of various factors on thinking distance based on data

Factors affecting braking distance
- Adverse road and weather conditions, poor condition of the vehicle's brakes or tyres.
- Make sure you can explain how these factors affect the distance required for road transport vehicles to come to rest in emergencies and the implications for safety.
- Estimate how the distance required for road vehicles to stop in an emergency varies over a range of typical speeds.
- In the brakes, work is done by the friction force between the brakes and the wheel to reduce the kinetic energy of the vehicle and the temperature of the brakes increases.
- The greater the speed of a vehicle, the greater the braking force needed to stop the vehicle in a certain distance.
- The greater the braking force the greater the deceleration of the vehicle. Large decelerations may lead to brakes overheating and/or loss of control.
- Make sure you can explain these dangers
- Estimate the forces involved in the deceleration of road vehicles in typical situations on a public road.

Momentum
- Momentum is a property of moving objects defined by the equation
- Momentum = mass x velocity (learn and recall this equation)
- $p = mv$
- momentum is measured in kg m/s

Conservation of momentum
- In a closed system the total momentum before an event is equal to the total momentum after the event. Conservation of momentum
- Make sure you can describe and explain examples of momentum in an event such as a collision and complete calculations involving the collision of two objects for example.
- Recall an experiment using the air track and light gates to investigate momentum conservation in collisions.

Changes in momentum
- When a force acts on an object that is moving or able to move a change in momentum occurs.
- $F = ma$ and $a=(v-u)/t$ combine to give
- $F=m\Delta v/\Delta t$ (you will be given this equation on the sheet)
- Where $m\Delta v$ is the change in momentum i.e. force equals rate of change of momentum.
- Use the idea of rate of change of momentum to explain safety features such as: air bags, seat belts, gymnasium crash mats, cycle helmets and cushioned surfaces for playgrounds.
- Apply the equations relating force, mass, velocity and acceleration to explain how the

changes involved are inter-related.			

Magnetism and Electromagnetism	😀	😐	🙁

Permanent and induced magnetism, magnetic forces and fields **Poles of a magnet** • Be able to describe how magenitic forces are strongest at the poles of a magnet. • Two magnets brought close together exert a force on each other. • Two like poles repel and two unlike poles attract. This is an example of a non-contact force. • Be able to describe the differences between a permanent (produces its own magnetic field) and induced magnet (a material that becomes a magnet when laced in a magnetic field.). • Induced magnetism always causes a force of attraction. • When removed from the magnetic field the magnet loses most/all induced magnetism quickly.			
Magnetic fields • Be able to describe how to plot the magnetic field pattern of a magnet using a compass. • Draw the magnetic field pattern of a bar magnet showing how strength 9represented by density of field lines and is strongest at the poles of the magnet) and direction (direction of the force on another north pole placed at that point – i.e. from North to South) change from one point to another – remember that field lines never touch. • Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic.			
The Motor Effect **Electromagnetism** • Be able to describe how the magnetic effect of a current can be demonstrated. • Draw the magnetic field pattern for a straight wire carrying a current and for a solenoid (coil) showing the direction of the field (using the RH grip rule) • Explain how a solenoid arrangement can increase the magnetic effect of the current – the magnetic field inside a coil is strong and uniform. The magnetic field around a solenoid is similar to a bar magnet. • Be able to interpret diagrams of electromagnetic devices in order to explain how they work.			
Fleming's Left-hand rule • When a conductor carrying a current is placed in a magnetic field, the magnet producing the field and the conductor exert a force on each other. This is called the motor effect. • Be able to show that Fleming's left-hand shows the orientation of the force (thumb), magnetic field (first finger) and current (second finger). • Be able to recall the factors that affect the size of the force on the conductor • For a conductor at right angles to a magnetic field and carrying a current • *Force = magnetic flux density x current x length* • $F = B \, I \, l$ (you will need to apply this equation it will be on the equation sheet) • Force, F in newtons, N • Mangetic flux density B, in tesla, T • Current, I in amperes, A (amp is acceptable) • Length, l in metres, m			
Electric motors • Be able to explain how the force on a conductor in a magnetic field causes the rotation of the coil in an electric motor.			
Loudspeakers • Be able to explain how a moving-coil loudspeaker and headphones work using the mo-			

tor effect to convert variations in current in electrical circuits to the pressure variations in sound waves.		
Induced Potential • Describe the basic structure of a transformer (primary coil, secondary coil, iron core (easily magnetised). • Explain how the effect of an alternating current in one coil can be used to induce an alternating p.d. in the other coil and a current if the circuit is complete. • Explain how the ratio of the potential differences across the two coils, V_p and V_s depends on the ratio of the number of turns on each coil n_p and n_s. • Be able to apply the equation: • $\frac{V_p}{V_s} = \frac{n_p}{n_s}$ (this equation will be given to you) • Potential difference, V_p and V_s in volts, V • In a step- up transformer $V_s > V_p$ • In a step- down transformer $V_p > V_s$ • If transformers were 100% efficient, the electrical power output would equal the electrical power input. • $V_s \times I_s = V_p \times I_p$ (this equation will be given to you) • Where $V_s \times I_s$ is the power output (secondary coil) and $V_p \times I_p$ is the power input (primary coil. • Power input and output in watts, W • Be able to calculate the current drawn from the input supply to provide a particular power output. • Be able to apply the equation linking the p.d.s and number of turns in the two coils of a transformer to the currents and the power transfer involved and relate these to the advantages of power transmission at high potential differences. (Reduction in energy loss due to thermal transfer in the transmission wires)		

Equations: These are the equations that you need to be able to recall and apply for your exam:

Equation number	Word equation	Symbol equation
1	Weight = mass x gravitational field strength (g)	$W = mg$
2	Work done = force x distance (along the line of action of the force)	$W = F\,s$
3	Force applied to a spring = spring constant x extension	$F = ke$
4	Moment of a force – force x distance (normal to direction of force)	$M = F\,d$
5	Pressure = force normal to a surface / area of that surface	$p = \frac{F}{A}$
6	Distance travelled = speed x time	$s = v\,t$
7	Acceleration = change in velocity / time taken	$a = \frac{\Delta v}{t}$
8	Resultant force = mass x acceleration	$F = m\,a$
9	Momentum = mass x velocity	$P = m\,v$
10	Kinetic energy = 0.5 x mass x (speed)^2	$E_k = \frac{1}{2}m v^2$
11	Gravitational potential energy = mass x gravitational field strength (g) x height	$E_p = m\,g\,h$
12	Power = energy transferred / time	$P = \frac{E}{t}$
13	Power = work done / time	$P = \frac{W}{t}$
14	Efficiency = useful output energy transfer/total input energy transfer	
15	Efficiency = useful power output/total power input	
16	Wave speed = frequency x wavelength	$V = f\,\lambda$
17	Charge flow = current x time	$Q = I\,t$
18	Potential difference = current x resistance	$V = I\,R$

19	Power = potential difference x current	P = V I
20	Power = (current)^2 x Resistance	P = I^{2}R
21	Energy transferred = power x time	E = P t
22	Energy transferred = charge flow x potential difference	E = Q V
23	Density = mass / volume	$\rho = \dfrac{m}{V}$

These are the equations that you will be given and will need to select from.

Equation number	Word equation	Symbol equation
1	Pressure due to a column of liquid = height of column x density of liquid x gravitational field strength (g)	P = h ρ g
2	(final velocity)^2 – (initial velocity)^2 = 2 x acceleration x distance	v^2-u^2 = 2 a s
3	Force = change in momentum / time taken	$F = \dfrac{m\Delta v}{\Delta t}$
4	Elastic potential energy = 0.5 x spring constant x (extension)^2	E$_e$= ½ k e^2
5	Change in thermal energy = mass x specific heat capacity x temperature change	$\Delta E = mc\Delta\theta$
6	Period = 1/frequency	
7	Magnification = image height /object height	
8	Force on a conductor (at right angles to a magnetic field) carrying a current = magnetic flux density x current x length	F=B I l
9	Thermal energy for a change of state = mass x specific latent heat	E = m L
10	$\dfrac{potential\ difference\ across\ primary\ coil}{potential\ difference\ across\ secondary\ coil} = \dfrac{number\ or\ turns\ in\ primary\ coil}{number\ of\ turns\ in\ secondary\ coil}$	$\dfrac{V_p}{V_s} = \dfrac{n_p}{n_s}$
11	Potential difference across primary coil x current in primary coil = potential difference across secondary coil x current in secondary coil	V$_s$I$_s$ = V$_p$I$_p$
12	For gases: pressure x volume = constant	p V = constant

Good Luck ☺