GCSE (9-1)

Separate

Physics 2

### Topics for Paper 2

#### Topic 8 – Energy – forces doing work

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| **Students should:** | | **Maths skills** |
| 8.1 | Describe the changes involved in the way energy is stored when systems change – *eg Gravitational potential energy in to kinetic energy or electrical energy into light energy.* |  |
| 8.2 | Draw and interpret diagrams to represent energy transfers  *Electricity -> Heat + Light* | 1c, 2c |
| 8.3 | Explain that where there are energy transfers in a closed system there is no net change to the total energy in that system  *1000J -> 350J + 650J For the example above in 8.2* |  |
| 8.4 | Identify the different ways that the energy of a system can be changed  a through work done by forces  b in electrical equipment  c in heating  *Examples include: Fricition -> Electrostatic, Kinetic energy -> electrical energy and Friction -> Heat* |  |
| 8.5 | Describe how to measure the work done by a force and understand that energy transferred (joule, J) is equal to work done (joule, J)  *Work done is the same as Energy and both are measured in Joules* |  |
| 8.6 | Recall and use the equation:  work done (joule, J) = force (newton, N) × distance moved in the direction of the force (metre, m)  *E* *F* *d*  *e.g A force of 50N acting for 2m gives 50 x 2 = 100J* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d  4f |
| 8.7 | Describe and calculate the changes in energy involved when a system is changed by work done by forces  *I can use the equation in 2.6* |  |
| 8.8 | Recall and use the equation to calculate the change in gravitational PE when an object is raised above the ground:  change in gravitational potential energy (joule, J) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg) × change in vertical height (metre, m)  *GPE* *m (kg)**g(N/kg)* *h(m) .* change | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 8.9 | Recall and use the equation to calculate the amounts of energy associated with a moving object:  kinetic energy (joule, J) = 1/2× mass (kilogram, kg) ×  (speed)2 ((metre/second)2, (m/s)2)  *KE* 1 *m* *v* 2  2  *e.g A 5kg mass at 3m/s Energy = ½ X5 X32 = 22.5J* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 8.10 | Explain, using examples, how in all system changes energy is dissipated so that it is stored in less useful ways.  *Dissipated means spread out, like heat lost through friction ion the brakes of a bike.* |  |

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| **Students should:** | | **Maths skills** |
| 8.11 | Explain that mechanical processes become wasteful when they cause a rise in temperature so dissipating energy in heating the surroundings *(See 8.10)* |  |
| 8.12 | Define power as the rate at which energy is transferred and use examples to explain this definition  *The faster you transfer energy, the more powerful you are* | 1c |
| 8.13 | Recall and use the equation:  power (watt, W) = work done (joule, J) ÷ time taken (second, s)  *P* *E*  *t*  *e.g. 3000J are transferred in 20sec.*  *Power (W) = 3000J / 20sec = 150W* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 8.14 | Recall that one watt is equal to one joule per second, J/s | 1c |
| 8.15 | Recall and use the equation:  useful energy transferred by the device  efficiency  total energy sup plied to the device  *e.g A kettle used 3MJ of electrical energy and 2.5MJ went into the hot water.*  *Efficiency = 2.5MJ/3.0MJ = 0.83*  *There are no units and it has to be less than 1.0* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |

Topic 9 – Forces and their effects

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| **Students should:** | | **Maths skills** |
| 9.1 | Describe, with examples, how objects can interact   1. at a distance without contact, linking these to the gravitational, electrostatic and magnetic fields involved 2. by contact, including normal contact force and friction c producing pairs of forces which can be represented as   vectors   1. *Falling to the ground, brushing your hair and a compass facing North/South* 2. *Push a car, pull a rope, slow down on a rough road* |  |
| 9.2 | Explain the difference between vector and scalar quantities using examples  *Vectors like velocity have magnitude (size) and direction and scalers like speed have just magnitude* |  |
| 9.3 | **Use vector diagrams to illustrate resolution of forces, a net force, and equilibrium situations (scale drawings only)**  *Resultant force = zero*  *Resultant force is to the right* | 4a, 5a, 5b |
| 9.4 | **Draw and use free body force diagrams**  Image result for balanced force diagram for a plane | 4a, 5a, 5b |
| 9.5 | **Explain examples of the forces acting on an isolated solid object or a system where several forces lead to a resultant force on an object and the special case of balanced forces when the resultant force is zero**  *Like the diagrams in 9.3* | 5a |
| 9.6P | Describe situations where forces can cause rotation  *e.g The lever created by a pair of scissors or by sitting on one end of a see-saw* |  |
| 9.7P | Recall and use the equation:  moment of a force (newton metre, N m) = force (newton, N) × distance normal to the direction of the force (metre, m)  *e.g. Simon, 300N, sits 4m from the pivot on a see-saw*  *His moment = 300N x 4m = 1200Nm* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 9.8P | Recall and use the principle of moments in situations where rotational forces are in equilibrium:  the sum of clockwise moments = the sum of anti-clockwise moments  for rotational forces in equilibrium  *Sophie is sat on the opposite side of Simon’s see-saw. She is 3m from the pivot and 400N. Moment = 400N x 3m = 1200Nm so the see-saw is balanced* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 9.9P | Explain how levers and gears transmit the rotational effects of forces  *Levers of different lengths either side of a pivot can multiply forces. Gears with different numbers of cogs can be used to multiply forces and to change their direction* | 5b |
| 9.10 | Explain ways of reducing unwanted energy transfer through lubrication  *Oil on a hinge reduces friction which will reduce heat lost to the environment* |  |

#### Topic 10 – Electricity and circuits

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| **Students should:** | **Maths skills** |
| 10.1 Describe the structure of the atom, limited to the position, mass and charge of protons, neutrons and electrons.   |  |  |  |  | | --- | --- | --- | --- | | Particle | Mass | Charge | Position | | Proton | 1 | +1 | Nucleus | | Neutron | 1 | 0 | Nucleus | | Electron | 1/2000 | -1 | Shells | | 5b |
| https://getrevising.co.uk/https_proxy/1408610.2 Draw and use electric circuit diagrams representing them with the conventions of positive and negative terminals, and the symbols that represent cells, including batteries, switches, voltmeters, ammeters, resistors, variable resistors, lamps, motors, diodes, thermistors, LDRs and LEDs. | 5b |
| 10.3 Describe the differences between series and parallel circuits.  *Series have 1 loop and parallel have more than 1 loop.* |  |
| https://www.siyavula.com/science/grade-11/11-electric-circuits/pspictures/dd78eaa844af485b64b311c5db95cbdb.png10.4 Recall that a voltmeter is connected in parallel with a component to measure the potential difference (voltage), in volt, across it |  |
| 10.5 Explain that potential difference (voltage) is the energy transferred per unit charge passed and hence that the volt is a joule per coulomb.  *1 Amp means 1C of charge flows in 1 second* | 1a, 1c  3c |
| 10.6 Recall and use the equation:  energy transferred (joule, J) = charge moved (coulomb, C) × potential difference (volt, V)  *E* *Q* *V*  *e.g What charge flows with 6V and 2400J of energy*  *coulomb = 2400J / 6V = 400C* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| http://www.bbc.co.uk/schools/gcsebitesize/science/images/ph_circuitsq7.gif10.7 Recall that an ammeter is connected in series with a component to measure the current, in amp, in the component |  |
| 10.8 Explain that an electric current as the rate of flow of charge and the current in metals is a flow of electrons ( see 10.5) |  |
| 10.9 Recall and use the equation:  charge (coulomb, C) = current (ampere, A) × time (second, s)  *Q* *I* *t*  *e.g. 3Amps flowing for 60secs = 3A X 60s = 180C* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 10.10 Describe that when a closed circuit includes a source of potential difference there will be a current in the circuit. *Source = cell. Closed = A complete circuit.* |  |
| 10.11 Recall that current is conserved at a junction in a circuit |  |
| 10.12 Explain how changing the resistance in a circuit changes the current and how this can be achieved using a variable resistor. *More resistance means less current can flow* |  |
| 10.13 Recall and use the equation:  potential difference (volt, V) = current (ampere, A) × resistance (ohm, )  *V* *I* *R*  *What current flows through a 200Ω resistor from a 6V cell?*  *I = V/R 6/200 = 0.03A* | 1a, 1d 2a  3a, 3c, 3d |
| 10.14 Explain why, if two resistors are in series, the net resistance is increased, whereas with two in parallel the net resistance is decreased *Two 30Ω resistors in series = 30 Ω +30 Ω = 60Ω Two 30Ω resistors in parallel. There are two paths so twice the current flows so the resistance is 15 Ω* |  |

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| **Students should:** | **Maths skills** |
| Image result for v=ixr triangle10.15 Calculate the currents, potential differences and resistances in series circuits. *Make sure that you can use the equation.* | 1a, 1d 2a  3a, 3c, 3d |
| 10.16 Explain the design and construction of series circuits for testing and measuring.  *By using a variable resistor to control the current and then measuring the potential difference across a component using a voltmeter.* |  |
| * 1. *Core Practical: Construct electrical circuits to:*      1. *investigate the relationship between potential difference, current and resistance for a resistor and a filament lamp*      2. *test series and parallel circuits using resistors and filament lamps* | 1a, 1c, 1d 2a, 2b, 2f  3a, 3b, 3c, 3d  4a, 4b, 4c, 4d, 4e |
| 10.18 Explain how current varies with potential difference for the following devices and how this relates to resistance  a filament lamps - *more current gives heat so resistance increases. More p.d. doesn’t give the same increase in current.* b diodes – *Only allows current to flow in one direction*  c fixed resistors – *Directly proportional. More p.d.=more current* | 2g  4a, 4b, 4c, 4d, 4e |
| 10.19 Describe how the resistance of a light-dependent resistor (LDR) varies with light intensity *More light = less resistance so more current flows* | 4c, 4d |
| 10.20 Describe how the resistance of a thermistor varies with change of temperature (negative temperature coefficient thermistors only) *More heat = less resistance so more current flows* | 4c, 4d |
| 10.21 Explain how the design and use of circuits can be used to explore the variation of resistance in the following devices  a filament lamps b diodes   1. Image result for using variable resistor to investigate componentsthermistors 2. LDRs | 5b |
| 10.22 Recall that, when there is an electric current in a resistor, there is an energy transfer which heats the resistor *Electricity -> Heat* |  |
| 10.23 Explain that electrical energy is dissipated as thermal energy in the surroundings when an electrical current does work against electrical resistance  *The heat is lost, but can be used in a kettle or a toaster* |  |
| 10.24 Explain the energy transfer (in 10.22 above) as the result of collisions between electrons and the ions in the lattice – *more collisions between + ions in the metal and electrons causes an increase in resistance* |  |
| 10.25 Explain ways of reducing unwanted energy transfer through low resistance wires -  *make wires shorter or have a bigger diameter so more current flows for the same p.d.* |  |
| 10.26 Describe the advantages and disadvantages of the heating effect of an electric current –  *PRO – you can use the heat energy for cooking or keeping warm.*  *CON – lose energy from the circuit into the surroundings which will increase the cost of running the appliance.* |  |

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| **Students should:** | **Maths skills** |
| 10.27 Use the equation:  energy transferred (joule, J) = current (ampere, A) × potential difference (volt, V) × time (second, s)  *E* *I* *V* *t e.g. How much energy does a 12A kettle at 230V use in 300sec?*  *E = 12 x 230 x 300 = 828,000J or 828kJ* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| Image result for power energy time triangle10.28 Describe power as the energy transferred per second and recall that it is measured in watt | 1c |
| 10.29 Recall and use the equation:  power (watt, W) = energy transferred (joule, J) ÷ time taken (second, s)  *e.g. A 3Kw kettle for 2 min Energy J = 3000 x 120 = 360,000J* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 10.30 Explain how the power transfer in any circuit device is related to the potential difference across it and the current in it *Increasing p.d. or current increase the energy flow* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 10.31 Recall and use the equations:  electrical power (watt, W) = current (ampere, A) × potential difference (volt, V)  *P* *I* *V e.g. Power W = 5A x 230V = 1150W*  electrical power (watt, W) = current squared (ampere2, A2) × resistance (ohm, Ω)  *P* *I* 2 *R e.g. Power = 5A x 5A x 50Ω = 1250W* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 10.32 Describe how, in different domestic devices, energy is transferred from batteries (*electrons flow to the motor/heater giving up their energy before going back to the battery to collect more)* and the a.c. mains (*electrons vibrate and pass on energy)* to the energy of motors and heating devices |  |
| 10.33 Explain the difference between direct and alternating voltage | 4c |
| 10.34 Describe direct current (d.c.) as movement of charge in one direction only and recall that cells and batteries supply direct current (d.c.)  *Go from the –ve to the +ve terminals of the cell* |  |
| 10.35 Describe that in alternating current (a.c.) the movement of charge changes direction  *They vibrate back and forth in the wire* |  |
| 10.36 Recall that in the UK the domestic supply is a.c., at a frequency of 50 Hz and a voltage of about 230 V |  |
| 10.37 Explain the difference in function between the live and the neutral mains input wires  *LIVE varies between +230V and -230V at 50 times each second, 50Hz. NEUTRAL kept at 0V* |  |
| 10.38 Explain the function of an earth wire and of fuses or circuit breakers in ensuring safety  *If the live touches a metal case which is earthed, a large current flows to earth. This current goes through the fuse which melts, breaking the circuit. Circuit breakers detect high currents and open a switch. They can be reset later.* |  |
| 10.39 Explain why switches and fuses should be connected in the live wire of a domestic circuit  *The earth and neutral are at 0V so no energy. Live is at 230V, so lots of energy.* |  |

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| **Students should:** | **Maths skills** |
| 10.40 Recall the potential differences between the live, neutral and earth mains wires *LIVE – EARTH = 230V LIVE – NEUTRAL = 230V EARTH – NEUTRAL = 0V* |  |
| 10.41 Explain the dangers of providing any connection between the live wire and earth  *This can cause a large current to flow* |  |
| Image result for power rating sticker appliance10.42 Describe, with examples, the relationship between the power ratings for domestic electrical appliances and the changes in stored energy when they are in use *Washing machine -  Electrical -> Heat + Kinetic energy + sound An efficient washing machine converts the electrical energy into useful energy like heat and movement and not a lot of sound.* | 1c 2c |

#### Topic 11 – Static electricity

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| **Students should:** | **Maths skills** |
| 11.1P Explain how an insulator can be charged by friction, through the transfer of electrons  *-ve electrons move between two different materials* |  |
| 11.2P Explain how the material gaining electrons becomes negatively charged and the material losing electrons is left with an equal positive charge  *Before each has an equal +ve and –ve charge. Gaining electrons leads to a –ve charge. Losing electrons leads to a +ve charge.* |  |
| 11.3P Recall that like charges repel and unlike charges attract -  -> + - <- <- + + -> <- - - -> |  |
| 11.4P Explain common electrostatic phenomena in terms of movement of electrons, including  a shocks from everyday objects *- Friction leads to a build up in charge.* b lightning - *If the difference in potential is large enough, this is discharged a shock travels to or from the earth.*  c attraction by induction such as a charged balloon attracted to a wall and a charged comb picking up small pieces of paper –*A –ve charged object brought close to a neutral object attracts the +ve charge and repels the –ve.* |  |
| 11.5P Explain how earthing removes excess charge by movement of electrons  C*harge flows to or from the object to earth to make the net charge zero.* |  |
| 11.6P Explain some of the uses of electrostatic charges in everyday situations, including insecticide sprayers  *friction causes identical charges which repel and spread out.* |  |
| 11.7P Describe some of the dangers of sparking in everyday situations, including fuelling cars, and explain the use of earthing to prevent dangerous build-up of charge  *fuels can ignite so we earth tankers so there is no chance of a spark* |  |
| 11.8P Define an electric field as the region where an electric charge experiences a force  *a charged particle will move in an electric field because of the force acting on it* |  |
| 11.9P Describe the shape and direction of the electric field around a point charge and between parallel plates and relate the strength of the field to the concentration of lines - *for a point, it is directly to or away from it and between plates it is towards one plate or the other.* | 5b |
| 11.10P Explain how the concept of an electric field helps to explain the phenomena of static electricity  *It creates a non contact force that affects the +ve or –ve charges close to it.* |  |

#### Topic 12 – Magnetism and the motor effect

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| **Students should:** | **Maths skills** |
| Image result for magnets attract repel12.1 Recall that unlike magnetic poles attract and like magnetic poles repel |  |
| 12.2 Describe the uses of permanent and temporary magnetic materials including cobalt, steel, iron and nickel  *can separate Al and Fe cans, move cars in a scrapyard and make speakers in a hifi work.* |  |
| 12.3 Explain the difference between permanent and induced magnets  *permanent are there all the time and induced only last when a current is flowing through a coil of wire.* |  |
| Image result for magnet field12.4 Describe the shape and direction of the magnetic field around bar magnets and for a uniform field, and relate the strength of the field to the concentration of lines | 5b |
| 12.5 Describe the use of plotting compasses to show the shape and direction of the field of a magnet and the Earth’s magnetic field  *plotting compass is a tiny magnet* | 5b |
| 12.6 Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic  *always points in a North South direction* | 5b |
| 12.7 Describe how to show that a current can create a magnetic effect around a long straight conductor, describing the shape of the magnetic field produced and relating the direction of the magnetic field to the direction of the current  *circles of a force field go around the wire. RH rule, thumb = current direction and fingers show field rotation.* | 5b |
| 12.8 Recall that the strength of the field depends on the size of the current and the distance from the long straight conductor – *increased current = larger field strength and the field gets weaker further away from the wire* |  |
| * 1. Explain how inside a solenoid (an example of an electromagnet) the fields from individual coils      1. add together to form a very strong almost uniform field along the centre of the solenoid – *strong through the core*      2. cancel to give a weaker field outside the solenoid – *weak on the outside because the fields cancel each other out* | 5b |
| * 1. **Recall that a current carrying conductor placed near a magnet experiences a force and that an equal and opposite force acts on the magnet**   2. ***This causes a force on the wire and the magnet, but wires are light so they move and the magnet stays still*** | 5b |
| * 1. **Explain that magnetic forces are due to interactions between magnetic fields**   ***repulsion or attraction*** |  |
| Image result for flemings LHR12.12 **Recall and use Fleming’s left-hand rule to represent the relative directions of the force, the current and the magnetic field for cases where they are mutually perpendicular** | 5b |

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| **Students should:** | **Maths skills** |
| 12.13 **Use the equation:**  **force on a conductor at right angles to a magnetic field carrying a current (newton, N) = magnetic flux density (tesla, T or newton per ampere metre, N/A m) × current (ampere, A) × length (metre, m)**  ***F*** ***B*** ***I*** ***l*** *e.g. What force acts a wire 0.5m long carrying 3A in a field of strength 0.2T?  Force N = 0.2T x 3A x 0.5m = 0.3N* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 12.14P **Explain how the force on a conductor in a magnetic field is used to cause rotation in electric motors**  *Forces act in opposite directions either side of a pivot so that it rotates/spins* | 5b |

#### Topic 13 – Electromagnetic induction

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| **Students should:** | **Maths skills** |
| P Explain how to produce an electric current by the relative movement of a magnet and a conductor  * + 1. **on a small scale in the laboratory – *Move the magnet in and out of a coil of wire***     2. **in the large-scale generation of electrical energy – *spin the coils of wires between the magnets N and S poles*** |  |
| * 1. **Recall the factors that affect the size and direction of an induced potential difference, and describe how the magnetic field produced opposes the original change**   *4 factors – magnetic field strength, direction of field, number of turns on the coil and the current through the coil* | 5b |
| 13.3P **Explain how electromagnetic induction is used in alternators to generate current which alternates ( *slip rings and carbon brushes to give a.c. )* in direction (a.c.) and in dynamos to generate direct current (d.c.)**  *have a split commutator which keeps the current flowing in one direction* | 5b |
| 13.4P **Explain the action of the microphone in converting the pressure variations in sound waves into variations in current in electrical circuits, and the reverse effect as used in loudspeakers and headphones**  *vibrations from the sound waves causes the coil to move back and forth through a magnetic field which leads to an a.c. current in the wire* | 5b |
| 13.5 **Explain how an alternating current in one circuit can induce a current in another circuit in a transformer -** *two circuits connected by an iron core ( ring )* |  |
| 13.6 **Recall that a transformer can change the size of an alternating voltage -** *different numbers of turns on each coil* |  |
| 13.7P **Use the turns ratio equation for transformers to calculate either the missing voltage or the missing number of turns:**  ***potential difference across primary coil*** =***number of turns in primary coil*** | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d  5b |
| ***potential difference across secondary coil number of turns in secondary coil***  Vp = Np  Vs Ns |  |
| 13.8 Explain why, in the national grid, electrical energy is transferred at high voltages from power stations, and then transferred at lower voltages in each locality for domestic uses as it improves the efficiency by reducing heat loss in transmission lines  *High voltage means low current. Energy loss through heat relates to the square of the current so ½ current means ¼ less heat produced ( ½ x ½ = ¼)* |  |
| 13.9 Explain where and why step-up and step-down transformers are used in the transmission of electricity in the national grid  *Step down near homes and factories to lower the voltage to make them safer and less chance of large shocks* |  |

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| **Students should:** | **Maths skills** |
| 13.10 Use the power equation (for transformers with 100% efficiency):  potential difference across primary coil (volt, V) × current in primary coil (ampere, A) = potential difference across secondary coil (volt, V) × current in secondary coil (ampere, A)  *VP* *IP* *VS* *IS*  *Current on secondary coil? Vp = 2,000V, Ip = 30A and Vs = 12,000V 2000 x 30 = 12000 x Is*  *Is = 2000 x 30 = 5A*  *12000* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 13.11P **Explain the advantages of power transmission in high- voltage cables, using the equations in 10.29, 10.31, 13.7P and 13.10** | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d  5b |

#### Topic 14 – Particle model

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| **Students should:** | **Maths skills** |
| Image result for solid liquid gas14.1 Use a simple kinetic theory model to explain the different states of matter (solids, liquids and gases) in terms of the movement and arrangement of particles |  |
| 14.2 Recall and use the equation:  density (kilogram per cubic metre, kg/m3) = mass (kilogram, kg) ÷ volume (cubic metre, m3)  ***m*  *V*  *What is the density of a 0.5m3 block of ice of mass 478kg?*  *478/0.5 = 956 kg/m3* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d 5c |
| 14.3 *Core Practical: Investigate the densities of solid and liquids* | 1a, 1b, 1c, 1d 2a, 2c, 2f  3a, 3b, 3c, 3d 4a, 4c  5c |
| 14.4 Explain the differences in density between the different states of matter in terms of the arrangements of the atoms or molecules  *When you melt a solid the particles spread out into a larger volume so are less dense and when they turn into a gas, they are widely spaced so have a really large volume and a very low density.* | 5b |
| 14.5 Describe that when substances melt, freeze, evaporate, boil, condense or sublimate (*goes from a solid to a gas)* mass is conserved and that these physical changes differ from some chemical changes because the material recovers its original properties if the change is reversed  *You have the same number of particles, but they are arranged differently, more spread out* |  |
| 14.6 Explain how heating a system will change the energy stored within the system and raise its temperature or produce changes of state *Gives particles more energy so they break the bonds between them and then change state* |  |
| 14.7 Define the terms specific heat capacity ( *Energy needed to raise the temperature of 1kg by 1oC )* and specific latent heat and explain the differences between them  *energy needed to change the state of 1kg of substance* |  |
| 14.8 Use the equation:  change in thermal energy (joule, J) = mass (kilogram, kg) × specific heat capacity (joule per kilogram degree Celsius, J/kg °C) × change in temperature (degree Celsius, °C)  *Q* *m* *c* **  *Energy needed to heat 2kg of water (SHC = 4200 J/kg °C) by 30°C?*  *E = 2 x 4200 x 30 = 252,000J or 252kJ* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 14.9 Use the equation:  thermal energy for a change of state (joule , J) = mass (kilogram, kg) × specific latent heat (joule per kilogram, J/kg)  *Q* *m* *L*  *Energy needed to turn 4kg of water into steam (SLH of water is 2.26 x 106 J/kg)*  *E = 4 x 2.26 x 106  = 9.04 x 106 J* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 14.10 Explain ways of reducing unwanted energy transfer through thermal insulation -  *A barrier stops the heat transfer to the surroundings. E.g. a wooly jumper keeps you warm in winter.* |  |

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| **Students should:** | **Maths skills** |
| 14.11 *Core Practical: Investigate the properties of water by determining the specific heat capacity of water and obtaining a temperature-time graph for melting ice* | 1a, 1b, 1c, 1d 2a, 2b, 2f  3a, 3b, 3c, 3d  4a, 4c, 4e |
| 14.12 Explain the pressure of a gas in terms of the motion of its particles  *Gas particles collide with the walls of a container creating a force – this leads to pressure* | 5b |
| 14.13 Explain the effect of changing the temperature of a gas on the velocity of its particles and hence on the pressure produced by a fixed mass of gas at constant volume (qualitative only)  *High temperature means particles move faster with more collisions so increased pressure* | 5b |
| 14.14 Describe the term absolute zero, −273 °C, in terms of the lack of movement of particles  *The particles stop vibrating so have no energy* |  |
| 14.15 Convert between the kelvin and Celsius scales  *K = C – 273o C = K +273o* | 1a  2a |
| 14.16P Explain that gases can be compressed or expanded by pressure changes |  |
| 14.17P Explain that the pressure of a gas produces a net force at right angles to any surface |  |
| 14.18P Explain the effect of changing the volume of a gas on the rate at which its particles collide with the walls of its container and hence on the pressure produced by a fixed mass of gas at constant temperature | 5b |
| 14.19P Use the equation:  *P*1 *V*1 *P*2 *V*2  to calculate pressure or volume for gases of fixed mass at constant temperature  *What pressure would you get if the volume of a gas at 20Pa increased from 2.5m3 to 7.5m3? 20 x 2.5 = P2 x 7.5, so P2 = 20 x 2.5 = 6.67Pa  7.5* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 14.20P **Explain why doing work of a gas can increase its temperature, including a bicycle pump**  *The energy you use or apply to the gas gives the particles kinetic energy as they move faster. This is converted into heat.* |  |

#### Topic 15 – Forces and matter

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| **Students should:** | **Maths skills** |
| 15.1 Explain, using springs and other elastic objects, that stretching, bending or compressing an object requires more than one force  *To compress or stretch a spring you need to push or pull at BOTH ends* |  |
| 15.2 Describe the difference between elastic *( goes back to shape )* and inelastic distortion *(changes shapes)* |  |
| 15.3 Recall and use the equation for linear elastic distortion including calculating the spring constant:  force exerted on a spring (newton, N) = spring constant (newton per metre, N/m) × extension (metre, m)  *F* *k* *x Force needed to extend a wire by 0.025m whose spring constant is 6x106 N/m? Force = 6x106 x 0.025 = 150,000N* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 15.4 Use the equation to calculate the work done in stretching a spring:  energy transferred in stretching (joules, J) = 0.5 × spring constant (newton per metre, N/m) × (extension (metre, m))2  *E* 1 *k* *x* 2  2  *The energy for the above example is*  *E = 0.5 x 6x106 x 0.025 x 0.025 = 1,875J* | 1a, 1c, 1d 2a  3a, 3b, 3c, 3d 4c, 4e, 4f |
| 15.5 Describe the difference between linear *( a straight line going through the origin of a force / extension graph)* and non-linear *( curved line)* relationships between force and extension | 4c, 4e |
| 15.6 *Core Practical: Investigate the extension and work done when applying forces to a spring* | 1a, 1c, 1d 2a, 2b, 2c, 2f 3a, 3b, 3c, 3d  4a, 4b, 4c, 4d |
| 15.7P Explain why atmospheric pressure varies with height above the Earth’s surface with reference to a simple model of the Earth’s atmosphere  *Higher up there are less gas particles to collide with things so there is less pressure* |  |
| 15.8P Describe the pressure in a fluid as being due to the fluid and atmospheric pressure -  *water particles collide with objects, but air pressure also pushes down on the water as well* |  |
| 15.9P Recall that the pressure in fluids causes a force normal to any surface – *( normal means at 90o to)* |  |
| 15.10P Explain how pressure is related to force and area, using appropriate examples  *Like cutting with a knife, a large force on a small area gives HIGH pressure.* | 1c |
| 15.11P Recall and use the equation:  pressure (pascal, Pa) = force normal to surface (newton, N) ÷ area of surface (square metre, m2)  *P* *F*  *A*  *What pressure is made by a 800N person covering 0.05m2? P = 800/0.05 = 16,000N/m2 If they wear snowshoes of area 0.25m2 then  P = 800/0.25 = 3,200 N/m2* | 1a, 1b, 1c, 1d 2a  3a, 3c, 3d 5b, 5c |
| 15.12P Describe how pressure in fluids increases with depth and density  *More density means more particles so mores collisions and increased pressure. More depth means the weight of the particles above creates more pressure* | 1c |

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| **Students should:** | **Maths skills** |
| 15.13P **Explain why the pressure in liquids varies with density and depth** – *(see 15.12)* | 1c |
| 15.14P **Use the equation to calculate the magnitude of the pressure in liquids and calculate the differences in pressure at different depths in a liquid:**  **pressure due to a column of liquid (pascal, Pa) = height of column (metre, m) × density of liquid *(Often using mercury in a barometer)* (kilogram per cubic metre, kg/m3) × gravitational field strength (newton per kilogram, N/kg)**  ***P*** ***h*** *******g***  *Pressure on earth is typically;*  *Pressure = 0.76m x 13593kg/m3 x 10N/kg Pressure = 103, 107Pa ( This is close to 1atm )* | 1a, 1b, 1c, 1d 2a  3a, 3b, 3c, 3d |
| 15.15P **Explain why an object in a fluid is subject to an upwards force (upthrust) *(****more pressure from below than above****)*  and relate this to examples including objects that are fully immersed in a fluid (liquid or gas) or partially immersed in a liquid** | 5b |
| 15.16P **Recall that the upthrust is equal to the weight of fluid displaced -  *measured in Newtons*** |  |
| 15.17P **Explain how the factors (upthrust, weight, density of fluid) influence whether an object will float or sink –** *If the density is greater than the fluid it sinks If the density is less than the fluid it floats* | 5b |