# AQA GCSE Physics

# Core Knowledge

## Questions & answers

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Paper 1 Topics:

- Energy
- Electricity
- Molecules & matter
- Radioactivity

Paper 2 Topics:

- Forces
- Waves
- Electromagnetic waves
- Electromagnetism
- *Space (Separate only)*

**Energy**

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| 1 | How can energy be stored? | Energy can be stored in a variety of different energy stores. |
| 2 | How can energy be transferred? | Energy is transferred by heating, by waves, by electric current or by force when it moves an object. |
| 3 | What changes in energy stores occur when an object falls? | The store of gravitational potential energy decreases and its kinetic energy store increases. |

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| 4 | What energy transfers happen when a falling object hits the ground without bouncing back? | Its kinetic energy store decreases. Some or all of its energy is transferred to the surroundings, as thermal energy or sound. |
| 5 | What is conservation of energy? | Energy cannot be created or destroyed. |
| 6 | Why is conservation of energy important? | Conservation of energy applies to all energy changes. |
| 7 | What is a closed system? | A closed system is an isolated system in which no energy transfers take place out of or into the energy stores of the system. |
| 9 | How can we describe the changes to energy stores in a closed system? | Energy can be transferred between energy stores within a closed system. The total energy of the system is always the same, before and after any such transfers. |
| 10 | What is the definition of 'work'? | Work is done on an object when a force makes the object move. |
| 11 | How are energy and work related? | Energy transferred = work done. |
| 12 | How do we calculate the work done by a force? | Work done = Force x distance ($W = F\ s$) |
| 13 | What happens to work done to overcome friction? | Work done to overcome friction is transferred as energy to the thermal energy stores of the objects that rub together and to the surroundings. |
| 14 | What happens to the gravitational potential energy stores of an object when it moves up or down? | It increases when it moves up, and decreases when it moves down. |
| 15 | Why is there an increase in gravitational potential energy when an object moves up? | Because work is done on it to overcome the force of gravity. |
| 16 | Why is it easier to lift an object on the Moon than on Earth? | The gravitational field strength is less on the Moon than on Earth. |
| 17 | How do we calculate the change in gravitational potential energy of an object when it moves up and down? | Change in Grav. Pot. energy = mass x gravitational field strength x change in height<br><br>$\square E_p = m\ g\ \square h$ |
| 18 | What does the amount of energy in a kinetic energy store depend on? | Mass and speed. |
| 19 | How do we calculate the amount of energy in a kinetic energy store? | Kinetic energy = ½ x mass x speed$^2$<br><br>$E_k = ½\ m\ v^2$ |
| 20 | What is an elastic potential energy store? | The energy stored in an elastic object when work is done on the object. |

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| 21 | How do we calculate the amount of energy in an elastic potential energy store? | Elastic potential energy = ½ x spring constant x extension$^2$<br>$E_e = ½\ k\ e^2$ |
| 22 | What is useful energy? | Energy in the place we want it and in the form we want it. |
| 23 | What is wasted energy? | Energy that is not useful energy and is transferred by an undesirable pathway. |
| 24 | What eventually happens to wasted energy? | Transferred to the surroundings, which become warmer. |
| 25 | Is energy still useful after it has been used? | As energy dissipates (spreads out), it becomes less and less useful. |
| 26 | What is meant by efficiency? | The efficiency of a device = useful energy transferred by the device ÷ total energy supplied to the device (x 100%) |
| 27 | What is the maximum efficiency of any energy transfer? | No energy transfer can be greater than 100% efficient. |
| 28 | How do machines waste energy? | Because of friction between moving parts, air resistance, electrical resistance, noise. |
| *29 H* | *How can energy transfers be made more efficient?* | *By reducing the energy they waste e.g. lubrication is used to reduce friction.* |
| 30 | How is energy supplied to your home? | By electricity, gas and/or oil. |
| 31 | Why are electrical appliances so useful? | They can transfer useful energy quickly. |
| 32 | What are most everyday appliances used for? | Heating, lighting, making objects move, and producing sound and images. |
| 33 | How do we choose an appliance for a particular job? | An appliance is designed for a particular purpose and should waste as little energy as possible. |
| 34 | What is meant by power? | Power is the rate of transfer of energy. |
| 35 | How do we calculate the power of an appliance? | Power = Energy ÷ Time<br>$P = E / t$ |
| 36 | How do we calculate efficiency of an appliance? | Efficiency = useful power out ÷ total power in (x 100%) |
| 37 | How do we calculate power wasted by an appliance? | Power wasted = total power in - useful power out |
| 38 | Which materials make the best conductors? | Metals |
| 39 | Which materials make the best insulators? | Non-metals such as wool and fibreglass |
| 40 | How does the thermal conductivity of a material affect the rate of energy transfer through it by conduction? | The higher the thermal conductivity of a material, the higher the rate of energy transfer through it. |

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| 41 | How does the thickness of a layer of material affect the rate of energy transfer by conduction through it? | The thicker the layer of insulating material, the lower the rate of energy transfer through it. |
| 42 | What is infrared radiation? | All objects emit and absorb infrared radiation. |
| 43 | How does infrared depend on the temperature of an object? | The hotter an object is, the more infrared radiation it emits in a given time. |
| 44 | What is meant by black body radiation? | Radiation emitted by a body that absorbs all incident radiation on it. |
| *45 H, T* | *What happens to the temperature of an object if it absorbs more radiation than it emits?* | *The temperature of an object increases.* |
| *46 H, T* | *How is the temperature of the Earth affected by the balance of absorbed and emitted radiation?* | *The temperature of the Earth depends upon the absorption of infrared radiation from the Sun and the emission of radiation from the Earth's surface and atmosphere.* |
| 47 | What is meant by specific heat capacity of a substance? | The amount of energy it takes to change the temperature of 1kg of a substance by 1℃. |
| 48 | How do we calculate the energy changes that occur when an object changes temperature? | Use the equation:<br>Energy transferred = mass x specific heat capacity x temperature change<br>□*E* = *m c* □□ |
| 49 | How does the mass of a substance affect how quickly its temperature changes when it is heated? | The greater the mass, the more slowly its temperature increases. |
| 50 | How do we measure the specific heat capacity of a substance? | Use a joulemeter and a thermometer to measure □*E* and □□, then use *c*= □*E* ÷ *m* □□ |
| 51 | How are homes heated? | Electric and/or gas heaters and gas or oil-fired central heating or solid-fuel stoves. |
| 52 | How can you reduce the rate of energy transfer from your home? | Loft insulation, cavity wall insulation, double-glazed windows, aluminium foil behind radiators, external walls with thicker brickers and lower thermal conductivity. |
| 53 | What is cavity wall insulation? | Insulation material is used to fill the cavity between the 2 brick layers of an external house wall. |
| 54 | How are most of your energy demands met each day? | By burning coal, oil and gas. |
| 55 | What other energy resources are used? | Nuclear power, biofuels and renewable resources. |
| 56 | How are nuclear fuels used in power stations? | Uranium or plutonium is used as the fuel. More energy is released per kilogram from uranium or plutonium than from fossil fuels. |
| 57 | What other fuels are used to generate electricity? | Biofuels are a renewable source of energy e.g. methane, ethanol |
| 58 | What is a wind turbine? | An electricity generator on top of a tall tower. |

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| 59 | How can waves be used to generate electricity? | By turning a floating generator. |
| 60 | What type of power station uses water running downhill to generate electricity? | Hydroelectricity |
| 61 | How can tides be used to generate electricity? | By trapping each high tide and using it to turn generators. |
| 62 | What are solar cells? | Flat, solid cells that use the Sun’s energy to generate electricity directly. |
| 63 | What is the difference between solar cells and a solar heating panel? | Solar heating panels use the Sun’s energy to heat water directly. |
| 64 | What is geothermal energy? | Energy from radioactive substances deep inside the Earth. |
| 65 | How can geothermal energy be used to generate electricity? | Water pumped into hot rocks underground produces steam to drive turbines at the Earth’s surface which generate electricity. |
| 66 | What do fossil fuels do to the environment? | Produce increased levels of greenhouse gases which can cause global warming. |
| 67 | Why are people concerned about nuclear fuels? | Because they produce radioactive waste. |
| 68 | What are the advantages and disadvantages of renewable energy resources? | They will never run out; they do not produce harmful waste products; they can be used in remote places BUT they cover large areas; they can disturb natural habitats. |
| 69 | How can we evaluate the use of different energy resources? | They can be evaluated in terms of reliability, environmental effects, pollution and waste. |
| 70 | How is it best to use electricity supplies to meet variations in demands | Gas-fired power stations and pumped-storage stations can meet variations in demand. |
| 71 | How do the economic costs of different energy resources compare? | Nuclear power stations are expensive to build, run and decommission. Carbon capture of fossil fuel emissions is expensive. Renewable resources are cheap to run but expensive to install. |
| 72 | Which energy resources need to be developed to meet people’s energy needs in future? | Nuclear power stations, fossil-fuel power stations that use carbon capture technology, and renewable energy resources. |

## Electricity

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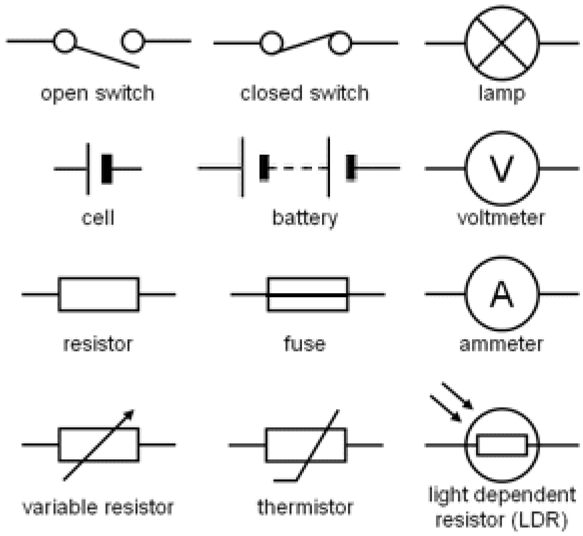
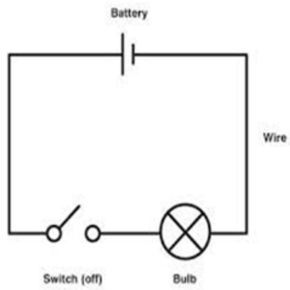
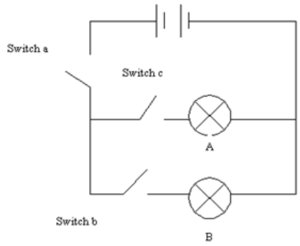
| 1 | Identify circuit symbols used in a circuit. |  |
| 2 | Construct circuit diagrams for series and parallel circuits using circuit symbols. |   |
| 3 | Define potential difference. | The potential difference between any two points in a circuit is the energy transferred to, or from, a given amount of charge as it passes between those points. |
| 4 | State the name of the particle that carries the electrical charge round a circuit. | Electron |
| 5 | Define an electric current. | Current is the flow of charge. |
| 6 | Describe and explain why an electric current will flow in a circuit. | A current flows when an electric charge moves around a circuit. No charge can flow if the circuit is broken, for example, when a switch is open. A 'potential difference' across an electrical component is needed to make a current flow in it. Cells or batteries often provide the potential difference needed. |
| 7 | What is the equation that links charge flow, current and time? State the units used for each quantity. | Charge = current x time<br>(in C) (in A) (in s) |

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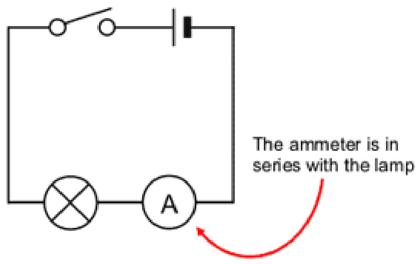
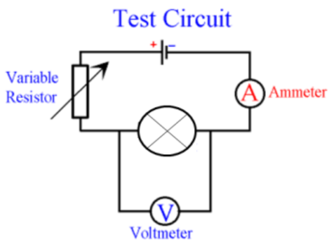
| 8 | Draw a circuit that can be used to measure the current in a component. |  |
| 9 | Describe how the current varies in a series circuit. | The current that flows in each component connected in series is the same. |
| 10 | Explain why the current at each point in a series circuit must be the same in terms of electrons not being lost from the wire. | The current is the same at any point in a series circuit because the same number of electrons pass around the circuit - no electrons are lost or gained. |
| 11 | Define resistance. | **Resistance** is a measure of how hard it is for a current to flow through a component in a circuit. |
| 12 | Describe and explain how increasing the resistance in a circuit will affect the current through the circuit.. | As resistance increases, current decreases. |
| 13 | Use the equation *V* = *I R* to calculate the potential difference (voltage), current or resistance when given the other two values. | Resistance = voltage / current<br>**R = V/I** |
| 14 | State the correct SI units for each quantity (potential difference, current and resistance). | Potential difference = volts (V)<br>Current = Amperes (A)<br>Resistance = Ohms (Ω) |
| 15 | What factors affect the resistance of a given length of wire? | Thickness of wire, temperature |
| 16 | Draw a circuit that can be used to find the resistance of an electrical component using a voltmeter and an ammeter. |  |
| 17 | Define what is meant by an ohmic conductor. | A resistor at constant temperature (**ohmic conductor**)<br>Current is directly proportional to potential difference. |
| 18 | What components are ohmic conductors? | Wire; fixed resistor |

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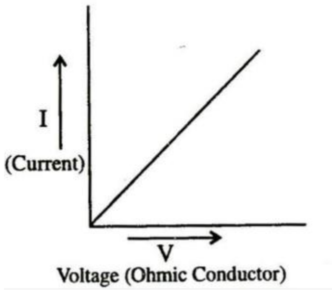
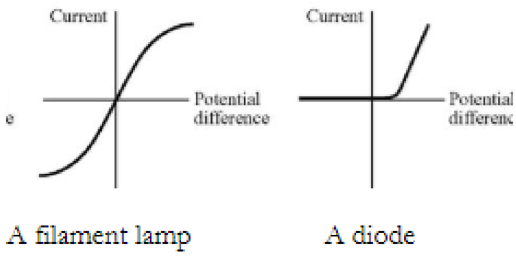
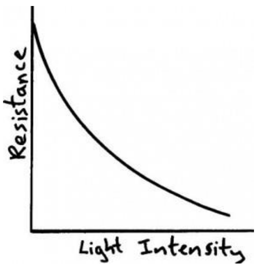
| 19 | Describe the conditions for which Ohm's law is valid. | Constant temperature |
| 20 | Explain why Ohm's law is not valid when the temperature of the conductor increases in terms of collisions. | The particles vibrate more as the temperature increases. They get in the way of the electrons trying to pass through the wire. The resistance increases as a result. |
| 21 | Draw the I-V graph for an ohmic conductor. Explain the shape of the I-V graph of the ohmic conductor. |  |
| 22 | Draw the I-V graphs for a filament lamp and a diode. Explain the shape of the resulting graph in terms of resistance and current. |  |
| 23 | Draw graphs to show how the resistance of an LDR will vary with light intensity and of a thermistor with temperature. |  |
| 24 | Why do the current-potential difference graphs for diodes and filament lamps look different to that of an ohmic conductor? | Lamp: Resistance increases as temperature increases.This happens whichever way around the electrons are flowing.<br>Diode: Current only flows in the forward direction (resistance is low). In the reverse direction there is no current flowing (resistance very high). |
| 25 | Describe and explain real world applications of thermistors and LDRs including thermostats and switching on lights. | Thermistors: Central heating systems; fridges (as resistance changes with temperature)<br>LDRs: Street lights (as resistance changes with light |

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| 26 | Describe the differences between series and parallel circuits in terms of current and potential difference. | Series:<br>The current is the same at any point in the circuit.<br>The total potential difference is divided up between the components.<br>Parallel:<br>The total current flowing from the cell equals the current flowing through each component when they are added together.<br>The potential difference supplied by the cell is the same potential difference as that across each component in the parallel circuit. |
| 27 | Calculate the resistance or two components in a series circuit using $R\ (total)\ = R1\ +\ R2$<br>Use the concept of equivalent resistance. | When **resistors are in series** with each other there total resistance is just there individual resistance added together. |
| 28 | Describe the effect on the resistance of adding resistors in parallel. | The sum of the currents through each path is equal to the **total** current that flows from the source. You can **find total resistance in a Parallel circuit** with the following **formula**:<br>1/R(total) = 1/R1 + 1/R2 + 1/R3 +... |
| 29 | What does a battery do to current in a circuit? | Makes it go around in one direction only. |
| 30 | State some common sources of a direct potential difference. | Cells, batteries and solar cells. |
| 31 | What is an alternating current? | A current that repeatedly reverses its direction. It flows one way then the opposite way in successive cycles. |

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| 32 | Describe mains electricity in the home in terms of potential difference, frequency and type of current. | The current in a mains circuit is alternating current.<br>Mains circuits have a live wire which is alternatively positive and negative every cycle (changing direction) and a neutral wire (at zero volts).<br>The potential difference of an a.c. supply is the maximum voltage measured from zero volts.<br>To measure the frequency of an a.c. supply measure the time period of the waves and the equation:<br>frequency = 1 / time taken for 1 cycle |
| 33 | Describe the construction of a three core electric cable. | 3 insulated copper wires surrounded by an outer layer of flexible plastic material. |
| 34 | State the name, the colour of the wire and the function of each wire in a three-core cable. | Live wire: brown; 325 volts<br>Neutral wire: blue; zero volts<br>Earth wire: green and yellow striped; stops metal case becoming live if the live wire breaks |
| 35 | Describe the potential difference in the live wire with respect to earth. | The difference between the live wire (up to 325 V) and the earth wire (0 V) - called the potential of the of the live wire |
| 36 | Describe how the earth wire acts as a safety wire. | The earth wire is connected to the longet pin in a plug and is used to earth the metal case of a mains appliance. |
| 37 | Define power. | The energy transferred to a device each second. $E = Pt$ |
| 38 | State the equation that links power, potential difference and current. | $P = IV$ |
| 39 | Rearrange the equation $P = I^2R$ to find any missing value given the other two. | $R = P / I^2$<br>$I = \sqrt{}R/P$ |
| 40 | Describe in terms of energy stores the energy transfers that are taking place in a given electrical appliance – stating which energy transfers are useful and which are wasted. | Useful energy: light; moving parts (fans)<br>Wasted energy: heat due to resistance in the wires and components; friction (for appliances with moving parts) |
| 41 | What does the amount of electrical energy transferred to an appliance depend on? | The time the appliance is on for; the power of the appliance. |

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| 42 | Describe how work is done when a charge flows in a circuit. | Work is done by the battery to make electrons pass through the circuit and to overcome any resistance the electrons may encounter. The electrical work done by the battery is equal to the energy transferred to the components of the circuit.. |
| 44 | State the equation that links energy transfer, power and time. | $E = P \times t$ |
| 45 | Describe how electricity gets from the power station to our homes. | Power stations generate electricity at an alternating potential difference of 25 000 V.<br>Step-up transformers transfer electricity from the power station to the National Grid. (25 000 V to 132 000 V).<br>Step-down transformers supply electricity from the National Grid to consumers.(132 000 V to 230 V). |
| *46 T* | *Describe and explain how rubbing materials against each other can get them to become charged, in terms of particle movement.* | *Electrons are transferred from the surface of one object to the surface of the other. One object therefore becomes negatively charged, and the other positively charged.* |
| *47 T* | *Describe what can happen when an object that has a large charge is brought near an earthed conductor.* | *Electrons in the air molecules between the two objects experience a force towards the positive object. This can lead to sparking - electrons are pulled out of the air and knock into other air molecules, knocking electrons out of them, creating a sudden flow of electrons between the two objects.* |
| *48 T* | *Describe the effect of two positively charged objects, two negatively charged objects and one positively charged and one negatively charged object placed near each other.* | *Positive and positive: repel*<br>*Negative and negative: repel*<br>*Positive and negative: attract* |
| *49 T* | *Describe how the strength of an electric field varies with distance from the charged object.* | *The electric field becomes stronger as the the distance decreases.* |
| *50 T* | *Describe how two charged objects in close proximity exert a force on each other and explain how the size of the force varies with the distance between the charged objects.* | *Two charged objects exert a non-contact force on each other.*<br>*The force between two objects becomes stronger as the distance between the objects decreases.* |

**Molecules and matter**

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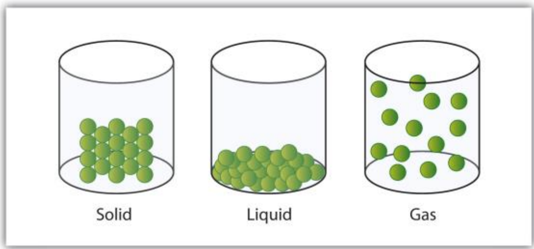
| 1 | Define density. | Density of a substance is its mass per unit volume. |
| 2 | Describe how the density of regular and irregular shapes can be found by experiment. | Volume should be determined from the dimensions of regularly shaped objects and by a displacement technique for irregularly shaped objects. |
| 3 | Recall the equation for density and apply it. Calculate the density, mass or volume of an object given any two other values. | The density of a material is defined by the equation: Density, $p$ (kg/m$^3$) = $\frac{\text{mass, } m \text{ (kg)}}{\text{volume, } V \text{ (m}^3\text{)}}$<br>Mass = density x volume<br>Volume = $\frac{\text{mass}}{\text{density}}$ |
| 4 | Draw diagrams to show the particle arrangements in solids, liquids and gases. |  |
| 5 | Why are particles arranged differently in solids, liquids and gases? | It is due to the strength of the bonds between the atoms. |
| 6 | Describe the motion of particles in solids, liquids and gases. | Solids: particles vibrate around a fixed position<br>Liquids: Particles move around each other<br>Gases: Particles move quickly in all directions |
| 7 | Describe and explain the limitations of the particle model of matter | The particles within the substance are not solid spheres; the forces between the particles are not represented. |
| 8 | Explain why the different states of matter have different densities in terms of mass and volume of the material.. | The differences in density between the different states of matter can be explained in terms of the arrangements of the particles (atoms or molecules). In solids, particles are close together, so in a given volume there are lots of solid particles (with greater mass) whereas in a gas there are less particles in the same volume (less mass). |
| 9 | Why do substances change state? | For a substance to change state, it needs to gain energy (usually by heating). This energy is used to break the bonds between particles. |
| 10 | Why does the temperature of a substance remain constant when the substance is changing state? | Whilst energy is being transferred to the bonds between particles, the temperature of the substance will not increase or decrease. |
| 11 | Explain how, when a substance changes state, the mass of the substance is unchanged. | There is still the same number of atoms in the substance and it is just their arrangement that has altered. |
| 12 | Describe the changes of state in terms of solids, | Solid to liquid = melting |

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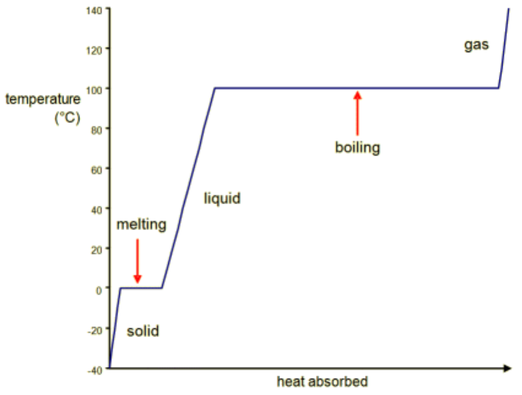
| | liquids and gases. | Liquid to gas = evaporation<br>Gas to liquid = condensation<br>Liquid to solid = freezing |
| 13 | What is the difference between a chemical and a physical change? | A physical change does not produce a new substance. If the change is reversed the substance recovers its original properties. A chemical change produces a new substance and is irreversible. |
| 14 | Give examples of physical and chemical changes.. | Physical change: melting ice and then refreezing.<br>Chemical change: a burning candle (combustion) |
| 15 | What effect does increasing the temperature of an object have on the atoms that make up the object? | The atoms move more ( have more kinetic energy) as the temperature increases. |
| 16 | Describe temperature. | A measure of the average kinetic energy of the particles in a substance. |
| 17 | Describe and explain how increasing the temperature of a substance affects the internal energy of a substance. | Heating changes the energy stored within the system by increasing the energy of the particles that make up the system. And, either the temperature of the system increases, or changes of state happen. |
| 18 | Define internal energy. | Internal energy is the total kinetic energy and potential energy of all the particles (atoms and molecules) that make up a system. |
| 19 | Explain how the strength of the bonds between the particles will affect how much energy is needed to change the state of the substance. | The stronger the bonds between particles, the more energy is required to break the bonds and change the state of the substance. |
| 20 | Define specific heat capacity. | 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. |
| 21 | Describe the factors that affect how quickly the temperature of a substance increases, eg why does a half-full kettle heat up faster than a full kettle of water? | The increase in temperature depends on the mass of the substance heated, what the substance is and the energy input to the system. |
| 22 | Define specific latent heat. | 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: |
| 23 | Draw heating and cooling graphs for a substance including a change of state. |  |

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| 24 | Explain why a block of ice at 0 °C that is being heated does not increase in temperature initially. | The energy supplied by heating the ice changes the energy stored in the bonds (internal energy), but not the temperature. |
| 25 | State the equation used to calculate specific latent heat. | [illegible]<br>= [illegible]<br>[illegible]<br>energy, *E*, in joules , J<br>mass, *m*, in kilograms, kg<br>specific latent heat, *L*, in joules per kilogram, J/kg |
| 26 | Define specific latent heat of fusion and vaporisation. | Specific latent heat of fusion – change of state from solid to liquid.<br>Specific latent heat of vaporisation – change of state from liquid to vapour. |
| 27 | Why is more energy required to vaporise 1 kg of water than to melt 1 kg of ice? | The specific latent heat of vaporisation is greater than the specific latent heat of fusion for a given material as the particles need to be separated further when changing from a liquid to a gas. |
| *28 T* | *Describe the motion of molecules within a gas.* | *The molecules of a gas are in constant random motion.* |
| *29 T* | *How does the temperature of a gas affect the movement of the particles within it?* | *The temperature of the gas is related to the average kinetic energy of the molecules. The higher the temperature, the greater the average kinetic energy and so the faster the average speed of the molecules.* |
| *30 T* | *Describe why gases exert a force on a container.* | *When the molecules collide with the wall of their container they exert a force on the wall.* |
| *31 T* | *Explain what is meant by gas pressure in terms of the forces exerted by the gas molecules on a given area.* | *The total force exerted by all of the molecules inside the container on a unit area of the walls is the gas pressure.* |
| *32 T* | *Describe and explain how changing the temperature of gas increases the gas pressure inside the container.* | *Changing the temperature of a gas, held at constant volume, changes the pressure exerted by the gas (known as the Pressure law).* |
| *33 T* | *Explain why it is easy to compress a gas, but not solids or liquids.* | *Gases have spaces between the particles, so they are easy to compress. Liquids and solids have no spaces between particles (the particles are touching).* |
| *34 T* | *Describe and explain using the particle model what happens to pressure as the volume of a container is increased.* | *Increasing the volume in which a gas is contained, at constant temperature, can lead to a decrease in pressure (known as Boyle's law). This is due to the reduced number of collisions per unit area. This is only true at constant temperature.* |
| *35 T* | *Which equation links pressure and volume of a gas.* | *For a fixed mass of gas held at a constant temperature:* |

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| | | [illegible] = [illegible] [ [illegible] = [illegible] ]<br>*pressure, p, in Pascals, Pa*<br>*volume, V, in metres cubed, $m^3$* |

**Radioactivity**

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| 1 | What is meant by a radioactive substance? | A substance that contains unstable nuclei that become stable by emitting radiation. |
| 2 | State the 3 main types of radiation. | Alpha, Beta & Gamma. |
| 3 | When do radioactive sources emit radiation? | Radioactive decay is a random event - it cannot be predicted. |
| 4 | What do radioactive substances emit? | Alpha, Beta & Gamma radiation. |
| 5 | What is an isotope? | An isotope is an atom of the same element with the same number of protons but with different numbers of neutrons. Isotopes have the same atomic number but different atomic mass. |
| 6 | What is an alpha particle composed of? | 2 protons and 2 neutrons |
| 7 | How is an alpha particle usually represented? | $^{4}_{2}\alpha$ |
| 8 | How does the nucleus of an atom change when it emits an alpha particle? | The nucleus loses 2 protons and 2 neutrons |
| 9 | How can the emission of an alpha particle from the nucleus be represented? | ${}^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}\alpha$ |
| 10 | What is a beta particle composed of? | An electron created and emitted from a nucleus that has too many neutrons compared with its protons. |
| 11 | How is an beta particle usually represented? | ${}^{0}_{-1}\beta$ |
| 12 | How does the nucleus of an atom change when it emits an beta particle? | A neutron in the nucleus changes into a proton. |
| 13 | How can the emission of an beta particle from the nucleus be represented? | ${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}\beta$ |
| 14 | How far can alpha radiation travel in air? | Alpha radiation is stopped by paper and has a range of a few centimetres. |

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| 15 | How far can beta radiation travel in air? | Beta radiation is stopped by a thin sheet of metal and has a range of approximately 1 metre. |
| 16 | How far can gamma radiation travel in air? | Gamma radiation is stopped by thick lead and has an unlimited range in air. |
| 17 | What is ionisation? | Ionisation occurs when atoms lose electrons and as a result carry a charge. Alpha, beta and gamma radiation ionise substances they pass through. |
| 18 | What is the ionising power of alpha, beta and gamma radiation? | Alpha radiation has the greatest ionising power; beta radiation is less ionising than alpha radiation and more ionising than gamma radiation. |
| 19 | Why is alpha, beta and gamma radiation dangerous? | Ionisation is dangerous - in a living cell, ionisation can damage or kill the cell. |
| 20 | What is half-life? | Half-life is the average time it takes for the number of nuclei of the isotope in a sample to halve. |
| 21 | What is meant by the count rate from a radioactive source? | The count rate is the number of counts per second from a Geiger counter. Count rate is proportional to the activity of the source. |
| 22 | What happens to the count rate from a radioactive isotope as it decays? | The count rate decreases as the activity of the source decreases. The count rate and the number of atoms of an isotope decrease by half every half-life. |
| *23 H* | *How would you calculate the count rate after a given number of half-lives?* | *The count rate after n half-lives = the initial count rate* $\div 2^n$ |
| *24 T* | *What are radioactive isotopes used for in medicine?* | *They are used for medical imaging, cancer treatment, and as tracers to monitor organs.* |
| *25 T* | *How do we choose a radioactive isotope to do a particular job?* | *It depends upon its half-life and the type of radiation it gives out.* |
| *26 T* | *What type of nuclear radiation can be used for medical imaging?* | *Radioactive isotopes are used with half-lives that are neither too short nor too long.* |
| *27 T* | *How can radioactivity be used in cancer treatment?* | *A gamma beam or a radioactive implant can destroy cancer cells in a tumour* |
| *28 T* | *What is nuclear fission?* | *Nuclear fission is the splitting of an atom's nucleus into 2 smaller nuclei and the release of 2 or 3 neutrons + energy* |
| *29 T* | *What is the difference between spontaneous fission and induced fission?* | *Induced fission is when a neutron is absorbed by a uranium-235 nucleus or a plutonium-239 nucleus and the nucleus splits. Spontaneous fission occurs without a neutron being absorbed.* |
| *30 T* | *What is a chain reaction?* | *A chain reaction occurs in a nuclear reactor when each fission event causes further fission events.* |
| *31 T* | *How can a chain reaction in a nuclear reactor be controlled?* | *Control rods absorb fission neutrons to ensure that on average, only 1 neutron per fission goes on to produce further fission.* |

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| *32 T* | *What is nuclear fusion?* | *Nuclear fusion is the process of forcing the nuclei of 2 atoms together so that they form a single larger nucleus.* |
| *33 T* | *How can nuclei be made to fuse together?* | *By making 2 light nuclei collide at very high speed.* |
| *34 T* | *Where does the Sun’s energy come from?* | *Energy is released when 2 light nuclei are fused together - nuclear fusion in the Sun’s core releases energy.* |
| *35 T* | *Why is it difficult to make a nuclear fusion reactor?* | *Fusion reactors need to be at a very high temperature before nuclear fusion can take place. The nuclei to be fused are difficult to contain.* |
| *36 T* | *What is radon gas? Why is it dangerous?* | *Radon gas is an alpha-emitting isotope that can seep into houses through the ground in some areas.* |
| *37 T* | *How safe are nuclear reactors?* | *Fission reactors are very safe - none are the same type as the reactors that exploded in Chernobyl.* |
| *38T* | *Why is nuclear waste dangerous?* | *Nuclear waste contains many different radioactive isotopes that emit nuclear radiation for many years. The radiation can cause cancer.* |
| *39 T* | *What happens to nuclear waste?* | *Nuclear waste is stored in safe and secure conditions for many years after unused uranium and plutonium are removed from it (to be used in the future)* |

## Forces in balance

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| 1 | What do we mean by displacement? | Displacement is distance in a given direction. |
| 2 | What is meant by a vector quantity? | A vector quantity is a physical quantity which has magnitude and direction. |
| 3 | What is meant by a scalar quantity? | A scalar quantity has magnitude but no direction. |

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| 4 | How to represent a vector quantity | A vector quantity can be represented by an arrow in the direction of the vector and of length in proportion to the magnitude of the vector. |
| 5 | What can forces can do? | Forces can change the shape of an object, or change its motion or its state of rest. |
| 6 | What is the unit of force? | The newton (N). |
| 7 | What is meant by a contact force? | A contact force is a force that acts on objects only when the objects touch each other. |
| 8 | What forces are being exerted when 2 objects interact? | When two objects interact, they always exert equal and opposite forces on each other. |
| 9 | What is a resultant force? | The resultant force is a single force that has the same effect as all the forces acting on an object. |
| 10 | What happens if the resultant force on an object is:<br>- zero<br>- greater than zero | If the resultant force on an object is:<br>- zero, the object stays at rest or at the same speed and direction<br>- greater than zero, the speed or direction of the object will change |
| 11 | How do you calculate the resultant force when an object is acted on by two forces acting along the same line? | If two forces act on an object along the same line, the resultant force is:<br>- their sum, if the forces are in the same direction<br>- Their difference, if the forces are in opposite directions. |
| *12 H* | *What is a free-body force diagram ?* | *A free-body force diagram of an object shows the forces acting on it* |
| 13 | What the moment of a force measures | The moment of a force is a measure of the turning effect of the force on an object. |
| 14 | How to calculate the moment of a force | The moment of a force about a pivot is $M = Fd$ where $d$ is the perpendicular distance from the line of action of the force $F$ to the pivot |

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| 15 | How the moment of a force can be increased | To increase the moment of a force, increase *F* or increase *d* |
| 16 | Why levers are force multipliers | Levers can be used to exert a force that is greater than the effort. |
| *17 T* | *How levers act as force multipliers* | *A lever used as a force multiplier exerts a greater force than the force applied to the lever by the effort.* |
| *18 T* | *How you can tell if a lever is a force multiplier* | *The pivot of a force multiplier is nearer to the line of action of the force it exerts than to the force applied to it.* |
| *19 T* | *What do gears do?* | *Gears are used to change the moment of a turning effect.* |
| *20 T* | *How do gears can give a bigger turning effect?* | *To increase the moment of a turning effect, a small gear wheel needs to drive a larger gear wheel.* |
| *21* | What the centre of mass of an object is | The centre of mass of an object is the point where its mass can be thought of as being concentrated. |
| *22* | Where the centre of mass of a metre rule is | The centre of mass of a uniform ruler is at its midpoint. |
| *23* | About the centre of mass of an object suspended from a fixed point | When an object is freely suspended, it comes to rest with its centre of mass directly underneath the point of suspension. |
| *24* | How to find the centre of mass of a symmetrical object | The centre of mass of a symmetrical . |
| *25 T* | *Use your knowledge of forces and moments to explain why objects at rest don't turn.* | *If an object at rest doesn't turn, the sum of the anticlockwise moments about any point = the sum of the clockwise moments about that point.* |
| *26 T* | *Identify the forces that can turn an object about a fixed point* | *All the forces acting on an object that don't pass through a fixed point can turn an object about that point.* |
| *27 T* | *Identify whether a turning force that can turn an object turns it clockwise or anticlockwise* | *The direction of the force and the position of the fixed point determines whether the moment acts clockwise or anticlockwise.* |
| *28 T* | *How to calculate the size of a force (or its perpendicular distance from a pivot) acting on an object that is balanced* | *To calculate the force needed to stop an object turning we use the equation:* $W_1d_1=W_2d_2$ |

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| | | *We need to know all the forces that don't act through the pivot and their perpendicular distances from the line of action to the pivot.* |
| *29*<br>*T* | *What the parallelogram of forces is* | *The parallelogram of forces is a scale diagram of two force vectors.* |
| *30*<br>*T H* | *What is the parallelogram of forces is used for?* | *The parallelogram of forces is used to find the resultant of two force lines.* |
| *31*<br>*T H* | *What is needed to draw a scale diagram of the parallelogram of forces* | *You will need a protractor, a ruler, a sharp pencil, and a blank sheet of paper.* |
| *32*<br>*T H* | *How to use the parallelogram of forces to find the resultant of two forces* | *The resultant is the diagonal of the parallelogram that starts at the origin of the two forces.* |
| *33*<br>*T H* | *What is meant by resolution of a force* | *Resolving a force means finding perpendicular component that have a resultant force that is equal to the force.* |
| *34*<br>*T H* | *How to resolve a force* | *To resolve a force in two perpendicular directions, draw a rectangle with adjacent sides along the two directions so that the diagonal represents the force vector.* |
| *35*<br>*T H* | *What forces act upon an object in equilibrium?* | *For an object in equilibrium, the resultant force is zero.* |
| *36*<br>*T H* | *How to use a force diagram to work out whether or not an object is in equilibrium* | *An object at rest is in equilibrium because the resultant force on it is zero.* |

## Forces in motion

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| 1 | How do we calculate speed for an object moving at constant speed? | The speed of an object is $v = s / t$ |
| 2 | How do you use a distance-time graph to determine whether an object is stationary or moving at constant speed? | The distance-time graph for an object that is:<br>- stationary, is a horizontal line<br>- moving at a constant speed, is a straight line that slopes upwards |

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| 3 | What does the gradient of a line on a distance-time graph tell you? | The gradient of the line represents the object's speed. |
| 4 | How do you use the equation for constant speed to calculate distance moved or time taken? | Rearrange *v= s/t* to give *s=vt* or *t=s/v* |
| 5 | What is the difference between speed and velocity? | Velocity is speed in a given direction. |
| 6 | How do you calculate the acceleration of an object? | The acceleration of an object is $a = \Delta v / t$ |
| 7 | What is the difference between acceleration and deceleration? | Deceleration is the change of velocity per second when an object slows down. |
| 8 | How can we measure changes in velocity? | Use a motion sensor linked to a computer. |
| 9 | What does a horizontal line on a velocity-time graph tell you? | The gradient of the line represents acceleration. |
| 10 | How do you use a velocity-time graph to work out whether an object is accelerating or decelerating? | Horizontal line: acceleration is zero<br>Positive gradient: positive acceleration<br>Negative gradient: deceleration |
| *11 H* | *What does the area under a velocity-time graph tell you?* | *Distance travelled.* |
| *12 H* | *How do you calculate speed from a distance-time graph*<br>*-where the speed is constant*<br>*-where the speed is changing* | *The speed at any instant in time is given by the gradient of the tangent to the line on a distance-time graph.* |
| 13 | How does the size of the resultant force acting on an object affect its acceleration? | The greater the resultant force on an object, the greater the object's acceleration. |
| 14 | How does the mass of an object affect its acceleration? | The greater the mass of an object, the smaller its acceleration for a given force. |
| 15 | How do we calculate a resultant force on an object from its mass and acceleration? | Resultant force = Mass x acceleration<br>F = ma |
| *16 H* | *What is meant by inertia of an object?* | *The inertia of an object is its tendency to stay at rest or in uniform motion.* |
| 17 | What is the difference between mass and weight? | Weight is the force acting on an object due to gravity. Mass is the quantity of matter in the object. |
| 18 | What can we say about the motion of an object acted on only by gravity? | It accelerates at about 10 $m/s^2$. |
| 19 | What is terminal velocity? | The velocity an object reaches when it is falling, where the weight of the object is equal to the frictional forces on the object. |
| 20 | What is the resultant force on an object falling at terminal velocity? | The resultant force is zero. |
| 21 | What forces oppose the driving force of a vehicle? | Friction and air resistance. |
| 22 | What does stopping distance depend on? | Thinking distance and braking distance. |
| 23 | What can increase the stopping distance of a vehicle? | Braking distance: High speed, poor weather conditions, poor vehicle maintenance. |

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| | | Thinking distance: Poor reaction time (tiredness, alcohol, drugs, using a phone), High speed. |
| 24 | How do we estimate the braking force of a vehicle? | $F = ma$ |
| *25 H* | *How do we calculate momentum?* | $p = mv$ |
| *26 H* | *What is the unit of momentum?* | *kg m/s* |
| *27 H* | *What does momentum mean for a closed system?* | *A closed system is on where the total momentum before an event is equal to the total momentum after an event. This is called conservation of momentum.* |
| *28 H* | *What happens when 2 objects collide?* | *They will push each other part with equal and opposite momentum.* |
| *29 HT* | *Is momentum a vector or scalar quantity?* | *It has a direction and a size, so it is a vector.* |
| *30 HT* | *Why do 2 objects that push each other apart move away at different speeds?* | *They move at different speeds if they have unequal masses,* |
| *31 HT* | *What happens to the total momentum of two objects when they collide?* | *They move apart with equal and opposite momentum, so their total momentum is zero.* |
| *32 HT* | *How do we calculate momentum of 2 objects pushing away from each other?* | *Use the equation:* $m_A v_A + m_B v_B = 0$ |
| *33 HT* | *What affects the force of impact when 2 vehicles collide?* | *Mass, change of velocity, length of impact time.* |
| *34 HT* | *How does the impact force depend on the impact time?* | *The longer the impact time, the more the impact force is reduced.* |
| *35 HT* | *What can be said about the impact forces and the total momentum?* | *When 2 vehicles collide:*<br>- *they exert equal and opposite forces on each other*<br>- *- their total momentum is unchanged* |
| *36 HT* | *Why does an impact force depend on impact time?* | *Impact force = change of momentum ÷ impact time, so the shorter the impact time, the greater the impact force.* |
| *37 HT* | *Why do cycle helmets and cushioned surfaces reduce impact forces?* | *They increase the impact time.* |
| *38 HT* | *Why do seat belts and air bags reduce the force on people in car accidents?* | *They spread the force, increasing the impact time.* |
| *39 HT* | *How do side impact bars and crumple zones work?* | *They give way in an impact, increasing the impact time.* |
| *40 HT* | *How do we work out if a car in a collision was speeding?* | *Use conservation of momentum to find the speed of the car before an impact.* |
| 41 | What is meant if an object is elastic? | If it returns to its original shape after the force deforming it has been removed. |
| 42 | How do we measure the extension of an object when it | Extension is the difference between the length of the |

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| | is stretched? | object and its original length. |
| 43 | How does the extension of a spring change with the force applied to it? | It is directly proportional to the force applied to it, as long as the limit of proportionality is not exceeded. This relationship is linear. |
| 44 | What is meant by the limit of proportionality of a spring? | Beyond the limit of proportionality, the extension of a spring is no longer proportional to the applied force. The relationship becomes non-linear. |
| *45 T* | *What is meant by pressure?* | *Pressure is the force normal to the surface ÷ area of the surface.* $p = F/A$ |
| *46 T* | *What is the unit of pressure?* | *Pascal (Pa), which is equal to 1* $N/m^2$. |
| *47 T* | *How do we rearrange the pressure equation?* | $p = F/A$; $F = pA$; $A = F/p$ |
| *48 HT* | *How does the pressure in a liquid alter with depth?* | *It increases with depth.* |
| *49 HT* | *Why is pressure along a horizontal line in a liquid constant?* | *A liquid flows until the pressure along the same horizontal line is constant.* |
| *50 HT* | *What does pressure in a liquid depend on?* | *The greater the density of a liquid, the greater the pressure.* |
| *51 HT* | *How do we calculate pressure caused by a liquid column?* | $p = h \rho g$<br>*(pressure = height x density x gravity)* |
| *52 T* | *Why does the atmosphere exert a pressure?* | *Air molecules collide with surfaces and create pressure.* |
| *53 T* | *How does the atmosphere change with altitude?* | *It decreases with higher altitude as there is less air above a given altitude than there is at a lower altitude.* |
| *54 T* | *How does the density of the atmosphere change with altitude?* | *It decreases with increasing altitude.* |
| *55 T* | *How do we calculate the force on a flat object due to a pressure difference?* | *Force = pressure difference x area of surface* |
| *56 TH* | *What is meant by upthrust?* | *An upward force on an object due to fluid.* |
| *57 TH* | *What causes upthrust?* | *It is caused by the pressure of the fluid.* |
| *58 TH* | *What does the pressure in a fluid depend on?* | *The density of the fluid and the depth of the fluid at that point.* |
| *59 TH* | *How do we explain whether an object in a fluid sinks or floats?* | *It sinks if its weight is greater than the upthrust when fully immersed.* |

## Waves

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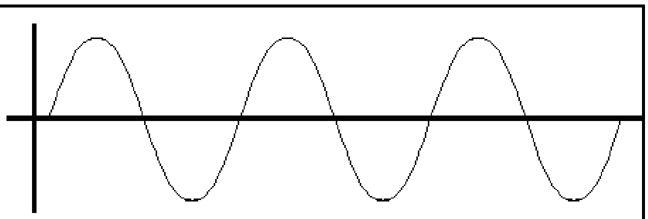
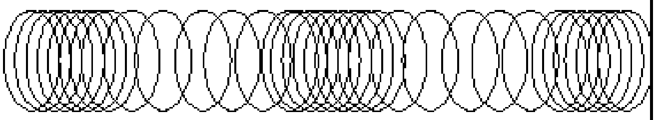
| 1 | Draw a diagram of a transverse wave. |  |
| 2 | Draw a diagram of a longitudinal wave. |  |
| 3 | Give an example of a transverse wave. | The ripples on a water surface are an example of a transverse wave. |
| 4 | Give an example of a longitudinal wave. | Sound waves travelling through air are longitudinal. |
| 5 | Explain how you would use a slinky to demonstrate the difference between longitudinal and transverse waves. | In a transverse wave the oscillations are perpendicular to the direction of energy transfer.In a longitudinal wave the oscillations are parallel to the direction of energy transfer. |
| 6 | When a sound wave passes through air, describe what happens to the air particles at a point of compression. | Compressions are regions of high pressure due to particles being close together. Rarefactions are regions of low pressure due to particles being spread further apart. |
| 7 | Give a definition of wavelength. | The wavelength of a wave is the distance from a point on one wave to the equivalent point on the adjacent wave. |
| 8 | Give a definition of amplitude. | The amplitude of a wave is the maximum displacement of a point on a wave away from its undisturbed position. |
| 9 | Give a definition of frequency. | The frequency of a wave is the number of waves passing a point each second. |

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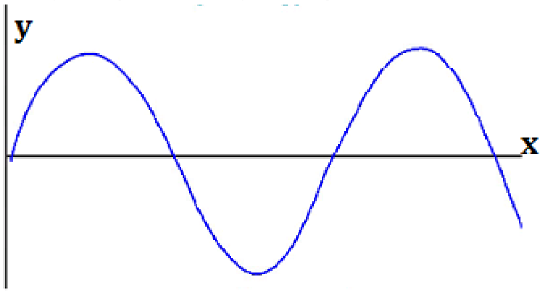
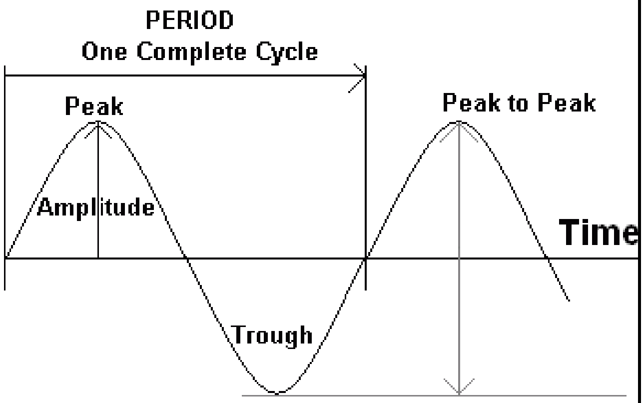
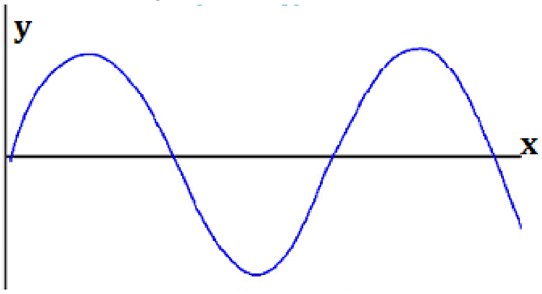
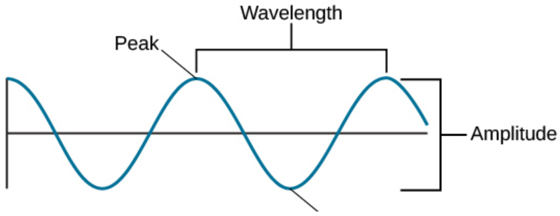
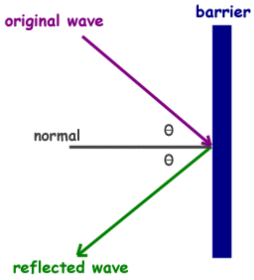
| 10 | Identify the peak, trough and period.   |   |
| 11 | How would you calculate the wavelength of a wave from a labelled diagram of a wave?   |   |
| 12 | What is the equation used to calculate wave speed? Include units. | Wave speed, *v* = frequency, *f* x wavelength, λ<br>(m/s) (Hertz,Hz) (m) |
| 13 | Rearrange the wave speed equation to find any unknown given the other two values. | Frequency = wave speed ÷ wavelength<br>Wavelength = frequency ÷ wave speed |
| 14 | Draw a ray diagram to illustrate the reflection of a wave at a surface. |   |
| 15 | State the law of reflection. | The incident ray, the **reflected** ray, and the normal to the surface of the mirror all lie in the same plane. Also, the angle of **reflection** is equal to the angle of incidence. |
| 16 | Describe and explain the effect of a wave moving from one medium into another. | Waves are **refracted** (change direction) when they move from one medium to another. |

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| 17 | Explain how echoes are created. | Sound waves reflect from smooth, bare surfaces to form an echo. |
| 18 | Explain why at night refraction of sound leads to sounds being heard from further afield than during daytime. | The speed of sound is greater in hot air than it is in cold air. This is because the molecules of air are moving faster and the vibrations of the sound wave can therefore be transmitted faster.On a cold night the air near the ground is cold and so the sound wave bends downwards. This is why you can sometimes hear sounds from a long way away if the night air is cold. |
| 19 | State the range of human hearing. | 20 - 20 000 Hz. |
| 20 | Explain why sound waves travel faster in solids than they do in liquids and gases. | The particles in a solid are closely packed together. They transfer the energy of wave along the particles easily. In liquids and gases the particles are spaced further apart and therefore the energy of the wave is not transmitted as easily or quickly. |
| 21 | Describe how sound waves travel from a source to the ear and the effect that this has inside the ear. | Sound waves travel through the air to the ear. Within the ear, sound waves cause the eardrum and other parts to vibrate which causes the sensation of sound. |
| 22 | Describe sound waves in terms of pitch and frequency. | The pitch of a note is a general description that tells us whether the note is low or high. Low pitched notes have waves that are long while high pitched notes have waves that are short.<br><br>The frequency of the sound is a precise scientific that we use to describe the rate of vibration of a wave such as sound. The frequency of a note is measured in Hertz (Hz). A vibration with a frequency of 1 Hz means that it is vibrating once every second. |
| 23 | Describe and explain why ear defenders are a required piece of safety equipment when using pneumatic drills. | Ear defenders absorb sound waves by increasing air resistance, thus reducing the amplitude of the waves. |
| 24 | Give similarities and differences between sound waves and ultrasound waves. | The range of human hearing is about 20 Hz to 20,000 Hz. Ultrasound waves have frequencies above about 20,000 Hz (which is 20 kHz). |
| 25 | State uses of ultrasound waves. | Medical and industrial imaging. |
| 26 | Describe and explain how ultrasound waves are used to build up a picture of the inside of a human body. | Ultrasound waves are partially reflected when they meet a boundary between two different media. The time taken for the reflections to reach a detector can be used to determine how far away such a boundary is. |

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| 27 | Give advantages and disadvantages of using ultrasound waves for diagnosis. | Advantages:<br>In real time; non-ionising so safe for developing foetus.<br>Disadvantages:<br>Poor quality of image. |
| 28 | How would you use time and speed of an ultrasound wave to calculate the distance of an object from the surface? | distance = speed x time ($d = v \times t$)<br>However, since the sound had to travel down to the object and back again, this distance must be divided by two to find the depth of the object. |
| 29 | State the 2 types of seismic wave. | P-waves (primary waves) and S-waves (secondary waves) are both types of seismic wave. |
| 30 | Describe the properties of P-waves and S-waves. | P-waves are longitudinal, seismic waves.<br>S-waves are transverse, seismic waves. |
| 31 | Describe and explain how P-waves and S-waves travel through the Earth's interior, and how this allows us to build up a picture of the Earth's interior. | P-waves travel through solids and liquids, so they can travel through all of the Earth's layers.<br>S-waves cannot travel through a liquid, so they cannot travel through the liquid core. |
| 32 | Explain how earthquakes are detected and the scale that they are measured on. | Earthquakes are detected by a seismometer. They are measured using the Richter. |
| 33 | Describe and explain how echo sounding is used in a given situation, eg, to find the depth of the ocean or to find fish when sea fishing. | High frequency sound waves can be used to detect objects in deep water and to measure water depth. The time between a pulse of sound being transmitted and detected and the speed of sound in water can be used to calculate the distance of the reflecting surface or object. |

## Electromagnetic waves

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| 1 | Describe the properties common to all electromagnetic waves. | Electromagnetic waves are transverse waves. All types of electromagnetic wave travel at the same velocity through a vacuum (space) or air. |
| 2 | What do electromagnetic waves do? | Transfer energy from one place to an absorber of that energy. |
| 3 | Name the seven types of electromagnetic wave, in the correct order from longest to shortest wavelength. | Going from long to short wavelength (or from low to high frequency) the groups are: - radio, microwave, infra-red, visible light (red to violet), ultra-violet, X-rays and gamma-rays. |
| 4 | State the range of wavelengths of electromagnetic waves. | Approximately $10^{-15}$m – $10^{4}$m |
| 5 | What is the only part of the electromagnetic spectrum that our eyes can detect? | Visible light |
| 6 | Describe what happens to an electromagnetic wave at a boundary between two different media. | Refraction - the wave changes of speed as it travels from one medium to a different medium. Refraction does not happen when a wave enters a medium at 90$^{o}$ to the surface. |
| 7 | Describe how electromagnetic waves are generated. | Changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated. |
| *8 H* | *Describe how radio waves can be produced in electrical circuits and also the effect that radio waves may have on electrical circuits.* | *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 also produce oscillations in an electrical circuit.* |
| 9 | Explain why atoms only absorb certain frequencies of electromagnetic radiation | The electrons in an atom can only occupy specific energy levels. An electron can only go to a higher energy level if it absorbs the correct amount of energy - or frequency of radiation. |
| 10 | Describe gamma radiation. | Gamma rays are produced when an unstable nucleus of an atom releases energy. Gamma rays have a short wavelength and high energy. |
| 11 | Describe and explain the effects that gamma, X-rays and ultraviolet radiation have on the body. | Ultra-violet waves, X-rays and gamma rays can have hazardous effects on human body tissue. Ultra-violet waves can cause skin to age prematurely and increase the risk of skin cancer. X-rays and gamma rays are ionising radiation that can cause mutation of genes and cancer. |
| 12 | Explain how the radiation dose that nuclear industry workers are exposed to is measured. | The effects depend on the type of radiation and the size of the dose. Radiation dose (in Sieverts) is a measure of the damage caused by the radiation in the body. |
| 13 | Explain how a radiation badge detects radiation. | The radiation badge shows how much ionising radiation its owner has been exposed to. |

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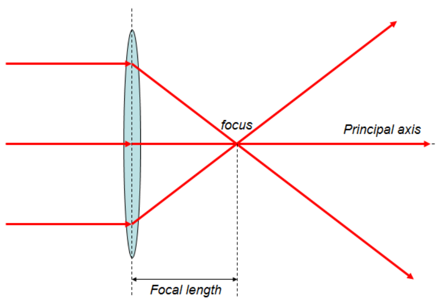
| 16 | Give the order of the electromagnetic spectrum. | Radio waves; Microwaves; Infra red; Visible light; Ultra violet; X rays; Gamma radiation |
| 17 | Describe uses of each wave in the electromagnetic spectrum. | Electromagnetic waves have many practical applications. For example:<br>● radio waves – television and radio<br>● microwaves – satellite communications, cooking food<br>● infrared – electrical heaters, cooking food, infra-red cameras<br>● visible light – fibre optic communications<br>● ultraviolet – energy efficient lamps, sun tanning<br>● X-rays – medical imaging and treatments. |
| *18 H* | *Explain the suitability/unsuitability of each wave for its practical application.* | ***Radio waves:*** *longer wavelengths to carry information over long distances (hazardous - penetrate people's bodies)*<br>***Microwaves:*** *Can pass through the atmosphere easier than radiowaves - used for satellite communication. Can penetrate food. (hazardous - penetrate people's bodies)*<br>***Infrared:*** *Communication systems - absorbed less than visible light. (can burn skin)*<br>***Visible light****: Photography*<br>***Ultraviolet:*** *security pens (harmful to skin)*<br>***X-rays:*** *detecting internal cracks in metals; medicine - photographing broken bones (harmful - ionising)*<br>***Gamma rays:*** *Killing harmful bacteria; killing cancer cells (harmful - ionising)* |
| 19 | Explain the precautions taken in a hospital when carrying out an X-ray. Precautions should include steps taken to reduce the risks for the patient and the radiographer. | Lead plates between the X ray tube and patient stop X rays reaching other parts of the body. |
| 20 | Describe how light travels through concave and convex lenses. | A lens forms an image by refracting light. In a convex lens, parallel rays of light are brought to a focus at the principal focus. The distance from the lens to the principal focus is called the focal length. Ray diagrams are used to show the formation of images by convex and concave lenses. |
| 21 | Describe the key features of a ray diagram where light passes through a lens. Students should be able to identify the:<br>● Principal axis<br>● Principal focus<br>● Focal length. |  |
| 22 | Explain the difference between real and virtual images. | A real image can be formed on a screen. A virtual image is formed where the light rays appear to come from. |
| 23 | State situations where real images and virtual images are produced. | Real images are produced if the object is further away than the principal focus; a virtual image is formed if the object is nearer than the principal focus. |

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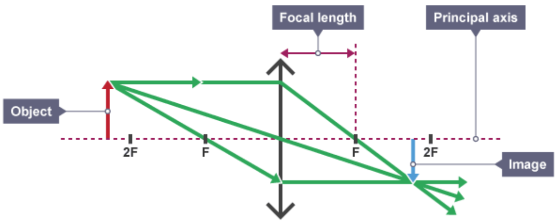
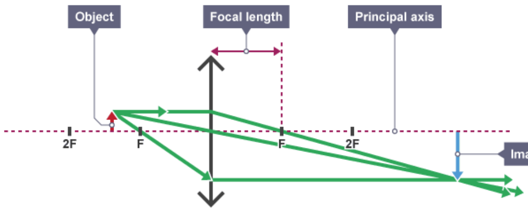
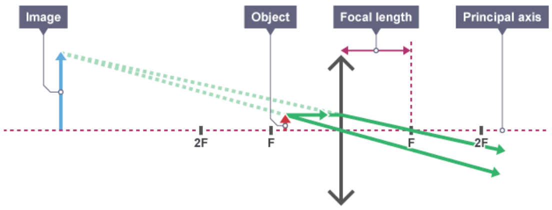
| 24 | Construct ray diagrams for a camera, a projector and a magnifying glass using a convex lens.. | Camera:<br><br>Projector:<br><br>Magnifying glass:<br> |
| 25 | State the equation used to calculate the magnification of a lens. | The magnification produced by a lens can be calculated using the equation:<br>magnification= (image height)/(object height)<br>Magnification is a ratio and so has no units. |
| 26 | Use the correct terminology when describing the image produced by a projector. | For a projector, the image is real, magnified and inverted. |
| 27 | Explain why objects appear different colours. | Colour depends upon the absorption, transmission and reflection of different wavelengths of light. |
| 28 | Explain what dispersion is. | **Dispersion** is the splitting of white light into the seven colours of the rainbow. |
| 29 | Draw rays diagrams to illustrate specular reflection by a smooth surface and scattering of light by a rough surface. | Reflection from a smooth surface in a single direction is called specular reflection. Reflection from a rough surface causes scattering this is called diffuse reflection. |
| 30 | What is an opaque object? | An opaque object reflects certain wavelengths of light and absorb other wavelengths. No light travels all the way through an opaque object. |
| 31 | Explain why a red jacket appears red under white light or red light and black under blue light | A red jacket absorbs all the colours of light except red (which is reflected). Under blue light a red jacket absorbs all the light - no red light is reflected, so it will look black. |
| 32 | Explain why objects appear black when placed under a light source. | Black objects absorb all the wavelengths of light (none is reflected). |

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| 33 | Define transparent and translucent. | Transparent objects lets through all the light that enters pass through it. It does not scatter or refract the light. Translucent objects lets light pass through but scatters or refracts the light. |

## Electromagnetic Induction

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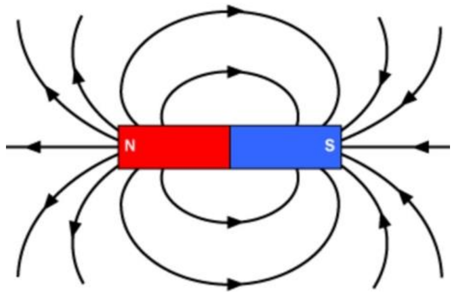
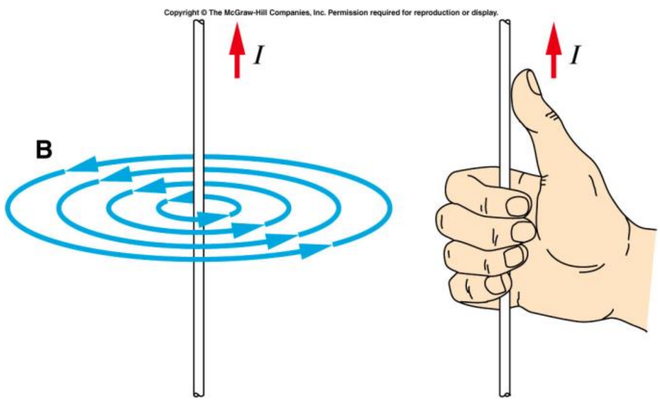
| 1 | What is the force rule for 2 magnetic poles near each other? | Like poles repel, unlike poles attract |
| 2 | Draw the pattern of magnetic field lines around a bar magnet. | The magnetic field lines of a bar magnet curve around from the north pole of the bar magnet to the south pole:   |
| 3 | What is induced magnetism? | Induced magnetism is magnetism created in an unmagnetised magnetic material when the material is placed in a magnetic field |
| 4 | Why is steel, not iron, used to make permanent magnets? | Steel is used instead of iron to make permanent magnets because steel does not lose its magnetism easily but iron does. |
| 5 | Describe/draw the pattern of the magnetic field around a straight wire carrying a current | The magnetic field lines ***around a wire*** are circles centred on the wire in a plane perpendicular to the wire.   |

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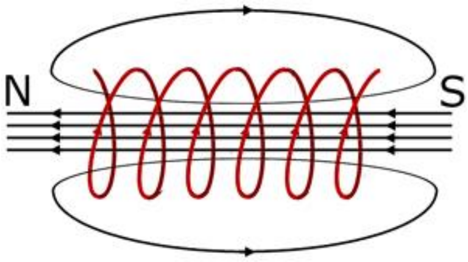
| 6 | Describe/draw the pattern of the magnetic field around a solenoid carrying a current | The magnetic field lines ***in a solenoid*** are parallel to its axis and are all in the same direction.<br> |
| 7 | How does the strength of the magnetic field vary with current? | Increasing the current makes the magnetic field stronger. |
| 8 | How does the direction of the magnetic field vary with current? | Reversing the direction of the current reverses the magnetic field lines. |
| 9 | What is a uniform magnetic field? | A uniform magnetic field is one in which the magnetic field lines are parallel. |
| 10 | What is an electromagnet? | An electromagnet is a solenoid that has an iron core. It consists of an insulated wire wrapped around an iron bar. |
| *11 T* | *What are electromagnets used for?* | *Electromagnets are used in scrapyard cranes, circuit breakers, electric bells and relays.* |
| *12 T* | *Describe how devices using electromagnets work.* | *An electromagnet works in a circuit breaker or electric bell or a relay by attracting an iron armature which opens a switch.* |
| *13 H* | *How can you change the size of the force on a current-carrying wire in a magnetic field?* | *Increase the strength of the magnetic field or the length of the conductor.* |
| *14 H* | *How can you reverse the direction of the force on a current-carrying wire in a magnetic field?* | *Reverse the direction of the current or magnetic field.* |
| *15 H* | *How does a simple electric motor work?* | *An electric motor has a coil that turns when a current is passed through it.* |
| *16 H* | *What is meant by magnetic flux density?* | *Magnetic flux density is a measure of the strength of a magnetic field.* |

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| *17 H* | *How do you calculate the force on a current-carrying wire?* | *To calculate the force on a current-carrying conductor at right angles to the lines of a magnetic field, use the equation F=B I l (Force = magnetic flux density x current x length)* |
| *18 T H* | *What is the generator effect?* | *The generator effect is the effect of inducing a potential difference using a magnetic field.* |
| *19 T H* | *How can you induce a potential difference in a wire?* | *When a conductor crosses through the lines of a magnetic field, a potential difference is induced across the ends of the conductor.* |
| *20 T H* | *What things affect the size of the induced potential difference?* | *The faster a conductor crosses through the lines of a magnetic field, the bigger is the induced potential difference. When a direct-current electromagnet is used, it needs to be switched on or off to induce a potential difference.* |
| *21 T H* | *How can you deduce the direction of an induced current?* | *The direction of an induced current always opposes the original change that caused it.* |
| *22 T H* | *How is a simple a.c. generator (alternator) constructed?* | *A simple a.c. generator is made up of a coil that spins in a uniform magnetic field.* |
| *23 T H* | *How does the induced potential difference of an a.c. generator vary with time?* | *The waveform, displayed on an oscilloscope, of the a.c.generator's induced potential difference is at:*<br>- *its peak value when the sides of the the coil cross directly through the magnetic field lines.*<br>- *its zero value when the sides of the the coil move parallel to the field lines.* |
| *24 T H* | *How is a simple d.c. generator (dynamo) constructed?* | *A simple d.c. generator has a split-ring commutator instead of two slip rings.* |
| *25 T H* | *What is a transformer used for?* | *Transformers are used to increase or decrease the size of an alternating potential difference.* |
| *26 T H* | *What is a step-up transformer?* | *The size of alternating potential difference is increased by step-up transformer.* |
| *27 T H* | *What is a step-down transformer?* | *The size of alternating potential difference is is decreased by a step-down transformer* |
| *28 T H* | *Why do transformers only work with a.c.?* | *A transformer works only with a.c. because a changing magnetic field is necessary to induce a.c. in the secondary coil.* |
| *29 T H* | *What is a transformer made up of?* | *A transformer has a primary coil, a secondary coil, and an iron core.* |
| *30 T H* | *State the transformer equation.* | $\frac{\text{Voltage across the primary coil}}{\text{Voltage across the secondary coil}} = \frac{\text{Number of loops in the primary coil}}{\text{Number of loops in the secondary coil}}$ |

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| | | or $\dfrac{V_p}{V_s} = \dfrac{n_p}{n_s}$<br>Where $n_p$ = number of primary turns and $n_s$ = number of secondary turns. |
| *31 T H* | *How does the number of turns on the secondary coil relate to the number of turns on the primary coil in a step-down transformer?* | *For a step-down transformer, $n_s$ is less than $n_p$* |
| *32 T H* | *How does the number of turns on the secondary coil relate to the number of turns on the primary coil in a step-up transformer?* | *For a step-up transformer, $n_s$ is greater than $n_p$* |
| *33 T H* | *What is meant by a transformer that is 100% efficient?* | *For a 100% efficient transformer: $V_p \times I_p = V_s \times I_s$, where $I_p$ = primary current and $I_s$ = secondary current* |
| *34 T H* | *Why is less power wasted by a high potential difference to transfer power through the grid system?* | *A high grid potential difference reduces the current that is needed so it reduces power loss and makes the system more efficient.* |

**Space *(Separate only)***

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| *1* | *How did the solar system form?* | *From gas and dust clouds that gradually became more and more concentrated because of gravitational attraction.* |
| *2* | *What is meant by a protostar?* | *A concentration of gas and dust that becomes hot enough to cause nuclear fusion.* |
| *3* | *How is energy released inside the Sun?* | *Due to hydrogen nuclei fusing together to form helium nuclei.* |
| *4* | *Why is the Sun stable?* | *Because gravitational forces acting inwards balance the forces of nuclear fusion energy in the core acting outwards.* |
| *5* | *Why do stars eventually become unstable?* | *When they have no more hydrogen nuclei that they can fuse together.* |
| *6* | *What are the stages in the life of a star?* | *<u>Stars with the same mass as the Sun:</u>*<br>*Protostar -> main-sequence star -> red giant -> white dwarf -> black dwarf*<br>*<u>Stars more massive than the Sun:</u>*<br>*Protostar -> main-sequence star -> red supergiant -> supernova -> neutron star (or black hole if not enough mass)* |
| *7* | *What will eventually happen to the Sun?* | *It will become a black dwarf.* |
| *8* | *What is a supernova?* | *The explosion of a red supergiant after it collapses.* |

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| *9* | *What force keeps planets and satellites moving along their orbits?* | *The force of gravity between a planet and the Sun keeps the planet moving along its orbit; the force of gravity between a satellite and the Earth keeps the satellite moving along its orbit.* |
| *10 H* | *What is the direction of the force on an orbiting body in a circular orbit?* | *Towards the centre of the circle.* |
| *11H* | *How does the velocity of a body in a circular orbit change as the body moves around the orbit?* | *The speed does not change but the direction of its velocity continually changes and is always at right angles to the direction of the force* |
| *12H* | *Why does an orbiting body need to move at a particular speed for it to stay in a circular orbit?* | *For a body to stay in orbit at a particular distance, it must move at a particular speed.* |
| *13* | *What is meant by red-shift of a light source?* | *The shift to longer wavelengths (and lower frequencies) of the light from the galaxy because it is moving away from you.* |
| *14* | *How does red-shift depend on speed?* | *The faster a distant galaxy is moving away from you, the greater the red-shift.* |
| *15* | *How do people know that the distant galaxies are moving away from Earth?* | *All distant galaxies show red-shift. The further away from you the galaxy is, the greater the red-shift.* |
| *16* | *Why do people think that the universe is expanding?* | *The distant galaxies are all moving away from you because the universe is expanding.* |
| *17* | *What is the Big Bang theory of the Universe?* | *The Big Bang was a massive explosion from a very small point.* |
| *18* | *Why is the Universe expanding?* | *It has been expanding ever since the Big Bang.* |
| *19* | *What is cosmic microwave background radiation?* | *Cosmic microwave background radiation (CMBR) is electromagnetic radiation that was created just after the Big Bang.* |
| *20* | *What evidence is there that the Universe was created in a Big Bang?* | *The red shifts of distant galaxies provide evidence that the Universe is expanding. CMBR can only be explained by the Big Bang theory.* |