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| **Topic** | **Physics Student Checklist** | **R** | **A** | **G** |
| **Topic 1: Forces** | Identify and describe scalar quantities and vector quantities |  |  |  |
| Identify and give examples of forces as contact or non-contact forces |  |  |  |
| Describe the interaction between two objects and the force produced on each as a vector |  |  |  |
| Describe weight and explain that its magnitude at a point depends on the gravitational field strength |  |  |  |
| Calculate weight by recalling and using the equation: [ W = mg ] |  |  |  |
| Represent the weight of an object as acting at a single point which is referred to as the object's ‘centre of mass’ |  |  |  |
| Calculate the resultant of two forces that act in a straight line |  |  |  |
| **HT ONLY: Use free body diagrams to qualitatively Describe examples where several forces act on an object and explain how that leads to a single resultant force or no force** |  |  |  |
| **HT ONLY: Use free body diagram sand accurate vector diagrams to scale, to resolve multiple forces and show magnitude and direction of the resultant** |  |  |  |
| Describe energy transfers involved when work is done and calculate the work done by recalling and using the equation: [ W = Fs ] |  |  |  |
| Describe what a joule is and state what the joule is derived from |  |  |  |
| Explain why work done against the frictional forces acting on an object causes a rise in the temperature of the object |  |  |  |
| Describe examples of the forces involved in stretching, bending or compressing an object |  |  |  |
| Describe the extension of an elastic object below the limit of proportionality and calculate it by recalling and applying the equation: [ F = ke ] |  |  |  |
| Explain why a change in the shape of an object only happens when more than one force is applied |  |  |  |
| Describe and interpret data from an investigation to explain possible causes of a linear and non-linear relationship between force and extension |  |  |  |
| Calculate the work done in stretching a spring by recalling or applying the equation: [ E = 0.5ke2 ] |  |  |  |
| Identify displacement as a vector quantity and express displacement in terms of both its magnitude and direction |  |  |  |
| Explain that the speed at which a person can walk, run or cycle depends on a number of factors and recall some typical speeds for walking, running, cycling |  |  |  |
| Explain why the speed of wind and of sound through air varies and calculate speed by recalling and applying the equation: [ s = v t ] |  |  |  |
| **HT ONLY: Explain, giving examples, why when an object moves in a circle at a constant speed, the direction of the object is continually changing, as is the velocity** |  |  |  |
| Represent an object moving along a straight line using a distance-time graph, describing its motion and calculating its speed from the graph's gradient |  |  |  |
| **HT ONLY: Calculate the speed of an accelerating object at any point by drawing a tangent to the distance-speed graph and measuring its gradient** |  |  |  |
| Describe an object which is slowing down as having a negative acceleration and estimate the magnitude of everyday accelerations |  |  |  |
| Calculate the average acceleration of an object by recalling and applying the equation: [ a = Δv/t ] |  |  |  |
| Represent motion using velocity–time graphs, finding the acceleration from its gradient and distance travelled from the area underneath |  |  |  |
| Apply, but not recall, the equation: [ v2 – u2 = 2as ] |  |  |  |
| Explain the motion of an object moving with a uniform velocity and identify that forces must be in effect if its velocity is changing, by stating and applying Newton’s First Law |  |  |  |
| Explain that the acceleration of an object is proportional to the resultant force acting on the object and calculate the force or acceleration by recalling and applying the equation: [ F = ma ] |  |  |  |
| **HT ONLY: Describe what inertia is and give a definition** |  |  |  |
| **HT ONLY: Estimate the speed, accelerations and forces of large vehicles involved in everyday road transport** |  |  |  |
| Apply Newton’s Third Law to examples of equilibrium situations |  |  |  |
| Describe stopping distance of a vehicle as the sum of the driver's reaction time and vehicle's braking distance |  |  |  |
| Explain why, for a given braking force, the braking distance increases dramatically with an increase in speed |  |  |  |
| State typical reaction times and describe how reaction time (and therefore stopping distance) can be affected by different factors |  |  |  |
| Explain methods used to measure human reaction times and take, interpret and evaluate measurements of the reaction times of students |  |  |  |
| Explain how the braking distance of a vehicle can be affected by different factors, including implications for road safety |  |  |  |
| Explain how a braking force applied to the wheel does work to reduce the vehicle's kinetic energy and increases the temperature of the brakes |  |  |  |
| Explain and apply the idea that a greater braking force causes a larger deceleration and explain how this might be dangerous for drivers |  |  |  |
| **HT ONLY: Estimate the forces involved in the deceleration of road vehicles** |  |  |  |
| **HT ONLY: Calculate momentum by recalling and applying the equation: [ p = mv ]** |  |  |  |
| **HT ONLY: Explain and apply the idea that, in a closed system, the total momentum before an event is equal to the total momentum after the event** |  |  |  |
| **HT ONLY: Describe examples of momentum in a collision** |  |  |  |
| **Topic 2: Energy** | Define a system as an object or group of objects and state examples of changes in the way energy is stored in a system |  |  |  |
| Describe how all the energy changes involved in an energy transfer and calculate relative changes in energy when the heat, work done or flow of charge in a system changes |  |  |  |
| Use calculations to show on a common scale how energy in a system is redistributed |  |  |  |
| Calculate the kinetic energy of an object by recalling and applying the equation: [ ke = 0.5mv2 ] |  |  |  |
| Calculate the amount of elastic potential energy stored in a stretched spring by applying, but not recalling, the equation: [ pe = 0.5ke2 ] |  |  |  |
| Calculate the amount of gravitational potential energy gained by an object raised above ground level by applying, but not recalling, the equation: [ gpe = mgh ] |  |  |  |
| Calculate the amount of energy stored in or released from a system as its temperature changes by applying, but not recalling, the equation: [ ΔE = mcΔθ ] |  |  |  |
| Define the term 'specific heat capacity' |  |  |  |
| State that a force does work on an object only when it causes a displacement, but that work is also done when charge flows in a circuit |  |  |  |
| Calculate work done by recalling and applying the equation: [ W = Fs ] |  |  |  |
| Define power as the rate at which energy is transferred or the rate at which work is done and the watt as an energy transfer of 1 joule per second |  |  |  |
| Calculate power by recalling and applying the equations: [ P = E/t & P = W/t ] |  |  |  |
| Explain, using examples, how two systems transferring the same amount of energy can differ in power output due to the time taken |  |  |  |
| State that energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed and so the total energy in a system does not change |  |  |  |
| Explain that only some of the energy in a system is usefully transferred, with the rest ‘wasted’, giving examples of how this wasted energy can be reduced |  |  |  |
| Explain the correlation between the thermal conductivity of a material and the higher rate of energy transfer by conduction across it |  |  |  |
| Calculate efficiency by recalling and applying the equation: [ efficiency = useful power output / total power input ] |  |  |  |
| **HT ONLY: Suggest and explain ways to increase the efficiency of an intended energy transfer** |  |  |  |
| List the main renewable and non-renewable energy resources and Define a renewable energy resource as one that is replenished as it is used |  |  |  |
| Compare ways that different energy resources are used, including uses in transport, electricity generation and heating |  |  |  |
| Explain why some energy resources are more reliable than others, explaining patterns and trends in their use |  |  |  |
| Evaluate the use of different energy resources, taking into account any ethical and environmental issues which may arise |  |  |  |
| Justify the use of energy resources, with reference to both environmental issues and the limitations imposed by political, social, ethical or economic considerations |  |  |  |
| **Topic 3: Waves** | Describe waves as either transverse or longitudinal, defining these waves in terms of the direction of their oscillation and energy transfer and giving examples of each |  |  |  |
| Define waves as transfers of energy from one place to another, carrying information |  |  |  |
| Define amplitude, wavelength, frequency, period and wave speed and Identify them where appropriate on diagrams |  |  |  |
| State examples of methods of measuring wave speeds in different media and Identify the suitability of apparatus of measuring frequency and wavelength |  |  |  |
| Calculate wave speed, frequency or wavelength by applying, but not recalling, the equation: [ v = f λ ]and Calculate wave period by recalling and applying the equation: [ T = 1/f ] |  |  |  |
| Describe what electromagnetic waves are and explain how they are grouped |  |  |  |
| List the groups of electromagnetic waves in order of wavelength |  |  |  |
| Explain that because our eyes only detect a limited range of electromagnetic waves, they can only detect visible light |  |  |  |
| Explain how different wavelengths of electromagnetic radiation are reflected, refracted, absorbed or transmitted differently by different substances and types of surface |  |  |  |
| Illustrate the refraction of a wave at the boundary between two different media by constructing ray diagrams |  |  |  |
| **HT ONLY: Describe what refraction is due to and illustrate this using wave front diagrams** |  |  |  |
| **HT ONLY: Explain how radio waves can be produced by oscillations in electrical circuits, or absorbed by electrical circuits** |  |  |  |
| Explain that changes in atoms and the nuclei of atoms can result in electromagnetic waves being generated or absorbed over a wide frequency range |  |  |  |
| State examples of the dangers of each group of electromagnetic radiation and discuss the effects of radiation as depending on the type of radiation and the size of the dose |  |  |  |
| State examples of the uses of each group of electromagnetic radiation, explaining why each type of electromagnetic wave is suitable for its applications |  |  |  |
| **Topic 4: Electricity** | Draw and interpret circuit diagrams, including all common circuit symbols |  |  |  |
| Define electric current as the rate of flow of electrical charge around a closed circuit |  |  |  |
| Calculate charge and current by recalling and applying the formula: [ Q = It ] |  |  |  |
| Explain that current is caused by a source of potential difference and it has the same value at any point in a single closed loop of a circuit |  |  |  |
| Describe and apply the idea that the greater the resistance of a component, the smaller the current for a given potential difference (p.d.) across the component |  |  |  |
| Calculate current, potential difference or resistance by recalling and applying the equation: [ V = IR ] |  |  |  |
| Define an ohmic conductor |  |  |  |
| Explain the resistance of components such as lamps, diodes, thermistors and LDRs and sketch/interpret IV graphs of their characteristic electrical behaviour |  |  |  |
| Explain how to measure the resistance of a component by drawing an appropriate circuit diagram using correct circuit symbols |  |  |  |
| Show by calculation and explanation that components in series have the same current passing through them |  |  |  |
| Show by calculation and explanation that components connected in parallel have the same the potential difference across each of them |  |  |  |
| Calculate the total resistance of two components in series as the sum of the resistance of each component using the equation: [ Rtotal = R1 + R2 ] |  |  |  |
| Explain qualitatively why adding resistors in series increases the total resistance whilst adding resistors in parallel decreases the total resistance |  |  |  |
| Solve problems for circuits which include resistors in series using the concept of equivalent resistance |  |  |  |
| Explain the difference between direct and alternating voltage and current, stating what UK mains is |  |  |  |
| Identify and describe the function of each wire in a three-core cable |  |  |  |
| State that the potential difference between the live wire and earth (0 V) is about 230 V and that both neutral wires and our bodies are at, or close to, earth potential (0 V) |  |  |  |
| Explain that a live wire may be dangerous even when a switch in the mains circuit is open by explaining the danger of providing any connection between the live wire and earth |  |  |  |
| Calculate power by recalling and applying the equations: [ P = VI ] and [ P = I2 R ] |  |  |  |
| Describe how appliances transfer energy to the kinetic energy of motors or the thermal energy of heating devices |  |  |  |
| Calculate and explain the amount of energy transferred by electrical work by recalling and applying the equations: [ E = Pt ] and [ E = QV ] |  |  |  |
| Identify the National Grid as a system of cables and transformers linking power stations to consumers |  |  |  |
| Explain why the National Grid system is an efficient way to transfer energy, with reference to change in potential difference reducing current |  |  |  |
| **Topic 5: Magnetism and electromagnetism** | Describe the attraction and repulsion between unlike and like poles of permanent magnets and explain the difference between permanent and induced magnets |  |  |  |
| Draw the magnetic field pattern of a bar magnet, showing how field strength and direction are indicated and change from one point to another |  |  |  |
| Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic |  |  |  |
| Describe how to plot the magnetic field pattern of a magnet using a compass |  |  |  |
| State examples of how the magnetic effect of a current can be demonstrated and explain how a solenoid arrangement can increase the magnetic effect of the current |  |  |  |
| Draw the magnetic field pattern for a straight wire carrying a current and for a solenoid (showing the direction of the field) |  |  |  |
| **HT ONLY: State and use Fleming's left-hand rule and explain what the size of the induced force depends on** |  |  |  |
| **HT ONLY: Calculate the force on a conductor carrying a current at right angles to a magnetic field by applying, but not recalling, the equation: [ F = BIL ]** |  |  |  |
| **HT ONLY: Explain how rotation is caused in an electric motor** |  |  |  |
| **Topic 6: Particle model of matter** | Calculate the density of a material by recalling and applying the equation: [ ρ = m/V ] |  |  |  |
| Recognise/draw simple diagrams to model the difference between solids, liquids and gases |  |  |  |
| Use the particle model to explain the properties of different states of matter and differences in the density of materials |  |  |  |
| Recall and describe the names of the processes by which substances change state |  |  |  |
| Use the particle model to explain why a change of state is reversible and affects the properties of a substance, but not its mass |  |  |  |
| State that the internal energy of a system is stored in the atoms and molecules that make up the system |  |  |  |
| Explain that internal energy is the total kinetic energy and potential energy of all the particles in a system |  |  |  |
| Calculate the specific latent heat of fusion/vaporisation by applying, but not recalling, the equation: [ E = mL ] |  |  |  |
| Interpret and draw heating and cooling graphs that include changes of state |  |  |  |
| Explain that the molecules of a gas are in constant random motion and that the higher the temperature of a gas, the greater the particles’ average kinetic energy |  |  |  |
| Explain, with reference to the particle model, the effect of changing the temperature of a gas held at constant volume on its pressure |  |  |  |
| **Topic 7: Atomic structure** | Describe the basic structure of an atom and how the distance of the charged particles vary with the absorption or emission of electromagnetic radiation |  |  |  |
| Define electrons, neutrons, protons, isotopes and ions |  |  |  |
| Relate differences between isotopes to differences in conventional representations of their identities, charges and masses |  |  |  |
| Describe why the evidence from Rutherford’s scattering experiment led to a change in the atomic model, compare the plum pudding and the nuclear model |  |  |  |
| Describe and apply the idea that the activity of a radioactive source is the rate at which its unstable nuclei decay, measured in Becquerel (Bq) by a Geiger-Muller tube |  |  |  |
| Describe the penetration through materials, the range in air and the ionising power for alpha particles, beta particles and gamma rays |  |  |  |
| Apply knowledge of the uses of radiation to evaluate the best sources of radiation to use in a given situation |  |  |  |
| Use the names and symbols of common nuclei and particles to complete balanced nuclear equations, by balancing the atomic numbers and mass numbers |  |  |  |
| Define half-life of a radioactive isotope |  |  |  |
| **HT ONLY: Determine the half-life of a radioactive isotope from given information and calculate the net decline, expressed as a ratio, in a radioactive emission after a given number of half-lives** |  |  |  |
| Compare the hazards associated with contamination and irradiation and outline suitable precautions taken to protect against any hazard the radioactive sources may present |  |  |  |
| Discuss the importance of publishing the findings of studies into the effects of radiation on humans and sharing findings with other scientists so that they can be checked by peer review |  |  |  |