6^{th} Year Syllabus – Revision Checklist

Electricity

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
Charges				
1. Electrification by contact	Charging by rubbing together dissimilar materials. Types of charge: positive, negative. Conductors and insulators. Unit of charge: coulomb.	Demonstration of forces between charges.	Domestic applications: • dust on television screen • static on clothes. Industrial hazards: • in flour mills • fuelling aircraft.	☐ ☐ ☐
2. Electrification by induction		Demonstration using an insulated conductor and a nearby charged object.		☐ ☐
3. Distribution of charge on conductors	Total charge resides on outside of a metal object. Charges tend to accumulate at points. Point discharge.	Van de Graaff generator can be used to demonstrate these phenomena.	Lightning. Lightning conductors.	☐ ☐ ☐
4. Electroscope	Structure.		Uses.	☐ ☐
Electric Field				
1. Force between charges	Coulomb's law $F = Q_1Q_2/(4\pi\varepsilon)d^2$ – an example of an inverse square law. Forces between collinear charges.	Appropriate calculations.		☐ ☐ ☐
2. Electric fields	Idea of lines of force. Vector nature of electric field to be stressed. Definition of electric field strength.	Demonstration of field patterns using oil and semolina *or* other method. Appropriate calculations – collinear charges only.	Precipitators. Xerography. Hazards: effect of electric fields on integrated circuits.	☐ ☐ ☐

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
3. Potential difference	Definition of potential difference: work done per unit charge to transfer a charge from one point to another. Definition of volt. Concept of zero potential.	Appropriate calculations.		☐ ☐ ☐

Capaitance

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
1. Capacitors and capacitance	Definition: $C = Q/V$ Unit of capacitance. Parallel plate capacitor. Use of $C = \varepsilon_o A/d$	Appropriate calculations. Demonstration that capacitance depends on the common area, the distance between the plates, and the nature of the dielectric. Appropriate calculations.	Common uses of capacitors: • tuning radios • flash guns • smoothing • filtering.	☐ ☐ ☐
	Energy stored in a capacitor.	Charge capacitor – discharge through lamp or low-voltage d.c. motor.		
	Use of $W = \frac{1}{2}CV^2$ Capacitors – conduct a.c. but not d.c.	Appropriate calculations. Demonstration.		

Electric Current

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
1. Electric current	Description of electric current as flow of charge; $1\ A = 1\ C\ s^{-1}$			☐ ☐
2. Sources of emf and electric current	Pd and voltage are the same thing; they are measured in volts. A voltage when applied to a circuit is called an emf.		Sources of emf: mains, simple cells, lead-acid accumulator, car batteries, dry batteries, thermocouple.	☐ ☐ ☐

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
3. Conduction in materials	Conduction in • metals • ionic solutions (active and inactive electrodes) • gases • vacuum • semiconductors. References in each case to charge carriers.	Interpretation of I–V graphs.	Neon lamps, street lights.	☐ ☐ ☐
	Conduction in semiconductors: the distinction between intrinsic and extrinsic conduction; p-type and n-type semiconductors.		Electronic devices. LED, computers, integrated circuits.	
	The p-n junction: basic principles underlying current flow across a p-n junction.	Demonstration of current flow across a p-n junction in forward and reverse bias, e.g. using a bulb.	Rectification of a.c.	
4. Resistance	Definition of resistance, unit. Ohm's law.	Appropriate calculations.		
	Resistance varies with length, cross-sectional area, and temperature. Resistivity. Resistors in series and parallel. Derivation of formulas.	Use of ohmmeter, metre bridge. Appropriate calculations.		☐ ☐ ☐
	Wheatstone bridge.	Appropriate calculations.	Practical uses of Wheatstone bridge for temperature control and fail-safe device.	
	LDR – light-dependent resistor. Thermistor.	Demonstration of LDR and thermistor.		
5. Potential	Potential divider.	Demonstration.	Potentiometer as a variable potential divider.	☐ ☐
6. Effects of electric current	Heating: $W = I^2Rt$	Demonstration of effect. Appropriate calculations.	Everyday examples. Advantage of use of EHT in transmission of electrical energy.	☐ ☐ ☐
	Chemical effect – an electric current can cause a chemical reaction.	Demonstration of effect.	Uses of the chemical effect. Everyday examples.	
	Magnetic effect of an electric current.	Demonstration of effect.		

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
7. Domestic circuits	Plugs, fuses, MCBs (miniature circuit breakers). Ring and radial circuits, bonding, earthing, and general safety precautions. RCDs (residual current devices). No drawing of ring circuits required. The kilowatt-hour. Uses.	Wiring a plug. Simple fuse calculations. Appropriate calculations.	Electricity at home • fuse box • meter, etc. Electrical safety.	☐ ☐ ☐
Electromagnetism				
1. Magnetism	Magnetic poles exist in pairs. Magnetic effect of an electric current.	Demonstration using magnets, coils, and nails.	Electromagnets and their uses.	☐ ☐
2. Magnetic fields	Magnetic field due to • magnets • current in - a long straight wire - a loop - a solenoid. Description without mathematical details. Vector nature of magnetic field to be stressed.	Demonstrations.	Earth's magnetic field – use in navigation.	☐ ☐ ☐
3. Current in a magnetic field	Current-carrying conductor experiences a force in a magnetic field. Direction of the force. Force depends on • the current • the length of the wire • the strength of the magnetic field. $F \propto I\,l\,B$ Magnetic flux density $B = F/Il$ Derivation of $F = qvB$ Forces between currents (non-mathematical treatment). Definition of the ampere.	Demonstration of the force on a conductor and coil in a magnetic field. Appropriate calculations. Appropriate calculations.	Applications in motors, meters, and loudspeakers.	☐ ☐ ☐

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
4. Electromagnetic induction	Magnetic flux $\Phi = BA$ Faraday's law. Lenz's law. Change of mechanical energy to electrical energy.	Demonstration of the principle and laws of electromagnetic induction. Appropriate calculations.	Application in generators.	☐ ☐ ☐
5. Alternating current	Variation of voltage and current with time, i.e. alternating voltages and currents. Peak and rms values of alternating currents and voltages.	Use oscilloscope to show a.c. Compare peak and rms values.	National grid and a.c.	☐ ☐ ☐
6. Concepts of mutual induction and self-induction	Mutual induction (two adjacent coils): when the magnetic field in one coil changes an emf is induced in the other, e.g. transformers. Self-induction: a changing magnetic field in a coil induces an emf in the coil itself, e.g. inductor. Structure and principle of operation of a transformer. Effects of inductors on a.c. (no mathematics or phase relations).	Demonstration. Demonstration. Demonstration. Appropriate calculations (voltage).	Uses of transformers. Dimmer switches in stage lighting – uses of inductors.	☐ ☐ ☐

ELECTRICITY: Experiments

1. Verification of Joule's law (as $\Delta\theta \propto I^2$).
2. Measurement of the resistivity of the material of a wire.
3. To investigate the variation of the resistance of a metallic conductor with temperature.
4. To investigate the variation of the resistance of a thermistor with temperature.
5. To investigate the variation of current (I) with pd (V) for
(a) metallic conductor
(b) filament bulb
(c) copper sulfate solution with copper electrodes
(d) semiconductor diode.

Modern Physics

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
The Electron				
1. The electron	The electron as the indivisible quantity of charge. Reference to mass and location in the atom. Units of energy: eV, keV, MeV, GeV.		Electron named by G. J. Stoney. Quantity of charge measured by Millikan.	☐ ☐ ☐
2. Thermionic emission	Principle of thermionic emission and its application to the production of a beam of electrons. Cathode ray tube consisting of heated filament, cathode, anode, and screen. Deflection of cathode rays in electric and magnetic fields.	Use of cathode ray tube to demonstrate the production of a beam of electrons – deflection in electric and magnetic fields.	Applications • cathode ray oscilloscope • television. Use of CRO to display signals: • ECG and EEG.	☐ ☐ ☐
3. Photoelectric emission	Photoelectric effect. The photon as a packet of energy; $E = hf$ Effect of intensity and frequency of incident light. Photocell (vacuum tube): structure and operation. Threshold frequency. Einstein's photoelectric law.	Demonstration, e.g. using zinc plate, electroscope, and different light sources. Demonstration of a photocell.	Applications of photoelectric sensing devices: • burglar alarms • automatic doors • control of burners in central heating • sound track in films.	☐ ☐ ☐
4. X-rays	X-rays produced when high-energy electrons collide with target. Principles of the hot-cathode X-ray tube. X-ray production as inverse of photoelectric effect. Mention of properties of X-rays: • electromagnetic waves • ionisation • penetration.		Uses of X-rays in medicine and industry. Hazards.	☐ ☐ ☐

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
The Nucleus				
1. Structure of the atom	Principle of Rutherford's experiment. Bohr model, descriptive treatment only. Energy levels. Emission line spectra. $hf = E_2 - E_1$	Experiment may be simulated using a large-scale model *or* a computer *or* demonstrated on a video. Demonstration of line spectra and continuous spectra.	Lasers. Spectroscopy as a tool in science.	
2. Structure of the nucleus	Atomic nucleus as protons plus neutrons. Mass number A, atomic number Z, $^{A}X_{Z}$, isotopes.			
3. Radioactivity	Experimental evidence for three ,kinds of radiation: by deflection in electric or magnetic fields or ionisation or penetration. Nature and properties of alpha, beta and gamma emissions. Change in mass number and atomic number because of radioactive decay. Principle of operation of a detector of ionising radiation. Definition of becquerel (Bq) as one disintegration per second. Law of radioactive decay. Concept of half-life: $T_{1/2}$ Concept of decay constant rate of decay = λN $T_{1/2} = \ln 2/\lambda$	Demonstration of ionisation and penetration by the radiations using any suitable method, e.g. electroscope, G-M tube. Demonstration of G-M tube or solid-state detector. Interpretation of nuclear reactions. Appropriate calculations (not requiring calculus). Appropriate calculations (not requiring calculus).	Uses of radioisotopes: • medical imaging • medical therapy • food irradiation • agriculture • radiocarbon dating • smoke detectors • industrial applications.	
4. Nuclear energy	Principles of fission and fusion. Mass-energy conservation in nuclear reactions, $E = mc^2$. Nuclear reactor (fuel, moderator, control rods, shielding, and heat exchanger).	Interpretation of nuclear reactions. Appropriate calculations. Audiovisual resource material.	Fusion: source of Sun's energy. Nuclear weapons. Environmental impact of fission reactors. Development of fusion reactors.	

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
5. Ionising radiation and health hazards	General health hazards in use of ionising radiations, e.g. X-rays, nuclear radiation. Environmental radiation: the effect of ionising radiation on humans depends on the type of radiation, the activity of the source (in Bq), the time of exposure, and the type of tissue irradiated.	Measurement of background radiation. Audiovisual resource material.	Health hazards of ionising radiations. Radon, significance of background radiation, granite. Medical and dental X-rays. Disposal of nuclear waste. Radiation protection.	

Particle Physics

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
Particle Physics **1. Conservation of energy and momentum in nuclear reactions**	Radioactive decay resulting in two particles. If momentum is not conserved, a third particle (neutrino) must be present.	Appropriate calculations to convey sizes and magnitudes and relations between units.		
2. Acceleration of protons	Cockcroft and Walton – proton energy approximately 1 MeV: outline of experiment.	Appropriate calculations.	First artificial splitting of nucleus. First transmutation using artificially accelerated particles. Irish Nobel laureate for physics, Professor E. T. S. Walton (1951).	
3. Converting mass into other forms of energy	"Splitting the nucleus" $^1H_1 + {}^7Li_3 \rightarrow {}^4He_2 + {}^4He_2 + Q$ 1 MeV 17.3 MeV Note energy gain. Consistent with $E = mc^2$	Appropriate calculations.		
4. Converting other forms of energy into mass	Reference to circular accelerators progressively increasing energy available: proton-proton collisions p + p + energy → p + p + additional particles.	Audiovisual resource material.	History of search for basic building blocks of nature: • Greeks: earth, fire, air, water • 1936: p, n, e. Particle accelerators, e.g. CERN.	
5. Fundamental forces of nature	Strong nuclear force: force binding nucleus, shortrange. Weak nuclear force: force between particles that are not subject to the strong force, short range. Electromagnetic force: force between charged particles, inverse square law. Gravitational force: inverse square law.			

Content	Depth of treatment	Activities	Science/Technology/Society	Revision
6. Families of particles	Mass of particles comes from energy of the reactions – $m = E/c^2$ The larger the energy the greater the variety of particles. These particles are called "particle zoo". Leptons: indivisible point objects, not subject to strong force, e.g. electron, positron, and neutrino. Baryons: subject to all forces, e.g. protons, neutrons, and heavier particles. Mesons: subject to all forces, mass between electron and proton.	Appropriate calculations.	Pioneering work to investigate the structure of matter and origin of universe. International collaboration, e.g. CERN.	
7. Anti-matter	e^+ positron, e^- electron. Each particle has its own anti-particle. Pair production: two particles produced from energy. γ rays $\rightarrow e^+ + e^-$ conserve charge, momentum. Annihilation: Two γ rays from annihilation of particles. $e^+ + e^- \rightarrow 2hf$ (γ rays) conserve charge, momentum.		Paul Dirac predicted anti-matter mathematically.	
8. Quark model	Quark: fundamental building block of baryons and mesons. Six quarks – called up, down, strange, charmed, top, and bottom. Charges: $u^{+2/3}$, $d^{-1/3}$, $s^{-1/3}$ Anti-quark has opposite charge to quark and same mass. Baryons composed of three quarks: p = uud, n = udd, other baryons any three quarks. Mesons composed of any quark and an anti-quark.	Identify the nature and charge of a particle given a combination of quarks.	James Joyce: "Three quarks for Muster Mark".	