MARINA INTERNATIONAL SCHOOL

PHYSICS SCHEME OF WORK

FORM 7 - TERM 1

WEEK	TOPIC	TOPIC DETAILS
1.1	PHYSICAL QUANTITIES AND UNITS	SI units ☐ recall the SI base quantity of amount of substance (mol) and its unit mole(mol) The Avogadro constant ☐ understand that the Avogadro constant NA is the number of atoms in 0.012 kg of carbon-12 ☐ use molar quantities where one mole of any substance is the amount containing a number of particles equal to the Avogadro constant NA
2.1	Practical	Practical ☐ Planning ☐ Evaluation

WEEK	TOPIC	TOPIC DETAILS
3.1	ELECTRIC FIELDS	Electric fields and field lines ☐ understand that an electric field is an example of a field of force and define electric field as force per unit positive charge ☐ recall and use F = qE for the force on a charge in an electric field ☐ represent an electric field by means of field lines Uniform electric fields ☐ recall and use E = ΔV / Δd to calculate the field strength of the uniform field between charged parallel plates ☐ describe the effect of a uniform electric field on the motion of charged particles Electric force between point charges ☐ understand that, for a point outside a spherical conductor, the charge on the sphere may be considered to be a point charge at its centre ☐ recall and use Coulomb's law F = Q1Q2 / (4πε0r2) for the force between two point charges in free space Electric field of a point charge ☐ recall and use E = Q / (4πε0r2) for the electric field strength due to a point charge in free space Electric potential ☐ define electric potential at a point as the work done per unit positive charge in bringing a small test charge from infinity to the point ☐ recall and use the fact that the electric field at a point is equal to the negative of potential gradient at that point ☐ use V = Q / (4πε0r) for the electric potential in the field due to a point charge ☐ understand how the concept of electric potential leads to the electric potential energy of two point charges and use EP = Qq / (4πε0r)

WEEK	TOPIC	TOPIC DETAILS
4.1	MOTION IN A CIRCLE	Kinematics of uniform circular motion ☐ define the radian and express angular displacement in radians ☐ understand and use the concept of angular speed ☐ recall and use $\omega = 2\pi / T$ and $v = r\omega$ Centripetal acceleration ☐ understand that a force of constant magnitude that is always perpendicular to the direction of motion causes centripetal acceleration ☐ understand that centripetal acceleration causes circular motion with a constant angular speed ☐ recall and use $a = r\omega^2$ and $a = v^2 / r$ ☐ recall and use $F = mr\omega^2$ and $F = mv^2 / r$
5.1	**CAPACITANCE	Capacitors and capacitance ☐ define capacitance, as applied to both isolated spherical conductors and to parallel plate capacitors ☐ recall and use $C = Q / V$ ☐ derive, using $C = Q / V$, formulae for the combined capacitance of capacitors in series and in parallel ☐ use the capacitance formulae for capacitors in series and in parallel Energy stored in a capacitor ☐ determine the electric potential energy stored in a capacitor from the area under the potential–charge graph ☐ recall and use $W = \frac{1}{2}QV = \frac{1}{2}CV^2$ Discharging a capacitor ☐ analyse graphs of the variation with time of potential difference, charge and current for a capacitor discharging through a resistor

WEEK	TOPIC	TOPIC DETAILS
6.1	GRAVITATIONAL FIELDS	Gravitational field □ understand that a gravitational field is an example of a field of force and define gravitational field as force per unit mass □ represent a gravitational field by means of field lines Gravitational force between point masses □ understand that, for a point outside a uniform sphere, the mass of the sphere may be considered to be a point mass at its centre □ recall and use Newton's law of gravitation $F = Gm_1m_2 / r^2$ for the force between two point masses □ analyse circular orbits in gravitational fields by relating the gravitational force to the centripetal acceleration it causes □ understand that a satellite in a geostationary orbit remains at the same point above the Earth's surface, with an orbital period of 24 hours, orbiting from west to east, directly above the Equator Gravitational field of a point mass □ derive, from Newton's law of gravitation and the definition of gravitational field, the equation $g = GM / r^2$ for the gravitational field strength due to a point mass □ recall and use $g = GM / r^2$ □ understand why g is approximately constant for small changes in height near the Earth's surface Gravitational potential □ define gravitational potential at a point as the work done per unit mass in bringing a small test mass from infinity to the point □ use $\phi = -GM / r$ for the gravitational potential in the field due to a point mass □ understand how the concept of gravitational potential leads to the gravitational potential energy of two point masses and use $E_P = -GMm / r$

WEEK	TOPIC	TOPIC DETAILS
7.1	MAGNETIC FIELDS	Concept of a magnetic field ☐ understand that a magnetic field is an example of a field of force produced either by moving charges or by permanent magnets ☐ represent a magnetic field by field lines Force on a current-carrying conductor ☐ understand that a force might act on a current-carrying conductor placed in a magnetic field ☐ recall and use the equation $F = BIL \sin \theta$, with directions as interpreted by Fleming's left-hand rule ☐ define magnetic flux density as the force acting per unit current per unit length on a wire placed at right angles to the magnetic field ☐ define magnetic flux density and the tesla ☐ understand how the force on a current-carrying conductor can be used to measure the flux density of a magnetic field using a current balance Force on a moving charge ☐ determine the direction of the force on a charge moving in a magnetic field ☐ recall and use $F = BQv \sin \theta$ ☐ understand the origin of the Hall voltage and derive and use the expression $V_H = BI / (ntq)$, where t = thickness ☐ understand the use of a Hall probe to measure magnetic flux density ☐ describe the motion of a charged particle moving in a uniform magnetic field perpendicular to the direction of motion of the particle ☐ explain how electric and magnetic fields can be used in velocity selection ☐ explain the main principles of one method for the determination of v and e/m_e for electrons

WEEK	TOPIC	TOPIC DETAILS
7.2	Magnetic fields due to currents	Magnetic fields due to currents ☐ sketch magnetic field/flux patterns due to the currents in a long straight wire, a flat circular coil and a long solenoid ☐ understand that the magnetic field due to the current in a solenoid is increased by a ferrous core ☐ explain the origin of the forces between current-carrying conductors and determine the direction of the forces ☐ describe and compare the forces on mass, charge and current in gravitational, electric and magnetic fields, as appropriate Nuclear magnetic resonance imaging ☐ explain the main principles behind the use of nuclear magnetic resonance imaging (NMRI) to obtain diagnostic information about internal structures ☐ understand the function of the non-uniform magnetic field, superimposed on the large constant magnetic field, in diagnosis using NMRI

WEEK	TOPIC	TOPIC DETAILS
8.1	IDEAL GASES	Equation of state ☐ understand that a gas obeying $pV \propto T$, where T is the thermodynamic temperature, is known as an ideal gas ☐ recall and use the equation of state for an ideal gas expressed as $pV = nRT$, where n = amount of substance (number of moles) and as $pV = NkT$, where N = number of molecules ☐ recall that the Boltzmann constant k is given by $k = R / N_A$ Kinetic theory of gases ☐ infer from a Brownian motion experiment the evidence for the movement of molecules ☐ state the basic assumptions of the kinetic theory of gases ☐ explain how molecular movement causes the pressure exerted by a gas and derive and use the relationship $pV = 1/3 Nm$, where is the mean-square speed (a simple model considering one dimensional collisions and then extending to three dimensions using 1/3 = is sufficient) ☐ understand that the root-mean-square speed cr.m.s. is given by square root of ☐ compare $pV = 1/3 Nm$ with $pV = NkT$ to deduce that the average translational kinetic energy of a molecule is $3/2 KT$ Kinetic energy of a molecule ☐ recall that the Boltzmann constant k is given by the expression $k = R/N_A$ ☐ compare $pV = 1/3 Nm$ with $pV = NkT$ and hence deduce that the average translational kinetic energy of a molecule is proportional to T
9.1	ELECTROMAGNETIC INDUCTION	Laws of electromagnetic induction ☐ define magnetic flux and the weber ☐ recall and use $\Phi = BA$ ☐ define magnetic flux linkage ☐ infer from appropriate experiments on electromagnetic induction: • that a changing magnetic flux can induce an e.m.f. in a circuit • that the direction of the induced e.m.f. opposes the change producing it • the factors affecting the magnitude of the induced e.m.f. ☐ recall and solve problems using Faraday's law of electromagnetic induction and Lenz's law ☐ explain simple applications of electromagnetic induction

WEEK	TOPIC	TOPIC DETAILS
9.2	ALTERNATING CURRENTS	Characteristics of alternating currents ☐ understand and use the terms period, frequency, peak value and root-mean-square value as applied to an alternating current or voltage ☐ deduce that the mean power in a resistive load is half the maximum power for a sinusoidal alternating current ☐ represent a sinusoidally alternating current or voltage by an equation of the form $x = x_0 \sin \omega t$ ☐ distinguish between r.m.s. and peak values and recall and solve problems using the relationship $I_{r.m.s.} = I_0 / \sqrt{2}$ for the sinusoidal case
10.1	TEMPERATURE	Thermal equilibrium ☐ appreciate that (thermal) energy is transferred from a region of higher temperature to a region of lower temperature ☐ understand that regions of equal temperature are in thermal equilibrium Temperature scales ☐ understand that a physical property that varies with temperature may be used for the measurement of temperature and state examples of such properties ☐ understand that there is an absolute scale of temperature that does not depend on the property of any particular substance (i.e. the thermodynamic scale and the concept of absolute zero) ☐ convert temperatures measured in kelvin to degrees Celsius and recall that $T / K = T / °C + 273.15$ Practical thermometers ☐ compare the relative advantages and disadvantages of thermistor and thermocouple thermometers as previously calibrated instruments

WEEK	TOPIC	TOPIC DETAILS
11.1	ALTERNATING CURRENTS	The transformer ☐ understand the principle of operation of a simple laminated iron cored transformer and recall and solve problems using NS/NP = VS/VP = IP/IS for an ideal transformer ☐ understand the sources of energy loss in a practical transformer Transmission of electrical energy ☐ appreciate the practical and economic advantages of alternating current and of high voltages for the transmission of electrical energy Rectification ☐ distinguish graphically between half-wave and full-wave rectification ☐ explain the use of a single diode for the half-wave rectification of an alternating current ☐ explain the use of four diodes (bridge rectifier) for the full-wave rectification of an alternating current ☐ analyse the effect of a single capacitor in smoothing, including the effect of the value of capacitance in relation to the load resistance
12.1	THERMAL PROPERTIES OF MATERIALS	Specific heat capacity and specific latent heat ☐ explain using a simple kinetic model for matter: • the structure of solids, liquids and gases • why melting and boiling take place without a change in temperature • why the specific latent heat of vaporisation is higher than specific latent heat of fusion for the same substance • why a cooling effect accompanies evaporation ☐ define and use the concept of specific heat capacity, and identify the main principles of its determination by electrical methods ☐ define and use the concept of specific latent heat, and identify the main principles of its determination by electrical methods Internal energy and the first law of thermodynamics ☐ understand that internal energy is determined by the state of the system and that it can be expressed as the sum of a random distribution of kinetic and potential energies associated with the molecules of a system ☐ relate a rise in temperature of a body to an increase in its internal energy ☐ recall and use the first law of thermodynamics $\Delta U = q + w$ expressed in terms of the increase in internal energy, the heating of the system (energy transferred to the system by heating) and the work done on the system

WEEK	TOPIC	TOPIC DETAILS
13.1	PRODUCTION AND USE OF ULTRASOUND IN DIAGNOSIS	☐ explain the principles of the generation and detection of ultrasonic waves using piezo-electric transducers
		☐ explain the main principles behind the use of ultrasound to obtain diagnostic information about internal structures
		☐ understand the meaning of specific acoustic impedance and its importance to the intensity reflection coefficient at a boundary
		☐ recall and solve problems by using the equation $I = I_0 e^{-\mu x}$ for the attenuation of ultrasound in matter
		☐ explain the principles of the production of X-rays by electron bombardment of a metal target
		☐ describe the main features of a modern X-ray tube, including control of the intensity and hardness of the X-ray beam
		☐ understand the use of X-rays in imaging internal body structures, including a simple analysis of the causes of sharpness and contrast in X-ray imaging
		☐ recall and solve problems by using the equation $I = I_0 e^{-\mu x}$ for the attenuation of X-rays in matter
		☐ understand the purpose of computed tomography or CT scanning
		☐ understand the principles of CT scanning
		☐ understand how the image of an 8-voxel cube can be developed using CT scanning

PHYSICS SCHEME OF WORK

FORM 7 - TERM 2

WEEK	TOPIC	TOPIC DETAILS
1.1	OSCILLATIONS	Simple harmonic oscillations ☐ describe simple examples of free oscillations ☐ investigate the motion of an oscillator using experimental and graphical methods ☐ understand and use the terms amplitude, period, frequency, angular frequency and phase difference and express the period in terms of both frequency and angular frequency ☐ recognise and use the equation $a = -\omega^2 x$ as the defining equation of simple harmonic motion ☐ recall and use $x = x_0 \sin \omega t$ as a solution to the equation $a = -\omega^2 x$ ☐ recognise and use the equations $v = v_0 \cos \omega t$ and ☐ describe, with graphical illustrations, the changes in displacement, velocity and acceleration during simple harmonic motion Energy in simple harmonic motion ☐ describe the interchange between kinetic and potential energy during simple harmonic motion

WEEK	TOPIC	TOPIC DETAILS
2.1	Damped and forced oscillations, resonance	☐ describe practical examples of damped oscillations with particular reference to the effects of the degree of damping and the importance of critical damping ☐ describe practical examples of forced oscillations and resonance ☐ describe graphically how the amplitude of a forced oscillation changes with frequency near to the natural frequency of the system, and understand qualitatively the factors that determine the frequency response and sharpness of the resonance ☐ appreciate that there are some circumstances in which resonance is useful and other circumstances in which resonance should be avoided

WEEK	TOPIC	TOPIC DETAILS
3.1	COMMUNICATION	**Communication channels** ☐ appreciate that information may be carried by a number of different channels, including wire-pairs, coaxial cables, radio and microwave links, optic fibres **Modulation** ☐ understand the term modulation and be able to distinguish between amplitude modulation (AM) and frequency modulation (FM) ☐ recall that a carrier wave, amplitude modulated by a single audio frequency, is equivalent to the carrier wave frequency together with two sideband frequencies ☐ understand the term bandwidth ☐ recall the frequencies and wavelengths used in different channels of communication ☐ demonstrate an awareness of the relative advantages of AM and FM transmissions **Digital communication** ☐ recall the advantages of the transmission of data in digital form, compared with the transmission of data in analogue form ☐ understand that the digital transmission of speech or music involves analogue-to-digital conversion (ADC) before transmission and digital-to-analogue conversion (DAC) after reception ☐ understand the effect of the sampling rate and the number of bits in each sample on the reproduction of an input signal **Relative merits of channels of communication** ☐ discuss the relative advantages and disadvantages of channels of communication in terms of available bandwidth, noise, crosslinking, security, signal attenuation, repeaters and regeneration ☐ recall the relative merits of both geostationary and polar orbiting satellites for communicating information **Attenuation** ☐ understand and use signal attenuation expressed in dB and dB per unit length ☐ recall and use the expression number of dB = 10 lg (P1/P2) for the ratio of two powers

WEEK	TOPIC	TOPIC DETAILS
4.1	QUANTUM PHYSICS	Energy of a photon ☐ appreciate the particulate nature of electromagnetic radiation ☐ recall and use E = hf Photoelectric emission of electrons ☐ understand that the photoelectric effect provides evidence for a particulate nature of electromagnetic radiation while phenomena such as interference and diffraction provide evidence for a wave nature ☐ recall the significance of threshold frequency ☐ explain photoelectric phenomena in terms of photon energy and work function energy ☐ explain why the maximum photoelectric energy is independent of intensity, whereas the photoelectric current is proportional to intensity ☐ recall, use and explain the significance of $hf = \Phi + \frac{1}{2}mv^2_{max}$
5.1	QUANTUM PHYSICS	Wave-particle duality ☐ describe and interpret qualitatively the evidence provided by electron diffraction for the wave nature of particles ☐ recall and use the relation for the de Broglie wavelength $m = h/p$ Energy levels in atoms and line spectra ☐ show an understanding of the existence of discrete electron energy levels in isolated atoms (e.g. atomic hydrogen) and deduce how this leads to spectral lines ☐ distinguish between emission and absorption line spectra ☐ recall and solve problems using the relation $hf = E_1 - E_2$ Band theory ☐ appreciate that, in a simple model of band theory, there are energy bands in solids ☐ understand the terms valence band, conduction band and forbidden band (band gap) ☐ use simple band theory to explain the temperature dependence of the resistance of metals and of intrinsic semiconductors ☐ use simple band theory to explain the dependence on light intensity of the resistance of an LDR

WEEK	TOPIC	TOPIC DETAILS
6.1	SENSING DEVICES	Sensing devices ☐ show an understanding of the change in resistance with light intensity of a light-dependent resistor (LDR) ☐ sketch the temperature characteristic of a negative temperature coefficient thermistor ☐ show an understanding of the action of a piezo-electric transducer and its application in a simple microphone ☐ describe the structure of a metal-wire strain gauge ☐ relate extension of a strain gauge to change in resistance of the gauge ☐ understand that an electronic sensor consists of a sensing device and a circuit that provides an output that can be registered as a voltage ☐ explain the use of thermistors, light-dependent resistors and strain gauges in potential dividers to provide a potential difference that is dependent on temperature, illumination and strain respectively

WEEK	TOPIC	TOPIC DETAILS
7.1	NUCLEAR PHYSICS	Mass defect and nuclear binding energy ☐ show an appreciation of the association between energy and mass as represented by E = mc2 and recall and use this relationship ☐ understand the significance of the terms mass defect and mass excess in nuclear reactions ☐ represent simple nuclear reactions by nuclear equations of the form ☐ define and understand the terms mass defect and binding energy ☐ sketch the variation of binding energy per nucleon with nucleon number ☐ explain what is meant by nuclear fusion and nuclear fission ☐ explain the relevance of binding energy per nucleon to nuclear fusion and to nuclear fission Radioactive decay ☐ infer the random nature of radioactive decay from the fluctuations in count rate ☐ show an appreciation of the spontaneous and random nature of nuclear decay ☐ define the terms activity and decay constant and recall and solve problems using A = ʎN ☐ infer and sketch the exponential nature of radioactive decay and solve problems using the relationship x = x0e–ʎt, where x could represent activity, number of undecayed nuclei or received count rate ☐ define half-life ☐ solve problems using the relation

WEEK	TOPIC	TOPIC DETAILS
8.1	**ELECTRONICS	The ideal operational amplifier ☐ recall the main properties of the ideal operational amplifier (op-amp) Operational amplifier circuits ☐ deduce, from the properties of an ideal operational amplifier, the use of an operational amplifier as a comparator ☐ understand the effects of negative feedback on the gain of an operational amplifier ☐ recall the circuit diagrams for both the inverting and the noninverting amplifier for single signal input ☐ understand the virtual earth approximation and derive an expression for the gain of inverting amplifiers ☐ recall and use expressions for the voltage gain of inverting and of non-inverting amplifiers
9.1	ELECTRONICS	Output devices ☐ understand that an output device may be required to monitor the output of an op-amp circuit ☐ understand the use of relays in electronic circuits ☐ understand the use of light-emitting diodes (LEDs) as devices to indicate the state of the output of electronic circuits ☐ understand the need for calibration where digital or analogue meters are used as output devices