SS Combined Science Curriculum (Physics Part) (for students taking 2016 and after 2016 HKDSE)

Heat (15 hours)

Topics	Content	Notes for teachers
(a) Temperature, heat and internal energy		
temperature and thermometers	• realise temperature as the degree of hotness of an object • interpret temperature as a quantity associated with the average kinetic energy due to the random motion of molecules in a system • explain the use of temperature-dependent properties in measuring temperature • define and use degree Celsius as a unit of temperature	• Same treatment as in HKCEE • Basic principle of how temperature dependent properties can be used for measuring temperature *is required* • Calibrating a thermometer by plotting a linear graph *is required* • The detailed structure and facts (e.g. working range, suitability) of thermometers *are not required*
heat and internal energy	• realise that heat is the energy transferred as a result of the temperature difference between two objects • describe the effect of mass, temperature and state of matter on the internal energy of a system • relate internal energy to the sum of the kinetic energy of random motion and the potential energy of molecules in the system	• Same treatment as in HKCEE
heat capacity and specific heat capacity	• define heat capacity as $C = \frac{Q}{\Delta T}$ and specific heat capacity as $c = \frac{Q}{m\Delta T}$ • determine the specific heat capacity of a substance • discuss the practical importance of the high specific heat capacity of water • solve problems involving heat capacity and specific heat capacity	• Same treatment as in HKCEE
(b) Transfer processes		
conduction, convection and radiation	• identify the means of energy transfer in terms of conduction, convection and radiation • interpret energy transfer by conduction in terms of molecular motion • realise the emission of infra-red radiation by hot objects • determine the factors affecting the emission and absorption of radiation	• Same treatment as in HKCEE • Molecular interpretation of convection *is not required* • Factors affecting the rate of conduction *are not required*

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Topics	**Content**	**Notes for teachers**
(c) Change of state		
melting and freezing, boiling and condensing	• state the three states of matter • determine the melting point and boiling point	• Same treatment as in HKCEE
latent heat	• realise latent heat as the energy transferred during the change of state without temperature change • interpret latent heat in terms of the change of potential energy of the molecules during a change of state • define specific latent heat of fusion as $\ell_f = \frac{Q}{m}$ • define specific latent heat of vaporization as $\ell_v = \frac{Q}{m}$ • solve problems involving latent heat	• Same treatment as in HKCEE
evaporation	• realise the occurrence of evaporation below boiling point • explain the cooling effect of evaporation • discuss the factors affecting rate of evaporation • explain evaporation in terms of molecular motion	• Same treatment as in HKCEE • Qualitative explanation of evaporation and its cooling effect in terms of molecular motion *are required* • Interpreting the factors affecting the rate of evaporation in terms of molecular motion *is not required*

Force and Motion (36 hours)

Topics	Content	Notes for teachers
(a) Position and movement		
position, distance and displacement	• describe the change of position of objects in terms of distance and displacement • present information on displacement-time graphs for moving objects	• Combining percentage errors *is not required* ☺ Vernier caliper and micrometer could be used as instruments in practical work Mathematics skills involved: Compulsory Part in Math • 2. Functions and graphs • 9. More about graphs of functions • Calculus is not expected
scalars and vectors	• distinguish between scalar and vector quantities • use scalars and vectors to represent physical quantities	Mathematics skills involved: Module 2 (Algebra and Calculus) in Ma*th* • 15. Introduction to vectors • Teachers are expected to introduce the necessary basic ideas of vectors
speed and velocity	• define average speed as the distance travelled in a given period of time and average velocity as the displacement changed in a period of time • distinguish between instantaneous and average speed/velocity • describe the motion of objects in terms of speed and velocity • present information on velocity-time graphs for moving objects • use displacement-time and velocity-time graphs to determine the displacement and velocity of objects	• Relative velocity *is not required* Mathematics skills involved: Compulsory Part in Math • 12. Equations of straight lines and circles
uniform motion	• interpret the uniform motion of objects using algebraic and graphical methods • solve problems involving displacement, time and velocity	
acceleration	• define acceleration as the rate of change of velocity • use velocity-time graphs to determine the acceleration of objects in uniformly accelerated motion • present information on acceleration-time graphs for moving objects	

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Topics	Content	Notes for teachers
equations of uniformly accelerated motion	• derive equations of uniformly accelerated motion $v = u + at$ $s = \frac{1}{2}(u + v)t$ $s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ • solve problems involving objects in uniformly accelerated motion	Mathematics skills involved: Compulsory Part in Math • 1. Quadratic equations in one unknown
vertical motion under gravity	• examine the motion of free-falling objects experimentally and estimate the acceleration due to gravity • present graphically information on vertical motions under gravity • apply equations of uniformly accelerated motion to solve problems involving objects in vertical motion • describe the effect of air resistance on the motion of objects falling under gravity	• Dependence of air resistance on mass, size and shape of objects *is not required*
(b) Force and motion		
Newton's First Law of motion	• describe the meaning of inertia and its relationship to mass • state Newton's First Law of motion and use it to explain situations in which objects are at rest or in uniform motion • understand friction as a force opposing motion/tendency of motion	• Concepts and formulae of kinetic friction and static friction *are not required*
addition and resolution of forces	• find the vector sum of coplanar forces graphically and algebraically • resolve a force graphically and algebraically into components along two mutually perpendicular directions	Mathematics skills involved: Compulsory Part in Math • 13. More about trigonometry
Newton's Second Law of motion	• describe the effect of a net force on the speed and/or direction of motion of an object • state Newton's Second Law of motion and verify $F = ma$ experimentally • use newton as a unit of force • use free-body diagrams to show the forces acting on objects • determine the net force acting on object(s) • apply Newton's Second Law of motion to solve problems involving motion in one dimension	• Solving problems involving two-body or many-body systems *is expected*
Newton's Third Law of motion	• realise forces acting in pairs • state Newton's Third Law of motion and identify action and reaction pair of forces	

Topics	Content	Notes for teachers
mass and weight	• distinguish between mass and weight • realise the relationship between mass and weight	
(c) Projectile motion	• describe the shape of the path taken by a projectile launched at an angle of projection • understand the independence of horizontal and vertical motions • solve problems involving projectile motion	• Resolving vector quantities into horizontal and vertical components and solving problems by considering the x and y directions separately *are required* • Deriving the equations for the range, time of flight and maximum height *is not required* • Deriving the equation $y(x)$ for the parabolic trajectory *is not required* • Quantitative treatment of air resistance on projectile motion is *not required*
(d) Work, energy and power		
mechanical work	• interpret mechanical work as a way of energy transfer • define mechanical work done $W = Fs\cos\theta$ • solve problems involving mechanical work	
gravitational potential energy (P.E.)	• state that gravitational potential energy is the energy possessed by an object due to its position under gravity • derive $P.E. = mgh$ • solve problems involving gravitational potential energy	
kinetic energy (K.E.)	• state that kinetic energy is the energy possessed by an object due to its motion • derive $K.E. = \frac{1}{2}mv^2$ • solve problems involving kinetic energy	
law of conservation of energy in a closed system	• state the law of conservation of energy • discuss the inter-conversion of P.E. and K.E. with consideration of energy loss • solve problems involving conservation of energy	• The concepts of energy being stored when spring/elastic cord is extended/compressed *are required* and that the amount of energy stored increases with the extension/compression *are also assumed* • The equation of *elastic* $P.E. = \frac{1}{2}kx^2$ *is not required* • Solving problems involving 2D motions (e.g. projectile motion) *is expected*
power	• define power as the rate of energy transfer • apply $P = \frac{W}{t}$ to solve problems	• The use of equation $P = Fv$ *is expected*
(e) Momentum		
linear momentum	• realise momentum as a quantity of motion of an object and define momentum $p = mv$	
change in momentum and net force	• understand that a net force acting on an object for a period of time results a change in momentum • interpret force as the rate of change of momentum (Newton's Second Law of motion)	• "Change in momentum" is used instead of the term "impulse" • Interpretation of F-t graph *is expected*

Topics	Content	Notes for teachers
law of conservation of momentum	• state the law of conservation of momentum and relate it to Newton's Third Law of motion • distinguish between elastic and inelastic collisions • solve problems involving momentum in one dimension only	• Deriving the law of conservation of momentum from Newton's laws of motion *is expected* • Mathematical proof of the right-angle fork collision *is not required* • The extension of right-angle fork collision to cases of unequal masses or with K.E. loss *is not required*

Wave Motion (31 hours)

Topics	Content	Notes for teachers
(a) Nature and properties of waves		
nature of waves	• interpret wave motion in terms of oscillation • realise waves as transmitting energy without transferring matter	• Huygen's principle *is not required*
wave motion and propagation	• distinguish between transverse and longitudinal waves • describe wave motion in terms of waveform, crest, trough, compression, rarefaction, wavefront, phase, displacement, amplitude, period, frequency, wavelength and wave speed • present information on displacement-time and displacement-distance graphs for travelling waves • determine factors affecting the speed of propagation of waves along stretched strings or springs • apply $f = 1 / T$ and $v = f\lambda$ to solve problems	• Direction of motion of medium particles in displacement-distance graphs *is assumed* • Predict the direction of motion of wave, time lags and time leads in displacement-time and displacement-distance graph • Study phase difference between two sinusoidal waves in simple cases (in-phase and anti-phase) only • Study displacement-time / displacement-position graph of transverse and longitudinal waves
reflection and refraction	• realise the reflection of waves at a plane barrier/ reflector/ surface • realise the refraction of waves across a plane boundary • examine the change in wave speeds during refraction and define refractive index in terms of wave speeds • draw wavefront diagrams to show reflection and refraction	• Frequency measurement by stroboscope *is not required* • Phase difference between two arbitrary wave particles *is not required* ☺ Ripple tank could be used to demonstrate wave motion and wave properties. ☺ Video Camera and HDMVA could be used to analyse wave motion, and measure wavelength and speed
diffraction and interference	• describe the diffraction of waves through a narrow gap and around a corner • examine the effect of the width of slit on the degree of diffraction • describe the superposition of two pulses • realise the interference of waves • distinguish between constructive and destructive interferences • examine the interference of waves from two coherent sources • determine the conditions for constructive and destructive interferences in terms of path difference	• Concept of phase / path difference is assumed in double slits interference • Qualitative treatment *only* for diffraction of wave • Problem on interference plus diffraction *is not required* • Conversion between path difference and phase difference is required for in-phase and anti-phase interference only • Mathematical treatment of superposition *is not required* ☺ Superposition of waves could be demonstrated on a long slinky

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Topics	Content	Notes for teachers
	• draw wavefront diagrams to show diffraction and interference	
(b) Light		
light in electromagnetic spectrum	• state that the speed of light and electromagnetic waves in a vacuum is 3.0×10^8 m s^{-1} • state the range of wavelengths for visible light • state the relative positions of visible light and other parts of the electromagnetic spectrum	
reflection of light	• state the laws of reflection • construct images formed by a plane mirror graphically	
refraction of light	• examine the laws of refraction • sketch the path of a ray refracted at a boundary • realize $n = \frac{\sin i}{\sin r}$ as the refractive index of a medium • solve problems involving refraction at a boundary	• Refraction by a prism *is assumed* • Dispersion of white light through a prism is assumed from Science (S1-3) Curriculum • Note that refractive index of light of different frequency (colour) is different • Solve problem related to the refractive index of different frequency of light *is required* • General Snell's law *is assumed* Mathematics skills involved: Compulsory Part in Math • 13. More about Trigonometry
total internal reflection	• examine the conditions for total internal reflection • solve problems involving total internal reflection at a boundary	• Critical angle *is assumed*
formation of images by lenses	• construct images formed by converging and diverging lenses graphically • distinguish between real and virtual images	• Compound lens system, such as telescope and microscope, *is not required* • Eye defects *are not required* • Using graphical methods to solve lens problems *is assumed*
wave nature of light	• point out light as an example of transverse wave • realise diffraction and interference as evidences for the wave nature of light • examine the interference patterns in the Young's double slit experiment • examine the interference patterns in the plane transmission grating	• Air wedge / soap film / adding a thin film to Young's double slits setting / immersing the set-up in water *are not required* • Only principal maxima for Young's double slit experiment *is required* • Interference pattern (fringes) of light *is required* • Spectrometer *is not required*

Topics	**Content**	**Notes for teachers**
(c) Sound		
wave nature of sound	• realise sound as an example of longitudinal waves • realise that sound can exhibit reflection, refraction, diffraction and interference • realise the need for a medium for sound transmission • compare the general properties of sound waves and those of light waves	• Interference pattern (change of loudness) in sound *is assumed* • Order of magnitude of speed of sound and light *is expected* • Phase method and stationary wave method to measure speed of sound *are not required* ☺ Pulse echo method could be used to estimate the speed of sound
audible frequency range	• determine the audible frequency range • examine the existence of ultrasound beyond the audible frequency range	
musical notes	• compare musical notes using pitch, loudness and quality • relate frequency and amplitude with the pitch and loudness of a note respectively	• Harmonics and overtones *are not required* • Quality of sound in terms of different shapes of waveform only
noise	• represent sound intensity level using the unit decibel • discuss the effects of noise pollution and the importance of acoustic protection	• Typical noise level in daily life *is required* • Noise pollution (very briefly) *is required* • The definition of sound intensity level *is not required* • Relationship between intensity level an*d amplitude is not required* • Curves of equal loudness *are not required* • *Qualitative* treatment of sound intensity level *only*

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SS Combined Science Curriculum (Physics Part) (for students taking 2016 and after 2016 HKDSE)

Electricity and Magnetism (32 hours)

Topics	Content	Notes for Teachers
(a) Electrostatics		
electric charges	• examine the evidence for two kinds of charges in nature • realise the attraction and repulsion between charges • interpret charging in terms of electron transfer	• Same treatment as in HKCEE • Concepts of conductor and insulator *are required* • Charging by sharing and induction *is required* • Gold-leaf electroscope could be used as an instrument to demonstrate the presence of electric charges.
electric field	• describe the electric field around a point charge and between parallel charged plates • represent an electric field using field lines	• Same treatment as in HKCEE • Point action *is not required* • Charge distributions on a metal sphere and parallel plates *are required*
(b) Circuits and domestic electricity		
electric current	• define electric current as the rate of flow of electric charges • state the convention for the direction of electric current	• Same treatment as in HKCEE
electrical energy and electromotive force	• describe the energy transformations in electric circuits • define the potential difference (p.d.) between two points in a circuit as the electric potential energy converted to other forms per unit charge passing between the points outside the source • define the electromotive force (e.m.f.) of a source as the energy imparted by the source per unit charge passing through it	• Same treatment as in HKCEE
resistance	• define resistance $R = \frac{V}{I}$ • describe the variation of current with applied p.d. in metal wires, electrolytes, filament lamps and diodes • realise Ohm's law as a special case of resistance behaviour • determine the factors affecting the resistance of a wire and define its resistivity $\rho = \frac{RA}{l}$ • describe the effect of temperature on resistance of metals and semiconductors	☺ Demonstration of the variation of current with applied p.d. in various conductors and circuit elements (metals, a filament bulb, electrolyte, thermistors and diodes) is encouraged

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SS Combined Science Curriculum (Physics Part) (for students taking 2016 and after 2016 HKDSE)

Topics	Content	Notes for Teachers
series and parallel circuits	• compare series and parallel circuits in terms of p.d. across the components of each circuit and the current through them • derive the resistance combinations in series and parallel $R = R_1 + R_2 + \ldots$ for resistors connected in series $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$ for resistors connected in parallel	• Quantitative problems involving simple parallel and series circuits *are required* • The concept of the conservation of charge and energy of a closed circuit *is required*
simple circuits	• measure *I*, *V* and *R* in simple circuits • assign the electrical potential of any earthed points as zero • compare the e.m.f. of a source and the terminal voltage across the source experimentally and relate the difference to the internal resistance of the source • explain the effects of resistance of ammeters and voltmeters on measurements • solve problems involving simple circuits	• The structure of ammeter and voltmeter, and operation principles are *not required* • Loading effect of ammeter and voltmeter on measurement *is required* • Concept of potential divider *is required* • Problems on converting a moving-coil meter by using a shunt or a multiplier *are not required* • Concept of internal resistance of a power supply (e.g. battery) *is required* ☺ Digital multimeter could be used to measure current (A), voltage (V) and resistance (Ω)
electrical power	• examine the heating effect when a current passes through a conductor • apply $P = VI$ to solve problems	• Same treatment as in HKCEE • Calculating the power rating and maximum possible current of an appliance is required • Applying $V = IR$ and $P = VI$ to solve problems is required
domestic electricity	• determine the power rating of electrical appliances • use kilowatt-hour (kWh) as a unit of electrical energy • calculate the costs of running various electrical appliances • understand household wiring and discuss safety aspects of domestic electricity • determine the operating current for electrical appliances • discuss the choice of power cables and fuses for electrical appliances based on the power rating	• Same treatment as in HKCEE • Understanding of household wiring and discussing safety aspects (e.g. live / neutral / earth wires) *are required* • Function of earth wire to prevent electric shock *is required* • The use of fuse and circuit breaker as a safety device *is required*, but detailed structure of them *is not required* • Ring circuit in domestic electricity *is required*
(c) Electromagnetism		
magnetic force and magnetic field	• realise the attraction and repulsion between magnetic poles • examine the magnetic field in the region around a magnet	☺ Plotting compass, hall probe, current balance and search coil could be used to examine magnetic field

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Topics	Content	Notes for Teachers
	• describe the behaviour of a compass in a magnetic field • represent magnetic field using field lines	
magnetic effect of electric current	• realise the existence of a magnetic field due to moving charges or electric currents • examine the magnetic field patterns associated with currents through a long straight wire, a circular coil and a long solenoid • examine the factors affecting the strength of an electromagnet	
current-carrying conductor in magnetic field	• examine the existence of a force on a current-carrying conductor in a magnetic field and determine the relative directions of force, field and current • determine the factors affecting the force on a straight current-carrying wire in a magnetic field • describe the structure of a simple d.c. motor and how it works	• *Qualitative treatment* of the force between currents in long straight parallel conductors *is required* • Principles of design / structure and operation of a moving-coil galvanometer are *not required* • Relative directions of force, field and current *is required*
electromagnetic induction	• examine induced e.m.f. resulting from a moving conductor in a steady magnetic field or a stationary conductor in a changing magnetic field • apply Lenz's law to determine the direction of induced e.m.f./current • describe the structures of simple d.c. and a.c. generators and how they work • discuss the occurrence and practical uses of eddy currents	☺ Using CRO as a meter / detector in practical work is encouraged. The detailed structure of CRO *is not required* ☺ Using induction cooking as an example of practical uses of eddy currents is encouraged
transformer	• describe the structure of a simple transformer and how it works • relate the voltage ratio to turn ratio by $\frac{V_p}{V_s}=\frac{N_p}{N_s}$ and apply it solve problems • examine methods for improving the efficiency of a transformer	• Same treatment as in HKCEE • Ohmic loss and eddy current loss are *required*
high voltage transmission of electrical energy	• discuss the advantages of transmission of electrical energy with a.c. at high voltages • describe various stages of stepping up and down of the voltage in a grid system for power transmission	• Same treatment as in HKCEE

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