IGCSE Physics Addendum to Syllabus

This document gives additional information and support about Papers 5 and 6, The practical and alternative to practical.
It consists of three sections:

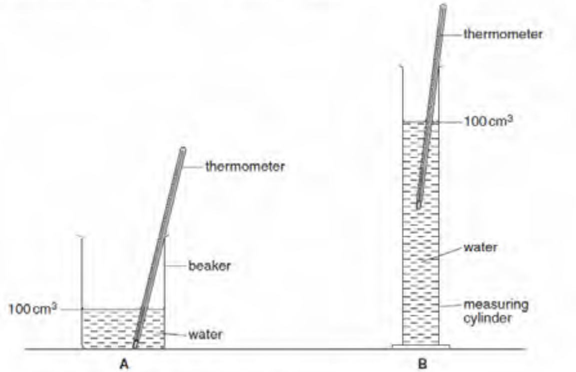
1. **Amplification of the curriculum aims supplied in the syllabus, with examples**
2. **A list of Opportunities for Practical Activities mapped to curriculum aims**
3. **A list of apparatus that would typically be needed to cover the curriculum aims in the syllabus**

Part 1: Amplification of the information supplied in the syllabus

Paper 5: Practical test

Practical skills students are expected to develop

Curriculum aim	Explanation	Task	Example	Mark scheme
follow written instructions for the assembly and use of provided apparatus: for example, for using ray tracing equipment, or for wiring up simple electrical circuit	The experiments are not ‘standard’ experiments (although they are based on work that the students should have carried out during the course), so full instructions are given.	Following written instructions for the use of apparatus	Refer to any past examination paper (0625/05)	
select, from given items, the measuring device suitable for the task give reasons for choosing particular items of apparatus	For example a student is expected to know where and how, in a circuit, to connect an ammeter or a voltmeter and to know the use of each one.	Use of ammeter and voltmeter in a circuit	Draw a circuit diagram of the circuit that has been set up for you. Use standard circuit symbols. (The circuit includes two identical resistance wires **AB** and **CD**) Use the standard symbol for a resistance to represent each of these wires).	Diagram: correct symbols for ammeter and voltmeter [1] correct symbol for resistor [1] correct circuit arrangement [1]
draw, complete and/or label diagrams of apparatus	Students are expected to be able to explain the details of a technique using a well labelled diagram	Drawing a diagram	Example: Draw a labelled diagram to show how you used the blocks of wood and the rule to find, as accurately as possible, a value for the external diameter of the test-tube.	diagram showing method, blocks correctly positioned either side of tube and rule shown (‘rule’ that is the same length as the gap between the blocks scores no mark) [1]

Curriculum aim	Explanation	Task	Example	Mark scheme
carry out the specified manipulation of the apparatus, for example: • when determining a (derived) quantity such as the extension per unit load for a spring • when testing/identifying the relationship between two variables, such as between the p.d. across a wire and its length • when comparing physical quantities such as the thermal capacity of two metals	Students are expected to use their practical experience to follow the instructions, take due care and record readings as accurately as possible as they have been taught to do during the course	Carrying out the specified manipulation	In this experiment you are to investigate the effect of surface area exposed to the air on the rate of cooling of hot water. Carry out the following instructions, referring to Fig. 3.1.  **Fig. 3.1** You are provided with two containers labelled **A** (a beaker) and **B** (a measuring cylinder). You also have a supply of hot water. **(a)** (i) Pour 100 cm^3 of hot water into container **A**. (ii) Measure the temperature θ of the hot water. Record this temperature in Table 3.1 (on page 8) for time t = 0 s.	Table: container A complete temp records descending [1] container B complete temp records descending [1] temps to nearest 1 °C or better [1]

			(iii) Start the stopwatch and then record the temperature of the water at 30 s intervals for a total of four minutes.	

Table 3.1

t/s	container **A** (beaker) θ/°C	container **B** (measuring cylinder) θ/°C
0		
30		
60		
90		
120		
150		
180		
210		
240		

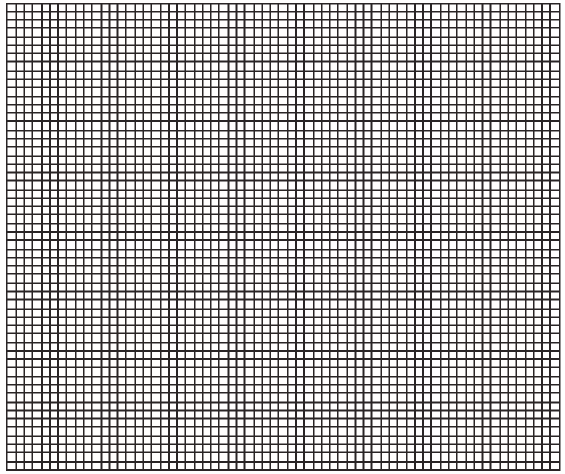
[3]

(iv) Pour 100 cm^3 of hot water into container **B**.

(v) Repeat steps **(ii)** and **(iii)**.

Curriculum aim	Explanation	Task	Example	Mark scheme
• take readings from a measuring device, including: – reading a scale with appropriate precision/accuracy – making consistent use of significant figures – use of appropriate units – interpolating between scale divisions – allowing for zero errors, where appropriate	Students are expected to be able to read a scale accurately and to record readings to a consistent number of significant figures for a particular instrument. They should be familiar with the instruments so that they are confident about what one division on the scale represents and can interpolate between divisions	Taking readings from a measuring device	Measure and record the distance *a* from the 50.0 cm mark (centre) of the rule to the pivot and the distance *b* from the centre of the mass to the pivot.	a + b = 38 – 42 cm [1] b > a [1] both in m, cm or mm, with unit [1]
• take repeated measurements to obtain an average value	Students are expected to do this when instructed or to suggest this as a technique to improve reliability when appropriate.	Taking repeated measurements	Remove the lens from its holder. By placing the lens on the metre rule, determine an average value for the diameter *d* of the lens. Record your readings in the space below.	More than one value shown [1] Correct method of finding average shown [1] *d* value 4 – 6 cm [1]

Curriculum aim	Explanation	Task	Example	Mark scheme
record their observations systematically, with appropriate units	Students are expected to record readings in a suitable table using correct units	Recording observations	**(b) (i)** Measure and record in Table 3.1 the temperature θ of the hot water. **(ii)** Pour 20 cm^3 of the water at room temperature into the measuring cylinder and then transfer this water to the beaker containing the hot water. Stir, then measure and record in Table 3.1 the temperature θ of the mixture of hot and room temperature water. Record in Table 3.1 the total volume V of room temperature water added. **(iii)** Repeat step **(ii)** four times until you have added a total of 100 cm^3 of room temperature water. **(iv)** Complete the column headings in the table. **Table 3.1** V/ | θ/ 0 | [3]	Table θ in °C, V in cm^3 [1] 6 sets of readings with correct V 0, 20, 40, 60, 80, 100 [1] Temps decreasing [1]
process their data as required	Students are expected to process data but any equations to be used are given in the question	Processing data	Calculate the focal length f of the lens using the equation $f = \frac{xy}{d}$.	correct arithmetic for f [1] f to 2/3 significant figures with correct unit [1]

Curriculum aim	Explanation	Task	Example	Mark scheme
• present their data graphically, using suitable axes and scales (appropriately labelled) and plotting the points accurately	Students are expected to plot graphs using readings obtained and draw a well judged, neat, thin line. The line can be a straight line (which must be drawn with a ruler) or a curve	Drawing a graph	Use the data in the table to plot a graph of temperature (*y*-axis) against volume (*x*-axis). Draw the best-fit curve.  [4]	Graph: axes labelled [1] axes suitable (e.g. not '3' scale) and plots occupy more than ½ grid [1] all plots correct (better than ½ sq) [1] well judged, thin best fit line [1]
• take readings from a graph by interpolation and extrapolation	Students are expected to take readings from a graph with the same accuracy as the plotting	Taking a reading from a graph	Use the graph to determine the number of paper clips that have the same mass as the nail. Show your working and give your answer to 1 decimal place.	calculation of d correct [1] correct reading from graph to ½ square and to 1dp [1]

Curriculum aim	Explanation	Task	Example	Mark scheme
determine a gradient, intercept or intersection on a graph	Students are expected to determine the gradient of a straight line graph using the triangle method and taking the readings from the line with the same accuracy as the plotting	Determining a gradient	Determine the gradient *G* of the graph.	triangle method using at least ½ line [1] correct G value [1
draw and report a conclusion or result clearly	Students are expected to report a conclusion from their graph or to comment on the validity of a suggested conclusion. Students are expected to make sensible estimates of quantities.	Reporting a conclusion	Within the limits of experimental accuracy, what do you conclude about the variation of resistance with distance along the wire? Justify your conclusion by reference to your graph. Statement .... Justification	

Curriculum aim	Explanation	Task	Example	Mark scheme
describe precautions taken in carrying out a procedure	Students are expected to briefly describe relevant precautions for an experiment to improve accuracy	Describing precautions	State and briefly explain one precaution you took in order to obtain reliable measurements. Statement... .... Explanation...	Any one statement (1) with matching explanation (1) from: use of darkened room; to see image clearly (1 + 1) slowly moving screen back and forth; to get clear image (1 + 1) clamp rule or place on bench; to obtain accurate distance measurements (1 + 1) avoid parallax; looking perpendicularly at rule (1 + 1) lining up of object and lens; to obtain clear image (1 + 1) mark centre of lens on block; to obtain accurate distance measurement (1 + 1) ensure lens vertical; to obtain clear image (1 + 1) object and lens same height from bench; to obtain clear image (1 + 1) [2]

Curriculum aim	Explanation	Task	Example	Mark scheme
explain and/or comment critically on described procedures or points of practical detail	Students are expected to carefully consider the procedure and comment on details, in particular the control of variables	Commenting on procedures	To make a fair comparison between the rates of cooling of the two thermometer bulbs under different conditions (in this experiment one thermometer bulb is covered with cotton wool) it is important to control other experimental conditions. Suggest two conditions that should be controlled in this experiment. 1... .... 2...	Any two from:same starting temperature constant room temperature carry out at same time same thermometer (words to that effect) same thermometer positions same time intervals [2]
comment on a procedure used in an experiment and suggest an improvement	Students are expected to carefully consider the procedure and comment on possible improvements.	Commenting on improvements	Example: During this experiment some heat is lost from the hot water to the surroundings. Also the room temperature water is added at random times and in quite large volumes each time. Suggest two improvements you could make to the procedure, that would show more accurately the pattern of temperature change of the hot water, due to addition of room temperature water alone, excluding other factors. 1... 2...	Mark Scheme: 1. sensible comment about heat loss to the surroundings, e.g. use of insulation/lid [1] 2. sensible comment about adding water in a regulated, timed flow [1]
plan an investigation, including suggesting suitable techniques and apparatus	Students are expected to carry out investigations during the course. In the examination some elements of the skills acquired are tested. These are all covered in the descriptions and examples above			

Paper 6: Alternative to Practical

This paper is based on the Practical Paper. Students are expected to have carried out practical work during the course in exactly the same way as those sitting the Practical Paper. Thus, with very few differences, the same skills are tested.
In the Alternative to Practical Paper, since laboratory equipment is not available, the experiments are described and students will be given readings in a table. They may be asked to take measurements from diagrams on the paper (using a ruler or protractor). They may be asked to draw a circuit diagram using conventional symbols. This may be from a circuit shown on the paper in pictorial form. In all other respects the skills tested are the same and details are given in the advice on the Practical Paper.

IGCSE Physics Addendum to Syllabus

Part 2: IGCSE PHYSICS (0625) Opportunities for Practical Activities

Opportunities for Practical Activities	
Syllabus reference	Practical Activity
1.1 Length and time **Core** • Use and describe the use of rules and measuring cylinders to calculate a length or a volume • Use and describe the use of clocks and devices for measuring an interval of time **Supplement** • Use and describe the use of a mechanicalmethod for the measurement of a small distance • Measure and describe how to measure a short interval of time (including the period of a pendulum)	This section will be covered practically during the course. Investigation of a pendulum provides opportunity for an investigative practical. The diameter of the pendulum bob could be measured with a micrometer as part of the investigation, covering the use of a mechanical method for measurement of a small distance.

1.2 Speed, velocity and acceleration
Core
• Define speed and calculate speed from total distance/total time
• Plot and interpret a speed/time graph or a distance/time graph
• Recognise from the shape of a speed/time graph when a body is
  o at rest
  o moving with constant speed
  o moving with changing speed
• Calculate the area under a speed/time graph to work out the distance travelled for motion with constant acceleration
• Demonstrate some understanding that acceleration is related to changing speed
• State that the acceleration of free fall for a body near to the Earth is constant
•
	Many opportunities to use apparatus such as dynamics trolleys. Graph plotting skills can be included.
	Students aiming for the Extended Paper can use (or see demonstrated) a free fall apparatus to determine the acceleration of free fall *g*.
	An investigation of freely falling bodies (including model parachutes) can be carried out to illustrate the concept of terminal velocity.

Syllabus reference	Practical Activity
Supplement • Distinguish between speed and velocity • Recognise linear motion for which the acceleration is constant and calculate the • acceleration • Recognise motion for which the acceleration is not constant Describe qualitatively the motion of bodies falling in a uniform gravitational field with and without air resistance (including reference to terminal velocity)	
1.3 Mass and weight **Core** • Show familiarity with the idea of the mass of a body • State that weight is a force • Demonstrate understanding that weights (and hence masses) may be compared using a balance **Supplement** • Demonstrate an understanding that mass is a property that 'resists' change in motion • Describe, and use the concept of, weight as the effect of a gravitational field on a mass	Students should become familiar with mass and weight as they carry out a number of experiments during the course.
1.4 Density **Core** • Describe an experiment to determine the density of a liquid and of a regularly shaped solid and make the necessary calculation **Supplement** • Describe the determination of the density of an irregularly shaped solid by the method of displacement, and make the necessary calculation	Opportunity here to use the displacement method to find density in addition to mass and volume determinations for regularly shaped solids and for liquids. The approximate density of a pupil can be determined by knowing the mass and calculating volume by regarding the body as made up of a number of cylinders with a sphere on top. **Note** that specific experiments are part of the syllabus here.

Syllabus reference	Practical Activity
1.5 Forces 1.5 (a) Effects of forces **Core** • State that a force may produce a change in size and shape of a body • Plot extension/load graphs and describe the associated experimental procedure • Describe the ways in which a force may change the motion of a body • Find the resultant of two or more forces acting along the same line **Supplement** • Interpret extension/load graphs • State Hooke's Law and recall and use the expression $F = k x$ • Recognise the significance of the term 'limit of proportionality' for an extension/load graph • Recall and use the relation between force, mass and acceleration (including the direction) • Describe qualitatively motion in a curved path due to a perpendicular force ($F = mv^2/r$ is *not* required)	Opportunities for stretching spring type class experiments. **Note** that a specific experiment is part of the syllabus here. A standard 'expendable' steel spring can be used and 'follow-up' experiment with a homemade copper spring (wind about 1m of 26swg bare copper wire around a pencil to make the spring) to show the effect when the elastic limit is exceeded. Plenty of opportunities here for practising graph skills. A collection of elastic bands can be used to follow this work with an investigation (effects of length, thickness of elastic band on extension produced by loads). Opportunities for class experiments and demonstrations of circular motion.
1.5 (b) Turning effect **Core** • Describe the moment of a force as a measure of its turning effect and give everyday examples • Describe qualitatively the balancing of a beam about a pivot **Supplement** • Perform and describe an experiment (involving vertical forces) to show that there is no net moment on a body in equilibrium • Apply the idea of opposing moments to simple systems in equilibrium	**Note** that a specific experiment is part of the syllabus here. There is a variety of class experiments that can be done illustrate the Law of Moments with good opportunities to practise recording skills and drawing conclusions.
1.5 (c) Conditions for equilibrium **Core** • State that, when there is no resultant force and no resultant turning effect, a system is in equilibrium	

Syllabus reference	Practical Activity
1.5 (e) Scalars and vectors **Supplement** • Demonstrate an understanding of the difference between scalars and vectors and give common examples • Add vectors by graphical representation to determine a resultant • Determine graphically the resultant of two vectors	
1.6 Energy, work and power 1.6 (a) Energy **Core** • Demonstrate an understanding that an object may have energy due to its motion or its position, and that energy may be transferred and stored • Give examples of energy in different forms, including kinetic, gravitational, chemical, strain, nuclear, internal, electrical, light and sound • Give examples of the conversion of energy from one form to another, and of its transfer from one place to another • Apply the principle of energy conservation to simple examples **Supplement** • Recall and use the expressions k.e. = $\frac{1}{2} mv^2$ and p.e. = mgh	Toy cars on flexible tracks can be used to show the conversion of gravitational potential energy to kinetic energy.

Syllabus reference	Practical Activity
1.6 (b) Energy resources **Core** • Distinguish between renewable and non-renewable sources of energy • Describe how electricity or other useful forms of energy may be obtained from: o chemical energy stored in fuel o water, including the energy stored in waves, in tides, and in water behind hydroelectric dams o geothermal resources o nuclear fission o heat and light from the Sun (solar cells and panels) • Give advantages and disadvantages of each method in terms of cost, reliability, scale and environmental impact • Show a qualitative understanding of efficiency **Supplement** • Show an understanding that energy is released by nuclear fusion in the Sun • Recall and use the equation: $\text{efficiency} = \frac{\text{useful energy output}}{\text{energy input}} \times 100\%$	
1.6 (c) Work **Core** • Relate (without calculation) work done to the magnitude of a force and the distance moved **Supplement** • Describe energy changes in terms of work done • Recall and use $\Delta W = Fd = \Delta E$	Opportunity for simple, quick class experiments measuring forces required to move objects over measured distances.
1.6 (d) Power **Core** • Relate (without calculation) power to work done and time taken, using appropriate examples **Supplement** • Recall and use the equation $P = E/t$ in simple systems	Opportunity for class experiments involving students calculating personal power.

Syllabus reference	Practical Activity
1.7 Pressure **Core** • Relate (without calculation) pressure to force and area, using appropriate examples • Describe the simple mercury barometer and its use in measuring atmospheric pressure • Relate (without calculation) the pressure beneath a liquid surface to depth and to density, using appropriate examples • Use and describe the use of a manometer • Recall and use the equation $p = F/A$ • Recall and use the equation $p = h\rho g$	Opportunity for class experiment in which students determine the pressure on the floor due to their own weight. Simple manometers can be used. Opportunity for demonstration experiments to show pressure in a liquid increases with depth and pressure in a liquid acts in all directions.
2.1 Simple kinetic molecular model of matter 2.1 (a) States of matter **Core** • State the distinguishing properties of solids, liquids and gases	
2.1 (b) Molecular model **Core** • Describe qualitatively the molecular structure of solids, liquids and gases • Interpret the temperature of a gas in terms of the motion of its molecules • Describe qualitatively the pressure of a gas in terms of the motion of its molecules • Describe qualitatively the effect of a change of temperature on the pressure of a gas at constant volume • Show an understanding of the random motion of particles in a suspension as evidence for the kinetic molecular model of matter • Describe this motion (sometimes known as Brownian motion) in terms of random molecular bombardment **Supplement** • Relate the properties of solids, liquids and gases to the forces and distances between molecules and to the motion of the molecules • Show an appreciation that massive particles may be moved by light, fast-moving molecules	Brownian Motion experiment (e.g. using smoke cells viewed under a microscope. Opportunity to use students themselves to model the behaviour of atoms and molecules.

Syllabus reference	Practical Activity
2.2 Thermal properties 2.2 (a) Thermal expansion of solids, liquids and gases **Core** Describe qualitatively the thermal expansion of solids, liquids and gases • Identify and explain some of the everyday applications and consequences of thermal expansion • Describe qualitatively the effect of a change of temperature on the volume of a gas at constant pressure **Supplement** • Show an appreciation of the relative order of magnitude of the expansion of solids, liquids and gases	Opportunity for demonstration experiments to show expansion of a metal rod and the force of expansion (bar-breaker experiment). Also the expansion of a liquid (water) using a round-bottom flask and tube (model thermometer) and the expansion of a gas (air) using the 'fountain' experiment.
2.2 (b) Measurement of temperature **Core** • Appreciate how a physical property that varies with temperature may be used for the measurement of temperature, and state examples of such properties • Recognise the need for and identify fixed points • Describe the structure and action of liquid-in-glass thermometers **Supplement** • Demonstrate understanding of sensitivity, range and linearity • Describe the structure of a thermocouple and show understanding of its use for measuring high temperatures and those that vary rapidly	Opportunity for heating and cooling curve experiments giving graph plotting practice and possible investigation activities.

Syllabus reference	Practical Activity
2.2 (c) Thermal capacity **Core** • Relate a rise in the temperature of a body to an increase in internal energy • Show an understanding of the term thermal capacity **Supplement** • Describe an experiment to measure the specific heat capacity of a substance	**Note** that a specific experiment is part of the syllabus here. Class experiment to determine specific heat capacity (or, if necessary a demonstration experiment).
2.2 (d) Melting and boiling **Core** • Describe melting and boiling in terms of energy input without a change in temperature • State the meaning of melting point and boiling point • Describe condensation and solidification **Supplement** • Distinguish between boiling and evaporation • Use the terms latent heat of vaporisation and latent heat of fusion and give a molecular interpretation of latent heat • Describe an experiment to measure specific latent heats for steam and for ice	**Note** that a specific experiment is part of the syllabus here. Class or demonstration experiments to determine the specific latent heats for steam and for ice. Opportunity for class experiment to investigate cooling curve for stearic acid (melting point around 60^{o}C) as it solidifies.
2.3 Transfer of thermal energy 2.3 (a) Conduction **Core** • Describe experiments to demonstrate the properties of good and bad conductors of heat **Supplement** • Give a simple molecular account of heat transfer in solids	**Note** that specific experiments are part of the syllabus here. Class and demonstration experiments to demonstrate the properties of good and bad conductors of heat.
2.3 (b) Convection **Core** • Relate convection in fluids to density changes and describe experiments to illustrate convection	**Note** that specific experiments are part of the syllabus here. Class and demonstration experiments to illustrate convection in liquids (water) and gases (air).

Syllabus reference	Practical Activity
2.3 (c) Radiation **Core** • Identify infra-red radiation as part of the electromagnetic spectrum **Supplement** • Describe experiments to show the properties of good and bad emitters and good and bad absorbers of infra-red radiation	**Note** that specific experiments are part of the syllabus here. Class and demonstration experiments to demonstrate the properties of good and bad absorbers and emitters of infra-red radiation.
2.3 (d) Consequences of energy transfer **Core** • Identify and explain some of the everyday applications and consequences of conduction, convection and radiation	

Syllabus reference	Practical Activity

3. Properties of waves, including light and sound
3.1 General wave properties
 	
Core
• Describe what is meant by wave motion as illustrated by vibration in ropes and springs and by experiments using water waves
• Use the term wavefront
• Give the meaning of speed, frequency, wavelength and amplitude
• Distinguish between transverse and longitudinal waves and give suitable examples
• Describe the use of water waves to show:
  o reflection at a plane surface
  o refraction due to a change of speed
  o diffraction produced by wide and narrow gaps
 	
Supplement
• Recall and use the equation $v = f \lambda$
• Interpret reflection, refraction and diffraction using wave theory
	Opportunity for class and demonstration experiments to illustrate wave motion using 'Slinky' springs, ropes, etc.
	Note that a specific experiment is part of the syllabus here.
	A ripple tank can be used to show reflection, refraction and diffraction of water waves.

Syllabus reference	Practical Activity
3.2 Light 3.2 (a) Reflection of light **Core** • Describe the formation, and give the characteristics, of an optical image by a plane mirror • Use the law angle of incidence = angle of reflection **Supplement** • Perform simple constructions, measurements and calculations	Opportunity for class experiments using optics pins and ray boxes to show the position of an image in a plane mirror and the law of reflection.
3.2 (b) Refraction of light **Core** • Describe an experimental demonstration of the refraction of light • Use the terminology for the angle of incidence *i* and angle of refraction *r* and describe the passage of light through parallel-sided transparent material • Give the meaning of critical angle • Describe internal and total internal reflection **Supplement** • Recall and use the definition of refractive index *n* in terms of speed • Recall and use the equation $\sin i / \sin r = n$ • Describe the action of optical fibres particularly in medicine and communications technology	**Note** that a specific experiment is part of the syllabus here. Opportunity for class experiments using optics pins and ray boxes with rectangular and semicircular Perspex blocks to show refraction, critical angle and total internal reflection.

Syllabus reference	Practical Activity
3.2 (c) Thin converging lens **Core** • Describe the action of a thin converging lens on a beam of light • Use the term principal focus and focal length • Draw ray diagrams to illustrate the formation of a real image by a single lens **Supplement** • Draw ray diagrams to illustrate the formation of a virtual image by a single lens Use and describe the use of a single lens as a magnifying glass	Opportunity for class experiments using converging lenses.
3.2 (d) Dispersion of light **Core** • Give a qualitative account of the dispersion of light as shown by the action on light of a glass prism	Opportunity for class or demonstration experiments to show dispersion of white light using a glass or Perspex prism.
3.2 (e) Electromagnetic spectrum **Core** • Describe the main features of the electromagnetic spectrum and state that all e.m. waves travel with the same high speed *in vacuo* • Describe the role of electromagnetic waves in: o radio and television communications (radio o waves) o satellite television and telephones o (microwaves) o electrical appliances, remote controllers for televisions and intruder alarms (infrared) o medicine and security (X-rays) • Demonstrate an awareness of safety issues regarding the use of microwaves and X-rays **Supplement** • State the approximate value of the speed of electro-magnetic waves • Use the term monochromatic	

Syllabus reference	Practical Activity
3.3 Sound **Core** • Describe the production of sound by vibrating sources • Describe the longitudinal nature of sound waves • State the approximate range of audible frequencies • Show an understanding that a medium is needed to transmit sound waves • Describe an experiment to determine the speed of sound in air • Relate the loudness and pitch of sound waves to amplitude and frequency Describe how the reflection of sound may produce an echo **Supplement** • Describe compression and rarefaction • State the order of magnitude of the speed of sound in air, liquids and solids	Opportunity for class experiments using a variety of musical instruments, tuning forks, etc. to describe the production of sound by vibrating sources. **Note** that a specific experiment is part of the syllabus here. A simple experiment to determine the speed of sound in air involving timing the delay between seeing a sound being produced and hearing it a significant distance away or a similar method using the echo from a large building is appropriate here.

Syllabus reference	Practical Activity
4. Electricity and magnetism 4.1 Simple phenomena of magnetism **Core** • State the properties of magnets • Give an account of induced magnetism • Distinguish between ferrous and non-ferrous materials • Describe methods of magnetisation and of demagnetisation • Describe an experiment to identify the pattern of field lines round a bar magnet • Distinguish between the magnetic properties of iron and steel • Distinguish between the design and use of permanent magnets and electromagnets	**Note** that a specific experiment is part of the syllabus here. Opportunity for class experiments using magnets, iron filings and plotting compasses. Opportunity for class experiments using iron cores and lengths of wire to make and investigate electromagnets.
4.2 Electrical quantities 4.2 (a) Electric charge **Core** • Describe simple experiments to show the production and detection of electrostatic charges • State that there are positive and negative charges • State that unlike charges attract and that like charges repel • Describe an electric field as a region in which an electric charge experiences a force • Distinguish between electrical conductors and insulators and give typical examples **Supplement** • State that charge is measured in coulombs • State the direction of lines of force and describe simple field patterns, including the field around a point charge and the field between two parallel plates • Give an account of charging by induction • Recall and use the simple electron model to distinguish between conductors and insulators	**Note** that specific experiments are part of the syllabus here. Class and demonstration experiments to show the production, detection and properties of electrostatic charges using cellulose acetate and polythene rods with dusters and (if available) a Van der Graaf generator.

<table>
<tr><th>Syllabus reference</th><th>Practical Activity</th></tr>
<tr><td>4.2 (b) Current
Core
• State that current is related to the flow of charge
• Use and describe the use of an ammeter
Supplement
• Show understanding that a current is a rate of flow of charge and recall and use the equation $I = Q / t$
• Distinguish between the direction of flow of electrons and conventional current</td><td>Opportunity for class experiments using simple circuits with an ammeter.</td></tr>
<tr><td>4.2 (c) Electro-motive force
Core
• State that the e.m.f. of a source of electrical energy is measured in volts
Supplement
• Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit</td><td></td></tr>
<tr><td>4.2 (d) Potential difference
Core
• State that the potential difference across a circuit component is measured in volts
• Use and describe the use of a voltmeter</td><td>Opportunity for class experiments using simple circuits with a volt.</td></tr>
<tr><td>4.2 (e) Resistance
Core
• State that resistance = p.d./current and understand qualitatively how changes in p.d. or resistance affect current
• Recall and use the equation $R = V/I$
• Describe an experiment to determine resistance using a voltmeter and an ammeter
• Relate (without calculation) the resistance of a wire to its length and to its diameter
Supplement
• Recall and use quantitatively the proportionality between resistance and length, and the inverse proportionality between resistance and cross-sectional area of a wire</td><td>Note that a specific experiment is part of the syllabus here.
Class experiment to determine resistance
using a voltmeter and an ammeter
Opportunity for class investigation style experiments to relate the resistance of a wire to its length and cross-sectional area.</td></tr>
</table>

Syllabus reference	Practical Activity
4.2 (f) Electrical energy **Supplement** Recall and use the equations *P* =*IV* and *E* = *IVt*	
4.3 Electric circuits 4.3 (a) Circuit diagrams **Core** • Draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), lamps, ammeters voltmeters, magnetising coils, transformers, bells, fuses and relays **Supplement** • Draw and interpret circuit diagrams containing diodes and transistors	
4.3 (b) Series and parallel circuits **Core** • Understand that the current at every point in a series circuit is the same • Give the combined resistance of two or more resistors in series • State that, for a parallel circuit, the current from the source is larger than the current in each branch • State that the combined resistance of two resistors in parallel is less than that of either resistor by itself • State the advantages of connecting lamps in parallel in a lighting circuit **Supplement** • Recall and use the fact that the sum of the p.d.s across the components in a series circuit is equal to the total p.d. across the supply • Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit • Calculate the effective resistance of two resistors in parallel	Opportunity for class experiments using series and parallel circuits with ammeters, voltmeters and other components (lamps, variable resistors etc).

Syllabus reference	Practical Activity
4.3 (c) Action and use of circuit components **Core** • Describe the action of a variable potential divider (potentiometer) • Describe the action of thermistors and light-dependent resistors and show understanding of their use as input transducers • Describe the action of a capacitor as an energy store and show understanding of its use in time-delay circuits • Describe the action of a relay and show understanding of its use in switching circuits **Supplement** • Describe the action of a diode and show understanding of its use as a rectifier • Describe the action of a transistor as an electrically operated switch and show understanding of its use in switching circuits • Recognise and show understanding of circuits operating as light sensitive switches and temperature-operated alarms (using a relay or a transistor)	Opportunity for a variety of class experiments using circuits with potential dividers, thermistors, capacitors, relays, diodes, light-dependent resistors, transistors etc.
4.3 (d) Digital electronics **Supplement** • Explain and use the terms digital and • analogue • State that logic gates are circuits containing transistors and other components • Describe the action of NOT, AND, OR, NAND and NOR gates • Design and understand simple digital circuits combining several logic gates • State and use the symbols for logic gates (candidates should use the American ANSI#Y 32.14 symbols)	Opportunity for a variety of class experiments using logic gates.

Syllabus reference	Practical Activity
4.4 Dangers of electricity **Core** • state the hazards of o damaged insulation o overheating of cables o damp conditions • Show an understanding of the use of fuses and circuit-breakers	Opportunity for class or demonstration experiments to show the action of a fuse.
4.5 Electromagnetic effects 4.5 (a) Electromagnetic induction **Core** • Describe an experiment that shows that a changing magnetic field can induce an e.m.f. in a circuit **Supplement** • State the factors affecting the magnitude of an induced e.m.f. • Show understanding that the direction of an induced e.m.f. opposes the change causing it	**Note** that a specific experiment is part of the syllabus here. Class or demonstration experiment using a coil, sensitive meter and a magnet to show that a changing magnetic field can induce an e.m.f. in a circuit.
4.5 (b) a.c. generator **Core** • Describe a rotating-coil generator and the use of slip rings • Sketch a graph of voltage output against time for a simple a.c. generator	

Syllabus reference	Practical Activity
4.5 (c) Transformer **Core** • Describe the construction of a basic iron-cored transformer as used for voltage transformations • Recall and use the equation (V_p /V_s) = (N_p /N_s) • Describe the use of the transformer in high-voltage transmission of electricity • Give the advantages of high-voltage transmission **Supplement** • Describe the principle of operation of a • transformer • Recall and use the equation $V_p I_p = V_s I_s$ (for 100% efficiency) • Explain why energy losses in cables are lower when the voltage is high	Opportunity for a demonstration experiment using a ‘demountable transformer’ kit (if available).
4.5 (d) The magnetic effect of a current **Core** • Describe the pattern of the magnetic field due to currents in straight wires and in solenoids • Describe applications of the magnetic effect of current, including the action of a relay **Supplement** • State the qualitative variation of the strength of the magnetic field over salient parts of the pattern • Describe the effect on the magnetic field of changing the magnitude and direction of the current	Opportunity for class and demonstration experiments to show the pattern of the magnetic field due to the current in straight wires and solenoids using iron filings and plotting compasses.

Syllabus reference	Practical Activity
4.5 (e) Force on a current-carrying conductor **Core** • Describe an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing: (i) the current (ii) the direction of the field **Supplement** • Describe an experiment to show the corresponding force on beams of charged particles • State and use the relative directions of force, field and current	**Note** that specific experiments are part of the syllabus here. The 'catapult' experiment or similar to show that a force acts on a current-carrying conductor in a magnetic field. Demonstration experiment to show the force on beams of charged particles using a 'Teltron' tube.
4.5 (f) d.c. motor **Core** • State that a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by increasing the number of turns on the coil • Relate this turning effect to the action of an electric motor **Supplement** • Describe the effect of increasing the current	Opportunity for class experiments where students make electric motors using simple d.c. motor kits.
4.6 Cathode-ray oscilloscopes 4.6 (a) Cathode rays **Core** • Describe the production and detection of cathode rays • Describe their deflection in electric fields • State that the particles emitted in thermionic emission are electrons	
4.6 (b) Simple treatment of cathode-ray oscilloscope **Supplement** • Describe (in outline) the basic structure and action of a cathode-ray oscilloscope (detailed circuits are **not** required) • Use and describe the use of a cathode-ray oscilloscope to display waveforms	Opportunity to demonstrate a cathode-ray oscilloscope.

Syllabus reference	Practical Activity
5. Atomic physics 5.1 Radioactivity 5.1 (a) Detection of radioactivity **Core** • Show awareness of the existence of background radiation • Describe the detection of α-particles, β –particles and γ -rays (β + are not included: β -particles will be taken to refer to β –)	

5.1 (b) Characteristics of the three kinds of emission
Core
• State that radioactive emissions occur randomly over space and time
• State, for radioactive emissions:
  o their nature
  o their relative ionising effects
  o their relative penetrating abilities
• Describe their deflection in electric fields and magnetic fields
• Interpret their relative ionising effects
	Opportunity for demonstration experiments using a Geiger counter, radioactive sources and absorbers (if available).

5.1 (c) Radioactive decay **Core** • State the meaning of radioactive decay, using equations (involving words or symbols) to represent changes in the composition of the nucleus when particles are emitted	
5.1 (d) Half-life **Core** • Use the term half-life in simple calculations, which might involve information in tables or decay curves	Opportunity for a class simulation experiment using coins, dice or small cubes to produce a graph showing half-life characteristics.
5.1 (e) Safety precautions **Core** • Describe how radioactive materials are handled, used and stored in a safe way	

Syllabus reference	Practical Activity
5.2 The nuclear atom 5.2 (a) Atomic model **Core** • Describe the structure of an atom in terms of a nucleus and electrons **Supplement** • Describe how the scattering of α-particles by thin metal foils provides evidence for the nuclear atom	
5.2 (b) Nucleus **Core** • Describe the composition of the nucleus in terms of protons and neutrons • Use the term proton number *Z* • Use the term nucleon number *A* • Use the term nuclide and use the nuclide notation *X*	
5.2 (c) Isotopes **Supplement** • Use the term isotope • Give and explain examples of practical applications of isotopes	

IGCSE Physics Addendum to Syllabus

Part 3 : Apparatus Lists

There are two sections in this document:

1. A list of general apparatus that is expected to be available in a School Science Laboratory. The apparatus specified for each Practical Examination (0625/5) is simple and basic (so much of it is covered in List 1). This is because large Centres need to be able to provide many sets of the same apparatus. This list must therefore NOT be taken as list of apparatus required in order to teach the course satisfactorily. A considerably larger range of apparatus is required for teaching purposes as shown in List 2.

2. A list of apparatus (additional to that in List 1) that is typically used when teaching the IGCSE Physics course (0625).

No quantities are suggested in the lists as this will depend on local requirements according to class sizes and the number of classes to be taught.

1. General Laboratory Apparatus

Bathroom scales
Bunsen burner
Clamp, stand and boss
Kettle
Metre rule, graduated in mm. Half-metre rule, graduated in mm. 30cm rule, graduated in mm
Microscope
Thermometer, $-10^{o}C$ – $110^{o}C$ with a minimum precision of $1^{o}C$

Glassware:

Beaker, glass $250cm^3$ and $100cm^3$
Test-tube
Boiling tube
Filter funnel
Measuring cylinder, $100cm^3$ and $250cm^3$
Round-bottom $250cm^3$ glass flask

Electrical:

Ammeter capable of reading currents up to 1A with a minimum precision of 0.01A
Voltmeter capable of reading voltages up to 5V with a minimum precision of 0.1V
Leads with suitable terminals for electrical experiments
Lamp, e.g. 2.5V with suitable holder
12V d.c. power supply (mains operated or made up of cells)
Selection of bare resistance wires
Variable resistor

Optics:
Optics pins
Ray box
Cork mats (or similar) approximately A4 size
Screen (for optics experiments)
Plane mirror
Rectangular glass or Perspex block (for refraction experiments)
Semi-circular glass or Perspex block (for refraction and total internal reflection experiments)
60^{o} prism (glass or Perspex)
Selection of converging lenses

Mechanics:
Expendable steel spring
Forcemeter (Newton meter) 0 – 10N, 0 – 100N, 0 – 500N
Slotted mass sets (9 x 10g with 10g hanger and 9 x 100g with 100g hanger)
Stopwatch or stopclock
26swg bare copper wire
Triangular pivot
Pendulum bob

2. Apparatus list for IGSCE Physics (0625/5)

This lists the apparatus (in addition to that in List 1) typically used for teaching the course. The list is arranged in the order of the Syllabus Sections.
This cannot be a definitive list since so much depends on local circumstances and the availability of equipment. There are many ways of enhancing the teaching with practical experience for the students and many teachers are very imaginative in their approaches, using locally available materials. At the other extreme, Educational Suppliers have produced many specialised kits (far too many to list here, although some of the more commonly used are included) to help the teaching of particular parts of the Syllabus. Naturally these tend to be expensive to buy.

Section 1:
Micrometer screw gauge
Dynamic trolley
Ticker tape
Ticker-timer
Trolley ramp
Acceleration of free-fall apparatus
Selection of different shaped 'objects' (for density determinations by displacement method)
Selection of cuboid made from different materials (for density determinations)
Selection of springs and rubber bands
Selection of card (for centre of mass of lamina experiment)
Toy cars with flexible tracks (to illustrate conversion of gravitational potential energy to kinetic energy and 'loop-the-loop' to illustrate circular motion)
Manometer
'Pressure of liquid increases with depth' apparatus

Section 2:
Brownian motion smoke cell kit
Metal rod (50cm – 100cm long, approx 0.4cm diameter to show expansion)
'Bar-breaker' apparatus
Specific heat capacity determination kit (1kg cylindrical metal block and immersion heater)
Stearic acid
Selection of conductivity rods (for conduction of heat experiments)
Potassium permanganate crystals (or similar to show convection currents in water)
Copper plate apparatus (to show good and bad emitters of heat radiation)

Section 3:
'Slinky' spring
Ripple tank with accessories
Set of tuning forks
Signal generator
Loudspeaker
Cathode Ray Oscilloscope (to illustrate amplitude, frequency and wavelength of sound waves)

Section 4:

Selection of magnets
Iron filings in suitable shaker
Plotting compass
Large iron nails (to act as core for a 'homemade' electromagnet)
Iron 'C' cores
Insulated single strand copper wire (for making electromagnets)
Van der Graaf generator with accessories
'Gold-leaf' electroscope
Electrostatics investigation kit (polythene and cellulose acetate strips, dusters, etc.)
Selection of resistors
Selection of potential dividers, thermistors, capacitors, relays, diodes, light-dependent resistors, transistors etc. (these could be part of a specialised kit designed for teaching electronics)
Logic gates kit
Sensitive, centre-zero galvanometer (to show the emf induced by a changing magnetic field)
Demountable transformer kit
Selection of solenoids
Low voltage (1V – 2V) power source (for 'catapult' experiment to show force on a current-carrying conductor)
'Teltron' tube (to show force on a beam of charged particles)
EHT supply
Simple d.c. motor construction kit

Section 5:
Large number of small cubes (100+) with one side marked (for half-life simulation experiment)
Geiger tube and holder
Geiger counter
Set of absorbers with holder
Set of radio-active sources (Americium 241, Strontium 90, Cobalt 60 and Radium 225) with holder and suitable storage and handling facilities
Tongs for handling radioactive sources