Cambridge Assessment

O Level

Physics

Session: 1974
Type: Syllabus
Code: 532

Ord.

Home Centres

Subject Syllabuses S (1974)

UNIVERSITY OF CAMBRIDGE
LOCAL EXAMINATIONS SYNDICATE

SYLLABUSES

SCIENCE SUBJECTS

1974–5

GENERAL CERTIFICATE OF EDUCATION
(ORDINARY LEVEL)

Correspondence should be addressed to
THE SECRETARY, SYNDICATE BUILDINGS, CAMBRIDGE
Telegraphic Address: Syndicate, Cambridge

July 1972

Price 10p

PHYSICS* (532)

[May not be taken with Physical Science or Engineering Science]

The syllabus is not intended to be used as a teaching syllabus, or to suggest a teaching order. It is expected that teachers will wish to develop the subject in their own way.

In the examination, questions will be aimed more at testing the candidates' understanding of fundamental physical principles, and the application of these principles to problem situations, than to their ability to remember a large number of facts and to perform numerical exercises. Some questions will, however, include appropriate calculations.

Although a practical examination will not be set,† an experimental approach to the subject is envisaged and it is assumed that candidates will spend adequate time on individual experimental work. Questions may be set requiring descriptions of experimental procedures which candidates might be expected to have carried out. Candidates should also know how to exhibit the results of experiments graphically and how to make deductions from graphs, e.g. from intercepts and slope and by interpolation in the case of straight-line graphs.

Questions will not be set in f.p.s. units. Candidates will be expected to be conversant with SI units.

SCHEME OF EXAMINATION

The syllabus is divided into three sections.

Section A (Items 1–20) Mechanics, Hydrostatics, Heat.

Section B (Items 21–32) Waves, Optics.

Section C (Items 33–51) Magnetism, Electricity, and Modern Physics.

There will be two written papers, Paper 1 of 2-hours' duration and Paper 2 of $2\frac{1}{2}$-hours' duration. A Practical examination will

* Formerly known as Syllabus T.

† In the Caribbean area: a $2\frac{1}{4}$-hour practical test (30 marks) will be set, see p. 47.

not be set but some questions will be set so as to test the candidate's personal experience of Practical work.

Paper 1* (90 marks) will contain 18 short-answer questions set on any part of the syllabus, and one other question (30 marks), which will be specifically designed to test knowledge of laboratory work relevant to the theoretical syllabus. Candidates will be required to answer 15 of the short-answer questions (60 marks) and there will be a choice of parts within the 30-mark question.

Paper 2 (100 marks) will contain 4 questions set on Section A of the syllabus, 3 questions set on Section B of the syllabus, and 5 questions set on Section C of the syllabus. All the questions will carry equal marks, and the paper will be divided into 3 sections corresponding to the division of the syllabus. Questions on item 51 of the syllabus will not be restricted to Section C of the paper but may be set in any Section as appropriate. Candidates will be required to answer 5 questions, including at least 1 from each of the Sections A and B, and at least 2 from Section C.

DETAILED SYLLABUS

SECTION A

SYLLABUS	NOTES
General introductory items	
1. Length, *l*. Mass, *m*. Time, *t*. Density, *ρ*.	
Measurement of length, area, *A*, and volume, *v* or *V*.	Use of measuring tapes, callipers, micrometer screwgauges and vernier scales.
Mass.	A property of a body depending on inertia.
Weight, *W*.	Its dependence on gravitational field. Use of spring balance and beam balance for comparison of weights and masses.
Time.	Use of clocks; experiments with simple pendulum to show period independent of amplitude for small amplitudes. Formula for period *not* required.
Density.	Definition. Densities found by measurement and weighing for liquids and regular solids, by displacement (immersion) for irregular solids.

* In the Caribbean area, Paper 1 will be a $1\frac{1}{2}$-hour paper (60 marks) containing 18 short-answer questions, of which 15 are to be answered.

SYLLABUS	NOTES
2. Speed, velocity, *u*, *v* or *w* and acceleration *a* (*g*, under gravity)	Simple examples not limited to uniformly accelerated motion. Graphical representation. Equations of uniformly accelerated motion as such *not* required, but problems on uniformly accelerated motion soluble from first principles, or by graphical methods, may be set. Treatment of bodies falling freely under gravity and a qualitative conception of the effect of air resistance.
3. Concept of force, *F*. Effects of forces.	Producing changes in size and shape. Producing changes in motion of a body (in magnitude or direction). Motion in a curved path as a qualitative illustration of the effects of forces. Knowledge of the relation: acceleration = v^2/r is *not* required.
Relation between force, mass, and acceleration. Definition of the newton, N.	
4. Moment of a force, *M*. Principle of moments. Conditions of equilibrium.	Turning effect of a force acting on a body. Application to balanced levers. Under a system of parallel forces only.
5. Vector and scalar quantities.	Distinction between them and some common examples of each. Addition of vectors; particular application to resultant velocity and resultant force. Resolution of vectors is *not* required.
6. Centre of gravity.	Treated experimentally. Its relation to stability of equilibrium. Stable, unstable and neutral equilibria are included.
7. Work, *W*, and energy, *E*.	Examples of work done by and against forces. Definition of work done. Definition of the joule, J. Illustrated by simple machines. Energy acquired when work is done. Kinetic and potential energy.
Power, *P*.	Rate of working. Definition of the watt, W.
8. Simple machines and their efficiency.	Principles of the action of machines illustrated by simple examples.
9. Friction between solid surfaces.	Advantages and disadvantages. Factors which affect the force of friction between two surfaces. The effect of lubrication. Experimental determination of the coefficient of friction *not* required.
Friction between solids and fluids.	

SYLLABUS	NOTES
Fluid pressure	
10. Pressure, p or P. Pressure in fluids at rest. Transmission of fluid pressure. Atmospheric pressure. Bicycle pump.	Force per unit area. Applications, e.g. manometers. Simple practical applications. Barometers, mercury and aneroid.
11. Upthrust in fluids. Flotation.	Treatment should include ships and balloons.
Properties of solids and fluids	
12. Distinction between solids, liquids, and gases. Distinction between saturated and unsaturated vapours.	Simple discussion of properties such as diffusion, surface tension, evaporation.
Simple explanation of the distinctions in terms of the kinetic theory.	Brownian movement of molecules (see also 19). Quantitative treatment of intermolecular forces or molecular motion is *not* required.
13. Longitudinal stretching by application of force.	Hooke's law. Elastic limit.
Compression of a gas by increase of pressure.	Boyle's law. Experimental demonstration for air. Derivation of law from kinetic theory *not* expected, though kinetic theory ideas of how gaseous pressure comes about would be expected.
Temperature and dimensional changes due to temperature	
14. Measurement of temperature.	By physical properties which change with temperature. Examples of these.
Scale of temperature; fixed points (see item 17).	Celsius (centigrade) scale.
Types of thermometer.	Liquid-in-glass. (Mercury and alcohol, clinical thermometer.) Thermo-couple as a convenient thermometer for high temperatures and for rapidly varying temperature. Simple type of constant volume gas thermometer.
15. Thermal expansion of solids, liquids and gases.	Effects and applications. Ideas of relative orders of magnitude. A knowledge of some method of measuring a small increase in length is expected.
Change of density of fluid consequent upon expansion.	Application to convection (see item 20).
Relation between volume and temperature of a gas. Charles' law.	Absolute temperature scale: the kelvin, K. Introduction to the kelvin as a temperature unit. The gas equation $\frac{PV}{T}$ = const. by combining Boyle's and Charles' laws.

SYLLABUS	NOTES
Quantity of heat and its measurement	
16. Units of heat. Specific heat capacity.	The joule as a unit of heat. Definition in terms of units (not as a ratio). Candidates will be expected to know the principles of some method of measuring specific heat capacity, but questions will *not* be set requiring a particular method to be described. Numerical problems may be set.
The heat energy of fuels.	
17. Melting and boiling.	Phenomena involving heat exchange with no change of temperature.
Melting and boiling points.	Influence on these of pressure and dissolved substances (see item 14).
Specific latent heats of fusion and vaporization.	Simple experimental determination of specific latent heats, l, for ice and steam.
Heat as a form of energy	
18. Historical approach.	The idea of a conservation law leading to identification of heat with energy.
Conversion of heat energy to work.	Illustrated by simple consideration of heat engines such as internal combustion engines, turbines, jets and rockets.
19. Heat as the kinetic energy of random molecular motion.	Brownian movement—evidence for the existence of molecules (see also item 12). Qualitative treatment of the kinetic theory applied to phenomena such as evaporation and cooling by evaporation, latent heat, saturated and unsaturated vapours (see also items 12 and 13).
Transference of heat energy	
20. Conduction, convection (see item 15), radiation and evaporation.	Qualitative explanation illustrated by simple experiments and from everyday experience.

Section B

SYLLABUS	NOTES
Light and vision	
21. Rays.	Formation of shadows; eclipses, the pin-hole camera.
The reflection of light and the formation of images. Laws of reflection.	Position and characteristics of the image formed by a plane mirror. Differences between specular reflection and the reflecting behaviour of a dull rough surface.

SYLLABUS	NOTES
22. Refraction of light.	Experimental evidence. Real and apparent depth. Passage of a ray of light through a rectangular glass block.
Laws of refraction. Total internal reflection.	Refractive index. Critical angle and its connection with refractive index. Use of totally reflecting prisms.
23. Thin converging and diverging lenses.	Their action on beams of light. Focal length, f; determination of focal length of a converging lens by any one method. Graphical methods for location of images.
Use of a converging lens as a magnifying glass, in a camera, and for the projection of a large real image.	Problems will *not* be set necessitating the use of lens formulae.
24. The physics of the human eye.	Accommodation, long sight and short sight, and their correction by spectacles. Quantitative problems will *not* be set.
25. Dispersion of white light. Simple characteristics of radiations just outside the boundaries of the visible region.	The detection and properties of these radiations.
Continuous spectra, line emission spectra and absorption spectra.	Examples of each. Differences in appearance. Line spectra characteristic of the atoms or molecules emitting the light, absorption spectra characteristic of the absorbing material.
26. Colour. Mixing of colours.	By addition of different coloured lights.
Colours of materials.	Selective absorption of light by pigments and filters. Appearance of objects in different coloured light.

Vibrations and waves

SYLLABUS	NOTES
27. Examples of vibrating systems.	Floating objects when ripples pass. Violin strings, tuning forks, pendulum, etc.
Production of sound by vibrating systems.	
Transmission of sound.	Necessity for a material medium.
28. Waves associated with vibrating systems: transverse waves	Ripple tank illustrations, crests and troughs.
longitudinal waves.	Compressions and rarefactions. Mechanical model illustration.
Characteristics of wave motion.	Frequency. Wavelength, velocity. Amplitude. $c = f\lambda$.
Speed of transmission of wave motion.	One simple method of determining the velocity of sound in air.

SYLLABUS	NOTES
	A knowledge of the order of magnitude of the velocity of electromagnetic waves.
Subjective properties of sound waves.	Simple treatment of pitch, loudness and quality.
29. Resonance.	Mechanical and acoustical examples.
30. Reflection of waves.	A study of the reflection of water ripples, sound waves and electromagnetic waves by plane and curved surfaces.
Refraction of waves. Refractive index.	Ripple tank and other illustrations. Explanation by different velocities in different media.
31. Superposition.	Destructive interference and reinforcement illustrated by ripple tank experiments.
In sound.	Beats.
Interference of light.	Some simple experiment to establish the wave nature of light.
32. The complete electromagnetic spectrum.	Visible light, infra-red (i.r.) and ultra-violet (u.v.), radio waves, X-rays and gamma-rays.

SECTION C

Magnetism

SYLLABUS	NOTES
33. Simple phenomenon of magnetism.	Including the properties of magnets, magnetic induction, magnetic screening (or shielding). Distinction between magnets and unmagnetized material. Methods of magnetization and demagnetization. Magnetic fields. Lines of force, with a qualitative treatment of neutral points.
Magnetic properties of iron and steel.	Factors affecting the suitability of materials as permanent magnets, or as an electromagnet.

Sources of electric current and magnetic effects of electric currents

SYLLABUS	NOTES
34. A simple cell.	Include polarization and back e.m.f. due to polarization.
Leclanché cell (wet or dry). Accumulators.	Care and maintenance of lead accumulators including practical details of charging and discharging. The characteristics of alkaline accumulators.
35. Magnetic effect of an electric current.	Nature of the magnetic field for straight wire, circular coil, solenoid.
Applications.	Electromagnets, the electric bell and the simple relay.

SYLLABUS	NOTES
36. Behaviour of a coil carrying a current in a magnetic field. D.C. motor. Galvanometers and ammeters.	Moving coil and moving iron instruments included. Use of wire suspension, lamp and scale *not* expected.
Current, charge, potential difference, power, resistance	
37. The ampere, A.	The unit in which current, *I*, is measured. A precise definition is not expected. Magnitude of current can be measured by an ammeter which is calibrated in terms of the force between two current-carrying conductors. A knowledge of formulae is *not* required.
The coulomb, C.	Ampere-second.
38. Energy transformation occurring when electricity is generated or used.	Demonstrated by suitable experiments. See also item 41.
Development of concept of potential difference. (p.d.) The volt, V.	Defined as a joule, J, per coulomb. Use of voltmeters.
Electromotive force.	From cells, accumulators, generators. Work done in driving unit charge round a closed circuit.
Power.	The relation between the volt, the ampere and the watt, W, is expected. Calculations of electrical energy involving cost may be set.
39. Relation between current and potential difference in a metallic conductor.	For experimental demonstration, potential difference across a conductor may be assumed equal to the e.m.f. applied, which may be assumed to be proportional to the number of accumulators of negligible resistance connected in series.
Ohm's law. Resistance, *R*.	Application to single conductors and whole circuits.
The ohm, Ω. Internal resistance of cells.	Existence of internal resistance causes the potential difference across a cell in a closed circuit to be less than the electromotive force. Methods of measurement are *not* required.
Relationships between current and potential difference in non-metallic conductors.	Electrolytes, semi-conductors, ionized gases, thermionic devices, (qualitative only). See item 47 also.
40. Resistors in series and parallel.	Calculation of effective resistance expected. Application to shunts for ammeters and series resistors for changing the range of voltmeters.

SYLLABUS	NOTES
Heating and chemical effect of electric currents	
41. The heating effect of an electric current.	See also item 38. Practical applications—electric fires, lamps, and irons. Numerical examples may be set.
Electrical wiring systems.	Use of switches, fuses and 'earth'. Safety precautions.
42. The chemical effect of electric currents.	Distinction between electrolytes and non-electrolytes. Electrolysis of copper(II) sulphate solution using copper electrodes, and the electrolysis of dilute sulphuric acid using electrodes such as platinum or carbon. Practical applications including electroplating.
Simple ionic theory.	Simple ideas of positive and negative charges within an electrolyte.
Faraday's laws.	
Electromagnetic induction	
43. The phenomenon of electromagnetic induction.	Experimental demonstration. Factors affecting the magnitude and direction of the induced e.m.f.
Simple applications.	For example moving coil microphone (linked with moving coil speaker).
44. Simple a.c. generator.	Either a coil rotating in a magnetic field or a magnet rotating with respect to fixed coils is sufficient.
Alternating current.	Peak value. R.M.S. value deduced from heating effect. Equal to the steady d.c. current which produces the same heating effect. Mathematical treatment *not* required.
Simple d.c. generator.	Simple a.c. generator modified by the use of some form of commutator, or by a bridge rectifier, is expected. Comparison of the form of the d.c. this gives with that produced from batteries.
45. The transformer. Transmission of electrical energy.	Advantages of high voltage transmission. Advantages of a.c. The grid system.
Electricity at rest	
46. Introduction to the concept of static charge. Positive and negative charges.	Simple experiments with charges (friction and induction). Conductors and insulators.
Simple ideas of electric field.	As a region in which electric charges move. No field inside a hollow charged conductor. Sparks and point discharge.

SYLLABUS	NOTES
Uses of electroscopes	To indicate sign of charge, potential. Small currents (ionization currents).
Connection between current and static electricity.	Experimental demonstration.
Simple capacitors and the factors which affect capacitance.	Qualitative. No knowledge of formulae expected.

Some topics connected with atomic structure

SYLLABUS	NOTES
47. The thermionic emission of charge.	Its application to the production of cathode rays. Rectification in a diode. Distinction between direction of flow of electron current and direction of conventional current.
Cathode rays.	Produced in tubes with hot cathodes and in tubes with cold cathodes. Advantage of hot cathode tubes.
Properties of cathode rays.	Demonstration of the simpler properties. Simple applications. Knowledge of the fact that they can produce X-rays.
Concept of the electron.	
48. Detection of radioactivity.	Photographs. Scintillations. Ionization. Tracks in a cloud chamber.
Identification of three kinds of emission from radioactive sources. Alpha- and beta-particles and gamma-rays.	Demonstration of the differing degrees of absorption in various materials. Rutherford's deflection experiments. Identification of α-particles as nuclei of helium atoms. Identification of β-particles as electrons. Demonstration of this.
Random nature of radioactive emission. Radioactive decay. Half-life.	Meaning of the term. Measurement of the half-life of any one radioactive source.
Safety precautions.	Use of absorbing matter. Effect of distance.
49. The atom.	Nature of the evidence for the existence of atoms and ions.
The idea of the nuclear atom. Atomic number, Z, with reference to the periodic table.	Evidence for this idea.
50. Constituents of the nucleus.	Protons and neutrons.
Changes in the nucleus when particles are emitted. Isotopes.	Atomic number and mass number, A, (including notation). Examples of non-radioactive and radioactive isotopes.

SYLLABUS	NOTES
Energy 51. Transformations of energy and conservation of energy. Sources of energy.	See items 7, 18, 19, 38, 48. Transformations from atomic changes. Solar energy. Energy from fuels. Hydroelectric energy. Nuclear energy.

(*Note.* Questions on this item may be set in any Section of Paper 2 as appropriate.)

PRACTICAL PHYSICS

This will be tested by a PRACTICAL EXAMINATION based on the above syllabus, except that there will be no questions on sound. The object of the practical examination is to test whether the candidates have worked through a satisfactory course in the laboratory and are capable of handling simple apparatus. The questions will, as far as possible, contain detailed instructions for all the operations to be performed. Even when standard experiments such as the determination of focal lengths or specific heat capacities are asked, candidates will be told what readings to take and how to calculate the result. It should not therefore be necessary for candidates to learn by heart how to do any experiments.

In addition to experiments on topics in the syllabus, candidates may be asked to carry out with the aid of full instructions:

1. variants on standard experiments, e.g. specific heat capacities of two metals compared and not actually measured;

2. experiments involving measurements where knowledge of the theory is not expected, e.g.: bending of a metre ruler weighted at the centre; heat evolved when two liquids are mixed; relative cubic expansivities of liquids by density bottle; location of *real* images applied to various simple determinations with spherical mirrors and lenses (either pin and parallax or light box and screen methods are acceptable).

Questions may also be set involving measurements with a vernier and screw-gauge, the plotting of rays through prisms with pins, the plotting of magnetic fields by compass needle and the location of neutral points.

The candidates should be trained to take as varied a set of readings as possible and to set out the actual observed readings systematically on one of the sheets of paper sent up. The experiments may require exhibition of results graphically and deduction from the graphs, e.g. interpolation, intercepts, slope of a straight-line graph. During the first 15 minutes of the Practical Examination candidates will be allowed to see the apparatus, but not to start work. This time is intended to enable them to read through the paper and choose their questions.

Questions on calorimetry will as far as possible contain alternatives for candidates trained to use thick calorimeter methods.

Questions requiring the use of a beam balance will not be set.

The rubric of the Practical Examination papers is as follows:

'*Answer Question* 1 *and* **one** *other question. You will not be allowed to start work with the apparatus for the first quarter of an hour.*

Candidates are recommended to record their observations as soon as these observations are made. These observations and any arithmetical working of the answers from them should be written on the answer sheets: scrap paper should not be used. The record may be in pencil provided it is sufficiently neat to be intelligible. A fair copy is **not** *wanted.*

An account of the method of carrying out the experiments is **not** *required; but candidates should record any precautions they have taken, and it must be clear (by diagrams or otherwise) how the readings were obtained. The theory of the experiments is* **not** *required.*

Mathematical tables and squared paper are provided.'