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O Level

Physics

Session: 1984
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Subject Syllabuses
SS11(HCO)
1984
Science Subjects

GENERAL CERTIFICATE OF EDUCATION

EXAMINATION SYLLABUSES FOR
1984

PHYSICS
AND
ENGINEERING SCIENCE
ELECTRICITY AND ELECTRONICS

UNIVERSITY OF CAMBRIDGE
LOCAL EXAMINATIONS SYNDICATE
INTERNATIONAL EXAMINATIONS
June 1982

PHYSICS
5050

GCE Ordinary Level/School Certificate

The syllabus is not intended to be used as a teaching syllabus nor to suggest a teaching order. It is expected that teachers will wish to develop the subject in their own ways.

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. Some questions will include simple calculations.

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. Candidates should also know how to exhibit the results of experiments graphically and how to make deductions from graphs, e.g. from intercepts and gradients in the case of straight-line graphs; deductions by interpolation.

Candidates will be expected to be conversant with SI units.

SCHEME OF EXAMINATION

U.K. only

There will be two written papers, Paper 1 of 2 h and Paper 2 of 2½ h.

Paper 1 (90 marks) will consist of two parts: Part I (60 marks) will consist of 15 compulsory short-answer questions and Part II (30 marks) will consist of 2 questions to test practical techniques in experimental work. Each question in Part II will contain alternative choices (*a*) and (*b*).

Paper 2 (100 marks) will consist of two parts: Part I (50 marks) will consist of 6 structured questions of which candidates will be required to attempt 5 and Part II (50 marks) will consist of 6 questions of the more traditional type of question of which candidates will be required to attempt 3.

Each section of both papers will contain questions set on any part of the syllabus.

Overseas including Caribbean

There will be two written papers, Paper 1 of 1½ h and Paper 2 of 2½ h and a practical examination of 2¼ h.

Paper 1 (60 marks) will consist of 15 compulsory short-answer questions.

Paper 2 (100 marks) will consist of two parts: Part I (50 marks) will consist of 6 structured questions of which candidates will be required to attempt 5 and Part II (50 marks) will consist of 6 questions of the more traditional type of question of which candidates will be required to attempt 3.

Paper 1 and each section of Paper 2 will contain questions set on any part of the syllabus.

The practical examination (30 marks) will contain three questions. Candidates will be required to attempt question 1 and one other question.

DETAILED SYLLABUS

SYLLABUS	NOTES
General introductory items	
1. Measurement of length, l, area, A, and volume, V.	Use of metre rule, callipers, micrometers and vernier scales.
Mass, m.	A property depending on inertia of a body.
Weight, W.	Its dependence on gravitational field. Use of spring and lever balances for comparison of weights and masses.
Time, t.	Use of clocks and devices for measuring short intervals of time.
Density, ρ	Determination by measurement and weighing for liquids and regular solids, and by displacement (immersion) for irregular solids.
2. Speed, velocity, u, v, acceleration, a, acceleration of free fall, g.	Simple examples not limited to uniform acceleration. Graphical representation. Equations of uniformly accelerated motion as such are *not* required; problems set will be soluble from first principles or graphically. Treatment of bodies falling freely and a qualitative conception of the effect of air resistance.
3. Force, F.	Effects of forces – producing changes in size and shape, and in the motion of a body in magnitude and direction. Qualitative illustration of motion in a curved path. Knowledge of v^2/r = const. is *not* required.
Relation between force, mass and acceleration. The newton, N.	Experimental demonstration is expected.
4. Moment of a force.	Illustrated by simple examples with forces applied to balanced levers. (Questions will not be set involving oblique forces or reactions at the support.)
5. Centre of gravity.	Treated experimentally.
6. Vector and scalar quantities	Distinction between them and some common examples of each. Addition of vectors; application to resultant velocity and resultant force. Resolution of vectors is *not* required.
7. Work, W. Energy, E.	Examples of work done by and against forces. Energy acquired when work is done. Kinetic and potential energy (qualitative only).
The joule, J. Power, P. The watt, W.	
8. Pressure, p.	Force per unit area.
Atmospheric pressure.	Simple mercury barometer.
Pressure in fluids at rest.	Qualitative only. Simple manometer.
Upthrust in fluids. Flotation.	Numerical examples will not be set.

SYLLABUS	NOTES
Temperature. Kinetic theory and energy exchanges	
9. Measurement of temperature.	By physical properties which vary with temperature. Examples of these. Celsius (centigrade) scale. Kelvin scale (temperature/kelvin = temperature/°C +273) (see item 11).
Types of thermometer.	Liquid in glass – laboratory and clinical. Thermocouple as a convenient method for high temperatures and those which vary rapidly.
10. Simple qualitative explanations of the following in terms of the kinetic theory. Distinction between solids, liquids and gases.	
Pressure in gases.	Including the effect of temperature on pressure in gases.
Diffusion. Brownian motion.	
Evaporation.	Including cooling effect.
Compression of gas by increase of pressure.	Including Boyle's law and a demonstration of this for air.
11. Thermal expansion of solids, liquids and gases (qualitative only).	Effects and applications. Ideas of relative orders of magnitude.
Change in density of a fluid as a result of expansion.	Application to convection (see item 13).
Relation between volume and temperature of a gas.	The absolute temperature scale. The kelvin K as a temperature unit.
The ideal gas equation pV/T = const.	
12. The unit of heat.	The joule, J.
Heat capacity, C. Specific heat capacity, c.	Some simple method of measuring specific heat capacity (of solids and liquids) is expected.
Melting and boiling.	Phenomena involving energy exchange without a change in temperature.
Melting and boiling points.	Influence on these of pressure and of dissolved substances.
Latent heat, L. Specific latent heats of fusion and vaporisation, l.	Simple experimental determination for ice and steam. Questions on this section will only involve methods in which energy is supplied at a constant rate (e.g. by electrical means). The effects of containers and cooling corrections are only to be treated qualitatively.
13. Conduction, convection and radiation.	Qualitative treatment, illustrated by simple experiments and examples from everyday experience.
Wave motion	
14. Simple ideas of wave motion.	Illustrated by mechanical models and by experiments with a ripple tank. Meanings of the terms wave-front, speed, frequency, wavelength, amplitude. Speed = frequency × wavelength. Distinction between transverse and longitudinal waves.

SYLLABUS	NOTES
15. Reflection, refraction, diffraction.	Reflection at plane surfaces. Refraction due to change of speed. Simple treatment of diffraction – wide obstacle, wide gap, narrow gap.
16. Superposition. Interference.	Destructive interference and reinforcement illustrated by ripple tank experiments, and by simple experiments with sound. Some simple experiment to establish the wave nature of light.
Light	
17. Rays.	Formation of shadows; eclipses, the pin-hole camera.
The reflection of light and the formation of images. Simple law of reflection ($i = r$).	Position and characteristics of the image formed by a plane mirror.
18. Refraction of light.	Experimental evidence. Real and apparent depth. Passage of a ray of light through a rectangular transparent block.
Simple law of refraction ($\sin i/\sin r$ = constant).	Refractive index. Critical angle and its connection with refractive index. Total internal reflection.
19. Thin converging and diverging lenses.	Their action on beams of light.
Focal length, f.	Determination of the focal length of a converging lens by any one method. Graphical methods for the location of images. Problems will *not* be set necessitating the use of lens formulae.
Use of a converging lens as a magnifying glass, in a camera, and for the projection of a large real image.	
20. Optical system of the human eye.	Focusing action of the cornea and the crystalline lens. Accommodation by changes in the crystalline lens. Questions on defects of the human eye will *not* be set.
21. Dispersion of light.	Treated qualitatively and illustrated by the action, on a narrow streak of light, of (i) a suitable prism, (ii) a finely ruled grating. Continuous spectrum. Meaning of the term monochromatic light.
22. Infra-red and ultra-violet radiations. Radiant energy.	Simple properties. Any *one* method of detection for each. The complete electromagnetic spectrum, with some reference to radio waves, X-rays and gamma-rays. A knowledge of the order of magnitude of the speed of electromagnetic waves, and the fact that all have the same speed *in vacuo*.

SYLLABUS	NOTES
Sound	
23. Production of sound.	
Transmission of sound.	Necessity for a material medium. Compressions and rarefactions.
Speed of sound.	One simple method of determining the speed of sound in air.
Subjective properties of sound.	Simple treatment of pitch, loudness, and quality.
Reflection of sound.	Echoes.
Magnetism	
24. Simple phenomenon of magnetism.	Including the properties of magnets, induced magnetism, magnetic screening (or shielding). Distinction between magnets and unmagnetised material. Methods of magnetisation and demagnetisation. Simple method of plotting a magnetic field with a compass, and the distribution of the magnetic field around a single bar magnet. (Earth's field excluded.)
Magnetic properties of iron and steel.	Factors affecting the suitability of materials as permanent magnets, or as an electromagnet.
Sources of electrical energy	
25. The dry cell.	Simple structure only.
The accumulator.	Care and maintenance of any *one* type of accumulator including practical details (without chemistry) of charging and discharging.
The simple generator.	See item 34.
Magnetic effects of electric currents	
26. Magnetic effect of an electric current.	Pattern of the magnetic field for straight wire, circular coil, solenoid.
Applications.	Electromagnets, the electric bell and the simple relay.
27. Behaviour of a current (in a wire or an electron beam) in a magnetic field.	
Galvanometers and ammeters.	Moving-coil and moving-iron instruments only. Use of wire suspension, lamp and scale *not* expected.
D.C. motor.	
Forces between parallel currents.	Treated qualitatively.
Current, charge, potential difference, power, resistance	
28. The ampere, A.	The unit in which current, I, is measured. A precise definition is not expected. Magnitude of current can be measured by a calibrated ammeter.
The coulomb, C.	Ampere-second.

SYLLABUS	NOTES
29. Energy transformation occurring when electricity is generated or used. Development of potential difference (p.d.).	Demonstrated by suitable experiments.
The volt, V.	Defined as a watt per ampere or as a joule per coulomb. Use of voltmeters.
Electromotive force.	From cells, accumulators, generators. Work done 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 and calculations relating electrical power to p.d. and current may be set. (Acquaintance with the term kW h is expected.)
30. Resistance, R. The ohm, Ω.	Measurement of resistance using an ammeter and voltmeter.
Relation between current and potential difference in a metallic conductor. Ohm's law.	The ammeter and voltmeter method of experimental demonstration is acceptable. Application to single conductors and whole circuits including cells with internal resistance but calculations involving the terminal p.d's of cells will not be set.
Relation between current and potential difference in semiconductor diodes.	Application to their use as rectifiers.
31. Resistors in series and parallel.	Calculation of effective resistance expected.
Heating effect of electric currents	
32. The heating effect of an electric current.	See also item 29. Practical applications – electric heaters, lamps, and irons. Numerical examples may be set.
Electrical wiring systems.	Use of switches, fuses and 'earth'. Safety precautions with special reference to safety in the home.
Electromagnetic induction	
33. 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 (compared with moving-coil speaker).
34. Simple a.c. generator.	Either a coil rotating in a magnetic field or a magnet rotating with respect to fixed coils is sufficient. Graph of current output against time.
Simple d.c. generator.	Simple a.c. generator modified by use of some form of commutator, or by a bridge rectifier, is expected. Use of the current output/time graph to compare the form of the d.c. this gives with that produced from batteries.

SYLLABUS	NOTES
35. The transformer.	Treated as ideal.
Transmission of electrical energy.	Advantages of high voltage transmission. Advantages of a.c.
Electricity at rest	
36. Introduction to the concept of static charge. Positive and negative charges.	Simple experiments with charges (friction and induction). Conductors and insulators.
Simple idea of electric field.	As a region in which electric charges experience a force.
Connection between current and static electricity.	Experimental demonstration.
Some topics connected with atomic and nuclear structure	
37. The thermionic emission of charge.	Distinction between direction of flow of electron current and direction of conventional current.
Properties of electron beams.	Demonstration of the simpler properties. Simple applications. Knowledge of the fact that they can produce X-rays.
Simple treatment of the cathode-ray oscilloscope.	Structure and action, including use to display wave forms. Details of circuits not required.
38. Detection of radioactivity.	Detection of α-particles, β-particles and γ-rays. (Any *one* method suited to the particular emission is all that is required.)
The main characteristics of the three kinds of radiation.	Different penetrating powers treated qualitatively. Deflection by magnetic fields. Nature of particles/rays.
Random nature of radioactive emission.	Demonstration by any *one* method.
Radioactive decay. Half-life.	Meaning of the terms and their graphical representation.
Safety precautions.	Use of absorbing matter. Effect of distance.
39. The idea of the nuclear atom.	Evidence for this idea, e.g. Geiger-Marsden's experiment on deflection of α-particles by metal foil.
Mass number, A. Atomic number, Z.	Notation e.g. $^{12}_{6}C$.
Changes in the nucleus when particles are emitted.	Illustrated by equations.
Isotopes.	Examples of non-radioactive and radioactive isotopes.
Energy	
40. Transformations of energy and conservation of energy.	Efficiency.
Sources of energy.	E.g. solar energy, chemical energy, hydro-electric energy, nuclear energy.
The Einstein mass–energy equation $E = mc^2$.	

PRACTICAL PHYSICS

[For Overseas candidates including the Caribbean area]

THE PRACTICAL EXAMINATION will be 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 the following (with the aid of full instructions):

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

(*b*) experiments involving measurements where knowledge of the theory is not expected, e.g. bending of a metre rule loaded 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 the Answer Booklet handed in. The experiments may require the exhibition of results graphically and deduction from the graphs, e.g. interpolation, intercepts, slope of a straight-line graph. During the first 15 min 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 rubrics of the Practical Examination papers are 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.*

You are expected to record your observations as soon as these observations are made. These observations and any arithmetical working of the answers from them should be written in the Answer Booklet: scrap paper should not *be used. The record may be in pencil provided it is sufficiently neat to be legible. A fair copy is* not *wanted.*

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

Mathematical tables are available.

Graph paper is provided in the Answer Booklet. Additional sheets of graph paper should only *be used if it is* neessary *to do so.*'