P510/1
PHYSICS
Paper 1
Nov/Dec 2008
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 1
2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Attempt five questions, including at least one, but not more than two question from each of the sections A, B and C

Non programmable scientific electronic calculators may be used

Assume where necessary:

Acceleration due to gravity, g	=	$9.81ms^{-2}$
Electron charge, e	=	1.6×10^{-19} C
Electron mass	=	9.11×10^{-31} kg
Mass of the earth	=	5.97 x 10 – 34 kg
Planck's constant h	=	6.6 x 10 – 34 Js
Stefan's Boltzman's constant, σ	=	5.67 x 10 – 5 W m^{-2} k^{-1}
Radius of the earth	=	6.4×10^6 m
Radius of the sun	=	7×10^8 m
Radius of Earth's orbit about the sun	=	1.5×10^{11} m
Speed of light in a vacuum, c	=	3.0 x 108 ms^{-1}
Thermal conductivity of copper	=	390 Wm^{-1} k^{-1}
Thermal conductivity of aluminium	=	210 Wm^{-1} k^{-1}
Specific heat capacity of water	=	4,200 J kg – 1 k^{-1}
Universal gravitational constant G	=	6.67×10^{-11} Nm2 kg^{-2}
Avogadro's number Na	=	6.02×10^{23} mol^{-1}
Surface tension of water	=	7.0×10^{-2} Nm^{-1}
Density of water	=	1000kg m^{-1}
Gas constant, R	=	8.31 J mol^{-1} k^{-1}
Charge to mass ratio, e/m	=	1.8 x 1011 Ckg – 1
The constant $\frac{1}{4\pi\varepsilon_o}$	=	9.0×10^9 F^{-1} m

SECTION A:

1. (a) Distinguish between fundamental and derived physical quantities. Give two examples of each. (04 marks)

 (b) (i) What is meant by scalar and vector quantities?
 (ii) A ball is thrown vertically upwards with a velocity of $10ms^{-1}$ from a point 5.0 m above the ground. Describe, with the aid of a velocity-time sketch graph, the subsequent motion of the ball (10 marks)

 (c) A boat crosses a river 3 m wide flowing at $4ms^{-1}$ to reach a point on the opposite bank 5 km upstream. The boat's speed in still water is $12ms^{-1}$. Find the direction in which the boat must be headed.

2. (a) Define the following terms:
 (i) angular velocity (01 mark)
 (ii) centripetal acceleration (01 mark)

 (b) (i) Explain why a racing car can travel faster on a banked track than on a flat track of the same radius of curvature

 (ii) Derive an expression for the speed with which a car can negotiate a bend on a blanked track without skidding. (03 marks)

 (c) Show how to estimate the mass of the sun if the period and orbital radius of one of its planets are known (03 marks)

 (d) The gravitational potential, U, at the surface of a planet of mass M and radius R is given by $U = \frac{GM}{-R}$
 where G is the gravitational constant
 Derive an expression for the lowest velocity, V, which an object of mass, M must have at the surface of the planet if it is to escape from the planet. (04 marks)

 (e) Communication satellites orbit the earth in synchronous orbits. Calculate the height of a communication satellite above the earth (04 marks)

3. (a) State the law of floatation.
 (b) With the aid of a diagram, describe how to measure the relative density of a liquid using Archimedes' principle and the principle of moments. (06 marks)

 (c) A cross-sectional area of a ferry at its water-line is 720m2. If sixteen cars of average mass 1100 kg are placed on board, to what extra depth will the boat sink in the water? (04 marks)

 (d) (i) Define the terms longitudinal stress and Young's modulus of elasticity (02 marks)
 (ii) Describe how to determine Young's modulus for a steel wire (07 marks)

4. (a) A mass of 0.1 kg is suspended from a light spring of force constant 24.5Nm – 1. Calculate the potential energy of the mass.
 (b) (i) State four characteristics of simple harmonic motion (04 marks)
 (ii) Show that the speed of a body moving with simple harmonic motion of angular frequency (¦) is given by:
 V (¦ x $A^2 – X^2$) ½ , where A is the amplitude and x is the displacement from equilibrium position (02 maraks)

 (c) A mass of 0.1 kg suspended from a spring of force constant 24.5 Nm^{-1} is pulled vertically downwards through a distance of 5.0 cm and released. Find the
 (i) period of oscillation
 (ii) position of the mass 0.3 seconds after release (04 marks)

SECTION B:

5. (a) (i) Define molar heat capacity of a gas at constant volume

(ii) The specific heat capacity of oxygen at constant volume is 719 $Jkg^{-1}\ k^{-1}$. If the density of oxygen at S.T.P is 1.429 kgm^{-1}, calculate the specific heat capacity of oxygen at constant pressure.

(04 marks)

(b) Indicate the different states of a real gas sat different temperature on a pressure versus volume sketch graph.

(c) (i) In deriving the expression $P = {}^{1}/_{3}P\overline{c}^{\,2}$ for the pressure of an ideal gas, two of the assumptions made are not valid for a real gas. State these assumptions.

(ii) The equation of state of one mole of a real gas is:

$$\left(p + \frac{a}{\sqrt{2}}\right)(v - b) = RT$$

Account for the terms $\frac{a}{\sqrt{2}}$ and b (02 marks)

(d) Use the expression $P = {}^{1}/_{3}\,P\overline{c}^{\,2}$; for the pressure of an ideal gas to derive Dalton's law of partial pressures (04 marks)

(e) Explain, with the aid of a volume versus temperature sketch graph, what happens to a gas cooled at constant pressure from room temperature to zero Kelvin. (04 marks)

6. (a) What is meant by a black body?

(b) Describe how an approximate black body can be realised in practice (02 marks)

(c) (i) draw sketch graphs to show variation of relative intensity of black body rediation with wavelength for three different temperatures.

(ii) Describe the features of the sketch graph in (c) (i) above (03 marks)

(d) (i) State Stefan's law

(ii) A solid copper sphere of diameter 10 mm and temperature of 150K is placed in an enclosure maintained at a temperature of 290K. Calculate, stating any assumptions made, the initial rate of rise of temperature of the sphere.

(Density of copper = 8.93 x 103 kg m^{-3}

Specific Heat Capacity of copper = 3.7 x 10^2 Jkg k^{-1}) (07 marks)

(e) With the aid of a labelled diagram, describe how a thermopile can be used to detect infra-red radiation (04 marks)

7. (a) (i) What is meant by Kinetic theory of gases? (03 marks)

(ii) Define an ideal gas

(iii) State and explain the conditions under which real gases behave as ideal gases (01 marks)

(b) (i) Describe an experiment to show that a liquid boils only when it's saturated vapour pressure is equal to the external pressure ()5 marks)

(ii) Explain how cooking at a pressure of 76 cm of mercury and a temperature of 100^{o} C, may be achieved on top of high mountains (03 marks)

(c) (i) Define not mean square speed of molecules of a gas

(ii) The masses of hydrogen and oxygen atoms are 1.66x 10 – 27 kg. And 2.66 x 10 – 26 kg respectively. What is the ratio of the root-mean -square speed of hydrogen to that of oxygen molecules at the same temperature?

SECTION C

8. (a) (i) State Rutherford's model of the action (02 marks)
(ii) Explain two main failures of Rutherford's model of the atom (03 marks)

(b) (i) Explain how Milikan's experiment for measuring the charge of the electron proves that charge is quantised (04 marks)

(ii) Oil droplets are introduced into the space between two for horizontal plates, set 5.0 mm apart. The plate voltage is then adjusted to exactly 780V so that one of the droplets is held stationary. Then the plate voltage is switched off and the selected droplet is observed to fall a measured distance of 1.5 mm in 11.2s. Given the density of the oil used is 900 kgm $^{-3}$ and the viscosity of air is 1.8 x 10 – 5 Nsm $^{-2}$; calculate the charge of the droplet. (06 marks)

(c) A beam of positive ions is accelerated through a potential difference of 1 x 103V into a region of uniform magnetic field of flux density 0.2T. While in the magnetic field it moves in a circle of radius 2.3 cm. Derive an expression for the charge to mass ratio of the ions, and calculate its value (05 marks)

9. (a) (i) What is meant by thermionic emission? (01 marks)
(ii) Sketch the current potential difference characteristics of a thermionic diode for two different operating temperatures and explain their main features (05 marks)

(iii) Describe one application of a diode (02 marks)

(b) (i) What features of an X-ray tube make it suitable for continuous production of X-rays (03 marks)
(ii) Sketch a graph of intensity versus frequency of a radiation produced in an X-ray tube and explain its features (05 marks)

(c) A mono chromatic X-ray beam of wavelength 1.0 x 10 $^{-19}$ cm is incident on a set of planes in a crystal of spacing 28 x 10 $^{-10}$ m. What is the maximum order possible with these X-rays? (04 marks)

10. (a) What is meant by the following terms
(i) nuclear number? (01 marks)
(ii) Binding energy? (01 marks)

(b) Calculate the energy released during the decay of $^{229}_{86}$Rn nucleus into 2^{16}_{84} P_o and an a- particle

$$\left\{\begin{array}{ll} \text{Mass of } ^{216}_{86}\text{Rn} & = 219.964176\text{u} \\ \text{Mass of } ^{220}_{84}\text{P}_o & = 215.955794\text{u} \\ \text{Mass of } ^{4}_{2}\text{He} & = 4.001566\text{u.} \\ (1\text{u} = 931 \text{ MeV}) & \end{array}\right\}$$

(c) Describe the Bainbrige mass spectrometer and explain how it can be used to distinguish between isotopes (076 marks)

(d) (i) Explain how you would use a decay curve for a radioactive material to determine its half-life.

(ii) A radioactive source contains 1.0 µg of plutonium of mass number 239. If the source emits 2300 a – particles per second. Calculate the half-life of plutonium
[Assume the decay law $N = N_g e^{-2t}$]

P510/2
PHYSICS
paper 2
Nov/Dec 2003
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of Education
PHYSICS
Paper 2
2 hours 30 minutes

SECTION A:

1. (a) (i) State the laws of reflection of light (02 marks)
(ii) Show that an incident ray of light reflected successively from two mirrors inclined at an angle θ to each other is rotated through an angle 2θ. (04 marks)

(b) Describe how a sextant is used to determine the angle of elevation of a star

(c) (i) Describe an experiment to measure the focal length of a convex mirror (05 marks)
(ii) A concave lens of focal length 20 cm is placed 10 cm in front of a concave mirror of focal length 16 cm. Calculate the distance from the lens at which an object would coincide with its image (04 marks)

2. (a) Define the wavelength of a wave (01 mark)
(b) A source of sound moving with velocity u_s approaches an observer moving with velocity u_o, in the same direction. Derive the expression for the frequency of sound heard by the observer. (05 marks)

(c) Explain what happens to the pitch of the sound heard by the observer in (b) above when the
(i) observer moves faster than the source (02 marks)
(ii) observer's velocity is equal to that of the sound (02 marks)

3. (a) Explain with the aid of a diagram, why a thick plane mirror forms multiple images (04 marks)

(b) Derive the expression for the focal length of a combination of two thin converging lenses in contact, in terms of their focal length. (05 marks)

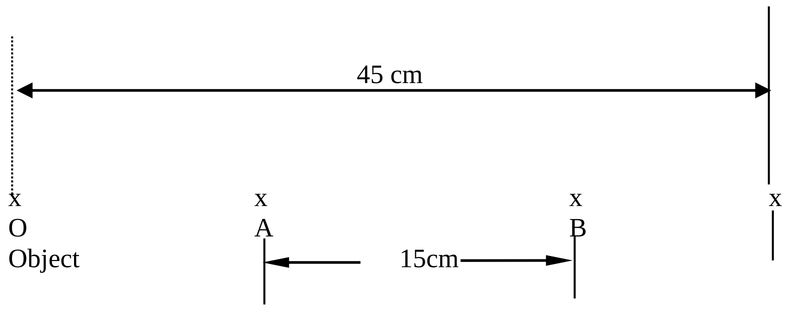


Fig 1

In the diagram in Figure 1, the image of the object is formed on the screen when a convex lens is placed either at A or B. If A and B are 15 cm apart, find the
(i) focal length of the lens (03 marks)
(ii) magnification of the image formed when the lens is at B (03 marks)

(d) Draw a ray diagram of a Galilean telescope and derive the expression for its magnifying power when in normal adjustment. (05 marks)

4. (a) (i) What is meant by interference of waves? (02 marks)

(ii) State the conditions necessary for the observation of an interference pattern (02 marks)
(iii) Describe how interference can be used to test for the flatness of a surface (03 marks)

(b) Describe with the aid of a labelled diagram, how the wavelength of monochromatic light is measured using Young's double-slit method. ((05 marks)

(c) Two microscope slides are in contact at one end and are separated by a thin piece of paper at the other end. Monochromatic light is directed normally on the wedge.
(i) What type of fringes will be observed? (02 marks)
(ii) Explain what will be observed if a liquid is introduced between the slides (02 marks)

(d) When monochromatic light of wavelength 5.8 x 10^{-2} m is incident normally on a transmission grating, the second order diffraction line is observed at an angle of 27o. How many lines per centimetre does the grating have? (04 marks)

SECTION B:

5. (a) (i) Write down the expression for the force exerted on a straight wire of length, l metres carrying a current, 1 amperes right angles to the magnetic field of flux density B teslas (01 marks)

(ii) A rectangular coil of N turns and area A m2 is suspended in a uniform magnetic field of flux density B telas. Initially the plane of the coil is at right angles to the magnetic field. Derive the expression for the initial couple on the coil when a current of, 1 amperes flows through the coil (05 marks)

(b) Draw a labelled diagram of a moving coil galvanometer and explain how it works (06 marks)

(c) A small circular coil of 10 turns and mean radius 2.5 cm is mounted at the centre of a long solenoid of
750 turns per metre with its axis at right angles to the axis of the solenoid. If the current in the solenoid is 2.0A. Calculate the initial torque on

the circular coil when a current of 1.0 A is passed through it

(05 marks)

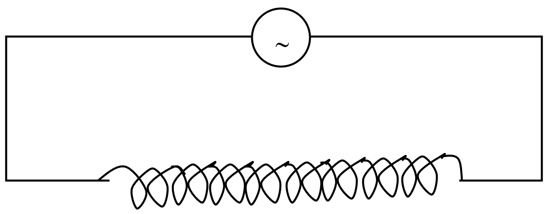
(d) Explain why a current carrying conductor placed in a magnetic field experiences a force (03 marks)

6. (a) (i) What is meant by the root mean square value of an alternating current? (01 marks)

(ii) Describe with the aid of a labelled diagram, the structure and action of a moving iron ammeter (05 marks)

(iii) What is meant by the term reactance? (01 marks)

(b) In the diagram in Figure 2 V_L is the voltage drop across the inductor.



V_L

Fig 2

(i) Draw a vector diagram to show the orientation of V_L with respect to current 1. (01 mark)

(ii) Using the same axes, sketch graphs to show the variations of V_L and 1 with time (02 marks)

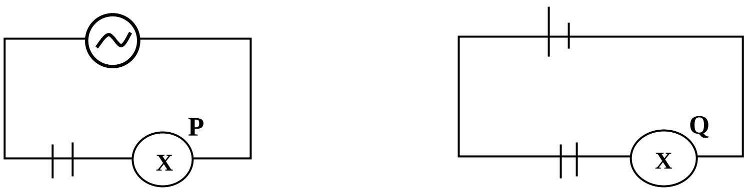


Fig 3

The bulbs P and Q have the same rating. P is connected in series with a capacitor across an a.c source while Q is connected in series with an identical capacitor across a d.c source of e.m.f equal to the root mean square voltage of the a.c as shown in Figure 3. Explain why bulb P lights continuously while bulb Q does not. (05 marks)

(d) A 240 V, 60Hz alternating voltage is applied across a capacitor of capacitance 10 μF. Calculate the

(i) root mean square value of the current which flows (04 marks)

(ii) power expanded (01 mark)

7. (a) (i) Define ampere (01 mark)

(ii)

very long wire

1_1 = 10A P

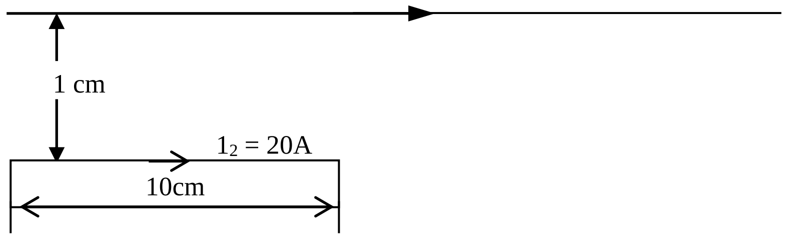


Fig 4

The diagram in Figure 4 shows two parallel wires P and Q placed 1cm apart and carrying currents of 10A and 20A respectively in the same direction. If wire Q is 10 cm long, find the magnetic force acting on it. (04 marks)

(b) A stream of electrons enters normally, a uniform magnetic field which is perpendicular to and directed into the plane of the page as shown in Fig 5.

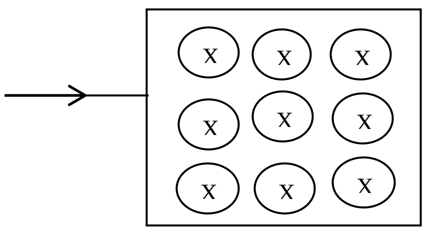


Fig 5

Explain, with the aid of a diagram the path of the electrons while inside the field and after leaving it (06 marks)

(c) Explain why when a current is switched off in some circuits, a spark is seen across the gap of the switch. (03 marks)

(d) Show that the total charge which passes through a coil depends only on the resistances of the coil and the total flux linked (06 marks)

SECTION C:

8. (a) (i) Define electrical resistivity and the ohm (02 marks)

(ii) Describe an experiment to determine the electrical resistivity of a material in the form of a wire using a metre bridge. (07 marks)

(b)

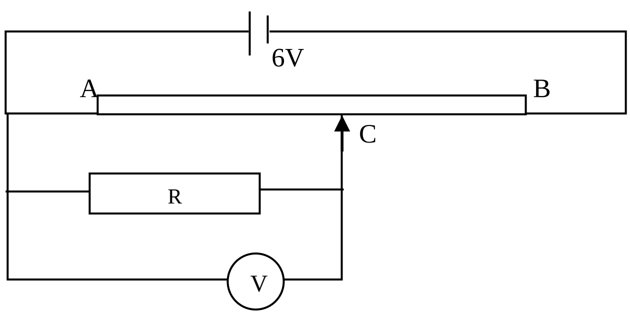


Fig 6

In figure 6 the wire AB of length 1.00m has a resistance of 10Ω . If point C is the mid-point of AB, and the volumeter reading is 2.0V, find the value of R (06 marks)

(c) Describe current versus voltage characteristics of a

(i) semi-conductor diode (02 marks)
(ii) filament lamp (02 marks)

(d) Why does ohm's law hold at constant temperatures only? (01 mark)

9. (a) Define the terms dielectric constant and capacitance (02 marks)
(b) An air capacitor of capacitance 400μF. is charged to 180V and the connected across an charged capacitor of capacitance 500μF.
(i) Find the energy stored in the 500μF capacitor (04 marks)
(ii) With the two capacitors still connected, a dielectric of dielectric constant 1.5 is inserted between the plates of the 400 μF. capacitor. If the separation between the plates remains the same, find the new p.d across the two capacitors. (03 marks)

(c) (i) State the characteristics of an equipotential surface (02 marks)
(ii) Describe how a conductor can be charged at zero potential (03 marks)

(d) Describe, with the aid of a diagram, how a high voltage can be generated using a Vande Graaf generator (06 marks)

10. (a) (i) State Coulomb;s law
(ii) Show that the electric flux through a spherical surface enclosing a charge in vacuum is Q/ϵ_o (02 marks)
(b) Define the terms electric field intensity and electric potential (02 marks)

(c)

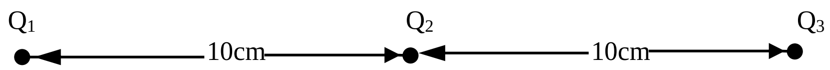


Fig 7

Three point charges Q_1, Q_2, and Q_3 of magnitude +5μC, + 6μC and – 20μC respectively are situated along a straight line as shown in Figure 7.

Calculate the electric field
(i) intensity mid-way between Q_1 and Q_2 (03 marks)
(ii) potential mid-way between Q_1 and Q_2 (03 marks)

(d) (i) Explain why two insulating bodies rubbed together acquire equal and opposite charges (03 marks)0
(ii) Describe how a gold leaf electroscope can be used to verify the observation (d) (i) (06 marks)

P510/1
PHYSICS
Paper 1
Nov/Dec 2002

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of Education
PHYSICS
Paper 1
2 hours 30 minutes

SECTION A

1. (a) (i) What is meant by the dimensions of a physical quantity? (01 marks)
(ii) For stream line flow of a non-viscous, incompressible fluid, the pressure, P at a point is related to the height h and the velocity v, by the equation $(P – a) = \rho g (h – b) + ½ \rho(v2 – d)$ where a, b and d are constants and ρ is the density of the fluid and g is the acceleration due to gravity. Given that the equation is dimensionally consistent, find the dimensions of a, b and d. (03 marks)

(b) Define *simple harmonic motion* (01 mark)

(c) Sketch the following graphs for a body performing simple harmonic motion.
(i) velocity against displacement (01 mark)

(ii) displacement against time (01 mark)

(d) The period oscillation of a conical pendulum is 2.0s. If the string makes an angle of 60o to the vertical at the point of suspension, Calculate the:

(i) vertical height of the point of suspension above the circle (03 marks)
(ii) length of the string (01 mark)
(iii) velocity of the mass attached to the string (03 marks)

(e) (i) Give one example of an oscillatory motion which approximates simple harmonic motion (01 mark)
(ii) What approximation is made in (e) (i)? (01 mark)

(f) Explain why the acceleration of a ball bearing falling through a liquid decreases continuously until it becomes zero (04 marks)

2. (a) (i) State Newton's law of universal gravitation
(ii) Show that this law is consistent with Kepler's third law. (03 marks)
(iii) two alternative units for gravitational field strength are N kg^{-1} and ms^{-1}. Use the method of dimensions to show that the two units are equivalent (03 marks)

(b) (i) Derive an expression for the speed of a boy moving uniformly in a circular path (03 marks)
(ii) Explain why a force is necessary to maintain a body moving with constant speed in a circular path (03 marks)

(c) A small mass attached to a string suspended from a fixed point moves in a circular path at constant speed in a horizontal plane.

(i) Draw a diagram showing the forces acting on the mass (01 mark)

(ii) Derive an equation showing how the angle of inclination of the string depends on the speed of the mass and the radius of the circular path. (03 marks)

(d) (i) Define moment of a force

(ii) A wheel of radius 0.60m is pivoted at its centre. A tangential force of 4.0N acts on the wheel so that the wheel rotates with uniform velocity. Find the work done by the force to turn the wheel through 10 revolutions (03 marks)

3. (a) (i) Show that the weight of fluid displaced by an object is equal to the upthrust on the object (05 marks)

(ii) A piece of metal of mass 2.60×10^{-3} kg and density 8.4×10^{3} kg m^{-3} is attached to a block of wax of mass 1.0×10^{-2} kg and density 9.2×10^{2} kg m^{-3}. When the system is placed in a liquid it floats with wax just submerged. Find the density of the liquid (04 marks)

(b) Explain the

(i) terms *laminar flow* and *turbulent flow*. (04 marks)

(ii) effects of temperature on the viscosity of liquids and gases (03 marks)

(c) (i) Distinguish between *static pressure* and *dynamic pressure*. (02 marks)

(ii) a pitot-static tube fitted with a pressure gauge is used to measure the speed of a boat at sea. Given that the speed of the boat does not exceed $10ms^{-1}$ and the density of sea water is 1050 kgm^{-3}. Calculate the maximum pressure on the gauge.

4. (a) Define the term surface tension in terms of surface energy (01 mark)

(b) (i) Calculate the work done against surface tension forces in blowing a soap bubble of diameter 15 mm, if the surface tension of the soap solution is 3.0×10^{-2} Nm^{-1} (03 marks)

(ii) A soap bubble of radius r1 is attached to another bubble of radius r2. If r1 is less than r2, show that the radius of curvature of the common interface is $\frac{r_1 r_2}{r_2 - r_1}$ (05 marks)

(c) (i) Define *coefficient of viscosity* of a liquid (01 marks)
(ii) Describe a simple experiment to demonstrate stream line and turbulent flow in a liquid (06 marks)

(d) (i) Sketch a graph of potential energy against separation of two molecules in a substance (01 marks)
(ii) Explain the main features of the graph in (d) (i) (03 marks)

SECTION B

5. (a) State the assumptions made in the derivation of the expression

$P = {}^1/_3\, \rho \overline{c^2}$ for pressure of an ideal gas (02 marks)

(b) Use the expression in (a) above to deduce Dalton's law of partial pressures (03 marks)
(c) Describe an experiment to determine the saturation vapour pressure of a liquid (06 marks)
(d) (i) What is meant by a *reversible isothermal change*? (02 marks)
(ii) State the conditions for achieving a reversible isothermal change (02 marks)

(e) An ideal gas at 27°C and at a pressure of 1.01 x 105 Pa is compressed reversibly and isothermally until its volume is halved. It is then expanded reversibly and adiabatically to twice its original volume. Calculate the final pressure and temperature of the gas if Y = 14 (05 marks)

6. (a) Explain the mechanism of heat conduction in solids (03 marks)
(b) Describe a method of determining the thermal conductivity of cork in the form of a thin sheet (06 marks)
(c) A window of height 1.0m and width 1.5 m contains a double glazed unit consisting of two single glass panes, each of thickness 4.0 mm separated through the window if the temperatures of the external surfaces of glass are 20^o C and 30^o C respectively.
[Thermal conductivities of glass and air are 0.72 Wm^{-1} k^{-1} and 0.025 Wm^{-1} respectively.] (07 marks)

(d) (i) State Stefan's law (01 mark)
(ii) The element of 1.0 kW electric fire is 30.0 cm long and 1.0 cm in diameter. If the temperature of the surroundings is 20°C, estimate the working temperature of the element. (03 marks)

7. (a) (i) Define specific heat capacity of a substance (01 marks)
(ii) State how heat losses are minimised in calorimetry (02 marks)

(b) (i) what is meant by a cooling correction? (01 marks)
(ii) Explain how the cooling correction may be estimated in the determination of the heat capacity of a poor conductor of heat by the method of mixture (05 marks)

(iii) Explain why a small body cools faster than a larger one of the same material. (04 marks)

(c) Describe how you would determine the specific heat capacity of a liquid by the continuos flow method (07 marks)

SECTION C

8. (a) What is meant by
(i) Bohr atom? (01 marks)
(ii) Binding energy of a nucleus? (02 marks)

(b) The total energy E, of an electron in an atom may be expressed at

$$E = \frac{-mq^4}{8\,\epsilon_o^2 n^2 h^2}$$

(i) Identify the quantities m, q, n and h in this express (02 marks)

(ii) Explain the physical implication of the fact that E is always negative. (02 marks)

(iii) Draw an energy level diagram for hydrogen to indicate emission of ultraviolet, visible and infra-red spectral lines (04 marks)

(c) (i) Explain briefly, the method of detecting infra-red-radiation (03 marks)

(ii) Describe briefly, the method of detecting infra-red radiation (03 marks)

(d) The atomic nucleus may be considered to be a sphere of positive charge with a diameter very much less than that of the atom. Discuss the experimental evidence which supports this view (03 marks)

9. (a) (i) What are cathode rays? (01 mark)

(ii) An electron gun operating at 3 x 10^3V is used to project electrons into the space between two oppositely charged parallel plates of length 10 cm and separation 5 cm.

Calculate the deflection of the electrons as they emerge from the region between the charged plates when the potential difference is 1 x 10^3V. (04 marks)

(b) (i) Describe a simple experiment to demonstrate photoelectric emission (04 marks)

(ii) Explain why the wave theory of light fails to account for the photoelectric effect (06 marks)

(iii) Describe an experiment to verify Einstein's equation for the photoelectric effect and explain how Planck's constant may be obtained from the experiment (06 marks)

10. (a) What is meant by

(i) half-life of a radioactive element (01 mark)

(ii) nuclear fission (01 mark)

(iii) nuclear fusion? (01 mark)

(b) An atom of ^{222}Ra emits an α- particle of energy 5.3 MeV. Given that the half-life of ^{222} Ra is 3.8 days, use the decay law, $N = N_o e^{-2t}$ to calculate

(i) decay constant, (03 marks)

(ii) amount of energy released by 3.0 x 10 – 9 Kg of ^{222}Ra after 3.8 days (05 marks)

(c) Describe a simple form of a mass spectrometer and explain how it is used to distinguish between isotopes (07 marks)

(d) The nucleus of $^{37}_{17}$ Cl emits an α-particle followed by two β-particles. Show that the final nucleus is an isotope of chlorine. (02 marks)

P510/2
PHYSICS
Paper 2
Nov/Dec 2002

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of Education
PHYSICS
Paper 2
2 hours 30 minutes

SECTION A

1. (a) (i) State the laws of reflection of light (02 marks)
(ii) Show, with the aid of a ray diagram, that the radius of curvature of a concave mirror is twice the focal length of the mirror (05 marks)

(b) An object is placed 20cm infront of a diverging lens placed coaxially with a concave mirror of focal length 15 cm. When the concave mirror is 20 cm from the lens the final image coincides with the object
(i) Draw the ray diagram to show how the final image is formed (02 marks)
(ii) Determine the focal length of the diverging lens (04 marks)

(c) (i) Define angular magnification of an optical instrument (01 mark)

(ii) What is meant by an exit pupil of a compound microscope? (02 marks)

(iii) Describe with the aid of a ray diagram, the structure and action of a compound microscope in normal adjustment (04 marks)

2. (a) (i) What is meant by the refractive index of a material?

(ii) Monochromatic light incident on a block of material placed in a vacuum is refracted through an angle θ. If the block has a refractive index n and is of thickness t, show that the light takes a time $\frac{nt\sec\theta}{c}$ to emerge from the block where c is the speed of light in a vacuum

(03 marks)

(b)

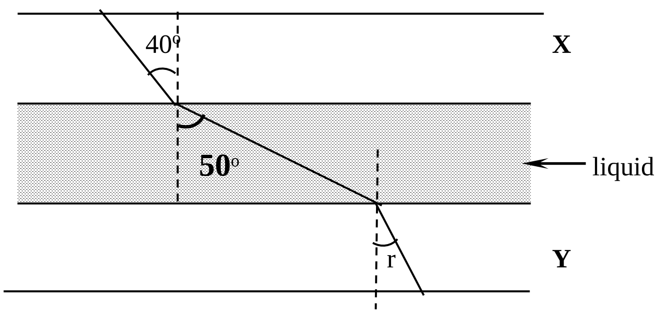


Fig 1

Figure 1 shows a layer of liquid confined between two transparent plates X and Y of refractive indices 1.54 and 1.44, respectively

A ray of mono-chromatic light making an angle of 40o with the normal to the interface between medium X and the liquid is refracted through an angle of 50o by the liquid. Find the

(i) refractive index of the liquid (02 marks)

(ii) angle of refraction, r in the medium Y (02 marks)

(iii) minimum angle of incidence in medium X for which the light will not emerge from medium Y (03 marks)

(c) (i) A ray of monochromatic light is incident at a small angle of incidence on a small angle prism in air. Obtain the expression d = (n – 1) A for the deviation of the light by the prism (05 marks)

(ii) Light of two wavelengths is incident at a small angle on a thin prism of refracting angle 5° and refractive indices 1.52 and 1.50 for the two wavelengths. Find the angular separation of the two wavelengths after refraction by the prism (03 marks)

3. (a) Why is light referred to as transverse wave? (01 mark)

(b) (i) State Huygen's principle (02 marks

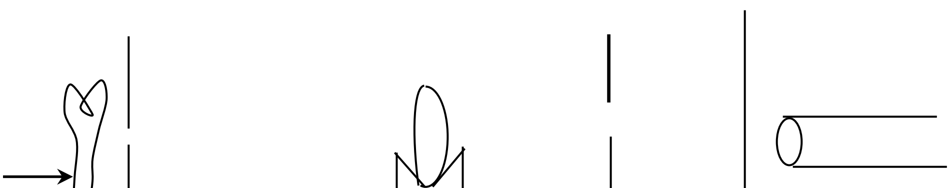
(ii) Use Huygen's principle to show that the refractive index of medium 2 relative to medium 1 is given by $_1n_2 = \frac{v_1}{V_2}$ where v1 and v_2 are the velocities of light in medium 1 and 2 respectively. (07 marks)

(c) (i) What is meant by division of wave fronts as applied to interference of waves?

(ii) Two slits A and B are separated by a distance d and illuminated with light of wavelength λ. Derive the expression for the separation between successive fringes on a screen placed a distance D from the slits (05 marks)

(iii) In Young's double-slit experiment, the 8^{th} bright fringe is formed 5 mm away from the centre of the fringe system when the wavelength of light used is 62 x 10^{-2} m. Calculate the separation of the two slits if the distance from the slits to the screen is 80 cm. (03 marks)

4. (a) Explain the term interference as applied to light (04 marks)



(b)

E
Eye piece

Source of
Of white light

Screen with
With a small hole

Adjustable aperture

Fig 2

In an experiment to observe diffraction of light, the set up in figure 2 is used
(i) Describe what you would see at E if the aperture is gradually reduced (02 marks)
(ii) Explain your observations in (b) (i) above (04 marks)

(c) A diffraction grating has 550 lines per mm. When it is illuminated normally by monochromatic light, the angle between the central maximum and first maximum is 19.1o. Find the
(i) wavelength of the light ()4 marks)
(ii) number of diffraction maxima obtainable (02 marks)

(d) State two uses of diffraction of light

SECTION B:

5. (a) Distinguish between self induction and mutual induction
(b) (i) Explain the factors which affect the efficiency of a transformer
(iii) power of 6000 W produced at 100V is to be transmitted over a distance of 2 km through cables of resistance 0.2 $\Omega\ m^{-1}$. Determine the voltage at the output of a transformer needed to transmit the power so that only 5% of it is lost.
Assume the transformer is 100% efficient) (05 marks)

(c)

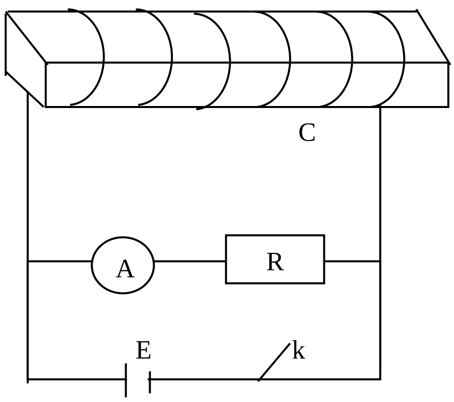


Fig 3

In the diagram in Figure 3 C is a coil of a large number of turns connected in series with a centre zero meter A, and a resistor R across cell E. The switch K is closed for some time and then opened.
(i) Sketch a graph to show the variation of current with time observed on the ammeter from the moment K was first closed. (01 marks)
(ii) Explain the variation of current observed in (c) (i) (05 marks)
(iii) Describe the effect of placing a bunch of soft iron wires inside the coil, on the observations in (c) (ii) (02 marks)

6. (a) (i) Write down the expression for the force on a charge, q coulombs moving with velocity, V at an angle, 0 to a uniform magnetic field of flux density, B

(01 marks)

(ii) Use the expression in (a) (i) above to deduce the force on a conductor carrying a current in a magnetic field

(03 marks)

(iii) Two thin, long parallel wires A and B carry currents of 5A and 2A respectively in opposite directions. If the wires are separated by a distance of 2.5 cm in a vacuum, calculate the force exerted by wire B on 1 m of wire A

(03 marks)

(b) With the aid of a diagram, explain the terms angle of dip and magnetic meridian, as applied to the earth's magnetic field

(c) (i) Describe, using an appropriate circuit diagram, an experiment to investigate the dependence of magnetic flux density at the centre of a circular coil, on the current through the coil (02 marks)

(ii) State two other factors on which the magnetic flux density in (c) (i) depends (02 marks)

7. (a) (i) Define magnetic flux (01 marks)

(ii) Describe an experiment to investigate the relationship between the force on a current conductor situated in a uniform magnetic field and the current, using the ampere/current balance (06 marks)

(b)

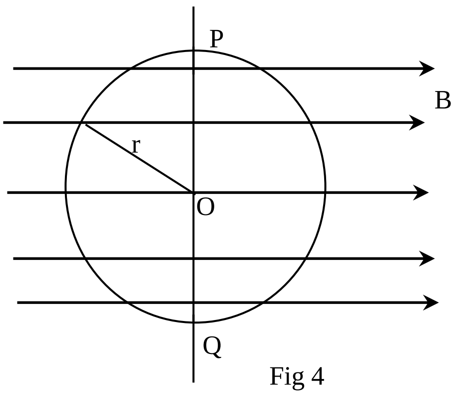


Fig 4

A circular loop of wire radius r is placed in a uniform magnetic field of flux density B, with the axis to the field as shown in Figure 4. Explain what happens to the loop when current starts to flow in it in a clockwise direction if the loop is pivoted about the axis POQ. (04 marks)

(c) A vertical square coil of side 5 cm has 100 turns and carries a current of 1 A. Calculate the torgue on the coil when it is placed in a horizontal magnetic field of flux density 0.2 T with its plane making an angle of 30^o to the field ()3 marks)

(d) Explain why a moving coil galvanometer should have a radial magnetic field, fine hair springs and many turns

SECTION C:

8. (a) State ohm's law (01 marks)

(b) Describe with the aid of a circuit diagram, an experiment to determine the relationship between the resistance and the length of a wire (06 marks)

(c) A dry cell gives a balance length of 84.8 cm on a potentiometer wire. When a resistor of resistance 15Ω is connected across the terminals of the cell, a balance length of 75.0 cm is obtained. Find the internal resistance of the cell. (04 marks)

(d) A battery of e.m.f 18.0V and internal resistance 3.0Ω is connected to a resistor of resistance 8Ω. Calculate the

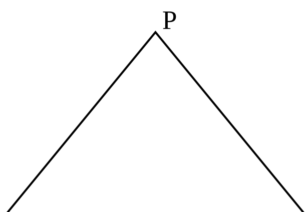
(i) power generated (02 marks)
(ii) efficiency (02 marks)

(e) If the 8Ω resistor in (d) is replaced by a variable resistor, sketch graphs to show the variation of power and efficiency with the load. (03 marks)

(f) Explain why a metal wire gets hot when current is passed through it (02 marks)

9. (a) define electric potential

(b) Obtain an expression for the electric potential at a point a distance, r from a point charge, Q, situated in a vacuum (04 marks)



(c)

5 cm 5cm Figure 5

A B

The point charges A and B of charges + 0.10 μc and +0.05μ c are separated by a distance of 8.0 cm along the horizontal as shown in Figure 5. Find the electric field intensity at P.

(d) Sketch the electric field pattern due to the charge distribution in (c) above. (02 marks)
(e) Explain how a lightening conductor works. (04 marks)

10. (a) Sketch the electric field lines between two large parallel metal plates across which a p.d is applied
(b) (i) Describe with aid of a diagram how you would investigate the factors which affect the capacitance of a parallel plate capacitor
(ii) Calculate the capacitance of a parallel capacitor whose plates are 10 cm by 10 cm separated b an air gap of 5 mm (02 marks)

(c) A hollow spherical conductor of diameter 21.4 cm carrying a charge of 6.9×10^{-10} C is raised to a potential of 50V. Find the permitivity of the surrounding medium (03 marks)

(d) (i) Show that the effective capacitance C, of two capacitances, C1 and C2, connected in series is given by

$$C = \left(\frac{C_1 C_2}{C_1 + C_2} \right)$$

()4 marks)

(ii) A 20μF capacitor is charged to 40V and then connected across an uncharged 60μF capacitor. Calculate the potential difference across the 60μF capacitor. ()3 marks)

PHYSICS
Paper 1
Nov/Dec 2001
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of Education

PHYSICS

(PRINCIPAL SUBJECT)

Paper 1

(2 hours 30 minutes)

SECTION A

1. (a) (i) State the principle of conservation of mechanical energy (1 mark)

(ii) Show that a stone thrown vertically upwards obeys the principle in (i) above throughout its upward motion (4 marks)

(b) (i) A wind turbine made of a blade of radius, r, is driven by a wind of speed, V. If σ is the density of air, derive an expression for the maximum power, P, which can be developed by the turbine in terms of σ, r and V. (3 marks)

(ii) Explain why the power attained is less than the maximum value in b (i) above (2 marks)

(c) State the conditions under which the following will be conserved in a collision between two bodies
(i) linear momentum (1 mark)
(ii) kinetic energy (1 mark)

(d) Two pendula of equal length, 1, have bobs A and B of masses 3M and M respectively. The pendula are hung with bobs in contact as shown in figure 1.

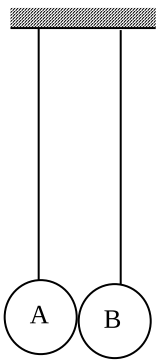


Fig 1

The both A is displaced such that the string makes an angle with vertical and released. If A makes a perfect inelastic collision with B, find the height to which B rises.

2. (a) Define the following terms:
(i) stress (1 mark)
(ii) strain (1 mark)

(b) The velocity, V, of sound travelling along a rod made of a material of Young's modulus, Y and density ρ is given by

$$V = \sqrt{\frac{Y}{P}}$$

Show that the formula is dimensionally consistent (3 marks)

(c) State the measurements necessary in the determination of Young's modulus of a metal wire (2 marks)

(d) Explain why the following precautions are taken during an experiment to determine Young's modulus of a metal wire

(i) two long, thin wires of the same material are suspended from a common support (1 mark)

(ii) the readings of the vernier are also taken when the loads are gradually removed in steps (1 mark)

(e) The ends of a uniform wire of length, 2.00 m are fixed to points A and B which are 2.00 m apart in the same horizontal line. When a 5kg mass is attached to the mid-point C of the wire, the equilibrium position of C is 7.5cm below the line AB. Given that Young's modulus for the material of the wire is 2.0×10^{11} Pa, find

(i) the strain in the wire (3 marks)
(ii) the stress in the wire (2 marks)
(iii) the energy stored in the wire (4 mark)
State any assumptions made (1 mark)

3. (a) Define surface tension and derive its dimensions
(b) Explain using the molecular theory the occurance of surface tension
(c) Describe an experiment to measure surface tension of a liquid by the capillary tube method
(d) (i) Show that the excess pressure in a soap bubble is given by

$$P = \frac{4y}{r}$$

(ii) Calculate the total pressure within a bubble of air of radius 0.1mm in water, if the bubble is formed 10 cm below the water. (Atmospheric pressure = 101×10^5 Pa)

4. (a) (i) Define coefficient of viscosity and determine its dimensions.
(ii) The resistive force on a steel ball bearing of radius r, falling with speed, V, in a liquid of viscosity, η, is given by $F = K\eta rV$, where K is a constant. Show that K is dimensionless.

(b) Write down Bermoull's equation for fluid flow, defining all symbols used

(c) A venturi meter consists of a horizontal tube with a constriction which replaces part of the piping system as shown in figure 2.

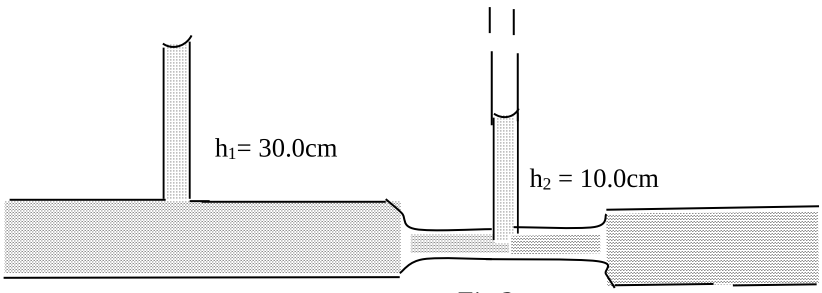


Fig 2

If the cross-sectional area of the main pipe is 5.81×10^{-3} m^2 and that of the constriction is 2.58×10^{-3} m^2, find the velocity v1, of the liquid in the main pipe. (5 marks)
(d) Explain the origin of the lift on an aeroplane at take-off (04 marks)

SECTION B:

5. (a) Define thermal conductivity of a substance and state its units
(b) The flux of solar energy incident on the earth's surface is 1.36 x 103 Wm – 2
Calculate:
(i) the temperature of the surface of the sun (3 marks)
(ii) the total power emitted by the sun (3 marks)
(iii) the rate of loss of mass by the sun (3 marks)

(c) (i) Explain how heat is conducted through a glass rod (3 marks)

(ii) Why is a metal a better conductor of heat than glass? (2 marks)

(iii) Explain briefly why it is necessary to use a thin specimen of a large cross-sectional area in determining thermal conductivity of a poor conductor of heat (3 marks)

6. (a) (i) Explain what happens when a quantity of heat is applied to a fixed mass of gas (5 marks)

(ii) Derive the relation between the principal molar heat capacties Cp and Cv for an ideal gas (5 marks)

(b) (i) What is an adiabatic process? (1 mark)

(ii) A bicycle pump contains air at 290K. The piston of the pump is slowly pushed in until the volume of the air enclosed is one fifth of the total volume of the pump. The outlet is then sealed off and the piston suddenly pulled out to full extension. If air escapes, find its temperature immediately after pulling the piston. (Take $^{Cp}/_{Cv}$ = 1.4) (3 marks)

(c) (i) Distinguish between unsaturated and saturated vapours. (2 marks)

(ii) Draw graphs to show the relationship between pressure and temperature for an ideal gas and for saturated water vapour originally at 0°C. (3 marks)

(d) In an experiment, the pressure of a fixed mass of air at constant temperature is 10.4 kPa. When the volume is halved, keeping the temperature constatnt, the pressure becomes 19.0 kPa. Discuss the applicability of the above results in verifying Boyle's (4 marks)

7. (a) Explain why temperature remains constant during change of phase (4 marks)

(b) Describe with the aid of a labelled diagram, an electrical method for determination of specific latent heat of vaporisation of a liquid (7 marks)

(c) Water vapour and liquid water are confined in an air-tight vessel. The temperature of the water is raised until all the water has evaporated. Draw a sketch graph to show how the pressure of the water vapour changes with temperature and account for its main features. (6 marks)

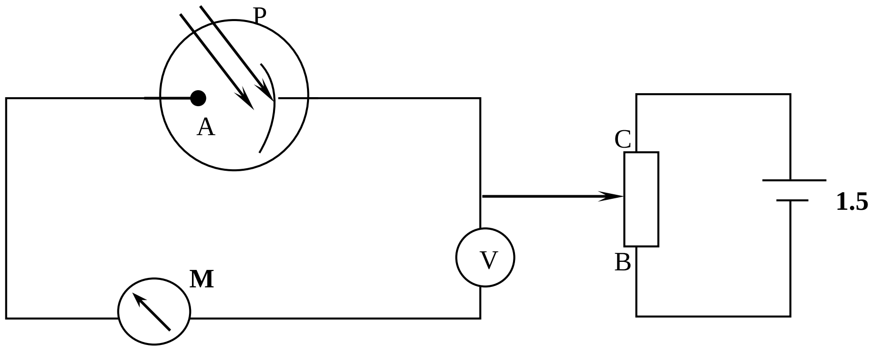
(d) Calculate the work done against the atmosphere when 1kg of water turns into vapour at atmospheric pressure of 1.0 x 105 Pa. [Density of water vapour = 0.598 kgm $^{-3}$]

SECTION C

8. (a) (i) Write down the Einstein photo-electric equation (1 mark)

(ii) Explain how the equation in (i) above accounts for the emission of electrons from metal surfaces illuminated by radiation (4 marks)

(b)



P is a vacuum photocell with anode, A, and cathode, K, made from the same metal of work function 2.0 eV. The cathode is illuminated by monochromtic light of constant intensity and of wavelength 4.4 x 10^{-7} m.

(i) Describe and explain how the current shown by the microammeter, M will vary as the slider of the potential divider is moved from B to C

(ii) What will the reading of the high resistance voltmeter, V, be when photo-electric emission just ceases?

(c) With the slider set mid-way between B and C, describe and explain how the reading of M would change if

(i) the intensity of the light was increased, (3 marks)

(ii) the wavelength of the light was changed to 5.5 x 10^{-7} m (6 marks)

9. (a) What is meant by the following

(i) an alpha particle (1 mark)

(ii) radioactivity? (1 mark)

(b) Show that when an alpha particle collides head-on with an atom of atomic number Z, the closet distance of approach to the nucleus, b_o , is given by

$$bo = \frac{Ze^2}{\pi \epsilon_o mv^2}$$ where e, is the electronic charge, ϵ_o

is the permitivity of free space, m mass of the alpha particle and V is the initial velocity of the particle (6 marks)

10. (a) (i) What is meant by emission line spectra?

E∞ - - - - - - - - - - - - - - - - o eV

E_4 -- –0.81ev

E_3 -- ⁻277ev

E_2 -- –4.87ev

E_1 -- – 21.47v

(ii) Figure 3 shows some of the energy levels of neon. Determine the wavelength of the radiation emitted in an electron transition from E_4 to E_3. In what region of the electro-magnetic spectrum does the radiation lie? (4 marks)

(b) Outline the principles of generation of continuous line spectra of X-rays in an X-ray tube (3 marks)

(c) State Bragg's law of X-ray diffraction (1 mark)

(d) A beam of X-rays of wavelength 1.0 x 10 – 10 m is incident on a set of cubic planes in a sodium chloride crystal. The first order diffracted beam is obtained for a grazing angle of 10.2o.

Find:

(i) the spacing between consecutive planes (3 marks)

(ii) the density of the sodium chloride (4 marks)

P510/2
PHYSICS
Paper 2
Nov/Dec 2001
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 2
2 hours 30 minutes

SECTION A:

1. (a) State the laws of refraction of light (2 marks)

(b) (i) Derive an expression for the refractive index of a prism in terms of the refracting angle, A, and the angle of minimum deviation, D (5 marks)
(ii) Monochromatic light is incident on one refracting face of a prism of refracting angle 60o, made of glass of refractive index 1.50

(c) (i) State three differences between compound microscopes and telescopes (3 marks)
(ii) Describe, with the aid of a ray diagram, how a compound microscope forms a final image at the near point (3 marks)

2. (a) Define the terms radius of curvature and focal length of a converging mirror (2 marks)

(b) (i) Draw a ray diagram to show the formation of a real image of a real object by a converging mirror
(ii) Use the ray diagram in (b) (i) to derive the expression

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$, where u, v and f are the object distance.

i mage distance and focal length, respectively (5 marks)

(c) (i) With the aid of a ray diagram, describe the structure and action of a reflecting telescope in normal adjustment

(ii) State two advantages of a reflecting telescope over an astronomical telescope (2 marks)

(d) An astronomical telescope has an objective of focal length 100cm and an eyepiece of focal length 10cm. Calculate the separation of the objective and eyepiece if the lenses are arranged in such a way that the final image is formed at 25cm from the eye

3. (a) (i) Distinguish free and damped oscillations
(ii) Describe how the amplitude of a forced oscillation builds up to a constant value

(b) The displacement in metres of a plane progressive wave is given by the equation
$y = 0.5 \text{ Sin } [\ \pi (200t - \frac{20x}{17})\ ]$

Find
(i) wavelength and (2 marks)
(ii) speed, of the wave (2 marks)

(c) (i)Explain the occurrence of beats in sound
(ii) Two tuning forks X and Y are sounded together to produce beats of frequency 8Hz. Fork X has a known frequency of 512 Hz. When Y is loaded with a small plasticine, beats at a frequency of 2Hz are heard when the two turning forks are sounded together. Calculate the frequency of Y when unloaded

(d) (i) What is meant by Doppler effect?
(ii) A car sounds its horn as it travels at a steady speed of 15 ms – 1 along a straight road between two stationary observers A and B. The observer A hears a frequency of 538 Hz while B hears a lower frequency.

Calculate the frequency heard by B, assuming the speed of Sound in air is $340ms^{-1}$ (4 marks)

4. (a) (i) What is meant by interference and diffraction of light waves? (2 marks)
(ii) State the condition necessary for observing diffraction (1 mark)

(b) (i) Derive the expression for the fringe separation in Young's interference pattern in terms of the slit-separation, d, the distance, D, of the screen from double slits and the wavelength λ of the light (5 marks)

(c) Two slits 0.5mm apart are placed at a distance of 1.0m from the screen. The slits are illuminated with light of wavelength 550nm. Calculate the distance between the fourth and second bright fringes of the interference pattern (5 marks)

(d) A transmission diffraction grating of spacing, d is illuminated normally with light of wavelength λ
(i) Derive the condition for occurrence of diffraction maxima (3 marks)

(ii) Describe briefly the intensity distribution on a screen placed beyond the grating (2m)

(iii) What is the effect on the diffraction pattern of

SECTION B:

5. (a) (i) Define the ampere.
(ii) Write down the expression for the force on a conductor carrying current which is inclined at an angle to a uniform magnetic field. (2 marks)

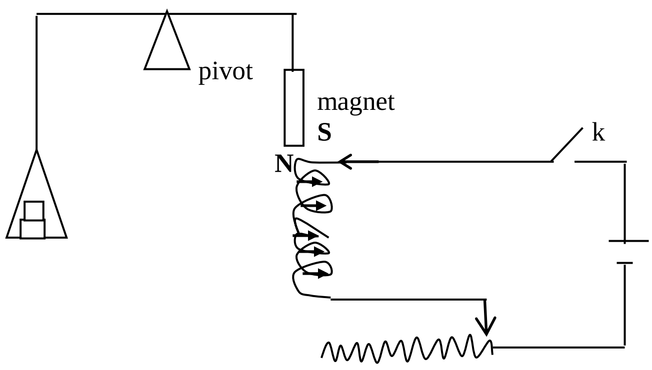


Fig 1

Figure 1 represents a current balance. When switch, K is open the force required to balance the magnet is 0.2N. When switch, K is closed and a current of 0.5A flows, a force of 0.22N is required for balance

(i) Determine the polarity at the end of the magnet closes to the coil
(ii) Calculate the weight required for balance when a current of 2A flows through the coil

6. A rectangular coil of N turns each of dimensions l x b is inclined at an angle θ to a uniform magnetic field of flux density, B. Derive an expression for the torque on the coil if a current I is passed through it.

(5 marks)

7. A ballistic galvanometer of sensitivity 2 divisions per μ C is connected across a coil of 10 turns wound tightly round the middle of a solenoid of 103 turns per metre and diameter 5.0cm. When the current in the solenoid is reversed, the ballistic galvanometer deflects through 8 divisions. If the total resistance of the coil and galvanometr is 20Ω, find the current in the coil

9. (a) State the laws of electro-magnetic induction (2 marks)

(b) A circular coil of 100 turns and cross-sectional area 0.2m2 is placed with its plane perpendicular to a horizontal magnetic field of flux density 1.0 x 10 – 2 T
The coil is roated about a vertical axis so that it turns through 60o in 2s.
Calculate"
(i) the initial flux linkage through the coil (2 marks)
(ii) the e.m.f induced in the coil (2 marks)

(c) (i) Explain the origin of the back e.m.f in an electric motor. (2 marks)
(ii) A motor whose armature resistance is 2Ω is operated on 240V mains supply. If the back e.m.f in the motor is 220V, calculate the armature current (3 marks)

(d) (i) Describe with the aid of a diagram the mode of action of a simple d.c. generator (6 marks)

(ii) Sketch the output of a d.c generator (1 mark)

(iii) What is the major difference between a d.c. motor and a d.c generator? (1 mark)

10. (a) Define root mean square value (rms) of an alternating current
(b) A sinusoidal alternating voltage V = 170 sin 12πt, volts, is applied across a resistor of resistance 100Ω

Determine:
(i) the rms value of the current which flows (2 marks)
(ii) the frequency of the current through the resistor (2 marks)

(c) With the aid of a labelled diagram describe the structure and action of a hot wire ammeter (6 marks)
(d) Explain the terms *self-induction* and *mutual induction* (3 marks)

11. A coil of self-inductance L and negligible resistance is connected across a source of alternating voltage
V = Vo cos ωt.

(i) Find the expression for the current which flows in the coil (3 marks)

(ii) Sketch, using the same axes, the time variation of the applied voltage and the current which flows in the coil (2 marks)

SECTION C

12. (a) Derive the conditon for a whetstone bridge to be balanced
(b) (i) Define temperature coefficient of resistance
(ii) When a coil X connected across the left-hand gap of a metre bridge is heated to a temperature of 30^{o} C, the balance point is found to be 51.5 cm from the left-hand end of the slide wire. When the temperature is raised to 100^{o} C, the balance point is 54.6 cm from the left end. Find the temperature coefficient of resistance of X

(c) (i) A battery of e.m.f ε and internal resistance, r is connected to a resistor of variable resistance, R. Obtain the expression for maximum power dissipated in the resistor.

(ii) A battery of e.m.f 6V and internal resistance 1Ω is connected across a network of resistors as shown in figure 2.

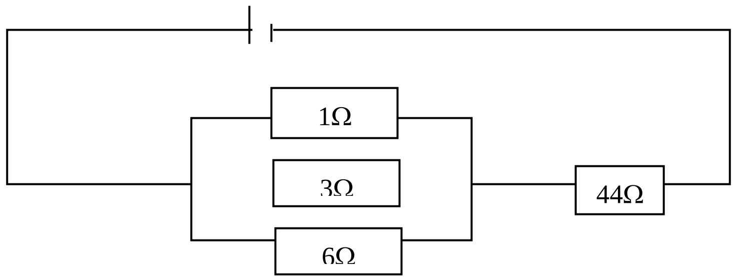
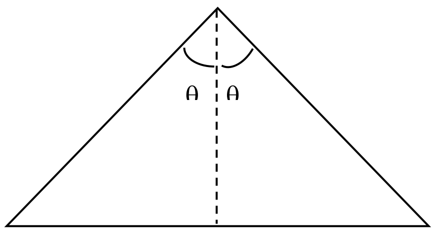


Fig 2

13. (a) State coulomb's law of electrostatics
(b) (i) Define electric field intensity and electric potential
(ii) Two identical conducting balls of mass, m are each suspended in air from a silk threat of length, I. When the two balls are each given identical charge, q, they move apart as shown in figure 3.



If at equilibrium each thread makes a small angle θ with the vertical, show that the separation, x, is given by

$$\left(\frac{q^2 l}{2\pi \varepsilon mg}\right)^{1/3}$$: Where ε is permitivity of air

(6 marks)

(c) (i) Define the term capacitance of a capacitor (1 mark)

(ii) State the factors that affect the capacitance of a capacitor (1 mark)

(d) The plates of a parallel plate capacitor each of area 2.0 cm^2 are 5 mm apart. The plates are in vacuum and a potential difference of 10,000V is applied across the capacitor. Find the magnitude of the charge on the capacitor.

14. (a) Define temperature coefficient of resistance and electrical resistivity.
(b) A nichrome wire of length 1.0m and diameter 0.72mm at 25° C, is made into a coil. The coil is immersed in 200cm^3 of water at the same temperature and a current of 5.0 A is passed through the coil for 8 minutes until when the water starts to boil at 100°C.
Find:
(i) the resistance of the coil at 25°C (2 marks)
(ii) the electrical energy expended assuming all of it goes into heating the water. (2 marks)
(iii) the mean temperature coefficient of resistance of nichrome between 0° C and 100°C.

(c) Describe, with the aid of a circuit diagram, how a slide wire potentiometer can be used to measure e.m.f of a cell. (4 marks)

(d) An accumulator of e.m.f 2.0V is connected across a uniform wire of length 1.0m and resistance 8.0Ω. A cell of e.m.f 1.50 V is connected in series with a galvanometer and connected across a length, l of the slide wire. The galvanometer shows no deflection when l is 90.0cm.

Find the internal resistance of the accumulator.

P510/1
PHYSICS
Paper 1
Nov/Dec 2000
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 1
2 hours 30 minutes

SECTION A

1. (a) (i) State Newton's laws of motion.
   (ii) Define impulse and derive its relation to linear momentum of the body on which it acts.

   (b) A body of mass $\mathbf{m_1}$ and velocity $\mathbf{u_1}$ collides head on with a body of mass m_2 having velocity $\mathbf{u_2}$, in the same direction as $\mathbf{u_1}$. Use Newton's laws to show the quantity, $\mathbf{m_1u_1}+m_2\mathbf{u_2}$ is conserved. (5 marks)

   (c) A ball of mass 0.5 kg is allowed to drop from rest, from a point a distance of 5.0 m above a horizontal concrete floor. When the ball first hits the floor, it rebounds to a height of 3.0m.
   (i) What is the speed of the ball just after the first collision with the floor? (4 marks)
   (ii) If the collision lasts 0.01 s, find the average force which the floor exerts on the ball. (5 marks)

2. (a) (i) State Archimede's principle (1 mark)
   (ii) What is simple harmonic motion? (2 marks)

   (b) A uniform cylindrical rod of length 0.08m, cross sectional area 0.02 m^2 and density 900 kg m^{-3} floats vertically in a liquid of density 1000 kg m^{-3}. The rod is depressed through a distance of 0.005 m and then released.
   (i) Show that the rod performs simple harmonic motion (5 marks)
   (ii) Find the frequency of the resultant oscillation (4 marks)
   (iii) Find the velocity of the rod when it is at a distance of 0.004m above the equilibrium position (3 marks)

   (c)

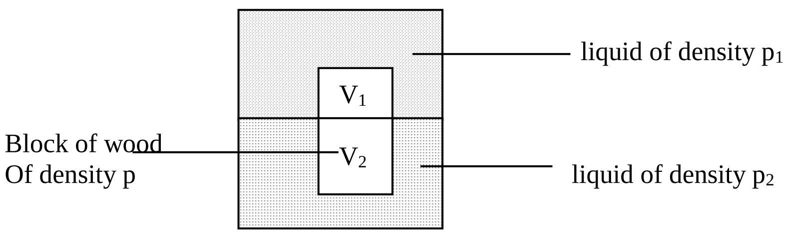


Fig 1

A block of wood of density p floats at the interface between immiscible liquids of densities p1 and p2 as shown in figure 1.
(i) Show that the ratio of the volume V1 to V2 of the block in the two liquids is given by

$$\frac{V_1}{V_2} = \frac{p_2 - p}{p - p_1}$$

(4 marks)

(ii) What happens when this block of wood is replaced with a denser one? (1 mark)

3. (a) Distinguish between scalar and vector quantities. Give two examples of each (3 marks)

(b) (i) Define the terms time of flight and range as applied to projectile motion (2 marks)

(ii) A projectile is fired in air with speed **u** ms^{-1} at an angle θ to the horizontal. Find the time of flight of the projectile. (2 marks)

(c) State the conditions for equilibrium of a rigid boy under the action of coplanar forces (2 marks)

(d) A mass of 5.0 kg is suspended from the end A of a uniform beam of mass 1.0 kg and length 1.0m. The end B of the beam is hinged in a wall. The beam is kept horizontal by a rope attached to A and to a point C, in the wall at a height 0.75 m above B.

(i) Draw a sketch diagram to show the forces acting on the beam (2 marks)
(ii) Calculate the tension in the rope (4 marks)
(iii) What is the force exerted by the hinge on the beam? (5 marks)

4. (a) State Kepler's laws on gravitation (3 marks)

(b) (i) Show that the period of a satellite in a circular orbit of radius **r** about the earth is given by:

$$T = \left(\frac{4\pi^2}{GMg}\right)^{½} r^{3/2}$$

where G is the universal gravitational constant and Mg is the mass of the earth (5 marks)

(ii) Explain briefly how world-wide radio or television communications can be achieved with the help of satellites. (4 marks)

(c) A satellite of mass 100 kg is in a circular orbit at a height of 3.59 x 107 m above the earth's surface.
(i) Find the mechanical energy of the satellite (4 marks)
(ii) Explain what would happen if the mechanical energy was decreased (4 marks)

SECTION B

5. (a) (i) Describe Seaarle's method of determining the thermal conductivity of a good conductor of heat (7 marks)
(ii) Why is the method in (a) (i) best suited for a good conductor of heat? (2 marks)

(b) The two ends of a metal bar of length 1.0 m are perfectly lagged up to 20 cm from either end. The ends of the bar are maintained at 100ºC and 0ºC respectively.
(i) Sketch a graph of temperature versus distance along the bar (2 marks)
(ii) Explain the features of the graph in (b) (i) (3 marks)

(c) The external walls of a house consist of two layers of brick separated by an air cavity. The outer face of the wall is at a temperature of 45ºC while the inside of the house is at 20ºC. If the thickness of each brick layer is 15 cm and of air cavity is 5 cm, calculate the temperatures of the walls in contact with air in the cavity.

6. (a) (i) State Boyle's law (1 mark)
(ii) What is meant by partial pressure of a gas? (1 mark)

(iii)

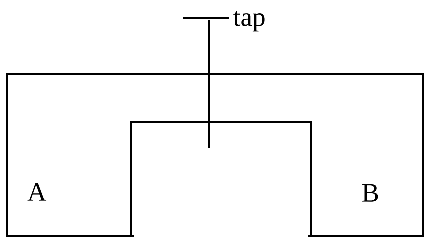


Fig 2

Two cylinders A and B of volumes V and 3V respectively are separately filled with gas. The cylinders are connected as shown in figure 2 with the tap closed. The pressures of the gas in A and B are P and 4P respectively. When the tap is opened the common pressure becomes 60Pa. Assuming isothermal conditions find the value of P (4 marks)

(b) (i) State three differences between ideal and real gases (3 marks)
(ii) Sketch a pressure versus volume curve for a real gas undergoing compression below its critical temperature (1 mark)
(iii) Explain the main features of the curve (3 marks)

(c) Two similar cylinders P and Q contain different gases at the same pressure. When gas is released from P the pressure remains constant for sometime before it starts dropping. When gas is released from Q the pressure continuously drops. Explain the observations above (5 marks)

(d) Using the expression for the kinetic pressure of an ideal gas, deduce the ideal gas equation if $\frac{1}{2} mc^2 = {}^3/_2 K_BT$ (2 marks)

7. (a) (i) State the desirable properties a material must have to be used as a thermometric substance (2 marks)
(ii) Explain why scales of temperature based on different thermometric properties may not agree

(b) (i) Draw a labelled diagram to show the structure of a simple constant volume gas thermometer (3 marks)
(ii) Describe how a simple constant-volume gas thermometer can be used to establish a Celsius scale of temperature (5 marks)

(iii) State the advantages and disadvantages of a mercury in glass thermometer and a constant-volume gas thermometer (3 marks)

(c) The resistance of the element of a platinum resistance thermometer is 4.00Ω at the ice-point and 5.46Ω at the stream point. What temperature on the platinum resistance scale would correspond to a resistance of 9.84Ω.

(d) The mean kinetic energy of one mole of helium gas at room temperature is 3.74 x 103 J. Calculate room temperature. (3 marks)

SECTION C:

8. (a) State the laws of photo electric emission (4 marks)

(b) (i) Describe an experiment to determine Planck's constant (5 marks)
(ii) Violet light of wavelength 0.4 μm is incident on a metal surface of threshold wavelength 0.65 μm. Find the maximum speed of emitted electrons (4 marks)

(iii) Explain why light whose frequency is less than the threshold frequency cannot cause photo emission

(2 marks)

(c) (i) What are X-rays?

(ii) Explain how the intensity and penetrating power of X-rays produced by an X-ray tube can be varied (4 marks)

9. (a) (i) Define the terms half-life and decay constant as applied to radioactivity. (2 marks)

(ii) State the relationship between half life and decay constant? (1 mark)

(b) The radio isotope ^{60}Co decays by emission of a β- particle and Y-ray. Its half life is 5.3 years.

(i) Find the activity of a source containing 0. 10 g of ^{60}Co. (4 marks)

(ii) In what ways do Y-rays differ from β-particles? (3 marks)

(c) (i) What is meant by mass defect in nuclear physics?

(ii) Calculate the mass defect for $^{59}_{26}Fe$, given the following information.:

Mass of $^{59}_{28}Fe$ nucleus = 58.93488U

Mass of a proton = 1.00728U

Mass of a neutron = 1.00867U (4 marks)

(d) Describe the structure and action of an ionisation chamber (5 marks)

10. (a) What is meant by specific charge of an ion? (1 mark)

(b)

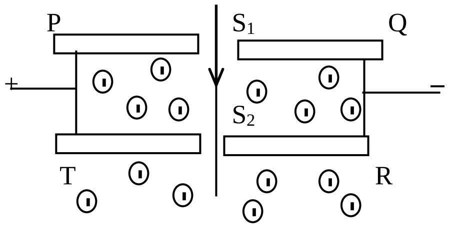


Fig 3

Positive ions of the same charge are directed through slit S1 into the region PQRT as shown in figure 3. There is a uniform electric field of intensity 300 NC^{-1} between the plates PT and QR. A uniform magnetic field of flux density 0.6 T is directed perpendicularly out of the plane of the page as shown above.

(i) Calculate the velocity of the ions which go through slit S_2. (3 marks)

(ii) Describe the motion of ions in the region below TR (3 marks)

(c) When fast moving electrons strike a metal target in a X-ray tube, two types of X-ray spectra are produced

(i) Draw a sketch graph of intensity against wavelength of the X-rays

(ii) Account for the occurrence of the two types of spectra (5 marks)

(d) Outline the experimental evidence for the quantum theory of matter (6 marks)

P510/2
PHYSICS
Paper 2
Nov/Dec 2000
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 2
2 hours 30 minutes

SECTION A:

1. (a) Define principle focus of a converging lens.

(b) A converging lens of focal length f is placed between a finite object and a screen: The position of the screen is adjusted until a clear magnified image is obtained on the screen. Keeping the screen fixed in this position at a distance l from the object, the lens is displaced through a distance d to obtain a clear diminished image on the screen
(i) Draw a ray diagram to show the formation of the images in the two cases (2 marks)
(ii) Show that $l^2 - d^2 = 4df$ (5 marks)
(iii) Find the product of the magnifications produced in the two cases (2 marks)

(c) (i) Draw any diagram to show how two converging lenses, one of long focal length, f_1, and the other of shorter focal length, f_2 can be arranged to make an astronomical telescope in normal adjustment.

(ii) Derive the expression for the magnifying power of the telescope in this setting (3 marks)

(d) The objective of a compound microscope has a focal length of 2.0 cm while the eye piece has a focal length of 5.0 cm. An object is placed at a distance of 2.5 cm infront of the objective. The distance of the eyepiece from the objective is adjusted so that the final images is 25 cm infront of the eyepiece. Find the distance between the objective and eyepiece. (5 marks)

2. (a) (i) What is meant by refraction of light? (3 marks)
(ii) State the laws of refraction (2 marks)

(b) Describe how the refractive index of a material of a glass prism of know refracting angle can be determined using a spectrometer (6 marks)

(c)

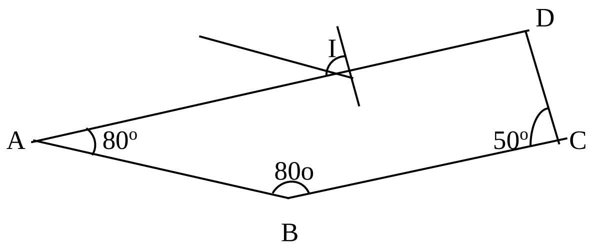


Fig 1

A ray of light is incident on the face AD of a glass block as shown in figure 1. The refractive inex of the material of the glass block is 1.52. If the ray emerges normally through face BC after total internal reflection, calculate the angle of incidence I. (5 marks)

(d) Explain how a mirage is formed

(e) An object at a depth of 3.0 m below the surface of water is observed directly from above the surface. Calculate the apparent displacement of the object if the refractive index is 1.33 (3 marks)

3. (a) State the principle of superposition of waves (1 mark)

(b) Two loud speakers producing sound of the same frequency are placed 50m apart facing each other. An observer walks from one speaker to the other along the line of the speakers

(i) What does the observer hear (2 marks)

(ii) Explain the observation in (b) (i) (4 marks)

(c) Describe with the aid of a diagram how you can determine the velocity of sound in air by a method which uses interference of sound

(d) A progressive and a stationary wave each has a frequency of 240 Hz and a speed of 80 ms – 1. Calculate

(i) phase difference between two vibrating points in the progressive wave which are 6 cm apart (4 marks)

(ii) distance between modes in the stationary wave (3 marks)

4. (a) What is meant by coherent sources of light? (3 marks)

(b) (i) Outline the principle of Young's double slit interference and derive the expression for the fringe separation.
(ii) What would be the effect of replacing monochromatic light by white light in Young's double slit experiment?

(c) An air wedge is formed by placing two glass slides of length 5.0 cm in contact at one end and a wire at the other end as shown in figure 2

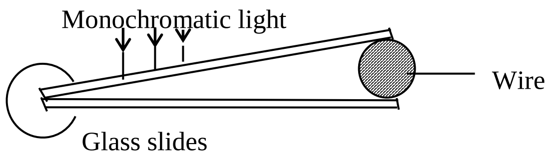


Fig 2

Viewing from vertically above, 10 dark fringes are observed to occupy a distance of 2.5 mm when the slides are illuminated with light of wavelength 500 nm.

(i) Explain briefly how the fringes are formed (3 marks)

(ii) Determine the diameter of the wire (4 marks)

SECTION B:

5. (a) Write down an expression for the magnetic flux density at:

(i) a perpendicular distance, d from a long straight wire carrying a current, 1 in a vacuum (1 mark)

(ii) the centre of a circular coil of, N turns each of radius, R and carrying a current I (1 mark)

(iii) the centre of an air-cored solenoid of n turns per metre each carrying a current, I (1 mark)

(b) Sketch the magnetic field pattern around a vertical current carrying straight wire in the earth's magnetic field and used it to explain a neutral point in a magnetic field (4 marks)

(c) What is meant by the terms:

(i) magnetic meridian?

(ii) Angle of dip?

(d) A circular coil of 10 turns and diameter 12 cm carries current I. The coil is placed with its plane in the magnetic meridium. A small magnetic needle placed at the centre of the coil makes 30 oscillations per minute about a vertical axis. When the current is cut off, it makes 15 oscillations per minute. If the horizontal component of the earth's magnetic lux density is 2.0 x 105T, calculate the magnitude of I. (Assume that the square of frequency of oscillaation is proportional to the magnetic flux density) (7 marks)

(e) Explain what is meant by eddy currents and give four of their applications

6. (a) State the laws of electromagnetic induction
(b) (i) With the aid of a labelled diagram, describe the structure and mode of action of an a.c. transformer
(ii) What are the main energy losses in a transformer and how are they minimised? (4 marks)

(c) An a.c. transformer operates on a 240 V mains. The voltage across the secondary which has 960 turns is 20V.

(i) find the number of turns in the primary (2 marks)
(ii) If the efficiency of the transformer is 80%, calculate the current in the primary coil when a resistor of 40Ω is connected across the secondary. (4 marks)

(d) Two long parallel wires X and Y are separately by 8cm in a vacuum. The wires carry currents of 10A and 5A respectively in the same direction. At what points between the wires is the magnetic flux density zero? (3 marks)

7. (a) Define the terms amplitude and root mean square (r.m.s) value of an alternating current (2 marks)

(b) A sinusoidal alternating current 1 = 4 Sin (100 amperes flows through a resistor of resistance 2.0Ω. Find the mean power dissipated in the resistor . Hence deduce the r.m.s value of the current (4 marks)

(c) Describe, with the aid of a labelled diagram, how a hot wire ammeter works

(d) An inductor of inductance L is connected across a source of alternating voltage V = Vo Sin wt.
(i) Find the current which flows (3 marks)
(ii) Sketch, using the same axes, the variation with time of the voltage across the inductor and the current through it, and explain the phase difference between them (6 marks)

SECTION C

8. (a) Distinguish between e.m.f and terminal p.d of a battery
(b) (i) Define electrical resistivity (1 mark)
(ii) Explain any two factors on which the resistance of a conductor depends (5 marks)
(c) Two wires A and B have lengths which are in the ratio 4.5 diameters which are in the ratio 2:1, and resistances in the ratio of 3:2. If the wires are arranged in parallel and current of 1.0 A flows through the combination, find the:
(i) ratio of resistance of wire A to that of wire B (4 marks)
(ii) current through wire A (3 marks)

(d) Explain why a wire becomes hot when current flows through it (5 marks)

9. (a) (i) State Ohm's law
(ii) State the factors which affect the resistance of a conductor
(iii) A conductor of length I and cross sectional area A has n free electrons per unit volume each of charge e. Find the drift velocity, v, of these electrons if a current I flows through the conductor. (4 marks)

(b) Outline the principle of operation of a slide wire potentiometer (4 marks)

(c)

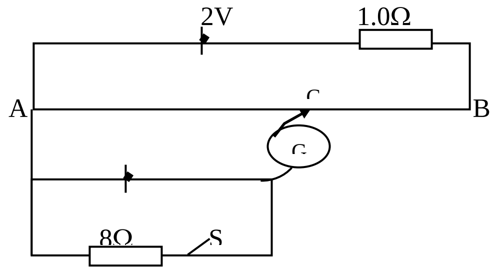


Fig 3

In the figure 3 the slide wire AB is 1 m long and has a resistance of 4Ω . When switch S is:

(i) open, the balance length AC is 88.8 cm. Find the value of the e.m.f of the cell (3 marks)

(ii) closed, the balance length is found to be 82.5 cm. Calculate the internal resistance of this cell (4 marks)

(d) State two advantages of using a potentiometer for measuring voltage. (2 marks)

10. (a) What is a dielectric material?

(b) A capacitor filled with a dielectric is charged and then discharged through a milliameter. The dielectric is then withdrawn half way and the capacitor charged to the same voltage, and discharged through the milliammeter against, show the relative permitivity, ϵr of the dielectric is given by

$$\epsilon_r = \frac{1}{2I^1 - 1}$$

Where I, and I^1 are the readings of the milliammeter respectively. (6 marks)

(c) Describe with the aid of a diagram how you would determine the capacitance of a capacitor

(d)

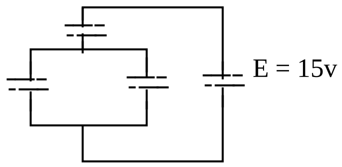


Fig 4

A battery of e.m.f 15V is connected across a system of capacitors as shown in figure 4 . Find the

(i) charge on the 4μF capacitor (4 marks)

(ii) energy stored in the 3μF capacitor. (4 marks)

P510/1
PHYSICS
Paper 1
Nov/Dec 1999
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 1
2 hours 30 minutes

SECTION A:

1. (a) What is meant by a *conservative force*? Give two examples (2 marks)
   (b) (i) Explain the terms *damped* and *forced oscillation* (4 Marks)
   (ii) Sketch displacement time graphs for underamped and overdamped oscillation (2 marks)

   (c) A mass of 0.5 kg is suspended from the free ends of two springs of force constants 100 Nm 4 and 50 Nm 4 respectively as shown in figure 1.

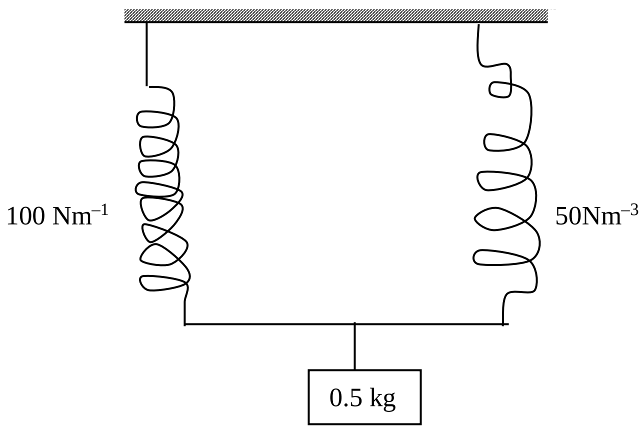


Fig 1

   Calculate the
   (i) extension produced (3 marks)
   (ii) tension in each spring (2 marks)
   (iii) energy stored in the springs (3 marks)
   (iv) frequency of small oscillations when the mass is given a small vertical displacement (4 marks)

2. (a) (i) What is meant by dimensions of a physical quantity? (1 mark)
   (ii) Define coefficient of *viscosity* of a fluid (1 mark)

   (b) The viscous force on a small sphere of radius a, falling with velocity v, in a liquid of coefficient of viscosity η, is given by
   $F = Ka^2\ \eta^2 v^2$ where K is a dimensionless content.

   (i) Use the method of dimension to determine the value of x, y and z (5 marks)
   (ii) If the constant K is equal to 6π, ivtain an expression for the terminal velocity of the sphere. Express your result in terms of a, density δ, of the liquid, density ρ, of the sphere and acceleration due to gravity g. (4 marks)
   (c) (i) Describe briefly an experiment to measure the viscosity of motor oil of known density
   (ii) Explain using kinetic theory, the effect on the viscosity of a liquid of increasing temperature (2 marks)

3. (a) What is meant by the gravitational field strength?

(b) Suppose you are provided with the following items: a spiral spring, a stop clock, a set of masses, a mass hanger, a paper pointer, a metre rule and retort stand and clamps. Describe how you would determine the acceleration due to gravity

(c) A 30 kg block is held in contact with a compressed spring of force constant 120 Nm^{-1}, The block rests on the smooth portion of a horizontal surface which is partly smooth and partly rough as shown in figure 2

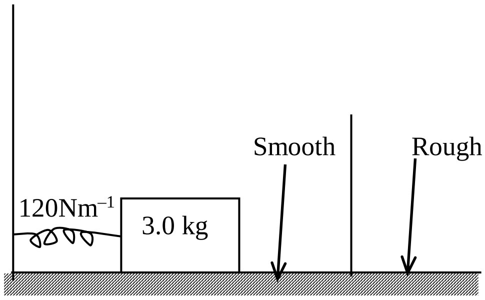


Fig 2

When the block is released, it slides without friction until it known the spring and then continues to move along the rough portion for 8.0 m before it comes to rest. The coefficient of sliding friction between the block and the rough surface is 0.20.

Calculate the:

(i) maximum kinetic energy of the block (3 marks)

(ii) compression of the spring before the block was released (3 marks)

4. (a) Show that the speed of an object moving in a circle of radius r with uniform angular velocity is $v = r\ \omega$

(b) A rigid body rotates about an axis with angular velocity ω. If the moment of enertia of the body about this axis is I, show that the rotational kinetic energy of tahe body is $\frac{1}{2} I\ \omega^2$.

(c) The oxygen atoms in an oxygen molecule at S.T.P are separated by a distance of about 1.2×10^{-10}m. The mass of an oxygen atom is 2.66×10^{-27} kg. The mean molecular sped is 480 ms^{-1} while its angular speed is 6.5×10^{12} $rad.s^{-1}$. Calculate for the molecule the:

(i) moment of inertia about its centre of mass (3 marks)

(ii) ratio of the rotational kinetic energy to the mean translational energy (5 marks)

(d) A disc of radius a, starting from rest, rolls without slipping down a plane inclined at an angle α to the horizontal. Find, using the principle of conservation of energy, the speed of the disc at the bottom of the incline, if the length of the incline is l.
[Momemnt of inertia of the disc about an axis through the centre of mass = $\frac{1}{2} Mn^2$]

SECTION B:

5. (a) Outline the steps necessary in setting up a Celsius scale of temperature

(b) The resistance of a platinum wire at the tripple point of water is 5.16Ω . What will its resistance be at 100°C? (3 marks)

(c) Describe, with aid of a labelled diagram how to measure high temperatures using an optical pyrometer.

(d) (i) Define a black body

(ii) Assuming that the sun is a sphere of radius 7.0×10^8 m at a temperature of 6,000 K, estimate the temperature of the surface of mars if its distance from the sun is 2.28×10^{11} m

6. (a) State any two ways in which real gases differ from an ideal gas (2 marks)

(b) Using the same axes, sketch pressure versus volume graphs for a real gas:
(i) above the critical temperature,
(ii) at the critical temperature,
(iii) below the critical temperature
Indicate in your sketch the different phases of the gas. (5 marks)

(c) Use the kinetic theory of matter to explain why the specific latent heat of vaporisation of water is higher at 20ºC than it is at its boiling point. (2 marks)

(d) Describe an experiment to determine the temperature dependence of saturated vapour pressure of water. (6 marks)

(e) A volume of 4.0×10^{-3} m3 of air is saturated with water vapour at 100ºC. The air is cooled to 20ºC at constant pressure of 1.33×10^{5} Pa. Calculate the volume of air after cooling, if the saturated vapour pressure of water at 20ºC is 2.3 x 103 Pa. [Atmospheric pressure = 1.01×10^{5} Pa.]

7. (a) Define specific heat capacity. (1 mark)

(b) Describe an electrical method of measuring the specific heat capacity of a metal. (6 marks)

(c) In a continuous flow calorimeter for measurement of specific heat capacity of a liquid, 3.6×10^{-3} m ^{3} of liquid flows through the apparatus in 10 minutes. When electrical energy is supplied to the heating coil at the rate of 44 W, a steady difference of 4 K is obtained between the temperatures of the outflowing and inflowing liquid. When the flow rate is increased to 4.8×10^{-3} m^3 of liquid in 10 minutes, the electrical power required to maintain the temperature difference is 58W. Find the

(i) specific heat capacity of the liquid (6 marks)
(ii) rate of loss of heat to the surroundings (2 marks)

(d) Explain why the difference between the specific heat capacity at constant pressure, C_p and that at constant volume, Cv is negligible for solids but not for gases. Hence show that for one mole of gas $C_p - C_v = R$ (5 marks)

SECTION C:

8. (a) What is meant by work function of a metal? (1 mark)
(b) Describe the main features of photoelectric emission (4 marks)
(c) A 100mW beam of light of wavelength 4.0 x 10 – 7 m falls on a Caesium surface of a photocell.
(i) How many photons strike the Caesium surface per second?
(ii) If 80% of the photons emit photoelectrons, find the resulting photocurrent (4 marks)
(iii) Calculate the kinetic energy of each photoelectron if the work function of Caesium is 2.15 eV. (3 marks)
(d) Describe one application of a photocell. (3 marks)

9. (a) (i) Explain what is observed when a beam of α - particles of energy 4.2 MeV is incident normal to a gold foil. What is the closest distance of approach by the α - particles to the nucleus of a gold atom? [Atomic number of gold = 79.] (4 marks)

(b) State Bohr's postulates of the hydrogen atom
(c) The energy levels of the hydrogen atom are given by

$$E_n = \frac{-21.7 \times 10^{-19}}{n^2} \text{ joules, where n tqkes on the values } 1,2,3, \ldots\ldots$$

(i) Use this result to account for the occurrence of emission and absorption line spectra (5 marks)
(ii) Find the shortest wavelength of radiation which can be emitted by the hydrogen atom (3 marks)

10. (a) With the aid of a labelled diagram, describe how an x-ray tube works

(b) A beam of cathode rays is directed mid-way between two parallel metal plates of length 4.0cm and separation 1.0 cm. The beam is deflected through 10.0 cm on a fluorescent screen placed 20.0 cm beyond the nearest edge of the plates when a potential difference (p.d) of 200 V is applied across the plates. If this deflection is annulled by a magnetic field of flux density. 1.14×10^{-3} T applied normal to the electric fields between the plates, find the charge to mass ratio of cathode rays (5 marks)

(c) (i) Draw a labelled diagram showing the essential features of a cathode ray oscilloscope (CRO). State the uses of these features (8 marks)

(ii) Explain the use of a time-base in a cathode ray oscilloscope (2 marks)

P510/2
PHYSICS
Paper 2
Nov/Dec 1999
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 2
2 hours 30 minutes

SECTION A

1. (a) Define refraction.

(b) (i) With the aid of suitable ray diagrams explain the terms critical angle and total internal reflection
(ii) Monochromatic light is incident at an angle of 45o on a glass prism of refracting angle 70° in air. The emergent light grazes the other refracting surface of the prism. Find the refractive index of the glass (6 marks)

(c) (i) With the aid of a labelled diagram describe the structure and action of prism binoculars. (4 marks)
(ii) Explains why prisms rather than plane mirrors are used in binoculars (2 marks)
(iii) In a pair of prism binoculars the optical path from the objective to the eye-piece is 50.0 cm. The eye-piece has a focal length of 2.5 cm. Find the magnifying power in normal adjustment. (3 marks)

2. (a) Describe how the focal length of a diverging lens may be determined (6 marks)

(b) A lens L_1 casts a real image of a distant object on a screen placed at a distance 15 cm away. When another lens , L_2 is placed 5 cm beyond lens L_1 the screen has to be shifted by 10 cm further away to locate the real image formed. Determine the focal length and the type of lens L_2. (5 marks)

(c) A convex lens of focal length 60 cm is arranged co-axially with a diverging lens of focal length 5 cm, to view a distant star.
(i) If the final image is at infinity, draw a ray diagram to show the formation of the image of the star (3 marks)
(ii) Calculate the magnifying power obtained if the image of the star is formed at a distance of 25 cm infront of the eyepiece. (4 marks)
(iii) List one advantage and one disadvantage of this type of arrangement over the astronomical telescope (2 marks)

3. (a) (i) What is meant by *coherent sources of waves*? (3 marks)
(ii) Distinguish between interference and diffraction of light. Give one example of each (4 marks)

(b) With the aid of suitable sketches, explain the following:
(i) Division of wave front, (2 marks)
(ii) Division of amplitude (2 marks)

(c) Monochromatic light of wave length 5 x 10^{-7} m is incident on two slits of separation 4 x 10^{-4} m. Calculate the fringe separation on a screen placed 1.5 m from the slits. (3 marks)

(d) A car travelling at 72 kmh – 1 has a siren which produces sound of frequency 500Hz. Calculate the difference between the frequency of sound heard by an observer by the roadside as the car approaches and recedes from the observer . [Speed of sound in air = 320 m s^{-1}] (6 marks)

4. (a) What is meant by the terms *free*, *damped* and *forced oscillations*? (6 marks)

(b) The displacement of a particle in a progressive wave is
$y = 2 \sin [2\pi (0.25 x - 100 t)]$, where x and y are in cm and t is in seconds. Calculate the :

(i) wave length, (3 marks)
(ii) velocity of propagation of the wave (3 marks)

(c) (i) Explain how beats are produced
(ii) An observer moving between two identical stationary sources of sound along a straight line joining them hears beats at the rate of 4.0. At what velocity is the observer moving if the frequencies of the sources are 500Hz and the velocity of sound when the observer makes the observation is 340 m s^{-1}? (5 marks)

SECTION B:

5. (a) Explain the following terms as applied to the Earth's magnetic field:
   (i) magnetic meridian (1 mark)
   (ii) angle of dip (1 mark)
   (iii) declination (1 mark)

(b) Draw sketch diagrams to show the magnetic field pattern due to an electric current flowing through a circular coil and a long solenoid
(c) A circular coil of 20 turns each of radius 10.0 cm lies flat on a table. The Earth's magnetic field intensity at the location of the coil is 43.8. A m^{-1} while the angle of dip is 67.0°. Find the:
   (i) magnetic flux threading the coil (4 marks)
   (ii) torque on the coil if a current of 2.0 A is passed through it (3 marks)

(d) If you are given a coil of known number of turns N, known area A and known resistaance, a resistance box, a compass needle and a calibrated ballistic galvanometer, describe briefly how you would determine the horizontal component of the Earth's magnetic flux density. (6 marks)

6. (a) What is meant by the following terms:
   (i) self-induction? (2 marks)
   (ii) Mutual induction? (2 marks)

(b) Two coils X and Y are placed coaxially near each other as shown in figure 1.

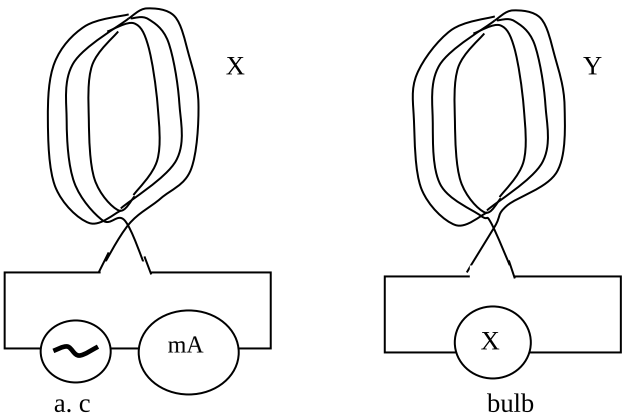


Fig 1

Explain the following observations:
   (i) When the a. c. supply is switched on, the bulb lights up (2 marks)
   (ii) The brightness of the bulb increases when a soft iron rod is placed inside and along the common axis of the coils (2 marks)
   (iii) The brightness of the bulb varies with distance between the coils (2 marks)

(c) An air cored long solenoid of 500 circular turns per metre and radius 8.0 cm has a secondary coil of 20 turns tightly wound round its middle. The current in the solenoid is 2.0 A. Find the e. m.. f induced in the coil when the current in the solenoid is reduced to zero in 10^{-2} S.

(d) With the aid of a circuit diagram, describe the mode of action of a full-ware rectifier. (4 marks)

7. (a) (i) With the aid of a labelled diagram describe the structure and mode of operation of an a.c. generator.
   (ii) Sketch a graph of the output voltage against time

(b) A flat circular coil with 500 turns each of radius 10 cm is rotated at a frequency of 200 revolutions per minute about its diameter at right angles to a uniform magnetic field of flux density 0.18 T. Calculate the :
- (i) maximum magnetic flux linking the coil
- (ii) e.m.f induced in the coil when the plane of the coil makes an angle of 30o with the magnetic field.
- (iii) Root mean square value of the e.m.f induced in the coil

(c) (i) State any three factors which limit the efficiency of a transformer and indicate how they are minimized in practice. (3 marks)
(ii) Show that the power loss, P_L, in a transmission line of total resistance R_L, is given by

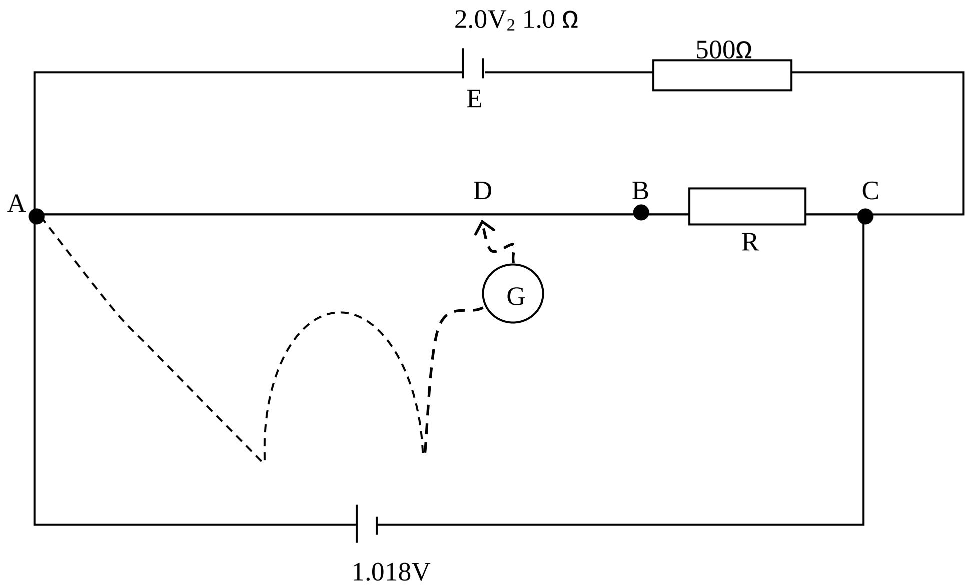
$PL = \frac{Pr^2 R_L}{V^2}$, where Pr and V are the power transmitted and the voltage delivered to the user,. respectively (4 marks)

SECTION C:

8. (a) What is meant by the e.m.f and internal resistance of a battery?
(b) A.d.c source of e.m.f 16V and negligible internal resistance is connected in series with two resistors of 400 and R ohms, respectively. When a voltmeter connected across the 400 Ω resistor, it reads 4.0 V while it reads 6.0 V when connected across the resistor of R ohms. Find the:
- (i) resistance of the voltmeter (6 marks)
- (ii) value of R (1 mark)

(c) Describe how you would use a slide wire potentiometer to measure the internal resistance of a dry cell. (5 marks)

(d) In figure 2, AB is a uniform resistance wire of length 1.00 m and resistance 10.0Ω E. is an accumulator of e.m.f 2.0 V and internal resistance 1.0 Ω



When a standard cell of e.m.f 1.018 V is connected in series with a galvanometer, G across AC, the galvanometer shows no deflection. When the standard c Fig 2 l and a thermocouple connected via the galvanometer, G, as shown by the dotted line, G sho... ion when AD = 41.0 cm.

Calculate the:
- (i) value of R, (3 marks)
- (ii) e.m.f of the thermocouple. (3 marks)

9. (a) Define electric potential and electric field intensity
(b) Consider two points A and B at distances of 15.0 cm and 20.0 cm respectively, from a point charge of 6.0 μC as shown in figure 3.

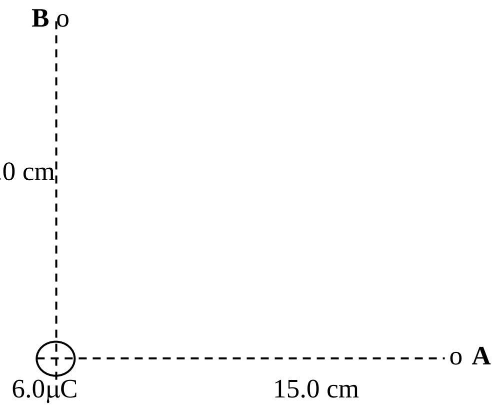


Fig 3

(i) Find the electric potential difference between A and B (6 marks

(ii) Calculate the energy required to bring a charge of + 1.0 μC from infinity to point A (3 marks)

(c) Alpha particles (charge = + 2e,) each having kinetic energy 1.0 x 1012 J are incident head-on gold nuclei (charge = + 79 e) in a gold foil. Calculate the [e = 1.6 x 10 $^{-19}$ C] (4 marks)

(d) Describe an experiment to show that charge resides only on the outside surface of a hollow conductor. (5 marks)

10. (a) Describe and account for the differences between the structures of a moving coil galvanometer and the ballistic form of the instrument (4 marks)

(b) With the aid of a circuit diagram, describe how you would compare capacitances of two capacitors using a ballistic galvanometer (5 marks)

(c) Two large oppositely charged plates are fixed 1.0 cm apart as shown in figure 4. The p.d between the plates is 50V.

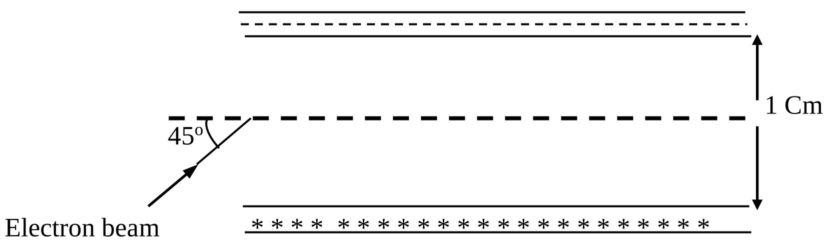


Fig 4

An electron beam enters the region between the plates at an angle of 45o as shown. Find the maximum speed the electrons must have in order for them not to strike the upper plate
[Mass of an electron = 9.11 x 1031 kg.] (8 marks)

(d) Describe the energy changes which occur when a capacitor is being charged from a battery (3 marks)

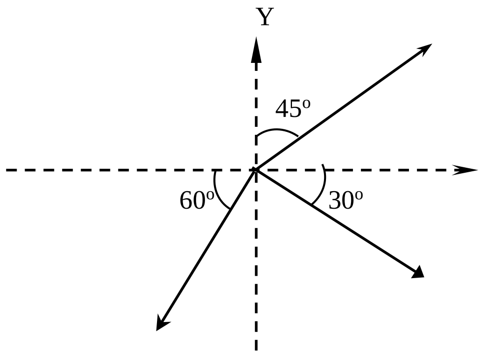
P510/1
PHYSICS
Paper 1
Nov/Dec 1998
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
PHYSICS
(PRINCIPAL SUBJECT)
Paper 1
2 hours 30 minutes

SECTION A

1. (a) State the conditions under which a rigid body is in equilibrium under the action of co-planar forces (2 marks)

(b) Describe how the centre of gravity of a piece of cardboard having an irregular shape may be determined (4 marks)



(c) Forces of 2.83 N, 4.00 N and 6.00 N act on a particle O as shown in figure 1 above. Find the resultant force on the particle (6 marks)

(d) (i) Explain the term *unstable equilibrium*

(ii) An oil drum of diameter 75 cm and mass 90 kg rests against a stone as shown in figure 2.

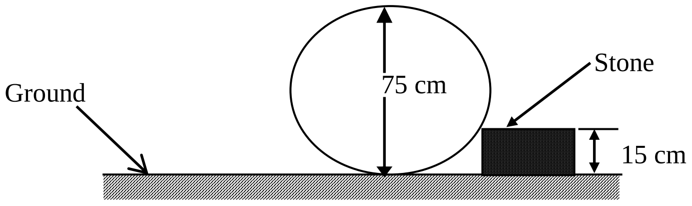


Fig 2

Find the least horizontal force applied through the centre of drum, which will cause the drum to roll up the stone of height 15 cm. (5 marks)

2. (a) State the laws of solid friction and explain them using molecular theory (6 marks)

(b) Describe how the coefficient of static friction for an interface between a rectangular block of wood and a plane surface can be determined (4 marks)

(c)

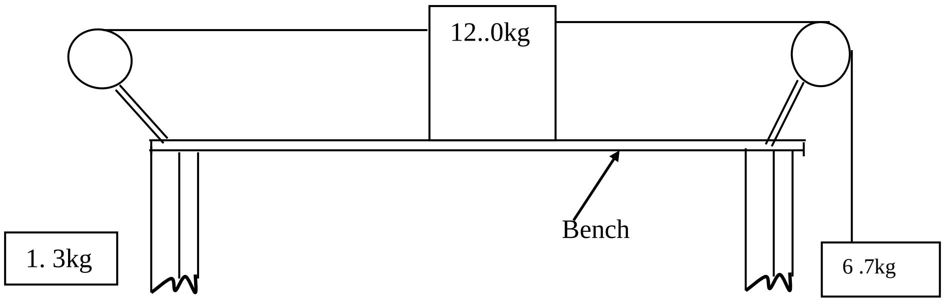


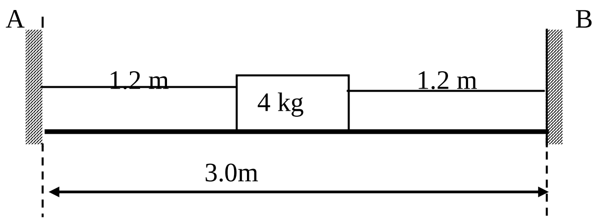
Fig 3

The diagram in figure 3 shows three masses connected by inextensible strings which pass over frictionless pulleys. The coefficient of friction between the bench and the 12.0kg mass is 0.25.

If the system is released from rest, determine the
(i) acceleration of the 12.0 kg mass (6 marks)
(ii) tension in each string. (2 marks)

(d) Explain the occurrence of viscosity in gases (2 marks)

3. (a) What is simple harmonic motion? (1 mark)



(b) A body of mass 4 kg rests on a smooth horizontal surface. Attached to the body are two pieces of light elastic strings each of length 1.2 m and force constant 6.25 N m^{-1}. The ends are fixed to points A and B, 3.0 m apart as shown in figure 4. The body is then pulled through 0.1 m towards B and then released.
(i) Show that the body will execute simple harmonic motion (3 marks)
(ii) Find the period of oscillation of the body (3 marks)
(iii) Calculate the speed of the body when it is 0.03 m from the equilibrium position (4 marks)

(c) Obtain an expression for the acceleration of a body moving in a circular path with uniform speed (4 marks)

(d) A car travels round a bend banked at an angle of 22.6o. If the radius of curvature of the bend is 62.5m and the coefficient of friction between the tyres of the car and the road surface is 0.3, calculate the maximum speed at which the car negotiates the bend without skidding. (5 marks)

4. (a) (i) Distinguish between lamina and turbulent flow (2 marks)
(ii) What are the origins of viscosity in liquids? (2 marks)
(iii) Explain the temperature dependence of viscosity of a liquid (3 marks)

(b) (i) State Bermoull's principle (1 mark)
(ii) Account for the variation of pressure and of velocity of a a liquid flowing in a horizontal pipe of varying diameter (4 marks)

(c) (i) State Archimede's principle and use a rectangular block immersed in a liquid to illustrate it (5 marks)

(ii) A cube of rubber of volume 1 x 10^{-3} floats with half of its volume submerged in a liquid of density 1200 kg m – 3. Find the depth to which the cube will be submerged in a liquid of density 1000 kg m^{-3} (3 marks)

SECTION B

5. (a) Define the specific latent heat of vaporisation
(b) Describe an electrical method of determining the specific latent heat of vaporisation of a liquid
(c) State any two advantages of the continuous flow method over the method of mixtures for the determination of specific heat capacities of liquids (2 marks)
(d) When electrical power is supplied at a rate of 12.0 W to a boiling liquid a mass of liquid of 8.6 x 10 $^{-3}$ kg evaporates in 30 minutes. On reducing the power to 7.0 W, 5 x 10 – 3 kg of the liquid evaporates in the same time.
Calculate the:
(i) specific latent heat of vaporisation of the liquid (4 marks)
(ii) power loss to the surrounding (2 marks)

(e) Explain why evaporation causes cooling (2 marks)

6. (a) Explain briefly why the centre of a fire appears white.
(b) With the aid of a labelled diagram describe how the temperature of a furnace may be measured (6 marks)
(c) The resistance of a platinum thermometer is 5.7, 5.5 and 5.2 Ω at boiling point of water, at an unknown temperature and at freezing point of water respectively. Determine the unknown temperature on the thermodynamic scale. (4 marks)

(d) (i) State Stefan's law (1 mark)
(ii) Calculate the rate of loss of heat energy of a black body of area 40 m2 at a temperature of 50ºc, if the radiation it receives from the sun is equivalent to a temperature in space of – 220ºC. (4 marks)

7. (a) (i) What is meant by an ideal gas? (1 mark)
(ii) State three differences between a real and an ideal gas (3 marks)
(iii) What is meant by kinetic theory of matter? (2 marks)
(iv) Describe briefly an experiment which you can carry out in support of Kinetic theory of matter (4 marks

(b) Derive the expression

$$P = \frac{1}{3} P \overline{C}^2$$

for a pressure of an ideal gas of density and mean square speed $\overline{C}^2$

(c) An ideal gas of volume 100 cm^3 at S.T.P . expands adiabatically until its pressure drops to a quarter its original value. Find the new volume and temperature if the ratio of the principal specific heat capacities is 1.4 (5 marks)

SECTION C

8. (a) (i) What are *cathode rays*? (1 marks)

(ii) Describe an experiment to show that cathode rays travel in straight lines (4 marks)

(iii) An electron accelerated by a p.d of 1000 V passes through a uniform electric field of intensity, E, crossed with a uniform magnetic field of flux density 0.3 T. If the electron emerges undeflected, calculate the electric intensity, E (3 marks)

(b) (i) State Bragg's law
(ii) An x-ray tube is operated on a potential difference of 100 kV. Calculate the highest possible frequency of the protons: (3 marks)

(c) (i) With the aid of a labelled diagram, describe the operation of a Geiger-Mullere tube
(ii) State briefly the steps taken to measure activity of a source using the Geiger-Muller tube. (2 marks)

9. (a) Define the following terms:
(i) nuclear binding energy, (1 mark)
(ii) isotopes (1 mark)

(iii) unified atomic mass unit (1 mark)

(b) Calculate the binding energy per nucleon for $^{56}_{26}$Fe nucleus (5 marks)

[mass of: $^{1}_{0}n$ = 1.008665 U; $^{1}_{1}p$ = 1.007277 U;

$^{0}_{-1}e$ = 5.4858 x 10 – 4 U; 1 u = 931 Me V;

50 Fe = 55.9349 U.]

(c) (i) What is meant by half-life of a radio-active material?

(ii) The Silver isotope $^{108}_{47}$Ag has a half-life of 2.4 min. Initially a sample countains 2.0 x 10^6 nuclei of $^{108}_{47}$Ag

Find the number of radio-active nuclei left after 1.2 min? [Assume N = Noe $^{-\lambda 1}$]

(d) (i) Describe the structure and mode of operation of a cloud chamber (6 marks)

(ii) List two hazards caused by radiations (5 marks)

10. (a) State the main characteristics of photo-electric emission
(b) Describe with the aid of a diagram how the stopping potential of a metal can be measured
(c) Calculate the maximum speed of the photo electrons emitted by a Caesium surface irradiated with light of wavelength 484 nm if the work function of caesium is 3 x 10^{-19} J. (3 marks)

P510/2
PHYSICS
Paper 2
Nov/Dec 1998
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
PHYSICS
(PRINCIPAL SUBJECT)
Paper 2
2 hours 30 minutes

SECTION A

1. (a) (i) State the laws of refraction of light (2 marks)
(ii) Show that the relation between refractive index, n, and a medium and critical angle, c, for a ray of light travelling from the medium and critical angle, c, for a ray of light travelling from the dediumto air is given by

$$n = \frac{1}{\sin c}$$ (3 marks)

(b) Describe with the aid of a diagram how the refractive index of a transparent liquid may be determined (5 marks)

(c) Explain how light from the sun reaches an observer in the morning before the sun appears above the horizon (4 marks)

(d)

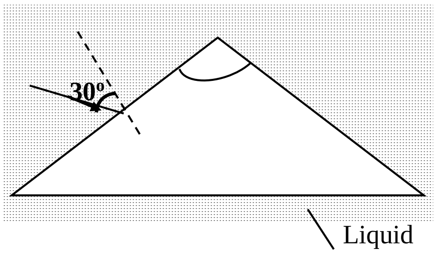


Fig. 1

(i) A ray of light propagating in a liquid is incident on a prism of refracting angle 50o and refractive index of 1.6 at an angle of 30o shown in figure 1. If the ray passes symmetrically through the prism, find the refractive index of the liquid. (4 marks)

(ii) Explain why white light is dispersed by a transparent medium (1 mark)

2. (a) (i) Define focal length of a lens
(ii) A convex lens is contained in a cylindrical tube such that its exact position in the tube is not accessible. Describe how you would determine the focal length of the length without removing the lens from the tube. Derive the formula used to obtain the final result. (6 marks)

(b) (i) Define *angular magnification* of an optical instrument. (1 mark)

(ii) Explain why the farthest vertical pole in line with others of equal height looks shorter. (2 marks)

(c) With help of a labelled diagram describe how a slide projector works. (5 marks)

(d) A projector projects an image of area 1 m2 onto a screen placed 5 m from the projection lens. If the area of the object slide is 4 cm2,
Calculate the
(i) focal length of the projection lens (3 marks)
(ii) distance of the slide from the lens (32 marks)

3. (a) (i) Define the terms amplitude, frequency and wavelength as applied to wave motion (3 marks)

(ii) Derive the relationship between velocity, wavelength and frequency of a wave (3 marks)

(b) A plane progressive wave is given by
$y = a \sin (100 \pi t - \frac{10}{9} \pi x)$ where x and y are millimetres and t is in seconds

(i) write the equation of the progressive wave which would give rise to a stationary wave if superimposed on the one above (1 mark)

(ii) find the equation of the stationary wave and hence determine its amplitude of vibration (3 marks)

(iii) determine the frequency and velocity of the stationary wave (4 marks)

(c) Describe how the velocity of sound in air may be determined using a resonance tube and turning forks of known frequencies (6 marks)

4. (a) State the conditions necessary for the production of interference effects with light and explain why these conditions are necessary (4 marks)

(b) (i) Describe with the aid of a labelled diagram the experimental set up for observing Newton's rings
(ii) Explain qualitatively how Newton's rings are formed (5 marks)

(c) Two glass plates 12.0 cm long are in contact at one edge and separated at the other edge by a piece of metal foil 2.5 x 10 – 3 cm thick. When the plates are illuminated normally as shown in figure 2, by light of wavelength 500 nm, a system of fringes is formed.

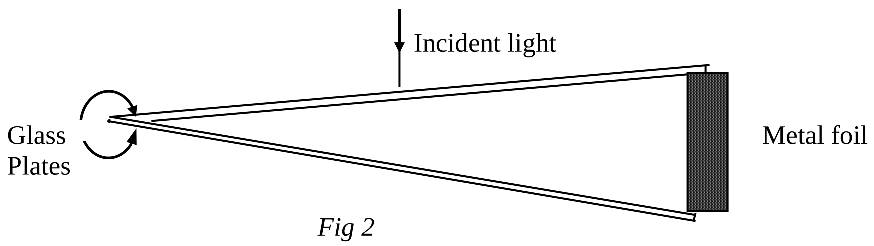


Fig 2

Find the
(i) separation of the fringes (5 marks)
(ii) Number of dark fringes formed. (2 marks)

SECTION B

5. (a) (i) Distinguish between root mean square value and peak value of an alternating current

(ii) what is the peak value of the voltage from a 240 V a.c. mains?

(iii) What is meant by self-induction?

(b)

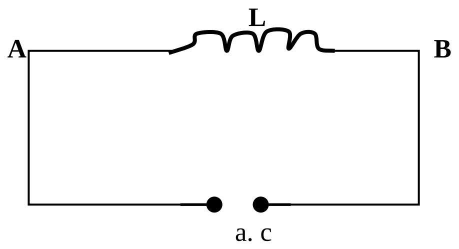


Fig 3

A coil of inductance L is connected to a source of alternating current as shown in figure 3. If the current in the coil is given by

$$I = I_o \sin \omega t$$

(i) Find an expression for voltage, V across the coil

(ii) Sketch, using the same axes, graphs to show variation of V and I with time and comment on the graphs.

(d) Explain why a capacitor allows the flow of alternating current but not of direct current yet it conducts direct current.

(e) (i) with the aid of a diagram describe how a repulsion type moving iron meter works

(ii) State two advantages of a moving iron meter over a moving coil one

6. (a) State the laws of electromagnetic induction

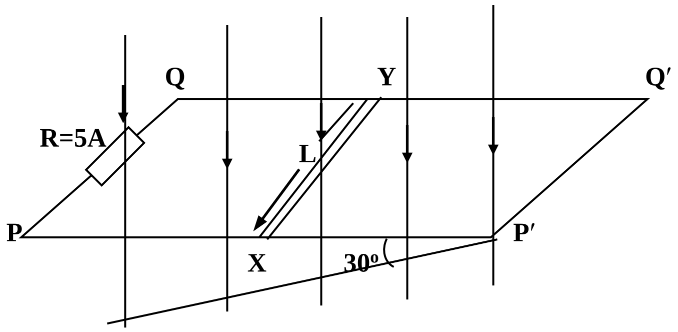


Fig 4

A metal rod XY of mass 0.2 kg, length, 0.8 m and negligible resistance rolls down frictionless metal rails PP′ and QQ′ inclined at 30º to the horizontal

(b) The rails lie in a uniform vertical magnetic field of flux density 0.4 T. The ends PQ of the rails are connected to a resistance of 5 as shown in figure 4. Calculate the constant speed the rod attains (5 marks)

(c)

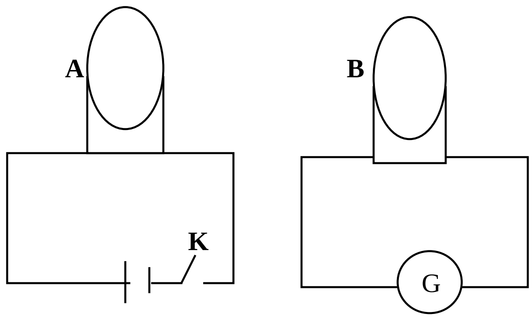


Fig 5

(i) Two coils A and B are placed close to each other with their planes parallel. A is connected in series with a cell and switch K. B is connected in series with a galvanometer, G, as shown in figure 5. Explain what is observed when K is momentarily closed (5 marks)

(ii) Explain how the observations in (c) (i) above would be affected if a branch of soft iron wires rather than a solid iron bar is placed inside the coils (4 marks)

(d)

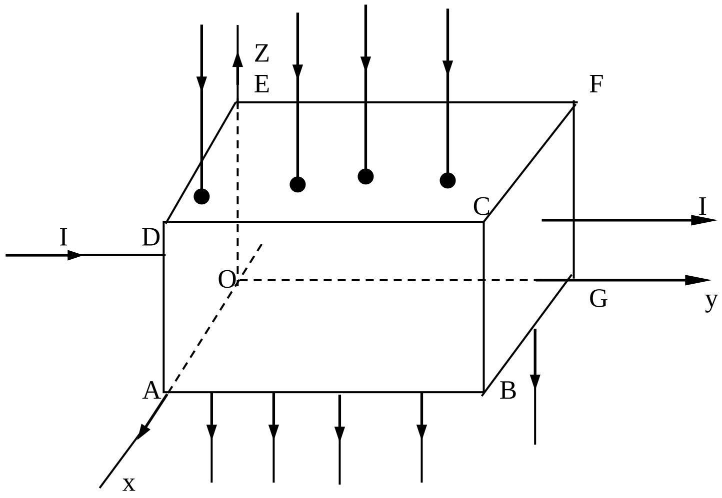


Fig 6

In the diagram above OABCDEFG is a rectangular conductor carrying current in the direction OY. The conductor is situated in uniform magnetic field which is perpendicular to the face CDEF as shown in figure 6. Explain why there is a p.d between faces ABCD and OEFG. (4 MARKS)

7.(a)(i) Define the term *magnetic flux density* and state its units (2 marks)

(ii) Describe the construction and working of a moving coil galvanometer (6 marks)

(iii) Explain the modifications on the features in (a) (ii) above which are necessary to make it a ballistic galvanometer. (3 marks)

(b) A capacitor of capacitance 200μF is fully charged to 10V. when capacitor is discharged through a ballistic galvanometer, the galvanomeer gives a maximum throw of 20 divisions. A coil of 25 turns, each of 10 cm is placed with its plane perpendicular to a uniform magnetic field. The coil is connected in series with the ballistic galvanometer. When the coil is rotated through 180°, the galvanometer gives a maximum throw of 15 divisions. Calculate the magnetic flux density, if the total resistance in the circuit is 3Ω

(c) Describe, using a labelled diagram the main characteristics of the Earth's magnetic field.

SECTION C

8. (a) (i) Define electrical resistivity

(ii) State the law of conservation of current at a junction in an electrical circuit?

(b) A battery of emf. ε and internal resistance, r , is connected across a resistor of variable resistance, R. Derive the expression for the maximum power expended in the resistor.

(c)

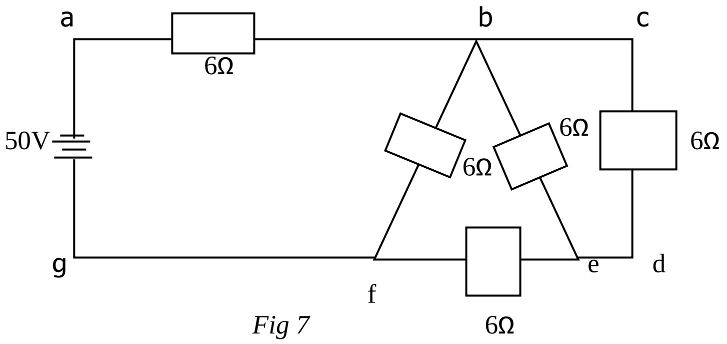


Fig 7

Figure 7 shows a network of resistors connected to a battery of e.m.f 50V and interval resistance 0.4Ω .
Calculate
(i) effective resistance in the circuit
(ii) power dissipated in the battery

(d) Describe with the aid of a circuit diagram, how the emfs of two cells can be compared using a potentiometer slide wire.

9. (a) (i) State Couloub's law of electrostatics
(ii) The electric intensity at the surface of the earth is about 1.2 x 10^2 V m^{-1} and points towards the centre of the earth. Assuming that the earth is a sphere of radius 6.4 x 10^6 m, find the charge held by the earth's surface.

(b) Two point charges +4.0μC and – 4 .0μC are separated by 10.0 cm in air as shown in figure 8.

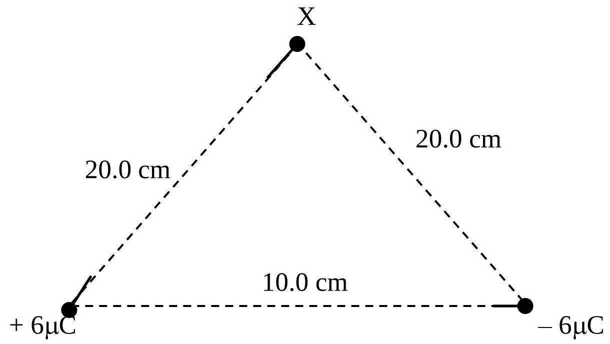


Fig 8

Find the electric field intensity at point x a distance of 20.0 cm from each charge (8 marks)

(c) (i) What is meant by corona discharge? (4 marks)

(ii) Explain how the lightening conductor works (4 marks)

10. (a) What is meant by
(i) capacitance of a capacitor (1 mark)

(ii) a dielectric material? (1 mark)

(b) (i) Explain the effect of a dielectric on the capacitance of a capacitor.
(ii) Derive the expression for the effective capacitance of three capacitors in parallel (4 marks)

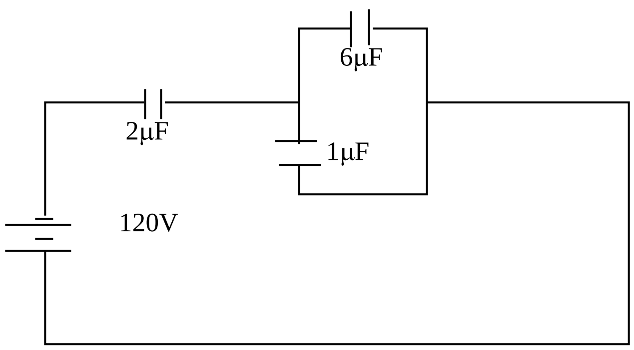


Fig 9

(c) Figure 9 shows a network of capacitors connected to a d.c. supply of 120 V. Calculate the
(i) charge on 4 μF capacitor (5 marks)
(ii) energy stored in 1μF capacitor (3 marks)

P510/1
PHYSICS
Paper 1
March 1998
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
PHYSICS
(PRINCIPAL SUBJECT)
Paper 1
2 hours 30 minutes

SECTION A

1. (a) (i) What is meant by scalar and vector quantities? (2)
(ii) Identify scalar and vector quantities from the following: momentum, density, acceleration, impulse, pressure and temperature (3)

(b) (i) What is meant by uniformly accelerated motion?
(ii) Sketch speed-time and distance-time graphs for a body moving with uniform acceleration (2)

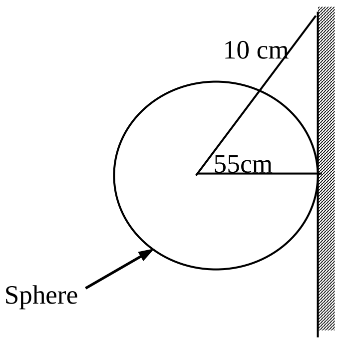
(c) A ball is kicked from a spot 30m from the goal posts with a velocity of 20 m s – 1 at 30o to the horizontal. The ball just clears the horizontal bar of the goal posts. Find
(i) the height of the goal posts (5)
(ii) the time of flight (4)
(iii) how far behind the goal posts the ball lands (3)

2. (a) (i) State Newton's laws of motion
(ii) Define linear momentum and state the law of conservation of linear momentum (2)

(b) A truck of mass 104 kg moving at 10 ms – 1 rams into a truck of mass 4 x 103 kg which is stationary. The trucks stick together and skid to a stop along a horizontal surface. Calculate the distance through which the trucks skid if the coefficient of kinetic friction is 0.25 (5)

(c) State the conditions which must be satisfied for a rigid body to be in static equilibrium (2)

(d) A sphere of weight 20N and radius 15 cm rests against a smooth vertical wall. The sphere is supported in this position by a string of length 10 cm attached to a point on the sphere and to a point on the wall as shown below



(i) Copy the diagram and show the forces acting on the sphere (3)
(ii) Calculate the reaction on the sphere due to the wall (2)
(iii) Find the tension in the string (3)

3. (a) (i) State Newton's law of gravitation and deduce the dimensions of gravitational constant , G.
(ii) A body has weight of 10N on Earth. What will be the weight of the body on the Moon if the ratio of the Moon's radius to the Earth is 0.27 and that of the Moon's mass to the Earth's mass is 1.2 x 10^3?

(iii) Sketch a graph to show the variation of the acceleration due to gravity with distance from the centre of the Earth.

(b) A 10^3 kg satellite is launched in a parking orbit about the Earth.
(i) Calculate the height of the satellite above the Earth's surface
(ii) Calculate the mechanical energy of the satellite
(iii) Explain the effect of friction between such a satellite and the atmosphere in which it moves.

4. (a) (i) Sketch using the same axes, the stress-strain curves for a glass wire, a metal wire and a rubber band.
(ii) Discuss briefly the main features of the curves

(b) Define Young's modulus and find its dimensions.
(c) One end of a copper wire is welded to a steel wire of length 1.6 m and diameter 1.0 mm, while the other end is fixed. The length of the copper wire is 0.80 m while its diameter is 0.5 mm. A load of 10 kg is suspended from the free-end of the steel wire. Find the
(i) extension which results
(ii) energy stored in the compound wire.
[Young's modulus for copper = 1.0 x 10^{11} m^{-2} ,]
[Young's modulus for steel = 2.0 x 10^{11} N m^{-2}]

(d) Explain briefly the term *plastic deformation* in metals.

SECTION B

5. (a) What assumptions are necessary in the derivation of the kinetic theory expression for the pressure of an ideal gas?
(b) A beam of 2 x 10^{22} nitrogen atoms, each of mass 2.32 x 10^{-26} kg is incident normally on a wall of a cubical container of edge 10.0 cm. The beam is reflected through 180o. If the mean speed of the atoms is 480 ms^{-1} find the pressure exerted by the nitrogen gas.

(c) (i) State Dalton's law of partial pressures (1)
(ii) Two containers A and B of volumes 3 x 10^3 cm^3 and 6 x 10^3 cm^3 respectively contain helium gas at a pressure of 1.0 x 10^3 Pa and temperature 300K. Container A is heated to 373 K while container B is cooled to 273 K. Find the final pressure of the helium gas. (5)

(d) Use the kinetic energy of matter to explain the effect of increasing temperature on saturation vapour pressure.

6. (a) Show that the work done by an ideal gas in expanding from a

volume V_1 to a volume V_2 is equal to $\int_{11}^{12}$ P dV where P denotes pressure and V the volume. (5)

(b) State the conditions required to effect the following processes
(i) isothermal process (2)
(ii) adiabatic process (2)

(c) A fire extinguisher is filled with 1.0 kg of compressed nitrogen gas at a pressure of 1.2 x 10^6 Pa and a temperature of 20^o C. If the gas escapes by expanding adiabatically to a pressure of 1.0 x 10^5 Pa when the nozzle of the fire extinguisher is opened. Find the
(i) original volume of the gas (4)
(ii) temperature of the expanded gas (3)

[Take Y = Cp = 1.4]
C

(d) By considering a gas confined in a cylinder by a movable piston, use kinetic theory to explain why an adiabatic expansion of a gas results in cooling (4)

15. (a) (i) Define thermal conductivity. (1)
(ii) Explain the mechanism of heat transfer by conduction (3)

(b) A wall 6 m x 3 m consists of two layers A and B of bricks of thermal conductivities 0.6 Wm $^{-1}$ K^{-}1 respectively. . The thickness of each layer is 15.0 cm. The inner surface of layer A is at a temperature of 20^{o}C while the outer layer of B is at a temperature of 10^{o} C. Calculate the
(i) temperature of the interface of A and B (4)
(ii) rate of heat flow through the wall (2)

(c) State Stefan-Boltzmann law of black body radiation.

(d) Consider the sun to be a sphere of radius 7.0 x 10^{8} m whose surface temperature is 5900 K.
(i) Find the solar power incident on an area of 1 m^{2} at the top of the Earth's atmosphere if this is a distance of 1.5 x 10^{11} m, from the some. Assume that the sun radiates as a blackbody.
(ii) Explain why the solar power incident on 1m2 of the Earth's surface is less than the calculated value in (d) (i) above.

(e) Explain briefly the greenhouse effect and its relation to global warning (6)

SECTION C

16. (a) A high p. d is applied across two electrodes in air contained in a closed glass tube. Describe with the aid of labelled diagrams what will be observed when the pressure in the tube is progressively reduced down to very low pressures.

(b) List four main properties of cathode rays

(c) A charged oil drop of mass 3.27 x 10 $^{-15}$ kg is held stationary between two horizontal metal plates across which a. p. d of 1.0 x 103 V is applied. If the separation of the plates is 1.5 cm, find the number of electrons on the drop.

(d) With the aid of a labelled diagram describe the principle of operation of an ionisation chamber.

17. (a) Draw a labelled diagram to show the main parts of an X-ray tube (4)
(b) Describe energy changes which occur in an X-ray tube in operation (2)
(c) Explain the production of the following spectra in an X-ray tube
(i) continuous spectrum (2)
(ii) line spectrum (3)

(d) Electrons of energy 75 ke V are stopped by the target of an X-ray tube. Calculate minimum wavelength of the X-rays produced. (5)

(e) A monochromatic beam of X-rays of wavelength 2.0 x 10^{-10} m is incident on a set of cubic planes in a potassium chloride crystal. First order diffraction maxima are observed at a glancing angle of 18.5o. Find the density of potassium chloride if its molecular weight is 74.55. (6)

18. (a) (i) What is meant by *nuclear binding energy*? (1)
(ii) Calculate the binding energy per nucleon of an α - particle, expressing your result in MeV.
Mass of a proton = 1.0080μ
Mass of neutron = 1.0087μ
Mass of an α - particle = 4.0026μ
lμ = 931 MeV. (4)

(iii) Sketch a graph of binding energy per nucleon against mass number and use it to explain liberation of energy by nuclear fusion and nuclear fission. (6)

(b) Show that the half-life ½ T of a radioactive material is related to the disintegration constant λ through the expression.

$$\frac{1}{2}T = \frac{0.693}{\lambda}$$ (3)

(c) When 238 U decays, the end product is $^{206}_{92}Pb$. The half life is 1.4 x 1017S. Suppose a rock sample contains $^{206}_{82}Pb$ and $^{238}_{92}U$ in the ratio 1:5 by weight.

Calculate the

(i) number of $^{206}_{82}Pb$ atoms in 1.0g of the rock sample (3)

(ii) age of the rock
[Assume the radioactive decay law $N = Noe^{-\lambda s}$] (4)

P510/2
PHYSICS
Paper 2
March 1998
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
PHYSICS
(PRINCIPAL SUBJECT)
Paper 2
2 hours 30 minutes

SECTION A:

1. (a) Describe and experiment to determine the focal length of a concave lens using a convex of known focal length (5)

   (b) A convex lens and a concave lens of focal lengths 17.5 and 15.0 cm respectively are mounted coaxially 7.5 cm a part with the concave lens facing a distant object. Find
   (i) the final position of the image (3)
   (ii) the magnification of the image produced b the concave lens (2)

   (c) Explain why a paraboloid mirror is used in search lights instead of a concave mirror. (3)
   (d) Describe how the angle of a prism can be measured using a spectometer (5)
   (e) Differentiate between chromatic and spherical aberrations (2)

2. (a) Define the terms refraction and refractive index. (2)
(b) Derive an expression for the apparent displacement of an object when viewed normally through a parallel sided glass block (5)
(c) (i) A glass block of refractive index n_g is immersed in a liquid of refractive index n_{1-}. A ray of light is partially reflected and refracted at the interface such that the angle between the reflected ray and the refracted ray is 90o. Show that $n_g = n_1 \tan \alpha$, where α is the angle of incidence from the liquid to glass (4)

   (ii) When the procedure in (i) is repeated with the liquid removed, the angle of incidence increases by 8^o. Given that $n_1 = 1.33$, find n_g and the angle of incidence at the liquid glass interface. (6)

   (d) A point source of white light is placed at the bottom of a water tank in a dark room. The light from the source is observed obliquely at the water surface. Explain what is observed. (3)

3. (a) Use Huygen's principle to show the angle of incidence is equal to the angle of reflection for light falling on a plane reflecting surface.

   (b) (i) Draw a ray diagram showing the path of light rays through the experimental arrangement for the determination of the wavelength of light using a single slit and biprism. (2)

   (ii) In a single slit and biprism experiment a prism of refracting angle 1.5^o and refractive index 1.5 is used. The slit and the screen are 5 cm and 1 m respectively from the biprism. If light of wavelength 5.80×10^{-7} is used, find the width of the fringes. (5)

   (iii) State one advantage of the biprism method over Young's double slit method. (1)

   (c) Distinguish between continuous and line emission spectra (3)
   (d) Describe one application of absorption line spectra (4)

4. (a) Explain the terms *wavelength* and *wavefront* as applied to wave motion (2)
   (b) (i) Define the term *resonance* (1)

   (ii) Describe how you would determine the velocity of sound in air using a resonance tube. (5)

   (c) Explain with the aid of suitable diagrams the terms *fundamental note* and *overtone* as applied to a vibrating wire fixed at both ends. (5)

   (d) A stretched wire of length 0.75m, radius 1.36 mm and density 1380 kg m^{-3} is clamped at both ends and plucked in the middle. The fundamental note produced by the wire has the same frequency as the first overtone in a pipe of length 0.15 m closed at one end.

   (i) Sketch the standing wave pattern in the wire (1)
   (ii) Calculate the tension in the wire (6)
   [The speed of sound along the stretched wire is $\sqrt{(T\delta)}$ where T is the tension in the wire and δ is the mass per unit length. Speed of sound in air = 330m s^{-1}]

SECTION B

5. (a) A circular coil of N turns, each of radius R carries current *I*.
   (i) Write an expression for magnetic flux at the centre of coil (1)
   (ii) Sketch the magnetic field pattern associated with the coil (2)
   (iii) Describe a simple experiment to verify the expression in (i) when N and R are constant (6)

   (b) (i) What is meant by *magnetic moment* of a current carrying coil? (2)
   (ii) A circular coil of 10 turns each of radius 10 cm is suspended with its plane along a uniform magnetic field of flux density 0.1 T. Find the initial torque on the coil when a current of 1.0 A is passed through it. (3)

   (c)

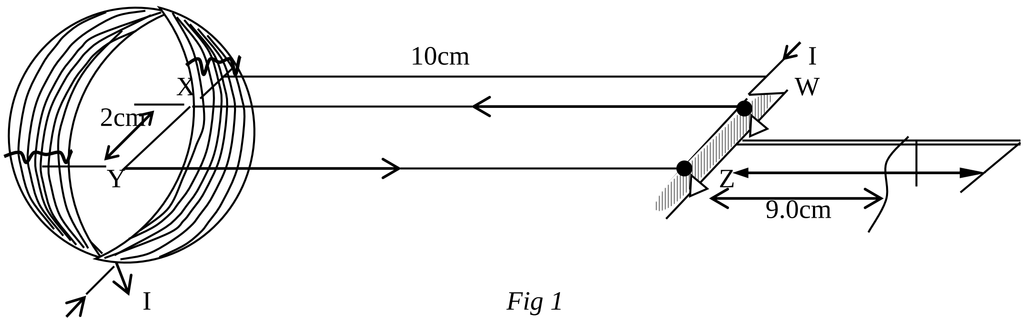


Fig 1

A rectangular loop of wire WXYZ is balanced horizontally so that the length XY is at the centre of a circular coil of 500 turns of mean radius 10.0 cm as shown in figure 1. When a current I is passed through XY and the circular coil, a rider of mass 5.0 x 10^{-4} kg has to be placed at a distance of 9.0 cm from WZ to restore balance. Find the value of the current I. (6)

6. (a) (i) Derive the relationship between peak value and root-mean square value of a sinusoidal current (4)
   (ii) Calculate the root mean square value of an alternating current which dissipates energy in a heating coil immersed in a liquid in a calorimeter at two times the rate at which direct current of 4A would if passed through the same coil under the same conditions (3)

   (b) A source of sinusoidal voltage of amplitude Vo and frequency f is connected across a capacitor of capacitance C.
   (i) Without using any formula
   (ii) Find the amplitute of the current which flows and sketch a graph of the applitude against frequency if the resistance of the connecting wire is negligible (4)

   (c) Draw a labelled diagram of a moving coil galvanometer and explain why it cannot be used to measure an alternating current (5)

7. (a) What is meant by
   (i) mutual induction
   (ii) self induction?

(b) Describe an experiment to demonstrate mutual induction

(c)

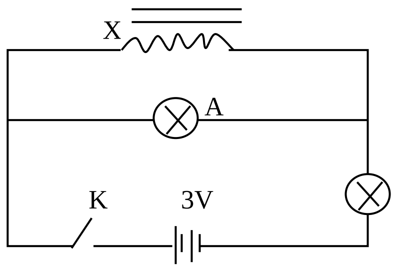


Fig 2

Bulbs A and B rated 3W, 6W are connected to an inductor, X, of large inductance as shown in figure 2. Explain what is observed when

(i) switch K is first closed (4)
(ii) Switch K is opened (2)

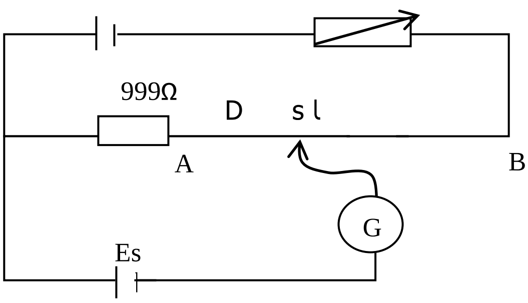
(d) (i) Describe briefly the action of a transformer
(ii) Describe briefly four causes of inefficiency in a transformer

(e) A transformer is designed to work on a 240V. 60W supply. It has 3000 turns in the primary and 200 turns in the secondary and its efficiency is 80%. Calculate the current in the secondary coil (4)

SECTION C

8. (a) (i) Draw the circuit diagram of the metrebridge and use it to derive the condition for balance
(ii) Explain why the metrebridge is unsuitable for comparison of low resistances
(iii) when resistors of resistances 4 Ω and 8Ω are connected respectively in the left and right hand gaps of a metrebridge a balance point is obtained at a point a distance of 32.0 cm from the left hand end of the bridge wire. On interchanging the resistors a balance point is obtained at a point 68.0 cm from the left hand end. The resistance of the uniform wire of the metrebridge is 5Ω . Calculate the end errors. (4)

(b)



In figure 3 above E is a driver cell of e.m.f 2V and negligible internal resistance. E, is standard cell of e.m.f 1.00 V. and AB is a uniform wire of resistance 10 Ω and length 100.0 cm. The galvanometer G shows no deflection when s l = 10.0 cm.
Find:
(i) the current flowing in the driver circuit (2)
(ii) the resistance of the rheostat (4)
(iii) the e.m.f of a thermocouple which is balanced by a length of 60.0 cm of the slide wire AB (2)

9. (a) (i)

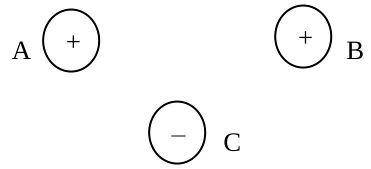


Fig 4

In figure 4, A,B and C are point charges of equal magnitudes.

(i) Sketch the field lines due to the charges and show the position of the neutral point
(ii) Explain why a charged material attracts an uncharged conductor

(b) With the aid of a labelled diagram describe how a large electric potential can be built up using a Van der Graaf generator

(c)

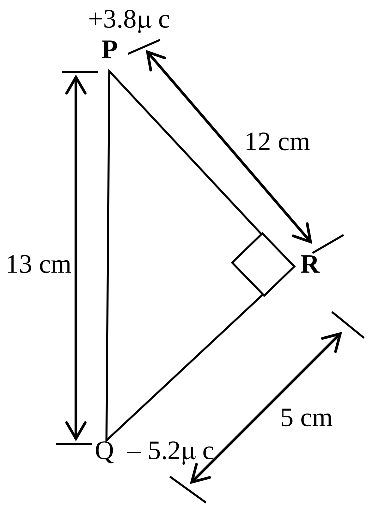


Fig 5

Two point charges of + 3.8 μ c and 5.2μ c are placed in air at points P and Q as shown in figure 5. Determine the electric field intensity at R.

10. (a) What is meant by capacitance of a *capacito*r? (1)

(b) Describe an experiment you would carry out to verify that the capacitance of a parallel plate capacitor is proportional to $\varepsilon A/d$, where d is the plate separation. A is the area of overlap of the plates and ε is the permittivity of the medium between the plates. (6)

(c) (i) Derive an expression for the effective capacitance of three capacitors of capacitance C_1, C_2 and C_3 connected in parallel.

(ii)

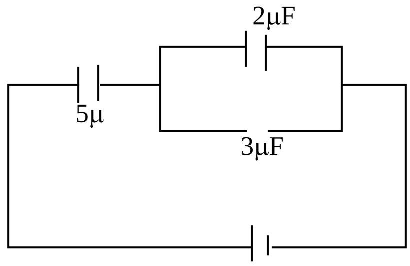


Fig 6

A attery of e.m.f 12 V is connected across a system of capacitors shown in figure 6. Calculate the total energy stored in the capacitors

(d) (i)

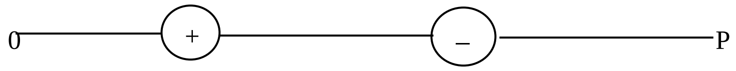


Fig 7

Figure 7 shows two charges +Q and –Q placed along a line OP, Sketch the variation of electric potential along OP.

(ii) Explain with the aid of a diagram the term electrostatic shielding. (4)

P510/1
PHYSICS
Paper 1
March 1997
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
PHYSICS
(PRINCIPAL SUBJECT)
Paper 1
2 hours 30 minutes

Attempt five questions, including at least one, but not more than two from each of Sections A, B and C
Non- programmable scientific electronic calculators may be used

SECTION A

1. (a) (i) What is meant by dimensions of a physical quantity? (1)
(ii) The centripetal force F required to keep a body of mass M moving in a circular path of radius r is given by
$F = \frac{MV^2}{r}$, show that the formula is dimensionally consistent (4)

(b) (i) State the principle of moments (1)
(ii) Explain why it is necessary for a bicycle rider moving around circular path to lean towards the centre of the path (5)
(iii) Derive the expression for angle of inclination to the horizontal skidding at a speed V, in terms of g, r , and V. (3)

(c) (i) What is meant by *parking orbit of a satellite?* (1)
(ii) Calculate the radius of parking orbit for an earth satellite. (5)

2 (a) Define the term *momentum* (1)
(b) A bullet of mass 300g travelling horizontally at a speed of 8 m s^{-1} hits a body of mass 450g moving in the same direction as the bullet at 1.5 m s^{-1} . The bullet and body move together after collision. Find the loss in kinetic energy. (6)

(c) (i) State the work energy theorem
(ii) A ball of mass 500 g travelling at a speed of 10 m s^{-1} at 60o to the horizontal strikes a vertical wall and rebounds with the same speed at 120o from the original direction. If the all is in contact with the wall for 8×10^{-3} s. Calculate the average force exerted by the ball. (6)

(d) (i) state the laws of kinetic friction
(ii) Describe a simple experiment to determine the coefficient of kinetic friction between two solid surfaces (3)

3. (a) A mass banging on a spring is given a small vertical displacement and then released
(i) Show that the mass performs simple harmonic motion (4)
(ii) Discuss briefly the energy transformations which occur as the mass oscillates (3)

(b) A mass of 0.2 kg is put on a scale pan of negligible mass hanging of constant 40 N m $^{-}$1. The mass is then depressed 3 cm below the position and released. Calculate the:
(i) frequency of the oscillations (3)
(ii) velocity of the mass when it is 1 cm above the equilibrium position. (3)
(iii) maximum amplitude of oscillation for the 0.2 kg mass to stay in contact with the pan throughout. (4)

SECTION B

4. (a) Explain why large mercury drops tend to flatten out whereas small drops assume spherical shapes (5)
(b) (i) Derive the expression for the excess pressure inside a spherical soap bubble in terms of the radius r of the bubble and the surface tension Y of the soap solution. (6)

(ii) Two soap bubbles of radii 2.0 cm and 4.0 cm respectively coalesce under isothermal conditions. If the surface tension of the soap solution is 2.5×10^{-2} N m^{-1}, calculate the excess pressure inside the resulting soap bubble. (4)

(c) Explain why raindrops hit the ground with less force than they should (5)

5. (a) Define specific het capacity and state its units (2)
(b) (i) With the aid of a labelled diagram, describe how the specific heat capacity of water can be measured by the continuous flow method.
(ii) State the advantages of this method (9)

(c) Distinguish clearly between a saturated *vapour* and an unsaturated *vapour.* (3)

(d) A horizontal tube of uniform bore, closed at one end, has some air trapped by a small quantity of water. If the length of the enclosed air column is 20 cm at pressure remains, constant at 760 mm of mercury?
[Saturated Vapour Pressure of water at 14o C and 40° C is 10.5 mm and 49.5 mm of mercury respectively]
(6)

6. (a) (i) Explain why the molar heat capacity of an ideal gas at constant pressure, Cp differs from the molar heat capacity, Cv
(ii) Derive the relation Cp – Cv = R, where R is the universal gas constant (4)

(b) A vessel containing 1.5×10^{-3} m^3 of an ideal gas at a pressure of 8.7 x 10 – 2 Pa and a temperature 25o C is compressed isothermally to half its volume and then allowed to expand adiabatically to its original volume
(i) calculate final pressure and temperature of the gas (Take $Cp/Cv = 1.41$) (7)
(ii) Sketch the P.V graph for the whole process (1)
(iii) Calculate work done during the Isothermal process (3)

7. (a) Describe how heat transfer by conduction takes place (2)
(b) (i) A wall consists of two layers of thickness L_1 and L_2 and thermal conductivities K_1 and K_2 respectively. If the surface of the wall are maintained at temperatures T1 and T2., show that the rate of heat transfer through the wall is

$$\frac{A(T_2 - T_1)}{L_1/K_1 + L_1/K_2}$$

where A is the area of the surface of the wall. (5)

(ii) State the assumption made in b (i) (1)
(iii) A cooking utensil of thickness 3 mm is to be made from two layers, one of aluminium and the other of brass. If one layer is to be 2 mm thick and the other 1 mm, determine which combination allows a higher rate of flow of heat.
[Thermal conductivities of aluminium and brass are 240 Wm^{-1} k^{-1} and 112 Wm^{-1} k^{-1} respectively.]

(c) (i) State Newton's law of cooling. (1)
(ii) Describe an experiment to verify Newton's law of cooling. (5)

(d) Explain briefly why at night its much colder in a valley than on top of the hills. (2)

SECTION C:

8. (a) (i) Describe briefly the steps involved in the dermination of the charge of an electron by Millikan's oil drop experiment. (7)

(ii) A spherical oil drop of radius 2.0×10^{4} m is held stationary between two parallel metal plates across which a p.d of 4500 V is applied. The separation of the plates is 1.5 cm. Calculate the charge on the drop if the density of the oil is 880 kg m^{-3} (4)

(b) With the aid of a labelled diagram, describe and give the theory of a mass spectrometer for measuring the charge to mass ratio of positive ions (5)

(c) A stream of singly ionised magnesium atoms is accelerated through a p.d of 50V and then enters a region of uniform magnetic field of flux density 2.08×10^{2} T. Calculate the atomic mass of the ions

9. (a) (i) Outline the process involved in the production of X-rays in a modern X-ray tube. (4)
(ii) How do X-rays differ from β -particles? (2)
(iii) Distinguish between X-ray production and the photoelectric effect (2)

(b) An x-ray tube produces a spectrum of one or more prominent lines together with a background of continuous radiation having minimum wavelength.

Explain the occurrence of the
(i) prominent lines (2)
(ii) minimum wavelength. (2)

(c) Describe briefly the Bragg diffraction of X-rays bycrystals and derive the Bragg's law (5)
(d) A second order diffraction image is obtained by reflection of X-rays at atomic planes of a crystal for a glazing angle of $11^{o}24'$

Calculate the atomic spacing of the planes if the wavelength of X-rays is 4.0×10^{-11} m.

10. (a) What is meant by the terms radioactivity, half-life and decay constant?
(b) The activity of a sample of dead wood is 10 counts per minute while activity for a living plant is 19 counts per minute. If the half life of carbon – 14 is 5500 years, find the age of the wood sample. [Assume $A = A_o e^{-\lambda t}$]

(c) (i) Draw the current voltage characteristic for a Geiger-Muller tube. (1)
(ii) Identify giving reasons the part of the characteristic over which the tube is normally operated. (2)

(d) What is *binding energy* of a nucleus? (2)

(e) consider the nuclear reaction below:

$${}^{235}_{92}U \; {}^{1}_{0}n \qquad {}^{6}_{56}Ba + 89\,Kr + 3\;{}^{1}_{0}n + \text{Energy}$$ (2)

(i) Find the values of x and y
(ii) Calculate the energy released by one mode of ${}^{235}_{92}U$ in the above reaction (5)

(f) Explain why neutrons are preferred to charged particles for inducing nuclear reactions (2)

P510/2
PHYSICS
Paper 2
March 1997
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
PHYSICS
(PRINCIPAL SUBJECT)
Paper 2
2 hours 30 minutes

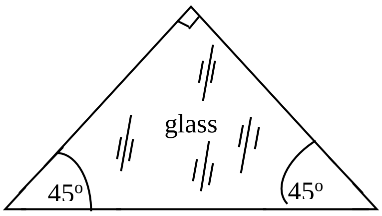
SECTION A

1. (a) Describe, giving the relevant equations, how the refractive index of a liquid can be determined using a convex lens of known radius of curvature (6)

(b) An object is placed 30 cm from a converging lens of focal length 10 cm and an image formed on a screen. When a diverging lens is placed half way between the converging lens and the screen, the screen has to be moved 4.5 cm further to obtain a clear image. Calculate the focal length of the diverging lens. (5)

(c) Explain the apparent shape of the bottom of a pool of water to an observer at the bank of the pool (4)

(d) Figure 1 shows a ray of light incident on a glass prism of refractive index 1.5. Calculate the angle of emergence of the ray. (5)



2. (a) (i) What is the centre of curvature of a convex mirror? (1)
(ii) With reference to a convex lens, explain what is meant by *spherical aberration*. (3)

(b) A lens L a plane mirror, m and a screen S are arranged as shown in figure 2 so that a sharp image of luminous object O is formed on the screen S. When the plane mirror is replaced by a convex mirror the lens has to be moved 5 cm further away from the screen so as to obtain a sharp image on the screen.

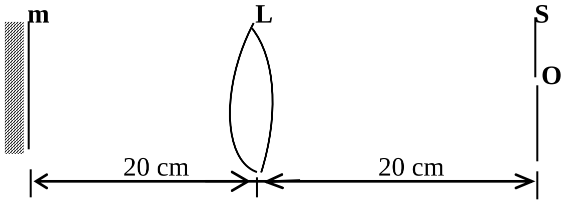


Fig 2

(i) Illustrate the two situations by sketch ray diagrams (4)
(ii) Calculate the focal length of the convex mirror (5)

(c) (i) The deviation d by a prism of small angle, A, and refractive index n is d = (n – 1)A. Use this to show that the focal length of a thin coverging lens of refractive index n is given by

$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$ where r_1 r_2 and are the radii of curvature of the lens surface . (5)

(ii) Calculate the focal length of a coverging meniscus with radii 25 cm and 20 cm, and refractive index 1.5 (2)

3. (a) What is meant by the terms *path difference* and interference? (3)

(b) (i) Explain how interference fringes are formed in an air-wedge film between two glass slides when monochromatic light is used. (6)

(ii) Describe the appearance of the fringes when white light is used (2)

(c) Two glass slides in contact at one end are separated by a metal foil 12.50 cm from the line of contact, to form an air-wedge. When the air-wedge is illuminated normally by light of wavelength 5.4×10^{-7} m interference fringes of separation 1.5 mm are found in reflection. Find the thickness of the metal foil (5)

(d) (i) Describe one method of producing plane polarised light (3)

(ii) Name two uses of polarised light (1)

3. (a) State Huygen's principle.
(b) Use Huygen's principle to derive the relation between critical angle and refractive indices of two media in contact (4)
(c) Explain the formation of beats and derive the expression for the beat frequency. (6)

(d) The equation: y – a cos(ωt – kx) represents a wave travelling along the x-axis. Find the
(i) speed of the wave (1)
(ii) direction in which the wave is travelling (1)
(iii) resultant wave when the wave is superposed with a wave represented by y = a cos (ωt – kx) (2)

(e) State any two characteristics of the wave in d (iii) above. (2)

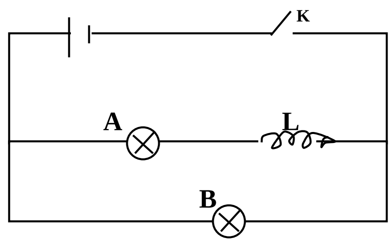
(f) Air vibrates in the fundamental mode in a pipe of uniform cross sectional area open at both ends

State the conditions of pressure at the ends of the pipe and sketch a diagram to show the first overtone in the pipe (2)

SECTION B:

5. (a) (i) State Lenz's law of electromagnetic induction (1)
(ii) Describe an experiment to verify Lenz's law (5)

(b) In the circuit in figure 3, A and B are identical bulbs



(i) Sketch using the same axes, the time variation of the current through each bulb when switch k is closed (2)

(ii) Explain the features of the curves in (i) (2)

(iii) Explain what would be observed on closing the switch, if the coil L was iron-cored and the battery was replaced with an alternating current source.

(d) Describe briefly one application of self induction (3)

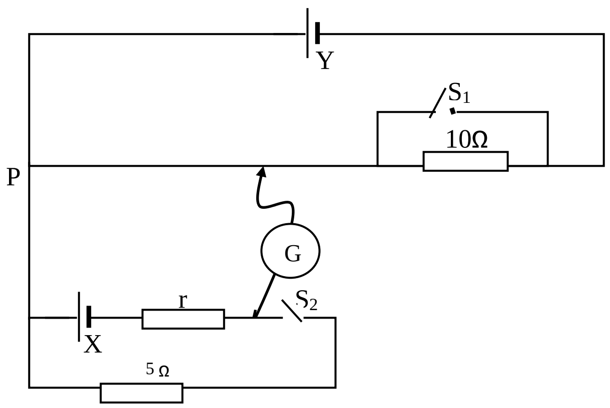
(e) Draw a labelled diagram of an induction coil and explain how it operates (7)

6. (a) (i) Briefly one advantage of using a potentiometer over a moving coil voltameter (2)

(ii) Explain one advantage of using a potentiometer over a moving coil voltameter. (2)

(b) With the aid of circuit diagram, describe how an ammeter is calibrated

(c) The figure below shows a cell Y of negligible internal resistance with e.m.f 2v PQ is a uniform slide wire of length 1.00 m and resistance 50Ω.



With both switches S_1 and S_2 open, the balance length PR is 0.90 m. When S_2 is closed and S_1 left open, the balance length changes to 0.75 m. Determine the

(i) e.m.f of cell X. (2)

(ii) internal resistance, r, of X (3)

(iii) balance length when both S1 and S2 are closed (3)

7. (a) With the aid of a labelled diagram describe how a simple d.c. motor works (5)

(b) (i) What is meant by back e.m.f in a motor? (2)

(ii) Explain the importance of back e.m.f in the operation of a motor (2)

(c) (i) Show that back e.m.f in the coil of a motor rotating at ω radians per second in a radial magnetic field, of flux density B is Eь = WNAB where N is the number of turns and A the area of the coil

(ii) The coil of a d.c. motor is mounted in a radial magnetic field of flux density IT. The coil has 20 turns each of area 40 cm2 and total resistance 2 Ω. Calculate the maximum angular velocity the motor attains when working on 240V and drawing a current of 1A.

(d) Find the force per metre between two long parallel wires 5 cm apart and carrying currents of 2A and 4A in opposite directions in a vacuum.

SECTION C

8. (a) (i) What is meant by e.m.f of a cell? (1)

(ii) Describe, with the aid of a circuit diagram how the e.m.f of a cell can be Determined using a potentiometer. (6)

(b) Explain why two cells connected in series deliver more current than when in parallel.

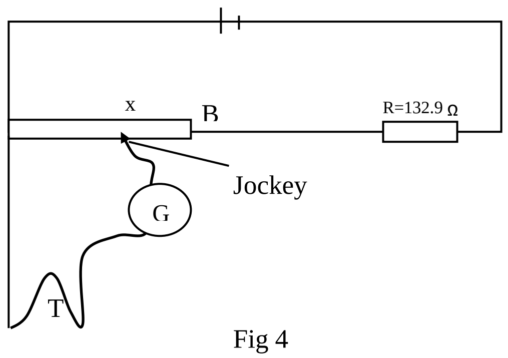


Fig 4

The e.m.f of a thermocoule. T, is determined using the circuit shown in figure 4. The resistance of the wire AB is 4.0 Ω

(i) Explain why resistor R is connected in the circuit (2)

(ii) The galvanometer G , deflected to the left when the jockey was tapped near A, to the right when tapped near B and showed no deflection when tapped at X. Explain (3)

(iii) If the galvanomter G has a aresistance of 98 Ω and the resistance of the thermocouple is negligible, find the current that flows through G when the balance point is midway between A and B.

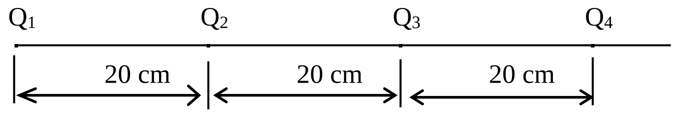
(iv) State the assumptions made in b (iii)

9. (a) (i) Define electric field intensity (1)

(ii) Describe how a conducting body may be positively charged but remains at zero potential (3)

(iii) Explain how the presence of a neutral conductor near a charged conducting sphere may reduce the potential of the sphere. (3)

(b) Figure 5 shows charge Q_1 Q_2 Q_3 and Q_4 of –1C, +2C, –3 C and +4C arranged in a straight line in a vacuum.



(i) Calculate the potential energy of Q_2 (5)

(ii) What is the significance of the sign of the potential energy in (i) above? (1)

(iii) Explain how a body may acquire charge by rubbing (4)

(c) What is meant by *corona discharge*? (3)

10. (a) What is *dielectric constant*?

(b) (i) Explain the effect of a dielectric placed between the plates of a charged capacitor (6)

(ii) Give two other uses of dielectrics in capacitors (2)

(c) Explain what would happen if a conductor instead of a dielectric was placed between the plates of a capacitor.

(d) A 2μ F capacitor that can just withstand a .p.d of 5000 V uses a dielectric. With a dielectric constant 6 which breaks down if the electric field strength in it exceeds 4 x 10^7 V m^{-1} .

Find the

(i) thickness of the dielectric

(ii) effective area of each plate

(iii) energy stored per unit volume of dielectric

[The capacitance, C = $\underline{\varepsilon_v \ \varepsilon_r \ A}$ where A is the surface area; d is the distance between the plates and is the ε_r dielectric constant]

P510/1
PHYSICS
Paper 1
April 1996
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 1
2 hours 30 minutes

SECTION A:

1. (a) State Kepler's laws of planetary motion

(b) (i) Derive the expression for the period of a satellite moving in a circular orbit about the Earth in terms of the radius of the orbit, the acceleration due to gravity at the Earth's surface and the radius of the Earth (4)

(ii) A communication satellite is launched in a circular orbit about the Earth's equator so that it appears to remain in the same position as viewed from the Earth.
Find the height of the satellite above the equator.
[Radius of the Earth = 6.4×10^4m] (4)

(iii) A satellite of mass 1000 kg is launched in a circular orbit of radius 7.2×10^6m about the earth . Calculate the mechanical energy of the satellite. (4)

(c) Explain briefly the effects of frictional forces on the motion of an earth satellite (3)
(d) Explain the term weightlessness as applied to space travel. (2)

2. (a) (i) State Newton's laws of motion
(ii) A body of mass m_2 and moving with velocity U_2. After collision, the bodies move with velocities, V_1 and V_2, respectively. (4)
Use Newton's laws of motion to show that the total linear momentum is conserved in the collision (4)

(b) A bullet of mass 10g is fired at short range into a block of wood of mass 990g resting on a smooth horizontal surface and attached to a spring of force constant 100 Nm^{-1}. The bullet remains embedded in the block while the spring is compressed by a distance of 5.0 cm.
Find the elastic energy of the compressed spring, and the speed of the bullet just before collision with the block.

(c) A car of mass 1000 kg climbs a track which is inclined at an angle of 30^o to the horizontal. The speed of the car at the bottom of the incline is $36kmh^{-1}$. If the coefficient of kinetic friction is 0.3 and the engine exerts a force of 4000N, how far up the incline does the car move in 10s?

3. (a) (i) Define pressure
(ii) Derive the expression for the pressure at a point a depth h from the surface of a liquid of density p. (3)

(b) A block of mass 0.10 kg is suspended from a spring balance. When the block is immersed in water of density block is immersed in a liquid of unknown denstity, the spring balance reads 0.70 N.

Find
(i) the density of the solid (4)
(ii) the density of the liquid (3)

(c) What is meant by the following
(i) terminal velocity? (1)
(ii) Coefficient of viscosity? (1)
(iii) Streamline flow (1)

(d) Explain qualitatively the origin of the lift force on an aeroplane at take off. (3)

(e) Briefly explain, using the kinetic theory of matter, the effect of temperature on viscosities of fluids. (3)

4. (a) What is meant by the terms *stress,* s*train* and *Young's modu*lus? (3)
(b) Derive in terms of stress and strain, an expression for the energy stored in unit volume of a stretched wire. (4)
(c) A uniform metal bar of length 1.0 m and of diameter, 2.0 cm is fixed between two rigid supports at 25°C. If the temperature of the rod of raised to 75°C,
Find
(i) the force exerted on the supports (3)
(ii) the energy stored in the rod at 75°C (3)
[Young's modulus for the metal = 2.0 x 10^{11} pa, coefficient of linear expansion = 1.0 x 10^{-3} K^{-1}]

(d) Compare the elastic properties of steel and glass. Draw using the same axes, the stress- strain curves for these two materials (4)

(e) Explain briefly the physical process involved in plastic deformation and work-hardening of metals. (3)

SECTION B:

5. (a) (i) With reference to an electrical thermometer, describe the steps involved in setting up a Kelvin scale of temperature (3)

(ii) State two advantages of a thermocouple over an electrical resistance thermometer (1)

(b) (i) With the aid of a labelled diagram, describe an electrical method of measuring the specific latent heat of vaporisation of a liquid (7)

(ii) What are the advantages of this method over the method of mixtures? (1)

(c) An electrical heater rated 500 W is immersed in a liquid of mass 2.0 kg contained in a large thermos flask of heat capacity 840 Jkg^{-1} at 28°C. Electric power is supplied to the heater for 10 minutes. If the specific heat capacity of the liquid is 2.5 x 10^3 Jkg^{-1} K^1 , its specific latent heat of vaporisation is 8.5 x 10^3 Jkg^{-1} and its boiling point is 78°C, estimate the amount of liquid which boils off.
State any assumptions made in your calculation. (8)

6. (a) Distinguish between reversible isothermal and adiabatic expansion of a gas
Starting from the same point (P_1, V_2) sketch P – V curves for these two processes. (3)

(b) A fixed mass of gas in the state (P_1, V_2) undergoes an isothermal expansion to the state (P_2, V_2) . Obtain an expression for the work done by the gas (4)

(c) An ideal gas at a pressure of 2.0 x 106 pa occupies a volume of 2.0 x 10^{-3} m^3 at 47.5°C. The gas expands a diabatically to a final pressure of 110 x 105 Pa. The ratio of the specific heat capacity at constant pressure to that at constant volume is 1.40.
(i) the number of moles of the gas
(ii) the final volume of the gas
(iii) the final temperature of the gas
[Universal gas constant R = 8.31 $Jmol^{-1}$ K^{-1}]

(d) (i) In what ways does a real gas differ from an ideal gas?
(ii) Sketch a P – V curve for a real gas below its critical temperature and label the main features of the curve

7. (a) Define thermal conductivity of a material.
(b) (i) Explain, using the molecular theory of matter the mechanism of heat conduction in insulators (3)
(ii) Briefly account for the fact that metals are better conductors of heat than insulators (3)

(c) A wall of a building consists of two brick layers each of thickness 10.0 cm and between which there is a layer of air 2.0 cm thick. Find the rate of heat flow through one m2 of the wall if the inner and outer temperatures of the buildings are 25ºC and 15ºC respectively.

[Thermal conductivities of brick and air are respectively, 0.7 $Wm^{-1}K^{-1}$ and 0.024 $Wm^{-1}K^{-1}$]

(d) (i) What is meant by a black body? (1)

(ii) The total power output of the sun is 4.0 x 10^{26} W. Given that the mass of the sun is 1.97 x 10^{10} kg, and its density is 1.4 x 103 kgm^{-3}, estimate the temperature of the sun. State any approximations made

[Stefan's constant = 5.67 x 10^{-8} $Wm^{-2}K^{-4}$)

SECTION C

8. (a) In a simple model of the hydrogen atom, an electron of mass m and charge –e , is considered to move in a nearly circular orbit about a proton

(i) Write down the expression for the electric force on the electron, and show that the kinetic energy of the electron is

$$\frac{e^1}{8\pi\varepsilon_o r}$$

where r is the radius of the orbit and ε_o is the permittivity of free space (2)

(ii) Find the total energy of the electron

(iii) Given that the angular momentum of the electron is equal to

$$\frac{nh}{2\pi}$$

where n is an integer and h is Planck's constant, show that total energy of the electron is

$$En = -\frac{[\ me\ ]}{[\ B\varepsilon_o{}^2h^2\ ]}\ \frac{1}{n^2}$$

(b) The figure below shows some of the energy levels of a neon atom

$E_2\omega$ -- 0.00eV

E_4-- – 0.81eV

E_3-- –2.77eV

E_2-- –4.87eV

E_1 -- –21.47eV

In what region of the electromagnetic spectrum does the radiation emitted in the transition E_2 E_2 lie?

(c) Explain the observation of absorption line spectra nature (3)

(d) Explain the physical processes that account for

(i) cut of wavelength (2)

(ii) characteristic lines, in an x-ray tube (3)

9. (i) What is meant by half life of a radioisotope?

(ii) Show that the half-life of a radioisotope is equal to

$$\frac{\log 2}{\lambda}$$

where λ is the decay constant.

Assume where necessary the radioactive law

$N = N_e e^{-\lambda t}$

(b) The radioisotope ^{60}Co decays to 60 Ni by emission of a β particle and two γ photons. The half-life of ^{60}Co is 5.27γ

(i) Calculate the maximum energy (in MeV) of the gamma radiation given off per disintegration (4)

(ii) Find the power of the radiation emitted by 5 g of ^{60}Co. (5)

[mass of ^{60}Co = 59.9338u
Mass of ^{60}Ni = 59.9308u
Mass of ^{e}e = 0.0005u]

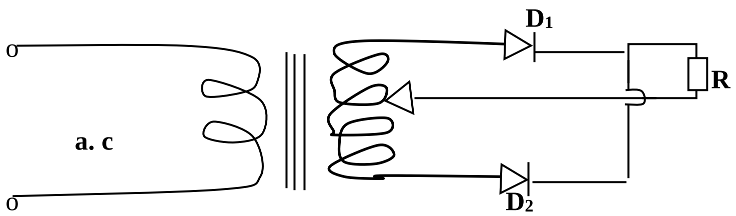
(c) With the aid of a labelled diagram describe the structure and action of an ionisation chamber (5)

(d) State two industrial applications of radioisotopes (2)

10. (a) (i) Draw the circuit diagram you would use to obtain the anode current (Ia) anode voltage (Va) characteristic of a thermionic diode. (1)

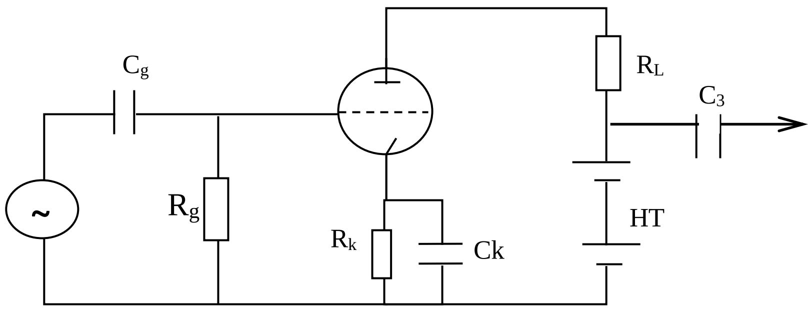
(ii) Sketch and explain the main features of a typical Ia – Va characteristic of a vacuum diode. (5)

(iii) Explain, with the help of suitable sketch diagrams, the time-variation of the voltage across the resistor in the circuit below



(iv) With reference to a (iii) above, explain the use of a filter circuit.

(b) The figure below represents a single-stage diode amplifier circuit.



(i) State the functions of the capacitors Cg and Ck (2)

(ii) What are the functions of resistors Rg and RL? (2)

(iii) Draw the equivalent circuit of the triode as an amplifier and deduce an expression for the gain (3)

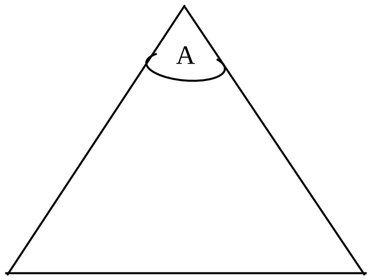
P510/2
PHYSICS
Paper 2
April 1996
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 2
2 hours 30 minutes

SECTION A:

1. (a) (i) State the laws of refraction (2)
(ii) What is meant by critical angle? (2)

(b) Monochromatic light is incident at an angle of 38o on a glass prism of refractive index 1.50. The emergent light glazes the surface of the prism as shown:



(i) calculate the angle of refraction r (2)
(ii) find the critical angle, C, for the glass air interface (3)
(iii) find the refractive angle, A of the prism (2)

(c) (i) For a ray of light passing through a prism, what is the condition for minimum deviation to occur? (1)
(ii) Describe how you would measure the minimum deviation, D of a ray of light passing through a glass prism. (6)

2. (a) (i) What is meant by principal axis and principal focus as applied to a converging lens
(ii) Describe how the focal length of a converging lens can be obtained using a plane mirror and the non parallax method

(b) A converging lens of focal length 20 cm is placed coaxially with a diverging lens of focal length of 6 cm
(i) If the lenses are 12 cm apart, determine the position of the image of a distant object placed on the same side as the converging lens. (4)
(ii) What is the nature of the image formed in b (i) above? (1)

(c) (i) Trace the path of three rays from a distant object through an astronomical telescope in normal adjustment
(ii) An astronomical telescope consits of two thin converging lenses of focal length 100 cm and 10 cm respectively. If the final image of a distant object is virtual and is 20 cm from the eye-piece, find the separation of the lenses. (4)

(iii) State any two advantages of a reflecting telescope over a refracting one (2)

3. (a) Distinguish between transverse and longitudinal waves (2)

(b) The displacement y given of a wave travelling in the x- direction at time t is:

$$y = a \sin 2\pi \left(\frac{t}{0.1} - \frac{x}{2.0} \right) \text{ metres.}$$

Find

(i) the velocity of the wave (4)

(ii) the period of the wave (1)

(c) (i) What is meant by the Doppler effect?

(ii) A police car sounds a siren of 1000 Hz as it approaches a stationary observer
What is the apparent frequency of the siren as heard by the observer if the speed of sound in air is 340?

(iii) Give one application of the Doppler effect (1)

(d) (i) Describe the motion of air in a tube closed at one end and vibrating in its fundamental mode (3)

(ii) A cylinderical pipe of length 29 cm is closed at one end. The air in the pipe reaonates with a tuning fork of frequency 860 Hz sounded near the open end of the tube. Determine the mode of vibration and find the end correction (5)

4. (a) What is meant by the terms

(i) constructive interference and

(ii) destructive interference, as applied to two sources of light (3)

(b) In Young's double slit experiment state what happens to the fringes

(i) when the source is moved near the slits? (1)

(ii) When separation of the slits is changed? (2)

(c) In Young's experiment, an interference pattern in which the tenth bright fringe was 3.4 cm from the centre of the pattern was obtained. The distance between the slits and the screen was 2.0m while the screen separation was 0.34mm. Find the wavelength of the light source (3)

(d) (i) What is polarised light? (1)

(ii) Explain the polarisation of light by reflection at a glass surface and by scattering (2)

(iii) The polarising angle for light in air incident on a glass plate is 57.5o, what is the refractive index of the glass? (2)

5. (a) (i) Define the unit of magnetic flux density (1)

(ii) Give the expression for the force experienced by a electron moving at an average velocity y_1, in a wire placed at right angles to a magnetic field of intensity B (1)

(b) (i) With the aid of a labelled diagram describe the mode of operation of a moving coil galvanometer

(ii) A rectangular coil of 100 turns is suspended in uniform magnetic filed of flux density 0.02T with the plane of the coil parallel to the field. The coil is 3 cm high and 2 cm wide. If a current of 50μA through the coil causes a deflection 30^o, calculate the torsional constant of the suspension. (3)

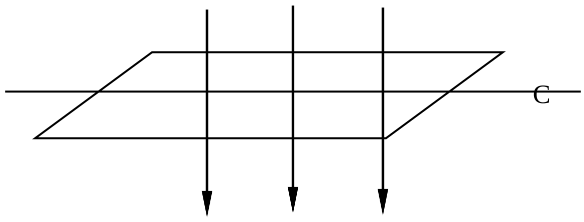
(c) (i) Define the ampere

(ii) Explain how the definition in c (i) above is used in the measurement of current (4)

(iii) Two parallel wires carrying currents of 5A and 3A respectively are 10cm apart. If the wire carrying current of 5A is 50cm long, find the force exerted on it. (3)

6. (a) State the laws of electromagnetic induction

(b) A coil of 100 turns and area 2×10^{-2} m^2 lies in a magnetic field of flux density $3x10^{-3}$ T and rotates uniformly at 100 revolutions per second about an axis perpendicular to the magnetic field as shown.



Calculate

(i) the emf induced when the plane of the coil makes 60^o with B (3)

(ii) the amplitude of the induced emf. (2)

(c) (i) What is meant by the back emf in a motor? (1)

(ii) State the major difference between a dc motor and a dc dynamo (2)

(d) A dc motor has an armature resistance of 1Ω and is connected to a 240 V supply. The armature current taken by the motor is 10A. Calculate

(i) the back emf in the armature (2)

(ii) the mechanical power developed by the motor (2)

(iii) the efficiency of the motor (3)

7. (a) (i) What is meant by the root-mean –square value of an alternating current? (1)

(ii) Describe, with the aid of a labelled diagram, the structure and mode of operation of repulsion type moving iron motor (2)

(b) A sinusoidal alternating voltage $V = V_o$ Sinwt, is connected across a pure capacitance C. Derive an expression for the capacitive reactance of the Capacitor.

(c) A transformer connected to an ac supply of peak voltage 240V, is to supply a peak voltage of 9V to a mini lighting system of resistance 5Ω

Calculate

(i) the ratio of the primary to the secondary turns (1)

(ii) the rms current supplied by the secondary (2)

(iii) the average power delivered to the lighting system (2)

(d) (i) Explain why the voltage of the electricity generated at Owen Falls Dam has to be stepped up to about 132 kv for transmission places in the Western Region, and then stepped down for general use.

(ii) Give any two power losses in a transformer and state how they are minimised.

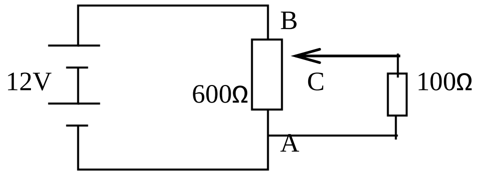
SECTION C

8. (a) (i) State Ohm's law (1)

(b) A 12 =V battery is connected across a potential divider of resistance 600Ω as shown. If a load of 100Ω is connected across the terminals A and C where the slider is half-way up the divider, find

(i) the p.d across the load (3)

(ii) the p.d across A and C when the load is removed (1)



(c) (i) Describe how a potientomenter is used to determine the emf of a cell

(ii) In the determination in c (i) above, why is the resistance of the galvanometer not important (1)

(d) A battery of emf 12V and internal resistance 0.5Ω is connected across a 6Ω load.

Calculate :

(i) the rate of energy conversion in the battery (2)

(ii) the rate of dissipation of electrical energy in the resistor (1)

(iii) comment on the difference in (i) and (ii) (1)

(iv) sketch a graph showing the variation of power out but with the load (2)

9. (a) (i) What is meant by dielectric constant?

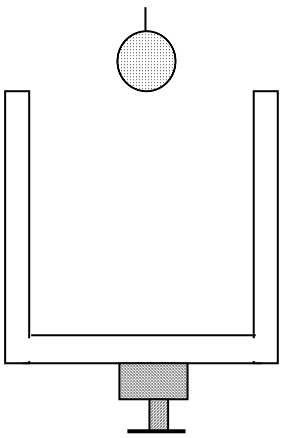
(ii) A parallel plate capacitor was charged to 100V and then isolated. When a sheet of dielectric was inserted between its plates, the p.d decreased to 30V. Calculate the dielectric constant of the dielectric (3)

(b) A 60μF capacitor is charged from a 100V supply. It is then connected across the terminals of a 15μF uncharged capactiro. Calculate

(i) the final p.d across the combination (3)

(ii) the difference in the initial and final energies stored in the capacitors and comment on the difference (5)

(c)



A charged conducting ball is suspended by an insulting thread and is gently lowered in a conducting container placed on an insulating stand.

Explain the distribution of charge on the conductor when

(i) the ball is well inside the container but still suspended (2)

(ii) the ball touches the inner surface of the container (2)

(d) (i) Explain how lightning can cause damage to buildings (3)

(ii) Explain the action of a lightning conductor (2)

10. (a) Define temperature coefficient of resistance

(b) The table shows the resistance of a wire at different temperatures

Temp (^oC)	30	50	70	90	110
Resistance (Ω)	103	107	111	115	119

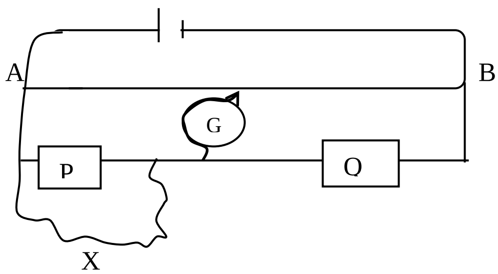
Plot a graph of resistance against temperature to find

(i) the resistance of the wire at 0^oc (4)

(ii) the temperature coefficient of the wire (3)

(c) (i) Derive the condition for balance when using a metre-bridge to measure resistance (4)

(ii) State any precautions taken to achieve an accurate measurement. (3)



In the diagram, the resistors P and Q are 5Ω and 2Ω respectively. A wire X of length 60 cm and diameter 0.02 mm is connected across P so that the balance point is 66.7 cm from A. Calculate the resistivity of the wire. (5)

P510/1
P510/1
PHYSICS
Paper 1
April 1995
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 1
2 hours 30 minutes

SECTION A

1. (a) (i) Write the equations of uniformly accelerated motion (3)

(ii) Derive the expression for the maximum horizontal distance travelled by the a projectile in terms of the initial speed, u, and the angle of projection θ to the horizontal (4)

(b) A bullet is fired from a gun placed at a height of 200 m with a velocity of 150 m s^{-1} at an angle of 30o to the horizontal.

(i) the maximum height attained

(ii) the time taken for the bullet to hit the ground (7)

(c) A ball of mass 500g, travelling at a speed of 10 m s^{-1} at 60° to the horizontal, strikes a vertical wall and rebounds with the same speed at 120° to the initial direction. If the ball is in contact with the wall for 8 x 10^{-3} s, calculate the average force exerted on the wall by the ball (6)

2. (a) What is meant by *potential energy*? (1)

(b) Describe the energy changes which occur when

(i) a ball is thrown upwards in air (3)

(ii) a loud speaker is vibrating (2)

(c) State Newton's law of gravitation and use it to show that the square of the period of a satellite in orbit is proportional to the cube of the radius of the orbit (4)

(d) (i) Derive the expression for the potential energy due to the earth at any point outside the earth (3)

(ii) Sketch a graph to show how the potential energy varies with distance from the centre of the earth for points outside the earth (2)

(iii) A mass is released from a point at a distance of 10R from the centre of the earth, where R is the radius of the earth

Find the speed of the mass at a point a distance of 7R from the centre of the earth (5)

3. (a) In an experiment to determine the acceleration due to gravity, the following values of period of oscillation were obtained for various lengths of a simple pendulum.

Length l (m)	0.20	0.30	0.40	0.50
Period, T (s)	0.90	0.90	1.09	1.40

(i) Plot a suitable graph and use it to determine the acceleration due to gravity (2)

(ii) State two factors that could affect the accuracy of the results in this experiment (2)

(b) What is the difference between damped and free vibrations?

(c) Two springs of force constants k_1 and k_2 are suspended from a horizontal support. A mass m hangs from the lower ends of the springs as shown in figure 1.

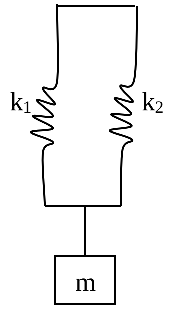


Fig 1

If both springs have negligible mass, show that when m is displaced from its equilibrium position, if describes a simple harmonic motion of frequency f given by:

$$f = \frac{1}{2x}\left(\frac{k_1 + k_2}{m}\right)$$ (6)

(d) A wave is described by the equation:

y = 0.2 sin (6r – 100) metres

Find:

(i) the wavelength (2)

(ii) the speed of the wave (2)

4. (a) (i) What is meant by viscosity? (1)

(ii) Explain the effect of temperature on the viscosity of a gas (3)

(iii) Sketch the velocity-time graph for the motion of an oil drop in air. (1)

(iv) Find the terminal velocity of an oil drop of radisu 2.5 x 10 – 6 m which falls through air. Neglect the density of air

(Viscosity of air $= 1.8 \times 10^{-5}$ N s m $^{-2}$

Density of oil $= 900$ km m $^{-3}$) (4)

(v) Explain why the velocity of a liquid at a wide part of a tube is less than that at a narrow part (2)

(b) (i) State Archimedes' principle (1)

(ii) Describe how you would measure the density of an irregular solid which floats in water (5)

(iii) A hydrometer floats in water with 72% of its volume submerged. The hydrometer floats in another liquid with 80% of its volume submerged. Find the relative density of the liquid (3)

SECTION B

5. (a) Define the term triple point (6)

(b) Describe how you would determine the absolute temperature of a body using a platinum resistance thermometer (3)

(c) Describe with the aid of a diagram, how you would calibrate a thermocouple thermometer. (8)

(d) A metallic rod at a temperature of θ °C has its ends rigidly fixed. If the temperature of the rod is reduced to a lower value θ °C, find the stress in the rod in terms of Young's modulus, the coefficient of linear expansion and the temperature change (4)

(e) Explain one application of a bimetallic element (4)

6. (a) Explain briefly how the kinetic theory of matter accounts for the existence of the three phases of matter. (5)

(b) Distinguish between

(i) a reversible process and an irreversible process and give one example of each (3)

(ii) an isothermal change and an adiabatic change (2)

(c) Show that the work, w, done by a gas which expands reversibly from volume V1 to volume V2 is given by

$$W = \int_{V_1}^{V_2} PdV$$

Where P is the pressure (3)

(d) A gas initially occupying a volume of 1.0 l at 273 K and 1.0×10^5 Pa is compressed isothermally to a volume of 0.5 l. It is then allowed to expand adiabatically to the original volume

(i) Find the final temperature and pressure of the gas (6)

(ii) Indicate the process on a P.V diagram (1)

7. (a) (i) Distinguish between conduction, convection and radiation of heat (6)

(ii) State two factors which control the rate of cooling of a body (2)

(b) The diagram in figure 2 shows a device for detecting infra-red radiation

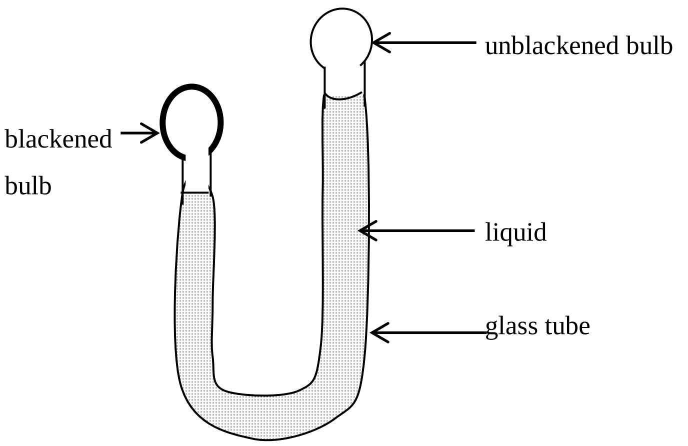


Fig 2

(i) What property of the liquid is employed in the device? (1)

(ii) Explain how the device operates (3)

(c) Describe one method by which the sun's surface temperature can be approximated

(d) One end of a perfectly lagged metal bar of length 0.10 m and cross sectional area 5.0×10^{-4} m ^{2} maintained at 100ºC while the other end is in contact with ice.

Calculate the rate at which the ice melts (5)

(Thermal conductivity of the metal is 400 W m $^{-1}$ K $^{-1}$)

SECTION C

8. (a) Describe the mechanism of thermionic emission (3)

(b) Explain the following terms as applied to a vacuum diode:

(i) space charge limitation (3)

(ii) saturation (1)

(c) (i) Draw a labelled diagram to show a triode being used as an amplifier

(ii) Derive an expression for the amplification factor, μ in terms of anode resistance, Ra and mutual conductance , gm for a triode valve. (3)

(iii) A triode with mutual conductance of 4.0 mA V^{-1} and an anode resistance of 5kΩ is connected to a load resistance of 10 kΩ . Assuming that the triode is operating under optimum conditions, estimate the output signal obtained for an alternating input signal of 25 mV.

(iv) State how alternating p.d is separated from the direct p.d in the output of a triode when used as an amplifier.

(d) State two advantages of a triode as an amplifier over a transistor

9. (a) List the main characteristics of the photoelectric effect (4)
(b) A freshly cleaned zinc plate, placed on the cap of a gold leaf electroscope, is irradiated with ultra violet radiation as shown in figure 3.

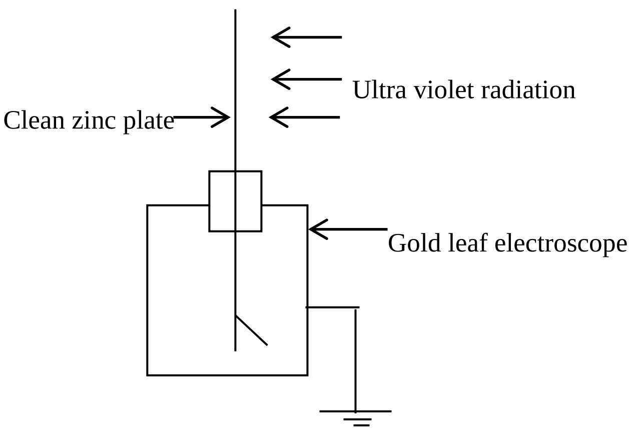


Fig 3

Explain what happens when the gold leaf electroscope is
(i) negatively charged (3)
(ii) positively charged (2)

(c) A metal of work function 2.50 eV is irradiated with light of an unknown frequency. The maximum velocity of the photo electrons is 1.14×10^6 m s^{-1} .
Calculate the maximum wavelength of the incident radiation (4)

(d) In a cathode ray oscilloscope (CRO), an electron beam passes between the Y deflector plates each 5 cm long and 0.5 cm apart. The distance between the centre of the Y plates and the screen is 20 cm and the potential difference between the anode and the electron gun is 250 V. Determine the deflection, in V m^{-1} of the electron beam on the screen of the CRO

10. (a) (i) Write the expression for the force on a particle, of charge Q, moving with velocity $\overline{V}$ in a uniform magnetic field of flux density $\overline{B}$ (2)
(ii) State the direction of the force in a (i) (1)

(b) A particle of charge 3.2 x 10 – 19 C is accelerated from rest through a p.d. of 104 V. It enters into a region of uniform magnetic field of flux density 0.5 T. The particle describes a circular path of radius 8.94 cm
Find
(i) the kinetic energy of the particle on entering the magnetic field (2)
(ii) the mass of the particle. (5)

(c) With the aid of a labelled diagram, explain the operation of an ionising chamber,
(d) A radioactive source emits 2.0 x 105 alpha particles per second. The particles produce a saturation current of 1.1 x 10 – 8 A in an ionisation chamber. If the energy required to produce an ion pair is 32 eV, determine the energy, in MeV, of an alpha particle emitted by the source. (4)

P510/2
PHYSICS
Paper 2
April 1995
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 2
2 hours 30 minutes

SECTION A

1. (a) State the laws of refraction of light
(b) Show that when a ray of light passes through different media separated by plane boundaries
$\mu \sin i$ = constant
where μ is the absolute refractive index of a medium and i is the angle made by the ray with the normal in the medium

(c) Describe how you would determine the refractive index of a liquid using an air-cell (6)
(d) A ray of light is incident on a prism of refractive index 1.3 and refracting angle 72°.
Find:
(i) the angle of incidence (4)
(ii) the deviation of the ray (2)
(e) Describe briefly two uses of glass prisms

2. (a) Describe briefly two uses of glass prisms
(b) (i) What is meant by the term radii of curvature as applied to a converging lens?

$$I = (\mu - 1)\left(\begin{array}{cc} \underline{1} & \\ \underline{1} & \\ r_1 & r_2 \end{array}\right)$$

Where μ is the refractive index of the material of the lens and r1 and r2 are the radii of curvature of the surfaces of the lens. (5)

(ii) A biconvex lens of radius of curvature 24 cm is placed on a liquid film on a plane mirror. A pin clamped horizontally above the lens coincides with its image at a distance of 40 cm above the lens.

(c) Describe, with the aid of a labelled diagram, the functions of the essential parts of a photographic camera. (4)
(d) A projector is required to project slides which are 5.0 cm square onto a screen which is 5.0 m square. If the focal length of the projection lens is 0.1m, what should be the distance between the screen and the slide? (4)

3. (a) (i) What is sound? (1)
(ii) In what ways do musical sounds differ from one another? (3)

(b) With the aid of a labelled diagram describe an experiment to demonstrate interference of sound waves. Give the relevant theory (6)

(c) A glass tube, open at the top, is held vertically and filled with water. A tuning fork vibrating at 264 Hz is held above the tube and water is allowed to flow out slowly. The first resonance occurs when the water level is 32.5 cm from the top while the second resonance occurs when the level is 96.3 cm from the top.
Find:
(i) the speed of sound in the air column (4)
(ii) the end correction (2)

(d) Why is sound propagation in air considered to be an adiabatic process? (4)

4. (a) Discuss briefly the nature of light (3)
   (b) Distinguish between unpolarised and polarised light (2)
   (c) Describe how polarised light can be produced by
      (i) reflection
      (ii) selective absorption
      Indicate the procedure you would use to detect the polarised light (6)
   (d) Explain why the sky appears blue on a clear day (3)
   (e) (i) Explain, with the aid of a diagram, the formation of a spectrum by a transmission grating (3)
      (ii) State the advantages of the transmission grating over a glass prism in determining the wavelength of a source (2)
   (f) State one application of polarisation (1)

SECTION B

5. (a) Explain the difference between magnetic flux and magnetic flux density.
   (b) (i) Two long conductors carrying a current are placed parallel to each other in a vacuum at a distance d metres apart Derive an expression for the force per unit length acting on each wire when a current L_1 amperes flows through one and L_2 amperes flows through the other

      (ii) How does the expression in (i) lead to the definition of the ampere?

   (c) (i) A mall rectangular coil of N turns with a cross sectional area A is suspended so that it can rotate about a vertical axis through the centre of its shorter sides. The coil is arranged so that the vertical sides are perpendicular to a uniform magnetic field of flux density B. Derive an expression for the couple acting on the coil when a current of L amperes flows and when the plane of the coil makes an angle θ with the direction of the magnetic field. (4)

      (ii) Explain the additions required if the arrangement described in (i) is to be used to measure current. What modifications are necessary to achieve a linear scale? (3)

   (d) A coil of cross sectional area 1.6×10^{-3} m 2 is to be used to produce a uniform magnetic flux density of 1.5×10^{-3} T.

      (i) Where will the magnetic field be uniform? (1)
      (ii) Calculate the total flux through the coil (2)

6. (a) (i) With the aid of a diagram, describe an experiment to determine how the e.m.f induced in a metal rod moving in a magnetic field depends on the rate of change of magnetic flux
      (ii) Explain how Lenz's law is an example of energy conservation (3)

   (b) (i) Give an expression for the magnetic flux density at the centre of a long solenoid of *n* turns per metre and carrying a current *I*
      (ii) A circular aluminium disc, of radius 30 cm, is mounted inside a long solenoid of 2×10^3 turns per metre carrying a current of 200.0 A such that its axis coincides with that of the solenoid. If the disc is rotated about its axis at 40 revolutions per minute, what will be the e.m.f induced? (2)

   (c) (i) What is meant by back e.m.f? (2)

      (ii) An iron-cored coil of many turns is connected in series with an ammeter, an accumulator and a switch. The switch is closed . Explain the movement of the pointer in each case (3)

7. (a) What is meant by the term *magnetic field*? (2)
   (b) (i) Write the expression for the magnetic flux density at the centre of a circular coil of N turns each of radius R and carrying a current I. (1)

      (ii) A copper wire of length 7.85 m is wound into a circular coil of radius 5cm. A current of 2A is passed through the coil Calculate the magnetic flux density at the centre of the coil (4)

   (c) Describe how you would detect the magnetic field at a point close to a long straight wire carrying an alternating current (4)

(d) Describe, with the aid of a labelled diagram, the structure and function of a moving iron ammeter. (5)

(e) An alternating current Ii is driven through a coil of inductance L as shown in figure 1.

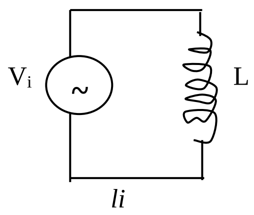


Fig 1

The instantaneous value of Ii = Im sin 2x ft where Im is its amplitude and f is the frequency

(i) Derive an expression for the voltage Vi across the coil (3)

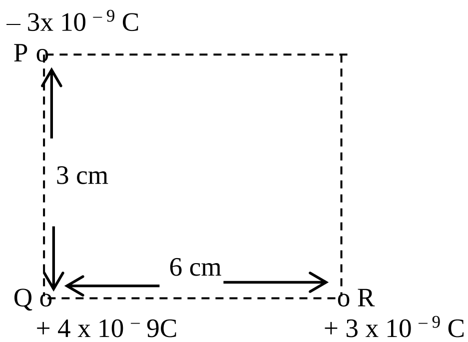
(ii) Show on the same sketch graph, how Vi and Ii vary with time t. (2)

SECTION C

8. (a) (i) State Couloumb's Law of electrostatics (1)

(ii) Derive an expression for the electric potential energy of two point charges Q_1 and Q_2 a distance *r* apart.

(b)



Three charges of -3×10^{-9} C, $+4 \times 10^{-9}$ C and $+3 \times 10^{-9}$ C are placed in a vacuum at the vertices P, Q and R respectively of a rectangle PQRS of sides 3cm x 4cm as shown in figure 2.

Calculate the resultant electric field intensity at S. (7)

(c) (i) What is an equilpotential surface? (1)

(ii) State the characteristics of an equipotential surface (2)

(d) Describe an experiment to show that a charge resides outside a hollow conductor (4)

9. (a) A conducting sphere of radius 9.0 cm is maintained at an electric potential of 10kV. Calculate tahe charge on the sphere

(b) Sketch a graph of:

(i) electric potential,

(ii) electric field intensity

against distance for a charged parallel plate capacitor whose separation of plates is fixed. (2)

(c) Use a simple atomic model to explain the effect of inserting an insulating material between the plates of the capacitor in (b) (5)

(d) (i) Describe the energy changes which occur when a capacitor is being charged from a battery (2)

(ii) Sketch a graph of current against time during the charging of a capacitor. Explain how you would use the graph to find the charge on the plates of the capacitor. (2)

(e)

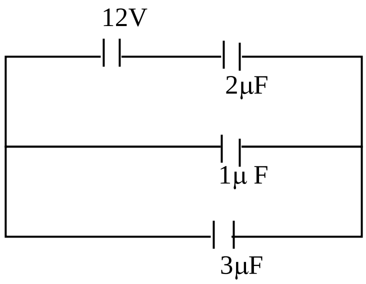


Fig 3

Find the energy stored in the capacitor of capacitance 3μF shown in figure 3, when the capacitor is fully charged

10. (a) Define *electrical resistivity* (1)

(b) (i) Draw a circuit diagram of a metre-bridge

(ii) Describe how the metre bridge may be used to measure the electrical resistivity of a material in the form of a wire.

(iii) A resistance coil is connected across the left hand gap of a metre bridge. When a 5.0 Ω standard resistor is connected across the right hand gap of the metre bridge and the coil is immersed in an ice-water mixture the balance point is at a point 45.0 cm from the left hand end of the bridge.

When tahe coil is immersed in a stream bath at 100^{o}C, the balance point shits to a point 52.8cm from the left hand end of the bridge. Find the temperature coefficient of the material of the coil

(c) In the circuit shown in figure 4, AB is a uniform wire of length 1 m and resistance 4.0 Ω. C_1 is an accumulator of e.m.f 2V and negligible internal resistance. C_2 is a cell of e.m.f 1.5 V.

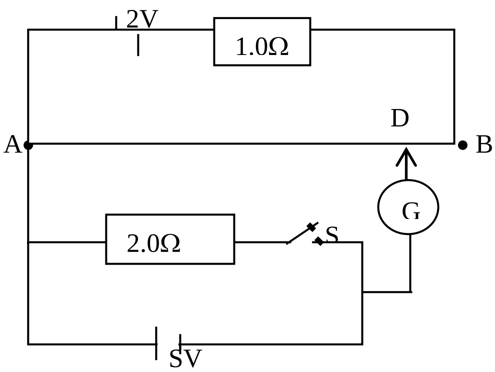


Fig 4

(i) Find the balance length Ad when the switch is open

(ii) If the balance length is 75.0 cm when the switch is closed, find the internal resistance of C2.

END

P510/1
PHYSICS
Paper 1
March/April 1994
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 1
2 hours 30 minutes

SECTION A

1. (a) State the conditions for mechanical equilibrium
(b) You are provided with the following items only:
One metre rule, one half-metre rule, one helical spring (of force constant k), one wedge, one 100 gram mass, a piece of inelastic thread, a piece of manila paper , one retort stand and two clamps.
(i) Design an experiment that can be carried out using all these items to determine the mass of the metre rule. Illustrate your answer with a diagram (8)
(ii) Comment one the accuracy of the results obtained in the experiment in (i) above (2)

(c) One end of a plank of length 4m and weight 100N is hinged to a vertical wall. An inelastic rope, tied to the other end of the plank, is fixed at a point 4 m above the hinge so that the plank is horizontal. A weight of 300N is suspended from the plank at a distance of 3m from the hinge.
Find:
(i) the tension in the rope (4)
(ii) the reaction of the wall on the plank (4)

2. (a) (i) State the laws of static friction (3)
(ii) Describe briefly how you would measure the coefficient of static friction between two solid surfaces (3)
(iii) A car of mass 1000 kg, moving a long a straight road with a speed of 72 km h – 1, is brought to rest by a steady application of the brakes in a distance of 50m. Find the coefficient of kinetic friction between the tyres and the road (4)

(b) Discuss the energy transformations which occur from the time the brakes of a moving car are applied to the time the car comes to a stop (3)

(c) (i) Giving two examples, explain the term *conservative force* (2)

(ii) A mass of 500g is released from rest so that if falls vertically through a distance of 20 cm onto a scale pan, of negligible mass, hung from a spring of force constant 100N m – 1. Find the position of the scale pan when it first comes to rest (5)

3. (a) State Kepler's laws of motion (3)
(b) Derive, fromNewton's law of gravitation, the dimensions of the universal gravittional constant (3)
(c) Calculate the ratio of the mass of the sun to that of the earth, given that the moon moves round the earth in a circular orbit of radius 4.0 x 105 km with a period of 27.3 days, and the orbital radius of the earth round the sun is 1.5 x 108 km and it's period is 365 days. (5)

(d) Account for the following
(i) Acceleration due to gravity varies with latitude
(ii) The moon has no atmosphere (2)

(e) Explain why any resistance to the forward motion of a space satellite results in an increase in kinetic energy (5)

4. (a) What is meant by
(i) elastic deformation (1)
(ii) plastic deformation (2)

(iii) work hardening? (2)

(b) Figure 1 shows the stress-strain curves for a metal wire, rubber and glass.

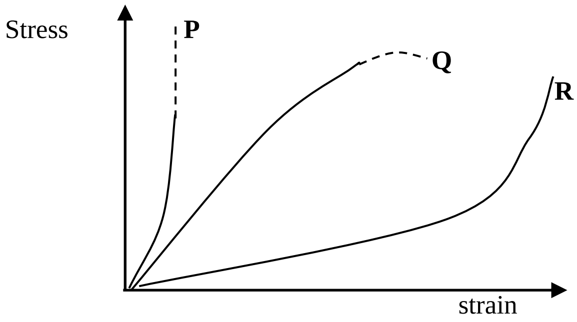


Fig 1

(i) Identify each of the curves (3)
(ii) Explain the characteristic features of curve R (3)

(c) Define *surface tension* (1)

(d) When a capillary tube is held in a vertical position with one end just dipping in a liquid of surface tension Υ and density ρ, the liquid rises to a height *h*. Derive an expression for *h* in terms of Υ, ρ and the radius of the capillary tube, assuming the angle of contact is zero. (4)

(e) Account for the temperature dependence of surface tension (4)

SECTION B:

5. (a) Define specific heat capacity
   (b) A copper cylinder is mounted along the axis of a wooden pulley of diameter 0.25m. The pulley rubs against the cylinder when it turns. When a steady force of 50N is applied tangentially to the pulley, the temperature of the cylinder rises by 10ºC after the pulley has turned through 20 revolutions
   (i) if the mass of the cylinder is 0.20 kg, find the specific heat capacity of copper (4)
   (ii) How would you measure the temperature rise? (1)
   (iii) Give reasons why this is not an accurate method for determining the specific heat capacity of copper (2)
   (c) Explain the steps taken in the continuous flow method for the measurement of specific heat capacities of liquids to ensure accurate results (3)
   (d) (i) What is a cooling correction in the method of mixtures for the determination of specific heat capacities? (1)
   (ii) Describe how you would obtain a cooling correction in the determination of specific heat capacity of rubber by the method of mixtures (7)

   (e) State one advantage of the continuos flow method over the method of mixtures (1)

6. (a) Sketch a well labelled graph to show the variation of pressure with volume for an unsaturated vapour below its critical temperature (2)

   (b) Use the kinetic theory of matter to explain the following observations:
   (i) Saturated vapour pressure of a liquid increases with temperature (3)
   (ii) Saturated vapour pressure is not affected by a decrease in volume at constant temperature (3)

   (c) Explain why it is possible to make water boil below its normal boiling point (3)

   (d) (i) Explain the formation of dew on grass (3)

(ii) State the conditions which favour the formation of dew (2)

(e) The total pressure in a closed vessel containing air and saturated vapour at 35°C is 1.01×10^5 Pa. If the saturation vapour pressures at 35°C and 87°C are 3.99×10^3 Pa and 7.18×10^4Pa respectively, calculate the total pressure in the vesset at 87°C, assuming the air remains saturated (4)

7. (a) Explain briefly why metals are good conductors of heat (4)
(b) Describe how you would determine the coefficient of thermal conductivity of a poor conductor of heat (7)
(c) A concrete floor of a hall has dimensions of 10.0m by 8.0m . It is covered with a carpet of thickness 2.0 cm. The temperature inside the hall is 22°C while that of the surroundings just below the concrete is 12°C. The thermal conductivities of the concrete and the material of the carpet are 1W m^{-1} k^{-1} and 0.05W m^{-1} K^{-1} respectively and the thickness of the concrete is 10cm.
Calculate :
(i) the temperature at the interface of the concrete and carpet (3)
(ii) the rate at which heat flows through the floor (2)

(d) Explain the green house effect and indicate why it leads to global warming. (4)

SECTION C:

8. (a) Explain the following as applied to a thermionic diode;
(i) space-charge (1)
(ii) rectification (2)

(b) Draw the equivalent circuit of a triode as a single stage voltage amplifier and derive an expression for the gain
(c) Describe briefly the functions of the main parts of a cathode ray oscilloscope (7)
(d) An electron of energy 10 keV enters midway between two horizontal metal plates each of length 5.0cm and separated by a distance of 2cm. A potential difference of 20V is applied across the plates. A fluorescent screen is palced 20 cm beyond the plates.
Calculate the vertical deflection of the electron on the screen (6)

9. (a) (i) State the conditions under which photoelectric emission occurs (2)
(ii) Explain how the photoelectric effect provides evidence for the quantum theory of light (2)
(iii) When light of wavelength 5.9×10^{-7} m is incident on sodium metal, electrons of maximum kinetic energy 1.17×10^{-20} J are emitted. Calculate the maximum kinetic energy of electrons that will be emitted by sodium metal illuminated by light of wavelength 4.5×10^{-7} m. (4)

(b) What are the differences between X-rays and cathode rays? (4)
(c) In an X-ray tube, 99% of the electrical power supplied to the tube is dissipated as heat. If the accelerating voltage is 75 kV and power of 742.5 W is dissipated as heat, find the number of electrons arriving at the target per second (5)

(d) What would be the effect of increasing the accelerating voltage in (c)? (1)
(e) X-rays of wavelength 1.0 x 10 – 10 m are diffracted from a set of planes of rubidium chloride. The first diffraction maximum occurs at 8.8o. Calculate the interplanar spacing (2)

10. (a) The following is a part of uranium – 238 decay series:

$$^{238}_{92}U \xrightarrow{(I)} {}^{234}_{90}Th \xrightarrow{(III)} {}^{234}_{91}Pa$$

Name the particle emitted at each of stages (I) and (II)

(b) With the aid of a labelled diagram, describe how a cloud chamber can be used to detect ionising radiation

(c) A source emits two types of radiations simultaneously. The radiations pass through an abseorber of different thickness and are detected
(i) Sketch a graph of intensity of radiation detected against thickness of absorber (1)
(ii) Explain the feature of the graph in (i) (2)

(d) (i) What is binding energy of anucleus?
(ii) Calculate in MeV, the energy liberated when a helium nucleus, 4 He, is produced by fusing two deuterium nuclei ${}^{2}_{1}H$

Mass of ${}^{4}_{2}He = 4.004$ u

Mass of ${}^{2}_{1}H = 2.015$ u

$1\ u = 1.66 \times 10^{-27}$ kg

(e) Consider the following nuclear reaction:

$${}^{235}_{92}U + {}^{1}_{0}n \qquad {}^{133}_{x}A + {}^{y}_{40}R + 6\,{}^{1}_{0}n$$

(i) Determine the values of x and y (1)
(ii) What is the importance of this reaction? (1)

END

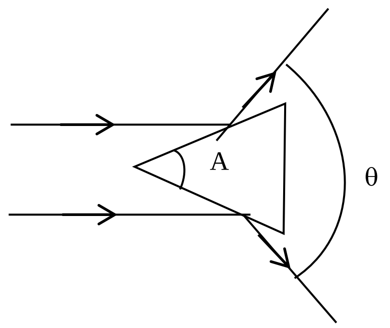
P510/2
PHYSICS
Paper 2
Nov/Dec 1994
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 2
2 hours 30 minutes

SECTION A:

1. (a) Describe how you would measure the refractive index of glass using a spectrometer.

(b)



A parallel beam of light is incident onto a prism of refracting angle A as shown in figure 1.
Show that θ = 24 (3)

(c) A glass prism of refractive index 1.5 and refracting angle 60o is completely immersed in a liquid of refractive index 1.3

(i) the angle of incidence (3)

(ii) the angle of deviation (2)

(d) A liquid is placed in a concave mirror to a depth of 2 cm. An object held above the liquid coincides with its own image when it is 45.5 cm from the pole of the mirror. If the radius of curvature of the mirror is 60.0 cm, calculate the refractive index of the liquid.

(e) Explain why a paraboloid mirror is used in search lights instead of a concave mirror. (2)

2. (a) What is meant by the terms principal focus and focal length of a converging lens?
(b) Name one defect of images formed by a lens and explain how the defect is minimised in practice (3)
(c) The magnification of an object in thin converging, lens is m. When the lens is moved a distance d towards the object, the magnification becomes m1 show that the focal length, f, of the lens is given by

$$f = \frac{dmm^1}{m^1 - m}$$

(d) A converging lens L1 of focal length 10 cm is placed at a distance y infornt of a diverging lens L2 of focal length 20cm. An illuminated object is placed at a distance of 20cm infront of L1 and the final image by L2 forms at the principal focus of L2.

(i) the distance y (5)

(ii) the final magnification (1)

(e) Explain

(i) why an object far away from the eye appears to be smaller than when it is near (2)

(ii) how loss of light by reflection at refractive surfaces can be minimised (3)

3. (a) Define the terms frequency and amplitude (2)
(b) Give two examples of waveform motion (2)
(c) A wave of amplitude 0.2m, wavelength 2.0m and frequency 50Hz. If the initial displacement is zero at point x = 0
   (i) write the expression for the displacement of the wave at any time t. (2)
   (ii) find the speed of the wave (2)

(d) Two waves of frequencies 256 Hz and 280 Hz respectively travel with a speed of 340 m s – 1 through a medium.
   Find the phase difference at a point 2.0m from where they were initially in phase (4)

(e) Explain how energy is transmitted in a progressive wave in a gas (3)
(f) Design an experiment to demonstrate that a metal wire under tension can vibrate with more than one frequency (5)

4. (a) State the conditions for observing an interference pattern and explain why these conditions are necessary (4)
(b) What is meant by *diffraction?* (2)

(c) (i) Account for the intensity distribution which occurs when a parallel beam of light passes through a narrow slit (7)
   (ii) What happens to the intensity distribution when the slit is enlarged? (1)

(d) Describe the principles involved in the formation of interference fringes in a double slit arrangement (6)

SECTION B:

5. (a) Write the expression for the magnetic flux density at
   (i) a perpendicular distance R from a long straight wire carrying a current I in a vacuum
   (ii) the centre of a circular coil, of N turns each of radius R and carrying a current I in a vacuum (1)
   (iii) the centre of an air-cored solenoid of n turns per metre each carrying a current I (1)

(b) Sketch the pattern of the earth's magnetic field (3)
(c) Explain the terms *magnetic meridian*, angle of dip and declination (4)
(d) A circular coil of 5 turns of mean diameter 10 cm is mounted with its plane vertical and along the magnetic meridian. A small compass needle is mounted on a vertical axis at the centre of the coil. When a current of 0.50 A is passed through the coil, the compass needle deflects through 61°. When the current in the coil is reversed, the compass needle deflects through 59°.
Calculate the horizontal component of the earth's magnetic field intensity (4)

(f) (i) What is meant by magnetic flux?
   (ii) A current of 1.0 A flows in a long solenoid of 1000 turns per metre. If the solenoid has a mean diameter of 8.0 cm, find the magnetic flux linkage with one metre-length of the solenoid (4)

6. (a) State the laws of electromagnetic induction
(b) A circular coil of many turns is fixed with its plane horizontal as shown in figure 2.

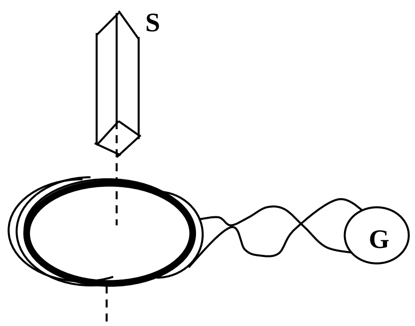


Fig 2

The ends of the coil are connected to a centre zero galvanometer G. A magnet is released from rest so that it falls vertically through the coil. Sketch a graph of deflection of the galvanometer against time of fall of the magnet and explain the main characteristics of the graph (6)

(c) Distinguish between self induction and mutual induction (4)

(d) State three factors which limit the efficiency of a transformer and indicate how they are minimised in practice. (3)

(e) An a.c transformer operates on 240 V mains,. It has 1200 turns in the primary and gives a voltage of 18 V across the secondary

- (i) Find the number of turns in the secondary (2)
- (ii) If the efficiency of the transformer is 90% , calculate the current in the primary coil when a resistor of 50 $\Omega$is connected across the secondary (3)

7. (a) (i) What is meant by a back e.m.f in a d.c motor? (2)

   (ii) Show how the back e.m.f in a motor is related to the efficiency of the motor (3)

(b) With the aid of a labelled diagram, explain how a hot wire ammeter words (4)

(c) (i) Define root mean square value of an alternating current (1)

(ii) A current I = 8.0 sin 100 t amperes is maintained in a heating coil immersed in 20kg of water. The resistance of the coil is 50Ω

Find the temperature rise obtained in 5 minutes

State the assumptions made (4)

(d) A capacitor of capacitance C and infinite resistance is connected across a source of alternating voltage and variable frequency *f*.

- (i) Find an expression for the reactance of the circuit, and sketch its frequency dependence
- (ii) Using the same axes, show how the applied voltage and the current in the circuit vary with time

Comment on the time variation (2)

SECTION C

8. (a) What is meant by *internal resistance* of a battery? (1)

(b) In the circuit in figure 3, the voltmeter V has resistance of 400 Ω

- (i) Find the reading of the voltmeter (4)
- (ii) Calculate the power dissipated in the 100 Ω resistor (2)
- (iii) What voltage would be obtained if the voltmeter was replaced by a cathode ray oscilloscope? (2)
- (iv) Explain the difference between the voltages obtained in (i) and (iii) above (2)

(c) Explain why, in a dynamo, the load resistance is usually bigger than the armature resistance (2)

(d) Define *potential difference* and the Coulomb. (2)

(e) A particle of charge + 4 + 10 $^{-9}$ C is situated between two parallel plates across which ad.c potential difference is applied. When the particle is moved 6.0 cm against the electric field 8 x 10 $^{-5}$ J of energy is used and the kinetic energy of the particle changes by 6.5 x 10 $^{-5}$ J.

Calculate:

- (i) the work done by the electric field (2)
- (ii) the magnitude of the electric field (3)

9. (a) With the aid of a labelled circuit diagram, describe how a Wheatstone bridge can be used to determine the value of a resistance of approximately 5Ω. Include the relevant theory in your description (10)

(b) State two factors on which the accuracy of the measurement obtained from a wheatstone bridge depends (2)

(c) In the circuit shown in figure 4, S is a standard cell of e.m.f 1.2 V.

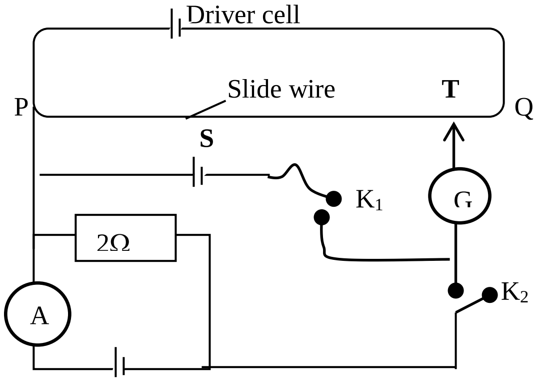
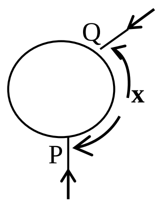


Fig 4

With switch K_1 closed and switch K_2 open, the balance length PT is 30.2 cm. When K1 is open and K2 is closed, the balance length becomes 26.8cm and the ammeter A reads 0.4 A
Calculate the percentage error in the ammeter reading.

(d) A wire of diameter d, length ℓ and resistivity Q forms a circular loop. A current enters and leaves the loop at points P and Q respectively as shown in figure 5.



Show that the resistance, R, of the wire is given by the expression

$$R = \frac{4pr(\ell - x)}{Xd^2\ell}$$

(3)

10. (a) Explain how an object gets charged by rubbing (3)
(b) Two metal spheres A and B are supported on insulating stands and placed in contact as shown in figure 6.

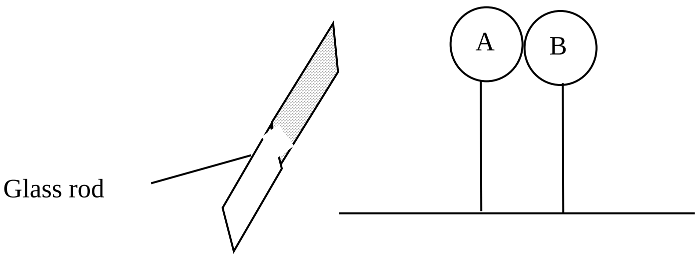


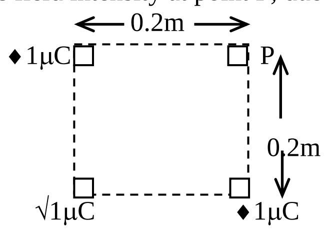
Fig 6

A glass rod, charged positively, is held close to sphere A. The spheres are then separated while the glass rod is in place

(i) State the charge acquired by each of the spheres (1)
(ii) Sketch the electric field pattern between the spheres (2)
(iii) Explain how the p.d between the spheres changes as the spheres are moved further apart. (2)

(c) Describe, with the aid of a labelled diagram, the application of corona discharge in a van de Graaf generator. (6)

(d) Find the resultant electric field intensity at point P, due to charges shown in figure 7.



END

P510/1
PHYSICS
Paper 1
March 1993
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 1
2 hours 30 minutes

SECTION A

1. (a) Define the terms:
   (i) displacement (1)
   (ii) uniform acceleration (1)

   (b) A stone is thrown vertically upwards from the top of a building with an initial velocity of 10 m s^{-1} . The stone takes 2.5s to land on the ground.
   (i) Sketch the velocity-time graph for the motion of the stone (4)
   (ii) Calculate the height of the building (5)
   (iii) State the energy changes that occurred during the motion of the stone (3)

   (c) A car of mass 500 kg moves from rest, with the engine switched off, down a road which is inclined at an angle of 49o to the horizontal.
   (i) Calculate the normal reaction (3)
   (ii) If the coefficient of friction between the tyres and the surface road is 0.32, find the acceleration of the car (3)

2. (a) State what is meant by the following;
   (i) angular velocity (1)
   (ii) period (1)

   (b) Derive an expression for the acceleration of a body moving along a horizontal circular path with uniform speed (6)

   (c) (i) Find an expression for the period of a satellite which moves in a circular orbit of radius r about a planet of mass M. (4)
   (ii) Explain the meaning of a parking orbit as applied to communication via satellite (3)

   (d) Calculate the ratio of the acceleration due to gravity on the surface of mercury to that on the surface of the earth given that the radius of mercury is 0.38 times the radius of the earth and the mean density of mercury is 0.68 times that of the earth. (5)

3. (a) Describe how you would determine Young's modulus for a steel wire (5)
   (b) A wire of length ℓ and cross-sectional area A, has a force constant k. The wire is stretched to a length (ℓ + x) by a constant force.
   (i) Assuming Hooke's law, find an expression for k in terms of ℓ A. and Young's modulus, E, for the wire (2)
   (ii) Show that the energy stored in a unit volume of the wire is equal to ½ E $(^{x}/_{\ell})^2$ (4)

   (c) A metal wire of diameter 2.0 x 10^{-4} m and length 2m is fixed horizontally between two points 2 m apart. Young's modulus for the wire is 2 x 10 11 Nm^{-2}
   (i) What force should be applied at the midpoint of the wire to depress it by 1.0 x 10^{-1} m? (6)
   (ii) Find the work done in (i) above (3)

4. (a) (i)State the difference between laminar flow and turbulent flow in fluids (2)
(ii) Describe a simple experiment to demonstrate these two kinds of fluid flow. Illustrate your answer with a diagram (5)

(b) (i) Give the factors which determine the rate of flow of a liquid through a pipe under a steady state
(ii) Explain, giving appropriate equations, the fall of an oil drop in air (5)

(c) (i) State Archimede's principle
(ii) A string supports a metal block of 2kg which is completely immersed in a liquid of density 8.8 x 102 kgm $^{-3}$. If the density of the metal is 9.103 kg $^{-3}$, calculate the tension in the string.

SECTION B:

5. (a) (i) State Boyle's law
(ii) The pressure P of an ideal gas of density Q, and mean square speed is given by

$$P= {}^{1}/_{3}\,P$$

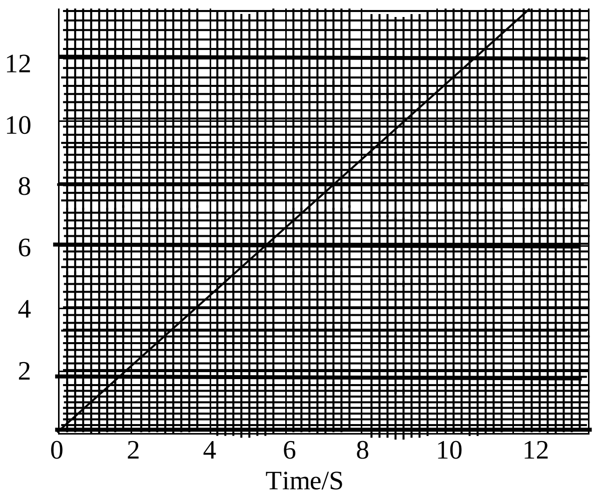
Use this expression to derive Boyle's law.

(b) Air consists approximately of 20% oxygen and 80% nitrogen. The relative molecular masses of oxygen and nitrogen are 32 and 28 respectively.
Calculate the ratio of
(i) the mean square speed of oxygen to that of nitrogen in air (3)
(ii) the partial pressure of oxygen to that of nitrogen in air (4)

(c) Explain why oxygen and nitrogen are gases found in the atmosphere close to the earth's surface (1)
(d) Derive the relation between the principal molar heat capacities of a gas (4)
(e) An ideal gas of volume 1.0ℓ at STP expands at constant pressure to a volume of 3.0ℓ . Calculate (i)

6. (a) (i) Define the term ***specific heat capacity*** ad state its units (2)
(ii) Describe a simple electrical method of determining the specific heat capacity of a solid. State the necessary precautions (7)

(b) The graph below shows the change of temperature with time when 100g of a liquid is heated using a 500 W immersion heater



Use the graph to calculate the specific heat capacity of the liquid

(c) Explain why a baby has to be wrapped well on a cold day. (2)

(d) (i) Define Saturation vapour pressure: (1)

(ii)

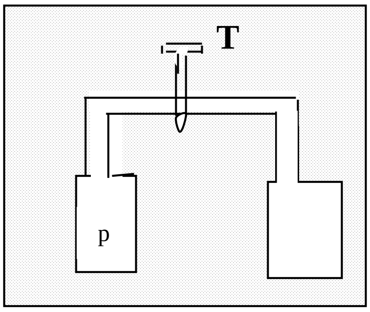


Fig 1

Two cylinders P and Q each of volume 1.5 t, are joined in the middle by a closed tap T, and placed in a constant temperature bath at 60ºC as shown in figure j. P contains a vacuum while Q contains air and saturated water vapour. The total pressure in Q is 200 mm Hg. When T is opened, equilibrium is reached, with the water vapour remaining saturated. If the final pressure in the cylinders is 150 mm Hg, calculae the saturation pressure of water at 60ºC. (4)

7. (a) (i) What is meant by black body radiation? (2)

(ii) Explain why a hollow sphere with a pin-hole outlet approximates a black body (3)

(b) Sketch on the same axes, the variation of relative intensity with wavelength for a black body and a non-black body at the same temperature. (2)

(c) With the aid of a labelled diagram, describe the structure of a sensitive infrared detector and explain how it works

(d) (i) Define thermal conductivity

(ii) An aluminium plate has a thickness of 5 cm. The upper and lower surfaces of the plate are maintained at temperatures of 120ºC and 20ºC respectively. If the thermal conductivity of aluminium is 2.37 x 102 W m^{-1} K^{-1} . Calculate

- (i) the rate of heart flow per cm^2 across the two surfaces (3)
- (ii) the temperature midway between the surfaces (3)

SECTION C

8 (a) Explain how beasts are produced and derive an expression for the beats frequency (6)

(b) Describe, with the aid of a labelled diagram a method based on the application of parabolic reflectors to measure accurately the velocity of sound in air (7)

(c) State

- (i) the factors which affect the velocity of sound in air (1)
- (ii) how the effects of the factors you have stated in (i) can be reduced (2)

(d) A closed organ pipe is of length 0.680 m

- (i) Calculate the frequency of the first harmonic (3)
- (ii) Sketch the standing wave in (i) (1)

9 (a) (i) With the aid of a diagram, describe how cathode rays are produced (5)

(ii) Explain how the sign of the charge of cathode rays may be determined (2)

(b) An electron is projected with a speed of 3.0 x 10 m s – 1 in the direction of a uniform electric field. After travelling a distance of 40 cm, the electron reverses its direction

(i) Why does the electron reverses its direction? (1)

(ii) Calculate the magnitude of the electric field. (5)

Stopping potential, Y(V)	3.10	1.60	1.00	0.35
Frequency x 10^{15} (Hz)	1.20	0.84	0.70	0.55

(i) What is meant by *photoelectric* effect? (2)

(ii) Plot a suitable graph and use it to determine Plack's constant (5)

10 (a) (i) Define specific charge (1)

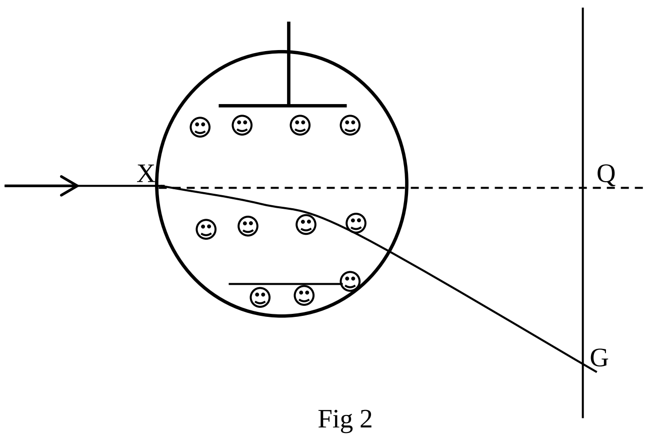


Fig 2

(ii) In an a experiment to determine the specific charge of an ion, the ion is projected horizontally along the direction XO and enters a region of uniform magnetic field of flux density 0.4 T at X as shown in figure 2.

On leaving the magnetic field, the ion strikes the screen at point G. When an electric field is applied perpendicularly to the magnetic field, the iron returns from G to O

If the path of the ion in the region of the magnetic field is an arc of a circle of radius 2 x 10^{-2} m and the electric field intensity is 1.408 x 10^{5} V m^{-1} . Calculate the specific charge of the ion. (7)

(b) Sketch the 1 – V characteristic curve for a vacuume diode and explain its features (3)

(c) (i) With the aid of a labelled diagram, explain how a triode can be used as a voltage amplifier (6)

(ii) A sinusoidal voltage of amplitude 0.2 V is applied to the grid of a triode of amplication factor 10. If the anode resistance of the triode is 15 KΩ what voltage will appear across a load of 10 KΩ? (3)

P510/2
PHYSICS
Paper 2
March 1993
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 2
2 hours 30 minutes

SECTION A:

1. (a) Define angular magnification of an optical instrument (1)

(b) Describe with the aid of a ray diagram, the operation of a telescope made up of a converging and a diverging lens when used in normal adjustment. State one limitation of this type of telescope (7)

(c) A telescope consists of a converging and a diverging lens of focal lengths 1.5 m and 0.3 m respectively. When it is used to read a scale 15.0 m from the objective, the final image is formed 0.6 m from the eyepiece. Find the separation of the lenses. (5)

(d) Draw a ray diagram to show the action or a projector (4)
(e) A point source of white light is placed at the bottom of a water tank in a dark room. The light from the source is observed obliquely at the water surface. Explain what is observed (3)

2. (a) Differentiate between each of the following pairs:
   (i) Regular reflection and diffuse reflection (6)
   (ii) Line emission spectra and continuous emission spectra (6)

   In each case illustrate your answer with an example and/or diagrams

(b) Explain the term ***focal point*** as applied to a lens. (1)

(c) A converging beam of light in the shape of a'cone with a vertex angle of 40o falls on a circular diaphragm of diameter 20 cm. When a converging lens is fixed in the diaphragm, the new vertex angle is 73^o. Calculate
   (i) the focal length of the lens (5)
   (ii) the displacement of the vertex of the cone (2)

3. (a) (i) What is meant by *radius* of curvature of a concave mirror? (1)
   (ii) Show that the radius of curvature, r, of a concave mirror is given by the expression: r = 2f: where f is the focal length of the mirror (5)

(b) Describe how the refractive index of a liquid can be determined using a concave mirror (5)

(c) A ray of monochromatic light enters one face of a 60^o glass prism and is totally internally reflected at the next face.
   (i) Draw a diagram to show the path of light through the prism (2)
   (ii) Calculate the angle of incidence at the first face if the refractive index of glass is 1.53 and the angle of incidence at the second face is 42^o (3)

(d) Explain how mirages are formed (4)

SECTION B:

4. (a) State Ohm's law
   (b) Sketch the current-voltage characteristics for very small voltage ranges of
   (i) a piece metallic wire (1)
   (ii) two electrodes immersed in an electrolyte (1)

   (c) Give two devices to which Ohm's law does not apply and sketch their current voltage characteristics (3)
   (d) Draw a circuit diagram to show how the value of a high resistance can be determined using a low resistance ammeter and a high resistance voltmeter. Justify your connection of the ammeter and voltmeter (5)

   (e)

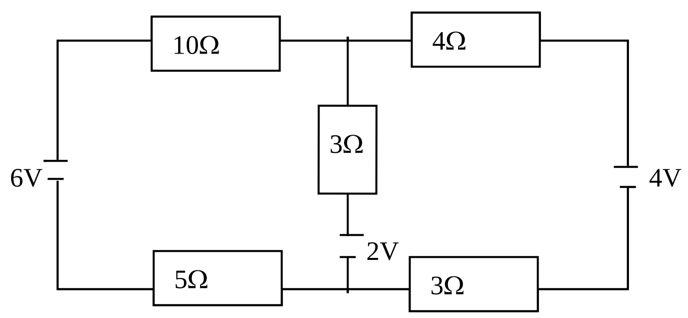


Fig 1

In the circuit diagram in figure 1
(i) find the values of the current through the 10, 3 and 4 resistors. (7)
(ii) calculate the power dissipated in the 5Ω resistor (2)

5.

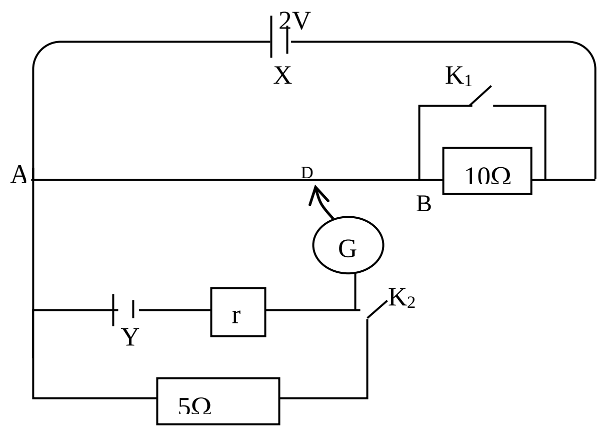


Fig 2

In figure 2 a cell, X, of negligible internal resistance, has e. m. f of 2V. AB is a uniform slide wire of length 100 cm and resistance 50 . With both switches K_1 and K_2 open, the balance length Ad is 90 cm. When K_2 is closed and K_1 is left open, the balance length changes to 75 cm. Calculate
(i) the e.m.f of cell Y (2)
(ii) the internal resistance , r. of Y. (3)
(iii) the balance length when both K_1 and K_2 are closed (3)

(d) Explain one advantage of a potentiometr over a moving coil voltmeter

6. (a) State the laws of electromagnetic induction (2)
   (b) (i) Explain how eddy currents are produced
   (ii) Explain briefly two applications of eddy currents (6)

(iii) Two parallel wires each of length 75 cm are placed 1.0 cm aparat. When the same current is passed through the wires, a force of 50 x 10 – 5 N develops between the wires. Find the magnitude of the current (4)

(c) With the aid of a diagram, describe how the magnetic flux density B between the poles of a strong magnet may be measured (5)

7. (a) Sketch field lines between two large parallel metal plates across which a p.d. is applied (1)
(b) Describe how you would investigate the factors which affect the capacitance of a parallel plate capacitor. Use sketch diagrams to illustrate your answer (7)

(c) Explain how lightning can cause severe damage to buildings. Name one device that can be used to prevent such damage and explain how it operates (5)

(d) Show that the effective capacitance, C of two capacitors of capacitances C1 and C2 connected in series is given by

$$C = \left(\frac{C_1 C_2}{C_1 + C_2} \right)$$ (3)

(e) A 20 μF capacitor is charged to 40V and then connected across an uncharged 60 μF capacitor. Calculate the potential difference across the 60 μF capacitor. (4)

SECTION

8. (a) Describe, with the aid of a labelled diagram, the determination of the velocity of light by Fizeaus rotating wheel method (7)
(b) Using Huygen's principle of wave propagation, derive an expression for the refractive index of a material in terms of the velocity of light (5)
(c) A soap film formed on a vertical wire frame is viewed in white light. Explain what is observed as the soap film gradually drains (5)
(d) Light from a point source is reflected from a rotting six sided prism to a stationary mirror from which it is reflected back to the prism along the same path. If the speed of rotation of the prism is 1000 revolutions per second and the image of the object is seen in the same position, calculate the distance between the mirror and the prism (3)

9. (a) Explain what is meant by the term
(i) Bohratom (2)
(ii) Binding energy (2)

(b) State Rutherford's model of the atom and discuss the experimental evidence that supports it (6)

(c) (i) Sketch a graph showing the variation of binding energy per nucleon with mass number (2)
(ii) Use the graph in (i) to explain how energy is released during fission and fusion (4)

(d) During the fission of uranuim, U – 235, 200 MeV of energy is released. Calculate the energy, in joules released when 1.5kg of uranium takes part in a bomb explosion (4)

10. (a) Define *isotope, mass number, radioactivity, and activity of a radioactive material* (4)
(b) Outline the principles of detecting alpha and beta particles
(c) A steel piston ring contains 15g of radioactive iron $^{54}_{26}Fe$, of activity of 3.7×10^5 disintergrtions per second. After 100 days of continuous use, the crank-case oil was found to have a total activity of 1.23×10^3 disintergrations per second find:
(i) the half life of $^{54}_{26}Fe$ (4)

(ii) the average mass of iron worn off the ring per day assuming that all the metal removed accumulates in the oil
(Activity $A = \lambda N$ and $\lambda = \frac{0.693}{TV_2}$) (2)

(d) Explain the application of carbon – 14 in carbon dating (4)

(e) State two precautions that should be taken by personnel working in a radioactive laboratory (2)

END

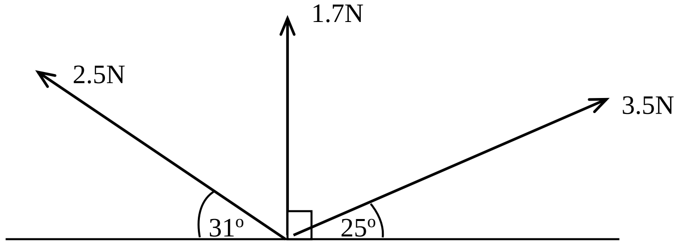
P510/1
PHYSICS
Paper 1
March 1992
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 1
2 hours 30 minutes

SECTION A:

1. (a) (i) Define the terms displacement and speed (2)
(ii) What are the dimensions of couple? (2)

(b)



Three forces of 3.5 N, 1.7N and 2.5 N act at a point as shown in figure 1. Find the resultant force

(c) A motorist travelling at a constant speed of 50 km h – 1 passes a motor cyclist just starting off in the same direction> if the motor cyclist maintains a constant acceleration of 2.8 m s – 2, calculate
(i) the time taken by the motor cyclist to catch up with the motorist
(ii) the speed with which the motor cyclist overtakes the motorist

(d) Explain why the tension in a cable of a lift is different when the lift is ascending from when it is descending. (4)

2. (a) Explain
(i) What is meant by acceleration due to gravity.
(ii) Why acceleration due to gravity varies on the earth's surface from one place to another

(b) Derive an expression for the acceleration of a particle moving with constant speed V along a horizontal circular path of radius r. (4)
(c) Explain the following
(i) A mass attached to a string rotating at a constant speed in a horizontal circle will fly off at a tangent if the string breaks.
(ii) A consmonaut in a satellite which is in a free circular orbit around the earth experiences the sensation of weightlessness even though he is influenced by the gravitational field of the earth. Illustrate your answer with a diagram (6)

(d) A pilot banks the wings of an aircraft so as to travel at a speed of 540 km h – 1 in a horizontal circular path of radius 8km
Calculate
(i) the angle the pilot will bank the aircraft (5)
(ii) the centripetal acceleration (2)

3. (a) Distinguish between elastic inelastic collisions (2)

(b) A body of mass 120 kg collides with a stationary body of mass 1450 kg. The two bodies stick together and move a distance of 6.2m before coming to rest. If the bodies experience a frictional force equals to one-fifth their total weight, calculate the speed with which the first body was moving when it hit the stationary one. (6)

(c) (i) Describe a simple experiment to measure the coefficient of static friction between two surfaces (2)

(ii) Give two instances in which increasing friction is beneficial (2)

(d) Describe a simple experiment to demonstrate
   (i) streamline flow
   (ii) Bernoulli effect
   In each case draw diagrams where necessary (65

4. (a) Define the terms *elastic limit* and *Young's modulus* (2)
   (b) Explain the energy transformation that occur when a wire is stretched
   (i) elastically
   (ii) plastically

   (c) A rod of mid steel of uniform cross sectional area 0.0030 m^2 and length 1.0 m is stretched steadily until it breaks
   (i) Sketch a graph to show the relationship between the force and the extension. Explain the shape of the graph
   (ii) When the applied force on the rod is 120 kN the strain is 4.0 x 10^{-4}. Calculate Young's modulus for steel.
   (iii) The rod is found to break at a stretching force of 240N. Explain why the stress at the section of the rod where the break occurs is likely to be much greater than 80000 kN m^{-2} (2)
   (iv) Just before the rod breaks, its extension is about 4cm. Estimate the work done is stretching the rod by this amount. Suggest why the calculated value of the work done is likely to be less than the actual value (4)

SECTION B

5. (a) Use the kinetic theory to explain the following
   (i) surface tension (2)
   (ii) latent heat of vaporisation (2)

   (b) With the aid of a p-v diagram, explain what happens when a real gas is compressed at different decreasing temperature
   (c) State the conditions for
   (i) an adiabatic change (2)
   (ii) an isothermal change (2)

   (d) One litre of gas at a pressure of 1.0 x 105 Pa and a temperature of 17ºC is compressed isothermally to a half its volume. It is then allowed to expand adiabatically to its original volume
   Calculate the final temperature
   (The ratio of the principal specific heat capacities , Y = 1.40) (6)

6. (a) Define coefficient of thermal conductivity of a substance (2)

   (b) With the aid of suitable sketch graphs; explain the temperature distribution along a lagged and an unlagged metal rod. (4)

   (c) Water in an aluminium saucepan, of diameter 16 cm and thickness 4mm, is kept boiling at 100ºc on a hot stove. The water boils off at a rate of 2.28 x 10^{-4} kgs $^{-1}$. Calculate the temperature of the underside of the saucepan, assuming it is uniformly heated and neglecting heat losses from the sides.

   (Thermal conductivity of aluminium = 2.06 X 102 w M^{-1} k^{-1}
   Latent heat of vapourisation of water = 2.26 x 106 J kg^{-1}) (4)
   (d) Describe an experiment to compare the energy radiated by two different surfaces (3)
   (e) Describe the characteristic features of the relative intensity distribution curves for a black body (4)

(f) The element of an electric fire has a temperature of 1150 K. Calculate the frequency at which the intensity of the radiation by the element is maximum (3)

7. (a) State the requirements for establishing the scale of temperature (2)
   (b) (i) With the aid of a labelled diagram, describe how a constant volume gas thermometer is used to measure temperature. (6)
   (ii) Give one disadvantage of a gas thermometer (1)
   (iii) If a wire has a resistance of 45Ω at the triple point of water, find its resistance at 80°C. (3)

   (c) In an experiment to determine the specific latent heat of vapourisation of a liquid by electrical method, the results in table 1 were obtained

Ammeter reading	Voltmeter reading (V)	Mass of liquid vapourised in 100s (g)
1.00	5.0	0.8
2.00	5.4	3.6
3.00	7.0	6.0
2.63	8.0	8.4

   Plot a suitable graph and use it to determine
   (i) the specific latent heat of vapourisation of the liquid (7)
   (ii) the rate of loss of heat (1)

SECTION C

8. (a) Explain the following terms as applied to wave motion:
   (i) phase difference (2)
   (ii) damping (2)
   (iii) transverse wave (2)
   (iv) beats (2)

   (b) Give the factors which affect the frequency of a transverse wave travelling along a stretched string and state how the frequency varies with each factor (3)
   (c) A long glass tube is filled with water. A tuning fork is held at the mouth of the tube and the tube is gradually emptied. Explain what happens (5)

9. (a) Distinguish between x-ray production and the photoelectric effect (2)

   (b) (i) Describe how Einstein's photoelectric equation accounts for the phenomenon of photoelectric emission (5)
   (ii) Light of wavelength 0.4 μm strikes the surface of a metal whose work function is 2.2eV. Calculate the greatest energy that a photoelectron can have. (3)

   (c) Sketch, on the same axes, graphs of stopping potential against frequency of incident light for two metals of different work function energies (2)

   (d) (i) Describe the Bragg diffraction of x-rays by crystals and derive the Bragg's law (6)
   (ii) Find the glazing angle for the first diffraction order for x-rays of wavelength 1.24 x 10 – 10 m using Bragg planes for which the spacing is 2.0 x 10 – 10 m. (2)

10. (a) State three differences between cathode rays and positive rays (3)

(b) With the aid of a labelled diagram, describe the operation of the Bainbridge mass spectrometer in the measurement of the ratio of charge to mass for positive ions (7)

(c) An oil drop carrying a charge of 3e falls under gravity in a air with a velocity of 4.6 x 10 – 4 ms – 1 between two parallel plates 5 mm apart. When a potential difference of 4600 V is connected between the plates, the drop rises steadily.

Assuming that the effect of air buoyancy on the drop is negligible, calculate

(i) the radius of the oil drop (4)

(ii) the velocity with which the oil drop rises (4)

[Density of oil = 900 kg m^{-3}

Viscosity of air = 1.8 x 10^{-5} Ns m^{-2}]

(d) Calculate the speed of electrons after being accelerated from rest through a potential difference of 10 kV (2)

P510/2
PHYSICS
Paper 2
March 1992
2 ½ hours

UGANDA NATIONAL EXAMINATIONS BOARD
Uganda Advanced Certificate of education
Physics
Paper 2
2 hours 30 minutes

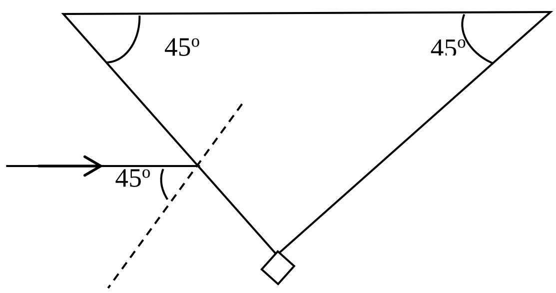
SECTION A:

1. (a) (i) State the characteristics of images formed in plane mirrors
   (ii) Show that when a ray of light undergoes two successive reflections in two plane mirrors inclined at angle (2)

   (b) (i) Explain total internal reflection and give two instances where it is applied. (3)
   (ii) Give two reasons for using prisms rather than plane mirrors in reflecting optical instruments (2)

   (c) Light which passes symmetrically through a glass prism of refractive index n and a large refracting angle A is deviated through an angle δ . Derive an expression for n in terms of A and δ

   (d)



A ray of light is incident at 45o on a glass prism as shown in figure 1. If the refractive index of glass is 1.5, calculate the angle of emergence and sketch the ray diagram (5)

2. (a) (i) Draw a ray diagram to show the formation of an image by a diverging lens
   (ii) Describe an experiment to determine the focal length of a diverging lens

   (b) Light from a distant object is incident on a converging lens of focal length 7.0 cm placed 4.0 cm in front of a diverging lens of focal length 2.5 cm. Determine the position and nature of the image of the object. (7)

   (c) State what is meant by the following terms:
   (i) visual angle (1)
   (ii) magnifying power (2)
   (iii) chromatic aberration (2)

3. (a) Draw a ray diagram to show an astronomical telescope in normal adjustment, derive the expression for its magnifying power

   (b) An astronomical telescope has an objective lens of focal length 50 cm and an eye piece of focal length 2 cm.
   (i) What will be the magnification in normal adjustment? (2)
   (ii) If the image is to be formed 25 cm from the eye piece, what will be the separation of the lenses? (4)

   (c) (i) Explain what is meant by *opertur*e and *secondary* axes of a diverging mirror (2)

(ii) Describe how the focal length of a diverging mirror can be determined using a converging lens (5)

SECTION B:

4. (a) Explain why a metal wire gets hot when an electric current passes through it

(b) A battery of e.m.f 12V and negligible internal resistance is connected to the ends of a metallic wire of length 50 cm and cross-sectional area 0.1 mm^2. If the resistivity of a material of the wire is 1.0 x 10^{-6} Ω m at what rate is heat generated in the wire? (5)

(c) (i) Define temperature coefficient of resistance
(ii) The table below shows the resistance of a nichrome wire at various temperatures.

Temperature (oC)	75	120	150	250	300
Resistance (Ω)	103	103.8	104.4	105.9	106.8

Plot a suitable graph and use it to determine the temperature coefficient of resistance of nichrome

(d) With the aid of a circuit diagram, describe how a potentiometer may be used to measure the internal resistance of a cell (6)

5. (a) State the laws of electromagnetic induction
(b) Describe with the aid of a labelled diagram, the structure and action ofj a transformer
(c) (i) Explain why high voltages are needed for long distance power transmission
(ii) Give two advantages of a.c over d.c. power transmission

(d) An electrical power of 16 kW is generated and transmitted through a cable of length 20km and resistance 0.025Ω km – 1 to a factory. If 7.8% of the electrical power is lost, calculate
(i) the voltage at which the generator operates (4)
(ii) the potential drop at the ends of the cable (2)
(iii) the electrical power available at the factory and suggest a way of increasing the power supplied to the factory (3)

6. (a) Explain the difference between magnetic flux and magnetic flux density.
(b) (i) Give an expression for the magnetic field due to a circular coil carrying an electric current (1)
(ii) Sketch the magnetic field pattern around the coil in (i) placed in the earth's magnetic field (2)

(c) With the aid of a labelled diagram, describe an experiment to investigate the variation of magnetic flux induction at the centre of a circular coil with the current through the coil (6)

(d)

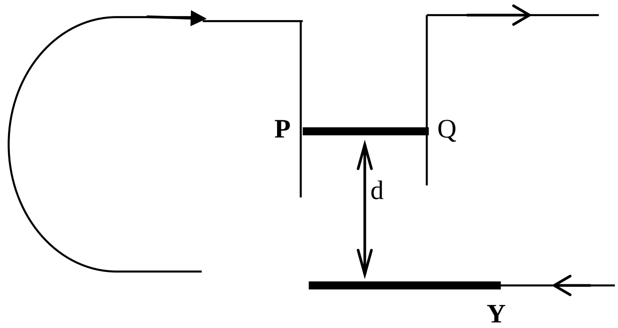


Fig. 2

A wire XY rests on a horizontal non-conducting table and another wire PQ of length 12.0 cm is free to move vertically in guides at the ends P and Q above XY as shown in figure 2. The mass per unit length of PQ is 3 mg cm^{-1}

A current of 3.6 A through the wires was enough to maintain the wire PQ at a distance d cm fro XY.

Calculate:

(i) the distance of separation, d (5)

(ii) the magnetic flux density due to PQ on XY (2)

(e) A circular coil is placed coaxially in a solenoid. The current in the solenoid is momentarily switched off. Sketch the variation of

(i) the magnetic flux density in the solenoid with time (1)

(ii) the magnetic flux density with the charge in the circular coil. (1)

7. (a) With the aid of a diagram, describe an experiment to show that no excess charge resides inside a hollow conductor

(b) State Coulomb's law of electrostatics

(c) (i) Two point charges A and B of – 17, 6 μC and 9.0 μC respectively are placed at a distance of 21 cm apart. A third charge, C, is placed at the midpoint of the line joining A and B. If the net force on B is zero, determine the charge on C. (4)

(ii) Calculate the electric potential at the position of C in (i) above

(iii) Sketch the electric field lines corresponding to the charge distribution in (i) above (3)

SECTION C

8. (a) What is meant by diffraction? (3)

(b) Describe how the wavelength of monochromatic light can be measured using a spectrometer and a transmission grating. In your description, include the initial adjustments of the spectrometer. (8)

(c) A transmission grating of 5 x 105 lines per metre is illuminated with light of wavelengths of 580 nm and 590 nm.

Calculate

(i) the highest order spectrum observed

(ii) the angular separation of the two wavelengths in the second order spectrum (6)

(d) (i) What is meant by polarised light?

(ii) Explain how polarised can be used to produce polarised light (2)

9. (a) The diagram in figure 3 shows some energy levels of the hydrogen atom

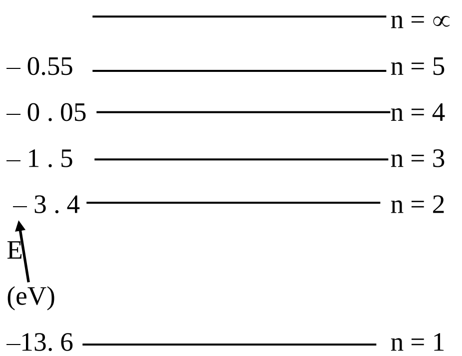


Fig 3

(i) Use the diagram to explain the emission spectrum of hydrogen

(ii) Calculate the speed of an electron which could just ionise the hydrogen atom

(iii) Calculate the minimum wavelength of the hydrogen spectrum and state the region of the electromagnetic specturm in which it lies

(c) $^{210}_{84}Pa$ decays to $^{206}_{82}Pb$ by emitting alpha particles

Calculate

(i) the mass of alpha particle (3)

(ii) the speed with which the alpha particle emitted (2)

Mass of ^{210}Po = 210.049u

Mass of ^{206} Pb = 206.034u

1u = 1.66×10^{-27} kg.

10. (a) (i) What is an alpha particle? (1)

(ii) sTate two differences between alpha and beta particles (2)

(b) The following equations represent typical nuclear reactions:

^{235} U + 1 ^{X}M + 139

(i) Describe briefly the significance of each of the two reactions (4)

(ii) Determine the values of x and y and identify the reaction product A (2)

(c) With the aid of a labelled diagram describe an experiment to distinguish between beta and gamma radiation from the same source. (4)

(d) A Geiger Muller (GM) tube placed 10 cm from 1.0g of radon, $^{222}_{86}$ Rn gives a count rate of 75 counts per second. If the entrance window of the GM tube has an area of 5 cm^2, calculate

(i) the number of radon atoms disintegrating per second (3)

(ii) the half life of radon. (4)

END