A LEVEL

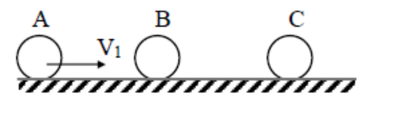
P510/1
PHYSICS
Paper 1
March. 1988

SECTION A

1.(a) State Newton's law of motion.

(b) Use Newton's law of motion to show that linear momentum is conserved when two particles moving in a straight line collide.

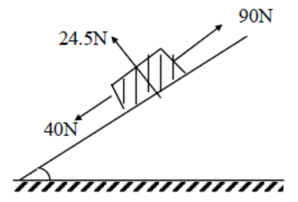
(c)



Balls A,B and C of masses marks$_1$, m_2 and m_3 respectively , lie on a straight line on a smooth surface. The balls are initially at rest . Ball A which is projected with a velocity V_1 towards B makes an elastic collision with B , if B moves and makes a perfectly inelastic collision with C , show that both B and C move with a velocity

$$V_3 = \frac{2m_1m_2V_1}{(m_1+m_2)(m_2+m_3)}$$

(d)



Three forces of 90.0N , 24.5N and 40.0.N act on a block placed on a smooth plane inclined at an angle of 60^0 to the horizontal as shown. Calculate

(i) the acceleration of the block

(ii) the gain in kinetic energy 5s after moving from rest.

2(a) Derive the expression for the acceleration of a body moving with uniform speed V in a circular path of
radius r.

(b) A space satellite of mass 100kg is launched in a circular orbit at a height of 6.4×10^6 m above the surface of the earth.

(i) find the period of the satellite.

(ii) Calculate the mechanical energy of the satellite.

(iii) Explain what would happen if the satellite speed were halved while the satellite were in the orbit.

(c) (i) Sketch a graph to show the variation of the acceleration due to gravity with distance from the centre of the earth, assuming the earth is spherical.

(ii) At what distance away from the earth's surface will the acceleration be one -eight of its value at the earth's surface?

3 (a) What is meant by simple harmonic motion ?

(b) A volume V of air at pressure P is contained in a cylindrical vessel of cross-sectional area A by a frictionless air -tight piston of mass M.

(i) Show that on slightly forcing down the piston and then reloading it.

the piston oscillates with simple harmonic motion of period T given by

$$T = \frac{2\pi}{A}\sqrt{\frac{MV}{P}}$$

(ii) Verify that the expression for T in b(1) above is dimensionally consistent.

(c) A particle executing simple harmonic vibration in a straight line speeds of $4ms^{-1}$ $3ms^{-1}$ at position 3cm and 6cm respectively.

the equilibrium position . Calculate

(i) the amplitude of the vibration.

(ii) the period

4(a) (i) Define pressure at a point in a liquid.

(ii) State the condition for a body to float in a fluid.

(iii) A piece of brass of density $8.4x10^3$ is attached to a block of wax of density $9.2x10^3$ kg^{-3} to act as a when the system is placed in a liquid of density 1.15x10 it floats with the wax just submerged. if the mass of wax is $1.0x10^{-2}$ kg . Find the mass of the piece of brass.

(b) (i) Derive the expression for the capillary rise in a tube of radius r dipped in a liquid of surface tension y and density .

(ii) Calculate the work done by surface tension force in (b) (i) above and compare the result with the change in the potential energy of the liquid. Explain the difference.

(c) Explain briefly how the lift on the wing of an aeroplane arises.

5 (a) (i) State any four assumptions made in the kinetic theory of ideal gas.

(ii) State two main difference between an ideal gas and a real .

(b) An ideal gas of N molecules , each of mass m ,is confined between two parallel plane walls which are a distance 1 apart and each f area $1m^2$. The molecules have a common speed V and move perpendicular to the walls. Assuming that all collisions are elastic , find

(i) the average force exerted on each wall.

(ii) the pressure exerted by the gas.

(c) Assuming that the average energy of each of the molecules in (b) above is kT , where K is the Boltzman's constant and T is the absolute temperature of the gas , find

(i) the variation of the pressure of the gas with T.

(ii) the heat capacity of the gas.

(iii) Assuming that the average energy of each of the molecules in (b)

(d) Distinguish between isothermal and adiabatic changes.

(e) An ideal gas undergoes the following sequence of processes starting at (P_1,V_1,T_1) .it is heated at constant volume until its pressure is doubled. it is then heated at constant pressure until its volume is doubled.The gas is then cooled at constant volume to its initial pressure. it is finally cooled at constant pressure to its initial volume V_1.

(i) represent the sequence of processes on a P-V diagram

(ii) Find the temperature of the gas at the end of the first process.

(iii) What is the work done by the gas.

6 (a) (i) Define specific latent heat of vaporization.

(ii) With the aid of a labelled diagram describe an electrical method for the determination of the specific latent heat of vaporization of water.

(b) A 500W electric heater is immersed in 4kg and specific heat capacity 500Jkg^{-1} k^{-1}. Neglecting loss of heat to the surroundings and the heat capacity of the heater, find

(i) how long it will take to heat the water to its boiling point of 100^0C.

(ii) how long will it cost to achieve (b) (i) and (b) (ii) if 1kwh costs Shs.2.

(c) At low temperatures the molar heat capacity of copper varies with temperature T as BT^3 where B = 4.6×10^{-5} J mole $^{-1}$ K^{-1}. How much heat is required to raise the temperature of 2 moles of copper from 0K to 2 K?

7(a) What is meant by thermal conductivity of a material ?

(b) Describe with the aid of a diagram a method of determining the thermal conductivity of a poor conductor.

(c) A uniform composite slab is made of two types of material A and B of thickness 6cm and 3cm and of thermal conductivities $360Nm^{-1}$ k^{-1} and $120Nm^{-1}$ K^{-1} respectively. if the ends of A and B are maintained at 80^0C and 20^0C respectively . Calculate

(i) the temperature of the junction of the two materials

(ii) the rate of heat flow through unit area of the slab.

(d) Describe an optical pyrometer and explain how it can be used to measure the temperature of a furnace.

8(a) Explain the term deffraction and superposition as applied to sound waves.

(b) A source emitting sound waves of frequency f is moving towards a stationary observer with velocity us . If the velocity of sound in air is v derive an expression for the frequency detected by the observer.

(i) When the observer remains stationary.

(ii) when the observer moves towards the source with velocity V_0

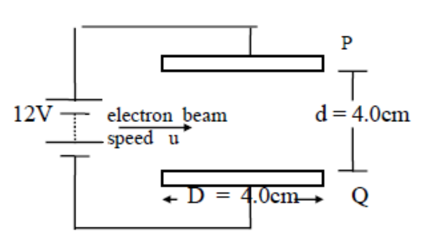
(c)A bat flying at a speed of $30ms^{-1}$ towards an obstacle omits sound waves of frequency $2.5x10^{8}$HZ. The bat hears an echo 0.5 s later .If the speed of the sound in air is $340ms^{-1}$, how far is the obstacle from the bat when the bat hears the echo.

(d) (i) Describe clearly two similarities and two difference between transverse longitudinal waves, Give examples of each type of wave.

(ii) Describe a simple experiment to demonstrate displacement of a sound wave.

9(a) (i) Draw a labelled diagram to show the essential parts of a cathode ray oscilloscope (CRO).

(ii) State four advantages of a CRO when used as a voltmeter.



in the diagram above P and Q are parallel and metal plates each of length D and F 4 cm and separated by a distance of 4.0cm. A p.d of 12V is applied between P and Q , the space between P and Q is a vacuum.

A beam of electrons of speed $1.0x10^6$ ms^{-1} is directed midway between P and Q at right angles to the electric field between P and Q , Show that the electrons beam emerges from the space between P and Q at an angle of 64.6^0 to the initial direction of the beam.

(c) Distinguish briefly between cathode rays and X-rays.

(d) An electron which has beam accelerated through a p.d of 10^3V passes undeflected through a region of uniform electric and magnetic field s. if the electric field intensity is $1.88x10^4$Vm and the magnetic flux density is $1.00x10^{-3}$ T, find the ratio0/m for the electron.

10. (a) Explain each of the following terms as applied to photo-electric emission.

(i) Work function of a metal

(ii)stopping potential

(iii) threshold frequency.

(b) The stopping potential for a copper surface irradiated with radiation of wavelength $2.5x10^{-7}$ m is 0.25V. Calculate

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(b) The stopping potential for a copper surface irradiated with radiation of wavelength 2.5×10^{-7} m is 0.25V.Calculate

(i) the threshold frequency for copper

(ii) the work done when the electron just escapes from the surface.

(c) (i) With the aid of a diagram , describe the operation of a Bainbridge mass spectrometer.

(ii) In a Bainbridge mass spectrometer singly ionized atoms of ^{35}Cl and ^{37} Cl into the deflection chamber with a velocity of 10^5 ms^{-1} . if the flux density of the magnetic field in the deflecting chamber is 0.08T, calculate the radii of the paths of the ions.

P510/2
PHYSICS
Paper 2
March. 1988

SECTION A

1(a) (i) What is meant by the term radius of curvature of a convex mirror.

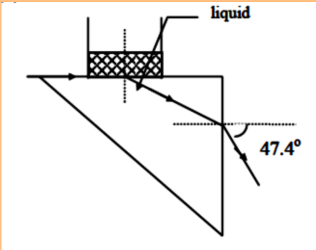
(ii) Derive an expression relating the radius of curvature of a convex mirror to object and image.

(b) (i) Sketch the graph of image distance against object distance for a concave mirror and use it to describe the image formed by the mirror as the object varies from very large to very small values.

(ii) Describe how the radius of curvature of a concave mirror may be determined.

(c) (i) Explain the term *total internal reflection* .

(ii)



The diagram above shows the path followed by a ray of monochromatic light through a right angled triangular prism of refractive index 1.52 the light emerges in air , find the refractive index of the liquid.

2(a) Draw ray diagrams to explain the following terms as applied to a thin converging lens.

(i) principal focus

(ii) conjugate points.

(b) A converging lens of focal length 20cm forms an image on a screen placed 40cm beyond the lens. A concave lens of focal length 40cm is then placed between the convex lens and the screen at 20cm from the lens.

(i) where must the screen be placed in order to receive the new image?

(ii) What is the magnification produced by the lens system?

(c) Show that the focal length f , of a thin convex lens in air is given by

$$\frac{1}{f}=(n-1)\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$$

where h is the refractive index of the material of the lens , r_1 and r_2 the radii of curvature of the surfaces of the lens.

(d) A thin biconcave lens is placed on a plane mirror. A pin is clamped horizontally above the pin coincides with its image at a distance of 15cm from the mirror. when a thin layer of water refractive 1.33 is placed between the lens and the mirror, the pin coincides with its image at a point 22.5 cm from the mirror.

when the water is replaced by paraffin , the pin coincided with its image at a distance of 27.5cm from the mirror. calculate the refractive index of paraffin.

3(a) Distinguish clearly between linear magnification and Angular magnification.

(b) (i) Draw a ray diagram to show the action of a compound microscope in normal use.

(ii) In what ways does a refracting telescope differ from a compound microscope ?

(c) The objective and eyepiece of a compound microscope have focal length of 1.00cm and 5.00cm respectively and are separated by a distance of 25cm. . An object is placed 1.05cm from the objective lens . find the position and nture of the final image formed by the compound microscope.

(d) Explain the terms chromatic and spherical aberration. How are these minimized in a reflecting telescope?

4(a) Sketch graphs to show the variation of current with pd. in

(i) homogeneous conductor

(ii) a thermionic diode

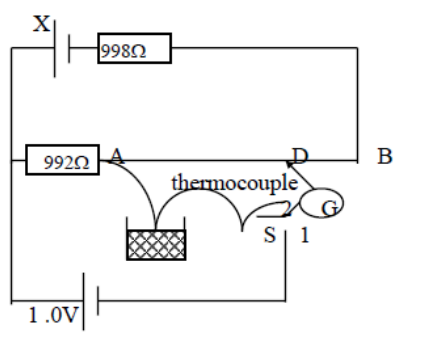
(iii) a gas at low pressure

(iv) a tungsten filament lamp

(b) Explain the features of the graph in (iii)

(c) Describe , with the aid of a labeled circuit diagram , how the internal resistance of a dry cell may be determined using a potentiometer.

(d)



The circuit above , X is an accumulator of negligible internal resistance . AB is a uniform wire of length 1.0m diameter $3.57 x 10^{-4}$ m and resistivity 1.0×10^{-6} Ωm. G is a galvanometer connected to sliding contact D.

when switch s is thrown into position 1, G shows no deflection when AD is 80.0cm . when s is thrown to position G shows no deflection when AD is 40.0cm. find

(i) the resistance of AB

(ii) the e.m.f of the thermocouple.

(iii) the e.m.f of cell x.

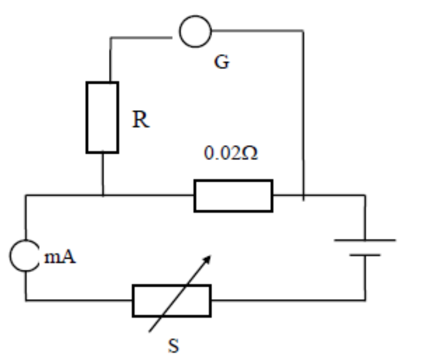
5(a) (i) Write down the expression for the force exerted on a straight wire of length 1m carrying a current of 1 ampere at right angles to a magnetic field of flux density B tesla.

(ii) A rectangular coil of N turns and area Am^2 is suspended in a uniform magnet field of flux B tesla, initially the plane of the coil is at right angles to the magnetic field. Determine the expression for the initial couple on the coil when a current 1 amperes flows through the coil.

(b) With the aid of a labeled diagram, describe the structure of a moving coil galvanometer and explain how it works.

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

(i) the magnetic flux density inside the solenoid
(ii) the initial torque on the circular coil when a current of 1.0A is passed through it.
(d) In the circuit below G is a suspension type of galvanometer of resistance R_G.



The rheostat s is adjusted to a value such that a miliameter reads 20mA ,when the resistance R is equal to 1500Ω,the galvanometer deflects through $1/2\pi$ radius. when R is charged to 120 keeping the milliameter reading constant , the galvanometer deflects through $1/9\pi$ radius , find the resistance R_g of the galvanometer.

6(a) Describe with the aid of a labelled diagram , the structure and action of a hot wire ammeter.

(b) A sinusoidally alternating voltage of 20V (rms) and frequency 60HZ s applied across a coil of wire of inductance 0.2H and negligible resistance.

(I) find the reactance of the acid at the frequency?

(ii) Calculate the rms value of the current which passes through the coil.

(iii) Using the same axes, sketch graphs to show the variation with time of the applied voltage , the current which flows and the power delivered to the inductor.

(iv) Explain why on the average , the power delivered to the inductor is zero.

(c) Draw a circuit of the bridge full-wave rectifier and explain its action.

7(a) What is meant by the terms electric field intensity and electric potential?

(b)

In the diagram above Q_1 and Q_2 are two points charges of magnitudes -3μc and +4μC respectively. The charges are 10cm apart.
find the electric field intensity and electric potential at a point midway between the charges.

(c) With the aid of a circuit diagram, describe , how you would determine the ratio of the capacitances of the two given capacitors.
(d) Two capacitors of capacitance 1F and 4 F are charged to 20V and 10V respectively. The capacitor s are then connected in parallel. calculate (i) the common p.d across the capacitors
(ii) the heat loss.
8(a)Explain what is meant by interference of light.
(b) (i) Outline the theory of double -slit experiment.
(ii) What is the nature of the interference fringes in b(i) above ?
(c) What happens to the fringes pattern in
(6) If

(i) The slit separation is reduced.

(ii) The space between the slits and the screen is filled with a liquid?

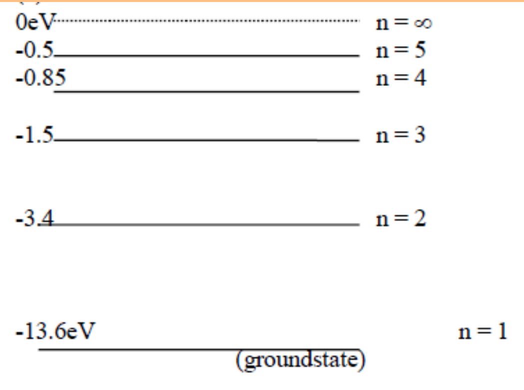
(d) In a double -slit experiment , the distance between adjacent bright fringes is 10^{-3} m . if the distance from the screen to the slits is doubled, the slit separation is halved and the light is changed from one of wave length 6.5×10^{-7} m to that of wave length 4.0×10^{-7} m, find the new fringe separation.

(e) .(i) What is meant by plane polarized light?

(ii) Describe how plane polarization can be demonstrated.

9.(a) Given an outline of the experimental evidence for the existence of a small nucleus at the centre of an atom.

(b)



The diagram above shows some of the energy levels of the hydrogen atom.

(i) Calculate the wave length of the radiation emitted when the electron initially in
the n = 2 state makes a transition to the ground state.

(ii) if the atom in its ground state absorbed $1.936 x 10^{-8}$ J of energy , to what level does the electron make a transition?

(c) Explain the origin of the continuous and characteristic line spectra in an X-ray tube.

(d) Describe one application of optical line spectra.

10(a) Explain the terms nuclear fission and nuclear fission giving one example of each.

(b) Alpha particles of energy 7.68 MeV were used to bombard nitrogen atoms , protons and oxygen nuclei were produced according to the reaction. Calculate the total kinetic energy of the proton and the 17_0 nucleus.

Mass of 14_N = 14.0031u

Mass of 4He = 4.0026u

Mass of 17_0 = 16.9991u

Massof $^1H_1$ =1.00781u