2013

1. a) Using the molecular theory, explain the laws of friction between solid surfaces.

b) With the aid of a labeled diagram, describe how the coefficient of static friction for an interface between a rectangular block of wood and a plane surface can be determined

c) The diagram in Figure **1** shows three masses connected by inextensible strings which pass over smooth pulleys. The coefficient of friction between the table and the 12.0 kg mass is 0.25.

12.0 kg

table

6.7 kg

9.4 kg

**Fig. 1**

If the system is released from rest, determine the

1. acceleration of 12.0 kg mass
2. tension in each string.
3. a) Define **terminal velocity.**

**b)** explain **laminar** flow and **turbulent** flow.

**c)** Describe an experiment to measure the coefficient of viscosity of water using Poiseulle’s formula.

**d) i)** State **Bernoulli’s principle.**

ii) Explain why a person standing near a railway line is sucked towards the railway line when a fast moving train passes.

e) A horizontal pipe of cross-sectional area 0.4m2, tapers to a cross-sectional area of

0.2 m2. The pressure at the large section of the pipe is 8.0 X 104Nm-2 and the velocity of water through the pipe is 1.2ms-1. If atmospheric pressure is 1.01 x 105 Nm-2 , find the pressure at the small section of the pipe.

1. a) (i) state the law of conservation of linear momentum.

(ii) A body explodes and produces two fragments of masses m and M. if the velocities of the fragments are u and v respectively, show that the radio of the energies of the fragments is

=

Where E1 is the kinetic energy of m and E2 IS the kinetic energy of M.

(b) show that the centripetal acceleration of an object moving with constant sped, V in a circle of radius, r is .

C) A car of mass 1000 kg moves round a banked tracked track at a constant speed of 108 kmh-1. Assuming the total reaction at the wheels is normal to the track, and the radius of curvature of the track is 100m, calculate;

i) angle of inclination of the track to the horizontal.

ii) reaction at the wheels.

d) i) Define **uniformly accelerated motion.**

ii) A train starts from rest at station A and accelerates at 1.25 ms-2 until it reaches a speed of 20 ms-1. It then travels at this steady speed for a distance of 1.56 km and then decelerates at 2ms-2 to come to rest at station **B**. find the distance from **A** to **B.**

1. a) i) State **Kepler’s laws** of planetary motion.

ii) Estimate the mass of the sun, if the orbit of the earth around the sun is circular.

b) A simple pendulum of length 1 m has a bob of mass 100 g. it is displaced from its mean position A to a position B so that the string makes an angle of 450 with the vertical. Calculate the;

i) maximum potential energy of the bob.

ii) velocity of the bob when the string makes an angle of 300 with the vertical. ` (Neglect air resistance­).

SECTION: B

1. a) Define

i) specific heat capacity.

ii) specific latent heat of vaporization of a liquid.

b) With the aid of a labeled diagram, describe an electrical method of determining the specific heat capacity of a solid.

c) An electrical heater rated 48 *W*, 12 *V*, is placed in a well insulated metal of mass 1.0 kg at a temperature of 180C. When the power is switched on for 5 minutes, the temperature of the metal rises to 340C. find the specific heat capacity of the metal.

d) i) State **Newton’s law of cooling.**

i) Use Newton’s law of cooling to show that

= - k(),

Where is the rate of fall of temperature and is the temperature of the surrounding.

e) Explain why evaporation causes cooling.

6) a) The pressure, P, of an ideal gas is given by P=*p*, where *p* is the density of the gas and its mean square speed.

i) Show clearly the steps taken to derive this expression.

ii) State the assumptions made in deriving this expression.

b) Sketch the pressure versus volume curve for a real gas for temperatures above and below the critical temperature.

c) For one mole of a real gas, the equation of state is

(V – b) = RT.

Explain the significance of the terms and b.

d) A ballon of volume 5.5 X 10-2m3 is filled with helium to a pressure of 1.10 X 105N m-2 at a temperature of 200C. Calculate the;

i) number of helium atoms in the balloon.

ii) net force acting on the square metre of material of the balloon if the

atmospheric pressure is 1.01 X 105Nm-2.

7) a) i) Define **thermal conductivity**  of a material.

ii) Describe an experiment to determine the thermal conductivity of copper.

b) i) What is meant by a **black body?**

ii) Describe how infrared radiation can be detected using a bolometer.

iii) Give **one** characteristic property of infrared radiation.

c) i) A spherical black body of radius 2.0 cm at -730C is suspended in an evacuated

enclosure whose walls are maintained at 270C. If the rate of exchange of thermal energy is equal to 1.85 Js-1, find the value of Stefan’s constant,.

ii) Calculate the wavelength at which the radiation emitted by the enclosure has maximum intensity.

SECTION C

8. a) Explain briefly how positive rays are produced.

b) An electron of charge, *e* and mass, *m*, is emitted from a hot cathode and then accelerated by an electric field towards the anode. If the potential difference between the cathode and the anode is V, show that the speed of the electron, is given by

*u*=

c) an electron starts from rest and moves in an electric field intensity of 2.4 x 103vm-1

find the

i) force on the electron.

ii) acceleration of the electron.

iii) velocity acquired in moving through a p.d of 90V.

d) A beam of electrons each of mass, *m*, and charge, *e*, is directed horizontally with speed,*u*, into an electric field between two horizontal metal plates separated by a distance, *d*.

i) If the p.d between the plates is V, show that the deflection *y* of the beam is given by

y = ,

where ,, is the horizontal distance travelled.

ii) Explain the path of the electron beam as it emerges out of the electric field.

9) a) Figure 2 shows some of the energy levels of a hydrogen atom.

Principal quantum

number, n Energy,eV

6

5

4

3

2

1

**-0.38**

**-0.54**

**-0.85**

**-1.51**

**-3.39**

**-13.60**

i) Why are the energies for the different levels negative?

ii) Calculate the wavelength of the line arising from a transition from the third to

the second energy level.

iii) Calculate the ionization energy in joules of hydrogen.

b) Explain the physical processes in an X-ray tube that account for

i) cut off wavelength.

ii) characteristic lines.

c) Calculate the maximum frequency of radiation emitted by an X-ray tube using an accelerating voltage of 33.0 kV.

d) Derive Bragg’s law of X-ray diffraction in crystals.

10. a) A beam of particles is directed normally to a thin metal foil. Explain

i) most of the α-particles passed straight through the foil.

ii) few α-particles are deflected through angles more than foil.

b) Calculate the least distance of approach of a 3.5 MeV α-particle to the nucleus of a gold atom . (*Atomic number of gold = 79).*

c) i) Define **space charge** as applied to thermionic diodes.

ii) Draw anode currect – anode voltage curves of a thermionic diode for two different filament currents and explain their main features.

d) i) What is a **decay constant?**

A sample from fresh wood of a certain species of tree has an activity of 16.0 counts per minute per gram. However, the activity of 5 g of dead wood of the same species of tree is 10.0 counts per minute. Calculate the age of the dead wood. (*Assume half-life of 5730 years).*

2012

1. a) State **Hooke’s law**

b) A copper wire is stretched until it breaks.

1. Sketch a stress-strain graph for the wire and explain the main features of the graph.
2. Explain what happens to the energy used to stretch the wire at each stage.
3. Derive what happens to the energy used to sketch a spring of force constant, k by a distance, e.

c) i) Define **Young’s Modulus.**

**ii)** Two identical steel bars A and B of radius 2.0mm are suspended from the ceiling .A mass of 2.0 kg is attached to the free end of bar A. calculate the temperature to which B should be raised so that the bars are again of again of equal length.

(*young’s Modulus of steel =*  1.0 X 1011Nm-2,

*Linear expansivity of steel =* 1.2 X 10-5K-1)

d) Why does an iron roof make cracking sound at night?

1. a) Define the following terms as applied to oscillatory motion.
2. Amplitude
3. Period.

b) State **four** characteristics of simple harmonic motion.

c) A mass, *m*, is suspended from a rigid support by a string of length, l. the mass is pulled aside so that the string makes an angle, with the vertical and then released.

1. Show that the mass executes simple harmonic motion with a period, T=2.
2. Explain why this mass comes to a stop after a short time.

d) A piston in a car engine performs a simple harmonic motion of frequency 12.5 Hz. If the mass of the piston is 0.50 kg and its amplitude of vibration is 45 mm, find the maximum force on the piston.

e) Describe an experiment to determine the acceleration due to gravity, g using a spiral spring, of known force constant.

1. a) Explain what is meant by **centripetal force.**

b) i) Derive an expression for the centripetal force acting on a body of mass,*m* moving in a circular path of radius, **r**.

ii) A body moving in a circular path of radius 0.5m makes 40 revolutions per second. Find the centripetal force if the mass is 1kg.

c) Explain the following:

1. 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.
2. A cosmonaut in a satellite which is in a free circular orbit around the earth experiences the sensation of weightlessness even though there is influence of gravitational field of the earth.

d) i) Derive an expression for the maximum horizontal distance travelled by a projectile in terms of the in terms of the initial Speed, *u* and the angle of projection, to the horizontal.

ii) Sketch a graph to show the relationship between kinetic energy and height above the group in a projectile.

1. a) i) What is meant by the following terms; **steady flow** and **viscosity?**

ii) Explain the effect of increase in temperature on the Viscosity of a liquid.

b) i) Show that the pressure, *P*, exerted at a depth, *h*, below the surface of a liquid of density.*p*, is given by:

P= *hp*g.

ii) Define **relative density.**

1. A U-tube whose ends are open to the atmosphere, contains water and oil as shown in Figure **1.**

Given that density of Oil is 800kgm-3, find the value of *h*.

10 cm

water

**Oil**

h

Figure 1

c) A metal ball of diameter 10 mm is timed as it falls through oil at a steady speed. It takes 0.5 s to fall through a vertical distance of 0.30 m. Assuming that density of the metal is 7500kgm-3 and that of oil is 900kgm-3, find.

i) The weight of the ball.

ii) The up thrust on the ball.

iii) The coefficient of viscosity of the Oil.

(*Assume the viscous force = 6O,**where 𝞰 is the coefficient of viscosity, r is radius of the ball and vo is the terminal velocity)*

**SECTION B**

1. a) i) Define the terms **specific heat capacity** and  **specific latent heat of fusion.**

**ii)** Explain the changes that take place in the molecular structure of substance during fusion and vaporization.

b) With the aid of a labeled diagram describe an experiment to determine the specific heat capacity of a liquid using the continuous flow method.

c) Steam at 1000C is passed into a copper calorimeter of mass 150g containing 340g of water at 150C. This is done until the temperature of the calorimeter and its contents is found to be 525g, calculate the specific latent heat of vaporization of water.

1. a) i) Define **saturated vapour pressure.**

ii) Describe with the aid of a diagram, how saturated vapour pressure of liquid can determined at a given temperature.

b) Use the kinetic theory to explain the following observations.

i) Saturated vapour pressure of a liquid increases with temperature.

ii) Saturated vapour pressure is **not** affected by a decrease in volume at constant pressure.

c) When hydrogen gas is collected over water, the pressures in the tube at 150C and 750C are 65.5cm and 105.6cm of mercury respectively. If the vapour pressuer at 150C is 1.42cm of mercury, find its value at 750C.

d) Explain why the molar heat capacity of an Ideal gas at constant pressure differs from the molar heat capacity at constant volume.

1. a) i)Define **thermal conductivity.**

**ii)** Compare the mechanisms of heat transfer in poor and good solid conductors.

b) Describe, with the aid of a diagram, how you would measure the thermal conductivity of a poor conductor, stating the necessary precautions.

c) A cylindrical iron vessel with a base of diameter 15cm and thickness 0.30 cm has its base coated with a thin film of soot of thickness 0.10 cm. It is then filled with water at 1000C and placed on a large block of ice at 00C. Calculate the initial rate at which the ice will melt.

(*Thermal conductivity of soot = 0.12*Wm-1K-1)

**SECTION C**

1. a) i) What are **cathode rays?**

ii)With the aid of a diagram, describe an experiment to show that cathode rays travel in straight lines.

b) A beam of electrons is accelerated through a potential difference of 500 V. the beam enters midway between two similar parallel plates of length 10 cm and are 3 cm apart. If the potential difference across the plates is 600 V, find the velocity of an electron as it leaves the region between the plates.

c) State the laws of photoelectric emission.

d) Explain how line emission spectra are produced.

1. a) i)What is meant by the terms: **radioactive decay, half-life** and **decay constant?**

**ii)**Show that the half-life *t* of a radioisotope is given by

*t* =

where 𝞴 is the decay constant.

(Assume the decay law N=N0e-𝞴t)

b) With the aid of a labeled diagram, describe the structure and action of a cloud chamber.

c) A radioactive isotope decays by emission of a gamma ray. The half-life of the isotope is 360 minutes. What is the activity of 1mg of the isotope?

d) Explain the term **avalanche** as applied to an ionization chamber.

1. a) Define the terms below as applied to a triode.
2. Space charge.
3. Amplification factor.
4. Mutual conductance

b) With the aid of a labeled diagram explain full wave rectification.

c) Derive an expression for the amplification factor µ in terms of anode resistance, Rα and mutual conductance, gm for a triode valve.

d) A triode with mutual conductance 3 Mav-1 and anode resistance of 10k. Calculate the amplitude of the output signal, if the amplitude of the input signal is 25 mV

e) i) Sketch the output characteristics of a transistor.

ii) Identify on the sketch in (e) (i), the region over which the transistor can be used as an amplifier.

2010.

SECTION A

1. (a) (i) State the laws of conservation of linear momentum.

(ii) Use Newton’s laws to derive the law in (a)(i).

(b) Distinguish between elastic and inelastic collisions.

(c) An object X of mass M, moving with a velocity of 10 ms-1 collides with a stationary object Y of equal mass. After collisions, X moves with a speed U, at an angle of 300 to its initial direction, while Y, moves with a speed of V, at an angle of 900 to the new direction of X.

(d) (i) Define uniform acceleration.

(ii) With the aid of a velocity-time graph, describe the motion of a body projected vertically upwards.

(iii) Calculate the range of a projectile which is fired at an angle of 450 to the horizontal with a speed of 20ms-1.

1. (a) (i) State Archimedes’ Principle.

(ii) A solid weighs 20.0g in air, 15.0g in water and 16.0g in a liquid, R. Find the relative density of liquid R.

(b) (i) What is meant by simple harmonic motion?

(ii) Distinguish between damped and forced oscillations.

(c) A cylinder of length, l, cross sectional area, A, and density σ floats in a liquid of density ρ. The cylinder is pushed down slightly and released.

(i) Show that it performs simple harmonic motion?

(ii) Derive the expression for period of the oscillation.

(d) A spring of force constant 40Nm-1 is suspended vertically. A mass of 0.1kg suspended from the spring is pulled down a distance of 5 mm and released. Find the

(i) Period of oscillation.

(ii) Maximum acceleration of the mass.

(iii) Net force acting on the mass when it is 2mm below the center of oscillation.

1. (a) Define viscosity of a fluid.

(b) (i) Derive an expression for terminal velocity attained by a sphere of density, *σ,* and radius , *a ,* falling through a fluid of density *l,*and viscosity, η.

(ii) Explain the variations of viscosity of a liquid with temperature.

(c) (i) State the laws of solid friction.

(ii) With the aid of a well labeled diagram, describe an experiment to determine the coefficient of kinetic friction between two surfaces.

(d) A body slides down a rough plane inclined at 300 to the horizontal. If the coefficient of kinetic friction between the body and the plane is 0.4, find the velocity after it has travelled 6m along the plane.

1. (a) (i) Describe the terms tensile stress and tensile strain as applied to a stretched wire.

(ii) Distinguish between elastic limit and proportionality limit.

(b) With the aid of a labeled diagram, describe an experiment to investigate the relationship between tensile stress and tensile strain of a steel wire.

(c) (i) A load of 60N is applied to a steel wire of length 2.5m and cross-sectional area of 0.22mm2. If Young’s Modulus for steel is 210GPa, find the expansion produced.

(ii) If the temperature rise of 1K causes a fractional increase of 0.001%, find the change in length of a steel wire of length 2.5m when the temperature increases by 4K.

(d) The velocity, V, of a wave in a material of Young’s Modulus, E, and density, ℓ, is given by

Show that the relationship is dimensionally correct.

SECTION B

1. (a) (i) Define the terms specific heat capacity, internal energy and their units.

(ii) Why is the direction between specific heat capacity at constant pressure and that at constant volume important for gases, but less important for solids and liquids?

(b) Explain why the temperature of a liquid does not change when the liquid is boiling?

(c) One kilogram of water is converted to steam at temperature of 1000C and a pressure of 1.0×105 Pa. If the density of steam is 0.58kg m-3 and the specific latent heat of vaporization of water is 2.3×106 J kg-1, calculate the

(i) external work done

(ii) internal energy

(d) Explain why the specific latent heat of fusion and specific latent heat of vaporization of a substance at the same pressure are different.

1. (a) (i) State the differences between isothermal and adiabatic expansion of a gas.

(ii) Using same axes and point, sketch graphs of pressure versus volume for a fixed mass of a gas undergoing isothermal and adiabatic changes.

(b) Show that the work, W, done by a gas which expands reversibly from V0 to V1 is given by

(c) (i) State two differences between real and ideal gases.

(ii) Draw a labeled diagram showing P-V isothermals for a real gas above and below the critical temperature.

(d) Ten moles of a gas, initially at 270C are heated at constant pressure of 1.01×105 Pa and the volume increased from 0.250 m3 to 0.375 m3. Calculate the increase in internal energy. [*Assume Cp= 28.5J mol-1 K-1]*

1. (a) What is meant by the following?
2. Conduction
3. Convection
4. Greenhouse effect

(b) One end of a long copper bar is heated in a steam chest and the other end is kept cool by a current of circulating water. Explain with the aid of sketch graphs, the variation of temperature along the bar, when steady state has been attained if the bar is

(i) lagged

(ii) exposed to the surrounding

(c) (i) What is meant by a black body?

(ii) Describe how a black body can be approximated in practice.

(d) (i) State Prevost’s theory of heat exchanges.

(ii) Sketch the variation with wavelengths of the intensity of radiation emitted by a black body at two different temperatures.

(e) A cube of side 1.0cm has a grey surface that emits 50% of the radiation emitted by a black body at the same temperature. If the cube’s temperature is 7000C, calculate the power radiated by the cube.

SECTION C

1. (a) (i) With the aid of labeled diagrams, describe what is observed when high tension voltage is applied across a gas tube in which pressure is gradually reduced to very low values.

(ii) Give two applications of discharge tubes.

(b) Describe Thomson’s experiment to determine the specific charge of an electron.

(c) In a Millikan’s oil drop experiment, a charged oil drop of radius 9.2×10-7 m and density 800 kg m-3 is held stationary in an electric field of intensity 4.0×104 Vm-1.

(i) How many electron charges are on the drop?

(ii) Find the electric field intensity that can be applied vertically to move the drop with velocity 0.005ms-1upwards. *[Density of air = 1.29kg m-3; Coefficient of viscosity of air = 1.8 ×10-5 Nsm-1 ]*

1. (a) Explain what is meant by photoelectric effect.

(b)

Zinc

Gold leaf electroscope

Fig. 1

Ultraviolet and infrared radiations are directed in turns onto a zinc plate which is attached to a gold leaf electroscope as shown in Figure 1.

Explain what happens when

1. Ultraviolet radiation falls on the zinc plate.
2. Infrared radiations fall on the zinc plate.
3. The intensity of each radiation is increased.

(c) An X-ray of wavelength 10-10m is required for the study of its diffraction in a crystal. Find the least accelerating voltage to be applied to an X-ray tube in order to produce these X- rays

(d) Sodium has a work function of 2.0eV and is illuminated by radiation of wavelength 150nm. Calculate the maximum speed of the emitted electrons.

(e) With the aid of a well labeled, describe how stopping potential of a metal can be measured.

1. (a) (i) What is meant by mass defect?

(ii) Sketch a graph showing how binding energy per nucleon varies with mass number and explain its main features.

(iii) Find the binding energy per nucleon of given that mass of 1 proton = 1.007825u

Mass of 1 neutron= 1.00866u

[ 1u = 931MeV]

(b) With the aid of a diagram, explain how an ionization chamber works.

(c) (i) Show that when an alpha particle collides head-on with an atomic number *z*, the closest distance of approach to the nucleus, xo is given by

.

Where:

*e* is electronic charge.

is permittivity of free space.

*m* is mass of the alpha particle.

*v* is initial speed of the alpha particle.

(ii) In a head-on collision between an alpha particle and a gold nucleus, the minimum distance of approach is 5×10-14 m. Calculate the energy of the alpha particle (MeV). [*Atomic number of gold = 79*]

2009.

SECTION A

1. (a) (i) Define the term impulse.

(ii) State Newton’s Laws of motion.

(b) A bullet of mass 10g travelling horizontally at a speed of 100ms-1 strikes a block of wood of mass 900g suspended by a light vertical string and is embedded in the block which subsequently swings freely. Find the

(i) vertical height through which the block rises

(ii) kinetic energy lost by the bullet

(c) Explain the terms time of flight and range as applied to projectile motion.

(d) A stone is projected at an angle of 200 to the horizontal and just clears a wall which is 10m high and 30m from the point of projection. Find the

(i) speed of projection

(ii) angle which the stone makes with the horizontal as it clears the wall.

1. (a) Define the following terms:

(i) velocity.

(ii) moment of a force.

(b) (i) A ball is projected vertically upwards with a speed of 50ms-1. On return it passes the point of projection and falls 78m below. Calculate the total time taken.

(ii) State the energy changes that occurred during the motion of the ball in (b)(i) above.

(c) (i) State the conditions required for mechanical equilibrium to be attained.

(ii) A uniform ladder of mass 40kg and length 5m rests with its upper end against a smooth vertical wall and with its lower end at 3m from the wall on a rough ground. Find the magnitude and the direction of the force exerted at the bottom of the ladder.

(d) State **four** instances where increasing friction is useful.

1. (a) What is meant by **Simple harmonic motion?**

(b) A cylindrical vessel of cross-sectional area, A, contains air volume, V, at pressure, P, trapped by frictionless air tight piston of mass, M. The piston is pushed down and released.

(i) If the piston oscillates with simple harmonic motion, show that its frequency, *f,* is given by:

(ii) Show that the expression for f, in b(i) is dimensionally correct.

(c) A particle executing simple harmonic motion vibrates in a straight line. Given that the speeds of the particle are 4ms-1 and 2ms-1 when the particle is 3cm and 6cm respectively from the equilibrium, calculate the

(i) amplitude of oscillation

(ii) frequency of the particle.

(d) Give two examples of oscillatory motion which approximate to simple harmonic motion and state the assumptions made in each state.

1. (a) (i) State Archimedes Principle.

(ii) Use Archimedes principle to derive an expression for the resultant force on a body of weight, W, and density, σ, totally immersed in a fluid of density ρ.

(b) A tube of uniform cross sectional area of 4×10-3 m2 and mass 0.2kg is separated floated vertically in water of density 1.0×102 kgm-3. Calculate the difference in the lengths immersed.

(c) (i) Define surface tension in terms of work.

(ii) Use the molecular theory to account for the surface tension of a liquid.

(iii) Explain the effect of increasing the temperature of a liquid on its surface tension.

(iv) Calculate the excess pressure inside a soap bubble of diameter 3.0cm if the surface tension of the soap solution is 2.5×10-2Nm‑1.

**SECTION B**

1. (a) (i) Define the term thermometric property.

(ii) State two thermometric properties.

(iii) With the aid of a labeled diagram, describe how the room temperature can be measured using uncalibrated resistance thermometer.

(b) (i) Define specific heat capacity of a substance.

(ii) Hot water at 850C and cold water at 100C are ran into a bath at a rate of 3.0×10-2 m3min-1 and V, respectively. At the point of filling the bath, the temperature of the mixture of water was 400C. Calculate the time to fill the bath if its capacity is 1.5m3.

(c) The specific latent heat of fusion of a substance is significantly different from its specific latent heat of vaporization at the same pressure. Explain how the differences arise.

(d) Explain in terms of specific heat capacity why water is used in car radiators other than any other liquid.

1. (a) (i) State Boyle’s law.

(ii) Describe an experiment that can be used to verify Boyle’s law.

(b) Explain the following observations using the kinetic theory.

(i) A gas is fills any container in which it is placed and exerts a pressure on its walls.

(ii) The pressure of a fixed mass of a gas rises when its temperature is increased at constant volume.

(c) (i) What is meant by a reversible process?

(ii) State the conditions necessary for isothermal and adiabatic process to occur.

(d) A mass of an ideal gas of volume 200 cm3 at 144k expands adiabatically to a temperature of 137K. Calculate its new volume (Take γ = 1.40).

1. (a) Define thermal conductivity.

(b) (i) Explain the mechanism of thermal conduction in non-metallic solids.

(ii) Why are metals better than conductors than non-metallic solids?

(c) With the aid of a diagram, describe an experiment to determine the thermal conductivity of a poor conductor.

(d) (i) What is meant by a black body?

(ii) Sketch curves showing the spectral distribution of energy radiated by a black body at three different temperatures.

(iii) Describe the main features of the curves you have drawn in (d)(ii).

(e) A small blackened solid copper sphere of radius 2cm is placed in an evacuated enclosure whose walls are kept at 1000C. Find the rate at which energy must be supplied to the sphere to keep its temperature constant at 1270C.

SECTION C

1. (a) State four differences between cathode rays and positive rays.

(b) An electron having energy of 4.5×102*eV*  moves at right angles to a uniform magnetic field of flux density 1.5×10-3T. Find the

(i) Radius of the path followed by the electrons

(ii) period of motion

(c) (i) Define the terms Avogadro constant and Faraday constant.

(ii) Use the Avogadro constant and Faraday constants to calculate the charges on an anion of a monoatomic element.

(d) Explain the meaning of the following terms as applied to a Geiger-Muller tube.

1. (a) State the laws of photoelectric effect.

(b) Describe an experiment to determine the stopping potential of a metal surface.

(c) A 100mW beam of light of wavelength 4.0×10-7m falls on a caesium surface of a photo cell.

(i) How many photons strike the caesium surface per second?

(ii) If 65% of the photons emit photoelectrons, find the resulting photocurrent.

(iii) Calculate the Kinetic energy of each photon if the work function of caesium is 2.20eV.

(d) Distinguish between continuous and line spectra in an X-ray tube.

1. (a) (i) Explain the observations made in the Rutherford α-particle scattering experiment.

(ii) Why is a vacuum necessary in this experiment?

(b) Distinguish between excitation and ionization energies of an atom.

(c) Draw a labeled diagram showing the main components of an X-ray tube.

(d) An X-ray tube is operated at 50kV and 20mA. If 1% of the total energy supplied is emitted as X-radiation, calculate the

(i) maximum frequency of emitted radiation.

(ii) rate at which heat must be removed from the from the target in order to keep it at a steady temperature.

(e) A beam of X-rays of wavelength 0.20nm is incident on a crystal at a glancing angle of 300. If the interplanar separation is 0.20nm, find the order of diffraction.

2008.

SECTION A

1. (a) (i) Define the terms **velocity** and **displacement.**

**(i)** Sketch a graph of velocity against time for an object thrown vertically upwards.

(b)

3.5N

2.0N

4.0N

Fig. 1

600

300

Three forces of 3.5N, 4.0N and 2.0N act at a point O as shown in Figure 1. Find the resultant force.

(c) (i) What is meant by saying that a body is moving with velocity V, relative to another?

(ii) A ship A is travelling due north at 20kmh-1 and a ship B is travelling due east at 15kmh-1. Find the velocity of A relative to B.

(iii) If ship B in (c) (ii) is 10km due west of A at noon, find their shortest distance apart and when this occurs.

(d) (i) What is meant by a couple in Mechanics?

(ii) State the condition for equilibrium of a system of coplanar forces.

1. (a) (i) State the laws of friction between solid surfaces.

(ii) Explain the origin of frictional forces between two solid surfaces in contact.

(iii) Describe an experiment to measure the coefficient of kinetic friction between two solid surfaces.

(b) (i) A car of mass 1000kg moves along a straight surface with a speed of 20ms-1. When brakes are applied steadily the car comes to rest after travelling 50m. Calculate the coefficient of friction between the surface and the tyre.

(ii) State the energy changes which occur from the time the brakes are applied to the time the car comes to rest.

(c) (i) State two disadvantages of Friction.

(ii) Give one method of reducing friction between solid surfaces.

(d) Explain what happens when a small steel ball is dropped centrally in a tall jar containing oil.

1. (a) (i) Define simple harmonic motion.

(ii) A particle of mass *m,* executes simple harmonic motion between two points *A* and *B* about equilibrium position *O*. Sketch a graph of restoring force acting as a function of distance*, r*, moved by the particle.

(b)

M

B

A

Fig.2

Two springs A and B of spring constants KAandKBrespectively are connected to a mass m as shown in Figure 2.

The surface on which the mass slides is frictionless.

(i) Show that when is displaced slightly, it oscillates with simple harmonic motion of frequency, *f*, given by

(ii) If the two springs in Figure 2 are identical such that and mass , calculate the period of the oscillations.

(c) (i) With the aid of a diagram, describe an experiment to determine the universal gravitational constant, G.

(ii) If the moon moves round the earth in a circular orbit of radius 4.0 × 108 m and takes exactly 27.3 days to go round once, calculate the value of acceleration due to gravity, g, at the earth’s surface.

1. (a) State

(i) Newton’s laws of motion.

(ii) The principle of conservation of momentum.

(b) A body *A* of mass *m1*moves with a velocity *u1*and collides head on elastically with another body B of mass m*2*whish is at rest. If the velocities of*A*and *B* are *v1*and *v2*respectively and given that

Show that,

(i)

(ii)

(c) Distinguish between conservative and non- conservative forces.

(d) A bullet of mass 4g is fired from a gun at 200ms-1 and hits a block of wood of mass 2kg whish is suspended by a light vertical string 2m long. If the bullet gets embedded in the wooden block,

(i) Calculate the maximum angle the String makes with the vertical.

(ii) State a factor on which the angle of swing depends.

SECTION B

1. (a) Define the following terms:

(i) Specific latent heat of vaporization of a liquid.

(ii) Coefficient of thermal conductivity.

(b) With the aid of a labeled diagram, describe an experiment to measure the specific latent heat of vaporization of water by an electrical method.

(c) An appliance rated 240V, 200W evaporates 20g of water in 5 minutes. Find the heat loss if specific latent heat of vaporization is 2.26 × 106 JKg-1.

(d) Explain why at a given external pressure a liquid boils at a constant temperature.

(e) With the aid of a suitable sketch graphs, explain the temperature distribution along lagged and unlagged metal rods, heated at one end.

1. (a) Describe an experiment to verify Newton’s law of cooling.

(b) (i) Distinguish between a real and an ideal gas.

(ii) Derive the expression:

for the pressureof an ideal gas of density, ⍴ and mean square speed C2.

(c) (i) Explain why the pressure of a fixed mass of a gas in a closed container increases when the temperature of the container is raised.

(ii) Nitrogen gas is trapped in a container by a movable piston. If the temperature of the gas is raised from 0℃ to 50℃ at a constant pressure of 4.0×105Pa and the total heat added is 3.0×104 J, Calculate the work done by the gas.

(The molar heat capacity of nitrogen at a constant pressure is 29.1Jmol-1  K-1;Cp/Cv=1.4.)

1. (a) (i) State the laws of Black Body Radiation.

(ii) Sketch the variation of intensity with wavelength in a black body for three different temperatures.

(b) (i) What is a perfectly black body?

(ii) How can a perfectly black body be approximated in reality?

(c) The energy intensity received by a spherical planet from a star is 1.4×103 Wm-2. The Star is of radius 7.0×105 km and is 14.0×107km from the planet.

(i) Calculate the surface temperature of the star.

(ii) State any assumptions you have made in (c)(i) above.

(d) (i) What is convection?

(ii) Explain the occurrence of land and sea breeze.

SECTION C

1. (a) What is meant by a line Spectrum?

(b) Explain how Line Spectrum accounts for the existence of discrete energy levels in atoms.

(c) The energy levels in a mercury atom are −10.4eV, −5.5eV, −3.7eV and −1.6eV.

(i) Find the ionization energy of mercury in joules.

(ii) What is likely to happen if a mercury atom in an unexcited state is bombarded with an electron of energy 4.0eV, 6.7eV or 11.0eV?

(d) Describe with the aid of a labeled diagram, the action of an X−ray tube.

(e) An X−Ray tube is operated at 20KV with an electron current of 16mA in the tube. Estimate the:

(i) Number of electrons hitting the target per second.

(ii) Rate of production of heat, assuming 99.5% of the kinetic energy of the electron is converted to heat.

1. (a) (i) Define the term Binding energy.

(ii) Sketch a graph showing the variation of binding energy per nucleon with the mass number.

(iii) Use the sketch graphs you have drawn in in (a)(ii) to explain how energy is released during fission and fusion.

(b) Explain why high temperature is required during fusion of nuclides.

(c) The isotope emits an alpha particle and forms an isotope of Thorium (Th), While the isotope when bombarded by a neutron, forms,and neutrons.

(i) Write the nuclear equation for the reactions of and.

(ii) How does the reaction of differ from that of?

(d) A steel piston ring contains 15g of radioactive iron, . The activity of is 3.7 × 105disintegrations per second. After 100 days of continuous use, the crankcase oil was found to have a total activity of 1.23×103 disintegrations per second.

Find the:

(i) Half-life of .

(ii) Average mass of iron worn off the ringer per day, assuming that all the metal removed from the ring accumulates in the oil.

1. (a) Describe the mechanism of thermionic emission.

(b) Explain the following terms as applied to a vacuum diode:

(i) Space charge limitation

(ii) Saturation

(ii) Rectification

(c) Sketch the current – potential difference characteristics of a thermionic diode for two different operating temperatures and explain their main features.

(d) (i) A triode valve with an anode resistance of 3.0×103 Ω is used as an amplifier. A sinusoidal alternating signal of amplitude 0.5V is applied to the grid of the valve. Find the r.m.s value of the output voltage if the amplification factor is 15 and anode load is 50kΩ.

(ii) Draw an equivalent circuit of a triode as a single-stage amplifier.

2007.

SECTION A

1. (a) Define Simple Harmonic motion. (SHM).

(b) Sketch a graph of:

(i) Velocity against displacement

(ii) Acceleration against displacement.

For a body executing SHM.

(c) A glass U –tube containing a liquid is tilted slightly and then released.

(i) Show that the liquid oscillates with Simple Harmonic motion.

(ii) Explain why the oscillation ultimately come to rest.

(d) Explain why the maximum speed of a car on a banked road.

(e) A small bob of mass 0.20kg is suspended by an inextensible string of length 0.80m. The bob is then rotated in a horizontal circle of radius 0.40m. Find the:

(i) Linear speed of the bob.

(ii) tension in the string

2. (a) State **Kepler’s laws of planetary motion.**

**(b)** (i) A satellite moves in a circular orbit of radius, R, about a planet of mass, M, with a period T. Show that:

Where G is the Universal gravitational constant.

(ii) The period of the moon around the Earth is 27.3days. If the distance of the moon from the Earth is 3.83×105 km, calculate the acceleration due to gravity at the surface of the Earth.

(iii) Explain the why any resistance to the forward motion of an artificial satellite results into an increase in its speed.

(c) (i) What is meant by weightlessness?

(ii) Why does acceleration due to gravity vary with location on the surface of the earth?

3. (a) (i) State the laws of solid Friction.

(ii) Using the molecular theory, explain the laws stated in (a)(i).

(b) Describe an experiment to determine the coefficient of static friction for an interface between a rectangular block of wood and a plane surface.

(c) (i) State the difference between conservative and non-conservative forces, giving one example of each.

(ii) State the work energy theorem.

(iii) A block of mass 6.0Kg is projected with a velocity of 12ms-1up a rough plane inclined at 450 to the horizontal. If it travels 5.0m up the plane, find the frictional force.

(d) Explain the effect of temperature on the viscosity of a liquid.

4. (a) (i) Define vector and scalar quantities and give one example of each.

400

200

600

25N

20N

30N

5N

M

Y - axis

(ii)

X- axis

A body, M of mass 6Kg is acted on by forces of 5N, 20N 25N and 30N as shown in figure 1. Find the acceleration of M.

(b) (i) What is meant by acceleration due to gravity?

(ii) Describe how you would use a spiral spring, a retort stand with a clamp, a pointer, seven 50g masses, a meter rule and a stop clock to determine the acceleration due to gravity.

(iii) State any two sources of errors in the experiment in (b)(ii) above.

(iv) A body of mass 1kg moving with simple harmonic motion has speeds of 5ms-1 and 3ms-1 when it is at distances of 0.10m and 0.20m respectively from the equilibrium point. Find the amplitudes of the motion.

SECTION B

1. (a) (i) Define a thermometric property and give two examples.

(ii) When is the temperature 0K attained?

(b) (i) With reference to the constant –volume gas thermometer, define temperature on the Celsius scale.

(ii) State two advantages and two disadvantages of the constant −volume gas thermometer.

(c) (i) Define the Triple point of water.

(ii) Describe how you would measure the temperature of a body on the thermodynamic scale using a thermocouple.

(d) The resistance, Rθof platinum varies with the temperature θ0C as measured by the constant−volume gas thermometer according to the equation:

(i) Calculate the temperature on the platinum scale corresponding to 600C on the gas scale.

(ii) Account for the difference between the two values and the temperatures at which they agree.

1. (a) (i) Define latent heat.

(ii) Explain the significance of latent heat in regulation of body temperature.

(b) (i) Using the kinetic theory, explain boiling of a liquid.

(ii) Describe how you would determine the specific latent heat of vaporization of water by the method of mixtures.

(iii) Explain why latent heat of vaporization is always greater than that of fusion.

(c) In an experiment to determine the specific latent heat of vaporization of a liquid using the continuous flow calorimeter, the following results were obtained.

Voltage, V/v Current, I/A Mass collected in 300, s/g

7.4 2.6 5.8

10.0 3.6 11.3

Calculate the power of the heater required to evaporate 3.0g of water in 2 minutes.

1. (a)

Figure 2.

Cylinder

Ideal gas

P,V

F

A fixed mass of an ideal mass is confined in a cylinder by a frictionless piston of cross- section area, A. The piston is in equilibrium under the action of a force, F, as shown in Figure2.Show that the work done, W, by the gas when it expands from V1 to V2 is given by

(b) State the first law of thermodynamics and use it to distinguish between isothermal and adiabatic changes in a gas.

(c) The temperature of one mole of a helium gas at a pressure of 1.0×105Pa increases from 200C to 1000C when the gas is compressed adiabatically. Find the final pressure of the gas. (Take γ= 1.67).

(d) With the aid of a P-V diagram, explain what happens when a real gas is compressed at different temperatures.

(e) The root-mean square speed of the molecules of a gas is 44.72ms-1. Find the temperature of the gas if its density is 9.0×10-2Kgm-3 and the volume is 42.0m3.

SECTION C

1. (a) Describe briefly the mechanism of thermionic emission.

(b) (i) Draw a labeled circuit to show a triode being used as a single-stagevoltage amplifier.

(ii) With the aid of an equivalent circuit of the triode being used as an amplifier, obtain an expression for the voltage again.

(iii) A triode with mutual conductance of 3.0×10-3 AV-1 and anode resistance of 1.0×104Ω is used as a single-stage amplifier. If the load resistance is 3×104Ω, calculate the voltage gain of the amplifier.

(c) (i) Describe the structure of a junction transistor.

(ii) Sketch and describe the collector-current against collector emitter voltage characteristic of a junction transistor.

1. (a) What are isotopes?

(b) With the aid of a diagram, describe the operation of a Bainbridge spectrometer in determining the specific charge of ions.

(c) Explain the purpose of each of the following in a Geiger-Muller tube’

(i) A thin mica window.

(ii) Argon gas at low pressure.

(iii) Halogen gas mixed with argon gas.

(iv) An anode in the form of a wire

(d) (i) What is meant by binding energy per nucleon of a nucleus?

(ii) Sketch a graph of binding energy per nucleon against mass number for naturally occurring nuclides.

(iii) State one similarity between nuclear fusion and nuclear fission.

(e) (i) At a certain time, an α−particle detector registers a count rate of 32s-1. Exactly 10 days later, the count rate dropped to 8s-1. Find the decay constant.

(ii) State two industrial uses and two health hazards of radioactivity.

1. (a) (i) Describe with the aid of a diagram, the production of cathode rays,

(ii) State and justify two properties of cathode rays.

(b) Explain each of the following terms as applied to photo-electric emission:

(i) Stopping potential

(ii) Threshold frequency

(c) Explain X−ray diffraction by crystals and derive Bragg’s law.

(d) The potential difference between the cathode and the anode of an X−ray tube is 5.0×10-4V. If only 0.40% of the kinetic energy of the electrons converted into X−rays and the rest is dissipated as heat in the target at a rate of 600W, find the:

(i) Current that flows

(ii) speed of the electrons striking the target.

2006.

SECTION A

1. (a) (i) What is meant by uniformly accelerated motion?

(ii) Sketch the speed against time graph for a uniformly accelerated body.

(iii) Derive the expression.

. For the distance, S moved by a body which is initially travelling with the speed, u and is uniformly accelerated for time, t.

(b) A projectile is fired horizontally from the top of a cliff 250m high. The projectile lands 1.414×103m from the bottom of the cliff. Find the:

(i) initial speed of the projectile.

(ii) velocity of the projectile just before it hits the ground.

1. (a) (i) Define force and power.

(ii) Explain why more energy is required to push a wheel barrow uphill than on a level ground.

(b)

M

Fig.1

Spring balance

A mass, M, is suspended from a spring balance as shown in Figure 1. Explain what happens to the reading on the spring balance when the setup is raised slowly to a very high height above the ground.

(c) (i) State the work energy theorem.

(ii) A bullet of mass 0.1kg moving horizontally with a speed of 420ms-1 strikes a block of wood of mass 2.0kg at rest on a smooth table and becomes embedded in it. Find the Kinetic energy lost if they move together.

(d) State the conditions for equilibrium of a rigid body under the action of coplanar forces.

(e) A 3m long ladder rests at an angle of 600 to the horizontalagainsta smooth vertical wall on a rough ground. The ladder weighs 5kg and its center of gravity is one third from the bottom of the ladder.

(i) Draw a sketch diagram to show the forces acting on the ladder.

(ii) Find the reaction of the ground on the ladder.

1. (a) (i) Define stress and strain.

(ii) Determine the dimensions of Young’s Modulus.

(b) Sketch a graph of stress versus strain for a ductile material and explain its features.

(c) A steel wire of cross-sectional area 1 mm2 is cooled from a temperature of 600C to 150c. Find the:

(i) Strain

(ii) Force needed to prevent it from contacting.

[Young’s Modulus = 2.0×1011 Pa.

Coefficient of linear expansion of steel = 1.1×10-5K-1 .]

(d) Explain the energy changes which occur during plastic deformation.

1. (a) (i) State Archimedes Principle.

(ii) Describe an experiment to determine the relative density of an irregular solid which floats on water.

(iii) A block of wood floats at an interface between water and oil with 0.25 of its volume submerged in the oil.

If the density of the wood is 7.3×102 kgm-3, find the density of the coil.

(b) (i) State Bernoulli’s principle.

(ii) Explain the origin of the lift on the wings of an airplane at takeoff.

(c) Water flowing in a pipe on the ground with a velocity of 8ms-1 and at a gauge pressure 2.0×105Pa is pumped into a water tank 10m above the ground. The water enters the tank at a Pressure of 1.0×105Pa. Calculate the velocity with which the water enters thetank.

(d) Describe how terminal velocity can be measured in a liquid.

SECTION B

1. (a) Define saturated vapor pressure(S.V.P)

(b) Use the Kinetic theory of matter to explain the following observations.

(i) saturated vapor pressure of a liquid increases with temperature.

(ii) saturated vapor pressure is not affected by a decrease in volume at constant temperature.

(c) Describe how the saturated vapor pressure of a liquid at various temperatures can be determined.

(d) (i) State Dalton’s law of partial pressures.

(ii) A horizontal tube of uniform bore, closed at one end, has some air trapped by a small quantity of water. The length of the enclosed air column is 20cm at 120C.

Find stating any assumption made the length of the air column when the temperature is raised to 380C.

[S.V.P of water at 120C and 380C are 105mmHg and 49.5mmHg respectively. Atmospheric pressure =75.0cmHg.

1. (a) (i) Define specific heat capacity of a substance of a substance .

(ii) State three advantages of the continuous flow method over the method of mixtures in the determination of specific heat capacity of a liquid.

(b) In a continuous flow experiment, steady difference of temperature of 150C is maintained when the rate of liquid flow is 45gs-1 and the rateofelectricalheating is 60.5W. On reducing the liquid flow rate of electrical heating is 60.5W. On reducing the liquid flow rate to 15gs-1, 36.5W is required to maintain the same temperature difference.

Calculate the:

(i) Specific heat capacity of the liquid.

(ii) rate of heat loss to the surroundings.

(c) (i) Describe an electrical method for the determination of specific latent heat capacity of a metal.

(ii) State the assumptions made in the above experiment.

(iii) Comment about the accuracy of the results of the experiment in (c) (i) above.

1. (a) (i) Define thermal conductivity.

(ii) Explain the mechanism of heat transfer in metals.

(b) Two brick walls each of thickness 10cm are separated by an air-gap of thickness 10cm. The outer faces of the brick walls are maintained at 200C and 50C respectively.

(i) Calculate the temperature of the inner surfaces of the walls.

(ii) Compare the rate of heat loss through the layer of air with that through a single brick wall.

[Thermal conductivity of air is 0.02Wm-1K-1 and that of bricks is 0.06Wm-1K-1]

(c) (i) State Stefan’s law of black body radiation.

(ii) The average distance of Pluto from the sun is about 40 times that of the Earth from the sun. If the sun radiates as a black body at 6000K, and is 1.5×1011m from the Earth, calculate the surface temperature of Pluto.

SECTION C

1. (a) (i) What is a photon?

(ii) Explain using quantum theory, the experimental observations on the photoelectric effect.

(iii) When light of wavelength 150mm falls on a certain metal, electrons of maximum kinetic energy 0.76eV are emitted. Find the threshold frequency for the metal.

(b) Explain using a suitable sketch graphs, how X-ray spectra in an X-ray tube are formed.

(c) A beam of X-rays of wave length 8.42×10-11m is incident on sodium chloride crystal of interplanal separation 2.82×10-10m. Calculate the first order diffraction angle.

1. (a) (i) A beam of electrons, having a common velocity, enters a uniform magnetic field in a direction normal to the field. Describe and explain the subsequent path of the electrons.

(ii) Explain whether a similar path would be followed if a uniform electric field were substituted for the magnetic field.

(b) Describe an experiment to measure the ratio of the charge to mass of an electron.

(c) Electrodes are mounted at opposite ends of a low pressure discharge tube and a potential difference of 1.20KV applied between them. Assuming that the electrons are accelerated from the rest, calculate the maximum velocity which they would acquire.

[Specific Electron Charge = −1.76 × 1011 CKg-1]

(d) (i) Give an account of the stages observed when an electric discharge passes through a gas at pressures varying from atmospheric to about 0.01mmHg as air is pumped out when the p.d across the tube is maintained at extra high tension.

(ii) State any two disadvantages of discharge tubes when used to study cathode rays.

1. (a) (i) What is meant by Half-life of a radioactive material?

(ii) Given that the radioactive law, = , obtain the relation between λ and half-life , .

(iii) What are radioisotopes?

(iv) The radioisotope decays by emission of β – particles. The half-life of the radioisotope is 28.8 years.

(b) (i) With the aid of a diagram, describe the structure and action of a Geiger-Muller tube.

(ii) Sketch the count rate-voltage characteristic of the Geiger Muller tube and explain its main features.

(iii) Identify, giving reasons, the suitable range in (b)(ii) of operation of the tube.

2005.

SECTION A

1. (a) Distinguish between Scalar and Vector quantities giving two examples of each.

(b) The equation for the volume, V, of a liquid flowing through a pipe in time, t, under steady flow, is given by

, where

r = radius of the pipe

*p* = pressure difference between

𝜄 = length of the pipe

η = coefficient of viscosity of the liquid.

If the dimensions of η are ML-1T-1, show that the above equation is dimensionally consistent.

(c) (i) Define linear momentum.

(ii) State the law of conservation of linear momentum.

(iii) Show that the law in (c)(ii) above follows from Newton’s law of motion.

(iv) Explain why, when catching a fast moving ball, the hands are drawn back while the ball is being brought to rest.

(d) A car of mass 1000kg travelling at a uniform velocity of 20ms-1 collides perfectly inelastically with a stationary car of mass 1500kg. Calculate the loss in Kinetic energy of the car as a result of the collision.

(e) (i) What is meant by conservative of energy?

(ii) Explain how conservation of energy applies to an object falling from rest in a vacuum.

1. (a) Explain the terms:

(i) Ductility,

(ii) Stiffness

(b) A copper wire and steel wire each of length 1.0m and diameter 1.0mm are joined end to end to form a composite wire 2.0m long. Find the strain in each wire when the composite stretches by 2.0×10-3m.

[Young’s modulus for copper and steel are 1.2×1011 Pa and 2.0×1011 Pa respectively.]

(c) (i) Define center of gravity.

(ii) Describe an experiment to find the center of gravity of a flat irregular piece of cardboard.

(d) Explain the laws of solid friction using the molecular theory.

1. (a) What is meant by the following terms?

(i) Velocity gradient,

(ii) Coefficient of viscosity.

(b) Derive an expression for the terminal velocity of a steel ball-bearing of radius *r,* and density ρ, falling through a liquid of density σ and coefficient of viscosity η.

(c) (i) Define surface tension.

(ii) Explain the origin of surface tension.

(iii) Describe an experiment to measure the surface tension of a liquid by the capillarity method.

(d) Explain, with the aid of a diagram why air flow over the wings of an aircraft at takeoff causes a lift.

1. (a) (i) Define angular velocity.

(ii) Derive an expression for the force F, on a particle of mass m, moving with angular velocity ω, in a circle of radius r.

(b) A stone of mass 0.5kg is attached to a string of length 0.5m which will brake if the tension in it exceeds 20N. The stone is whirled in a vertical circle, the axis of rotation being at a vertical height of 1.0m above the ground. The angular speed is gradually increased until the string breaks.

(i) In what position is the string most likely to break? Explain

(ii) At what angular speed will the string break?

(iii) Find the position where the stone hits the ground when the string breaks.

(c) Explain briefly the action of a centrifuge.

(d) Describe how the acceleration due to gravity can be measured using a helical spring of unknown force constant, and the other relevant apparatus.

**SECTION B**

1. (a) (i) What is meant by the term fixed points in thermometry?

(ii) How is temperature on a Celsius scale defined on a platinum resistance thermometer?

(b) Explain the extent to which two thermometers based on different properties but calibrated using the same fixed points are likely to agree when used to measure a temperature.

(i) near one of the fixed points

(ii) Mid-way between the two fixed points.

(c) The continuous flow method is used in the determination of the specific heat capacity of liquids.

(i) What are the principle advantages of this method compared to the method of mixtures?

(ii) In such a method, 50g of water is collected in 1 minute. The voltmeter and ammeter readings are 12.0V and 2.50A respectively, while the inflow and outflow temperatures are 200C and 280C respectively. When the flow rate is reduced to 25 g min-1, the voltmeter and ammeter read 8.8v and 1.85A respectively while the temperature remain constant. Calculate the specific Heat Capacity of water.

(d) What are the advantages of a thermocouple over a constant volume gas thermometer in measuring temperature?

1. (a) (i) What is meant by isothermal and adiabatic changes?

(ii) Using the axes and starting from the same point, sketch a P-V diagram to illustrate the changes in (a)(i).

(b) An ideal gas is trapped in a cylinder by a movable piston. Initially it occupies a volume of 8×10-3 m3 and exerts a pressure of 108kPa. The gas undergoes an isothermal expansion until its volume is 27×10-3m3. It is then compressed adiabatically to the original volume of the gas.

(i) Calculate the final pressure of the gas.

(ii) Sketch and label the two stages on a p-v diagram. (The ratio of the principal molar heat capacities of the gas = 5:3)

(c) (i) Define molar heat capacities at constant pressure.

(ii) Derive the expression, for 1 mole of a gas.

(iii) In what ways does a real gas differ from an ideal gas?

1. (a) (i) Define thermal conductivity.

(ii) State two factors which determine the rate of heat transfer through a material.

(b) (i) Describe with the aid of a labeled diagram an experiment to measure the thermal conductivity f a glass.

(ii) Briefly discuss the advantages of the apparatus in (b)(i).

(c) Metal rods of copper, brass and steel are welded together to form a Y- Shaped figure. The cross- sectional area of each rod is 2cm2. The free end of the copper rod is maintained at 1000C, while the free ends of the brass and steel are maintained at 00C. If there is no heat loss from the surfaces of the rod sand the lengths of the rods are 0.46m, 0.13m and 0.12m respectively.

(i) Calculate the temperature at the junction.

(ii) Find the heat current in the copper rod.

[Thermal conductivities of copper, brass and steel are 385 Wm-1K-1, 109Wm-1K-1 and 50.2Wm-1K-1 respectively]

**SECTION C**

1. (a) (i) Draw a labeled diagram of an X-Ray tube.

(ii) Use the diagram in (a)(i) above to describe how x-rays are produced.

(iii) State one industrial and one biological use of X-rays.

(b) (i) Sketch a graph of intensity versus wavelength of X-rays from an X-Ray tube and describe its main features.

(ii) Calculate the maximum frequency of X-rays emitted by an X-ray tube operating a voltage of 34.0kV.

(c) In the measurement of electron charge by Millikan’s apparatus, a potential difference of 1.6KV is applied between two horizontal plates 14mm apart. With the potential difference switched off, an oil drop is observed to fall with constant velocity 4.0×10-4ms-1. When the potential difference is switched on, the drop rises with constant velocity 8.0×10-5ms-1.

If the mass of the drop oil is 1.0×10-14kg, find the number of electron charges on the drop.

[Assume air resistance is proportional to the velocity of the oil drop and neglect the upthrust due to air.]

1. (a) (i) State the laws of photo-electric emission.

(ii) Write down Einstein’s equation of photo electric emission.

(iii) Ultra-violet light of wavelength 3.3×10-8m is incident on a metal. Given that the work function of the metal is 3.5eV, calculate the maximum velocity of the liberated electron.

(b) Describe. With the aid of a diagram, the structure and mode of operation of a cathode ray oscilloscope (C.R.O).

(c) A C.R.O has its y-sensitivity set to 10 V Cm-1. A sinusoidal input voltage is suitably applied to give a steady trace with time base switched on so that the electrons beam takes 0.01s to traverse the screen. If the trace seen has a peak-to-peak height of 4.0cm and contains two complete cycles, find the

(i) r.m.s value of the input voltage

(ii) Frequency of the input signal.

1. (a) Define binding energy of nuclide.

(b) (i) Sketch a graph showing how binding energy per nucleon varies with mass number.

(ii) Describe the main features of the graph in (b)(i).

(c) Distinguish between nuclear fission and nuclear fusion and account for the energy released.

(d) (i) With the aid of a labeled diagram, describe the working of a Geiger-Muller tube.

(ii) How could you use a Geiger-Muller tube to determine the half-life of a radioactive sample?

(e) A radioactive source produces alpha particles each of energy 60MeV. If 20% of the alpha particles enter an ionization chamber, a current of 0.2µA flows. Find the activity of the alpha source, if the energy needed to make an ion pair in the chamber is 32 MeV.

2004.

1. (a) State the laws of friction.

(b) A block of mass 5.0Kg resting on the floor is given a horizontal velocity of 5.0ms-1 and comes to rest in a distance of 7.0m. Find the coefficient of kinetic friction between the block and the floor.

(c) (i) State the law of conservation of linear momentum.

(ii) What are perfectly inelastic collisions?

(d) A car of mass 1500kg rolls from rest down a road inclined to the horizontal at an angle 0f 350, through 50m. The car collides with another car of identical mass at the bottom of the incline. If the two vehicles interlock on collision, and the coefficient of kinetic friction is 0.20. Find the common velocity of the vehicles.

(e) Discuss briefly the energy transformations which occur in (d) above.

1. (a) Define the term angular velocity.

(b) A car of mass m, travels round a circular track of radius r, with a velocity, V.

(i) Sketch a diagram to show the force acting on the car.

(ii) Show that the car does not overturn if , where a is the distance between the wheels, h is the height of the centre of gravity above the ground and g is the acceleration due to gravity.

(c) A pendulum bob of mass 0.2kg is attached to one end of an inelastic string of length 1.2m. The bob moves in a horizontal circle with the string inclined at 300 to the vertical. Calculate:

(i) the tension in the string.

(ii) the period of the motion.

(d) Explain and sketch the variation of the acceleration due to gravity with distance from the center of the earth.

1. (a) (i) What is meant by simple harmonic motion?

(ii) Show with the aid of a diagram a suitable sketch graph ho the kinetic energy of a mass attached at the end of an oscillating light string changes with the distance from the equilibrium position.

(b)

1Kg

Fig.1

S­2

S­1

A mass of 1.0kg is hung from two springs S­1 and S2 connected in series as shown in Figure 1. The force constants of the springs are 100Nm-1 and 200Nm-1 respectively. Find

1. The extension produced in the combination.
2. The frequency of oscillation of the mass if it is pulled downwards through a small distance and released.

(c) Explain with the aid of a sketch graph, what would happen to the oscillations in (b)(ii) above if the mass was immersed in a liquid such as water.

1. (a) (i) Define the term gravitational field strength.

(ii) Draw a sketch to show how the gravitational field strengths varies with the height, h, above the earth’s surface.

(b) The period of a simple pendulum is measured at different locations along a given longitude. Explain what is observed.

(c) Derive the expression for the escape velocity of a rocket fired from earth.

(d) The rings of the planet Saturn consists of a vast number of small particles, each in a circular orbit about the planet. Calculate the speed of the particles nearest to Saturn if it’s mass is 6.0×1026kg.

(e) The moon moves in a circular orbit of radius 3.84×108m around the earth with a period of 2.36×106s. Calculate the gravitational field of the earth at the moon.

SECTION B

1. (a) What is meant by:
2. Thermometric property
3. Triple point of water.

(b) (i) Describe the steps taken to establish a temperature scale.

(ii) Explain why two thermometers may give different values for the same unknown temperature.

(c) (i) Describe, with the aid of a diagram, how a constant –volume gas thermometer may be used to measure temperature.

(ii) State three corrections that may need to be made when using the thermometer in (c)(i) above.

1. State and explain the sources of inaccuracies in using mercury-in-glass thermometer.
2. (a) Define thermal conductivities of a material and state its unit.

(b) Describe with the aid of a diagram how the thermal conductivity of a poor conductor can be determined.

(c) A cooking saucepan made of iron has base area of 0.005m2 and thickness of 2.5mm. It has a thin layer of soot of average thickness 0.5mm on its bottom surface. Water in the saucepan is heated until it boils at 1000C. The water boils away at rate of 0.60kg per minute and the side of the soot nearest to the heat source is at 1500C. Find the thermal conductivity of the soot.

(Thermal conductivity of iron = 66 Wm-1K-1 and specific latent heat of vaporization =2200 kJ/kg)

(d) (i) What is a black body?

(ii) Sketch the spherical distribution of black body radiation for three different temperatures and describe their main features.

1. (a) Derive the expression for the pressure P, of an ideal gas of density ρ and mean square speed, C2. State any assumptions made.

(b) A gas is confined in a container of volume 0.1m3 at a pressure of 1.0×105Nm-2 and a temperature 300k. If the gas is assumed to be ideal, calculate the density of the gas.

(The relative molecular mass of the gas is 32.)

(c) What is meant by

(i) Isothermal change?

(ii) adiabatic change?

(d) A gas at a pressure of 1.0×106Pa is compressed adiabatically to half its volume and allowed to expand isothermally to its original volume. Calculate the final pressure of the gas. (Assume the ratio of the principal specific heat capacities)

SECTION C

1. (a) (i) Describe with the aid of a labeled diagram the main features of a cathode ray oscilloscope(C.R.O)

(ii) State two uses of a C.R.O.

(iii) The gain control of a C.R.O is set on 0.5Vcm-1 and an alternating voltage produces a vertical trace of 2.0cm long with the time base off. Find the root mean square value of the applied voltage.

(b) A beam of electrons is accelerated through a potential difference of 2000V and is directed mid-way between two horizontal plates of length 5.0cm and a separation of 2.0cm. The potential difference across the plates is 80V.

(i) Calculate the speed of the electrons as they enter the region between the plates.

(ii) Explain the motion of the electrons between the plates.

(iii) Find the speed of the electrons as they emerge from the region between the plates.

1. (a) Explain the term stopping potential as applied to photo electric effect.

(b) Explain how intensity and penetrating power of X-Rays from an X-Ray tube would be affected by changing:

(i) the filament current

(ii) the high tension potential difference across the tube.

(c) When a p.d of 60kV is applied across an X-ray tube, a current of 30mA flows. The anode is cooled by water flowing at a rate of 0.060kg s-1. If 99% of the power supplied is converted into hat heat at the anode, calculate the rate at which the temperature of the water rises. [Specific heat capacity of water = 4.2×103kgm-3]

(d) (i) Derive Bragg’s law of X-Ray diffraction.

(ii) Calculate the atomic spacing of sodium chloride if the relative atomic mass of sodium is 23.0 and that of chlorine is 35.5. [Density of sodium chloride = 2.18×103kg m-3]

1. (a) (i) Explain briefly the mechanism of thermionic emission.

(ii) Draw a labeled diagram of the circuit used to determine the anode current and anode voltage characteristics of a thermionic diode.

(iii) Sketch the characteristic expected in (a)(ii) at a constant filament current, and account for its special features.

(b) Describe with the aid of a labeled diagram, the structure and action of a diffusion cloud chamber.

(c) (i) Define the terms radioactivity and half-life of a radioactive substance.

(ii) A radioactive isotope of Strontium of mass 5.0µg has a half-life of 28 years. Find the mass of the isotope left after 14 years. Find the mass of the isotope left after 14 years.

(Assume the decay law)

2003.

SECTION A

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

(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 5.0m above the ground. Describe with the aid of a velocity-time graph, the subsequent motion of the ball.

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

1. (a) Define the following terms:

(i) *angular velocity*

(ii) *centripetal force*

(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 track without skidding.

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

(d) The gravitational potential U, at the surface of a planet of Mass M and radius R is given by , where G is the gravitational constant.

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

1. (a) State the laws 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.

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

(d) (i) Define the terms *longitudinal stress* and *Young’s Modulus* of elasticity.

(ii) Describe how to determine Young’s Modulus for a steel wire.

1. (a) A mass of 0.1kg 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.

(ii) Show that the speed of a body moving with simple harmonic motion of angular frequency, ω is given by:

, where A is the amplitude and X the displacement from the equilibrium position.

(iii) Sketch graphs to show the variation with displacement, of the kinetic and potential energies of a body moving with simple harmonic motion.

(c) A mass of 0.1kg suspended from a spring of force constant 24.5Nm-1 is pulled vertically downwards through a distance 5.0cm and released. Find the:

(i) period of oscillation

(ii) position of the mass 0.3 seconds after release.

**SECTION B**

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

(ii) The specific heat capacity of Oxygen at constant volume is 719JKg-1K-1. If the density of Oxygen at S.T.P is 1.429kg m-3, calculate the specific heat capacity of oxygen at constant pressure.

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

(c) (i) In deriving the expression P = ⍴ 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:

.

Account for the terms and b.

(d) Use the expression P = ⍴c2; for the pressure of an ideal gas to derive Dalton’s law of partial pressures.

(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.

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

(b) Describe how an approximate black body can be realized in practice.

(c) (i) Draw sketch graphs to show variation of relative intensity of black body radiation with wavelength for three different temperatures?

(ii) Describe the features of the sketch graphs in (c)(i) above.

(d) (i) State Stefan’s Law.

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

(Density of copper = 8.93×103kg m-3, specific heat capacity of copper = 3.37×102 Jkgk-1 )

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

1. (a) (i) What is meant by Kinetic Theory of gases?

(ii) Define an ideal gas.

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

(b) (i) Describe an experiment to show that a liquid boils only when it’s saturated vapor pressure is equal to its external pressure.

(ii) Explain how cooking at a pressure of 76 cm of mercury and a temperature of 1000C, may be achieved on top of high mountains.

(c) (i) Define root mean square speed of a molecule of a gas.

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

SECTION C

1. (a) (i) State Rutherford’s model of the atom.

(ii) Explain two main failures of Rutherford’s model of the atom.

(b) (i) Explain how Millikan’s experiment for measuring the charge of the electron proves that the charge is quantized.

(ii) Oil droplets are introduced into the space between two flat 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 kg m-3 and the viscosity of air is 1.8×10- 5Nsm-2, calculate the charge of the droplet.

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

1. (a) (i) What is meant by thermionic emission?

(ii) Sketch the current-potential difference characteristic of a thermionic diode for two different operating temperatures and explain their main features.

(iii) Describe one application of a diode.

(b) (i) What features of an X-Ray tube make it suitable for continuous production of X- rays.

(ii) Sketch a graph of intensity versus frequency of a radiation produced in an X-ray tube and explain its features.

(c) A mono chromatic X-ray beam of wavelength 1.0×10-10 cm is incident on a set of planes in a crystal of spacing 2.8×10-10m. What is the maximum order possible with these X-rays?

1. (a) What is meant by the following terms:

(i) nuclear number?

(ii) binding energy?

(b) Calculate the energy released during the decay of nucleus into and an α−particle.

(c) Describe the Bainbridge mass spectrometer and explain how it can be used to distinguish between isotopes.

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

(ii) A radioactive source contains 1.0µg of plutonium of mass number 239. If the source emits 2300 α-particles per second, calculate the half-life of plutonium.

[Assume the decay law N=N0e-λt]

2002.

SECTION A

1. (a) (i) What is meant by dimension of a physical quantity?

(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, , 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.

(b) Define *simple harmonic motion.*

(c) Sketch the following graphs for a body performing simple harmonic motion.

(i) velocity against displacement,

(ii) displacement against time.

(d) The period of oscillation of a conical pendulum is 2.0s. If the string makes an angle of 600 to the vertical at the point of suspension, calculate the:

(i) vertical height of the point of suspension above the circle,

(ii) length of the string

(iii) velocity of the mass attached to the string.

(e) (i) Give one example of an oscillatory motion which approximates simple harmonic motion.

(ii) What approximation is made in (c)(i)?

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

1. (a) (i) State *Newton’s law of universal gravitation.*

(ii) Show that this law is consistent with Kepler’s third law.

(iii) Two alternative units for gravitational field strengths are N kg-1 and ms-1. Use the method of dimensions to show that the two units are equivalent.

(b) (i) Derive an expression for the speed for a body moving uniformly in a circular path.

(ii) Explain why a force is necessary to maintain a body moving with constant speed in a circular path.

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

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

(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.

(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.

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

(ii) A piece of metal of mass 2.60×10-3kg and density 8.4×103 kg m-3 is attached to a block of wax of mass 1.0×10-2kg and density 9.2×102 kg m-3. When the system is placed in a liquid, it floats with wax just submerged. Find the density of the liquid.

(b) Explain the

(i) terms laminar flow and turbulent flow,

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

(c) (i) Distinguish between static pressure and dynamic pressure.

(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 1050kgm-3, calculate the maximum pressure on the gauge.

1. (a) Define the term surface tension in terms of surface energy.

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

(ii) A soap bubble of radius r1is attached to another bubble of radius r2. If r1 is less than r2, show that the radius of curvature of the common interface is .

(c) (i) Define coefficient of viscosity of a liquid.

(ii) Describe a simple experiment to demonstrate stream line and turbulent flow in a liquid.

(d) (i) Sketch a graph of potential energy against separation of two molecules in a substance.

(ii) Explain the main features of the graph in (d)(i).

SECTION B.

1. (a) State the assumptions made in the derivation of the expression for the pressure of an ideal gas.

(b) Use the expression in (a) above to deduce Dalton’s law of partial pressures.

(c) Describe an experiment to determine the saturation vapor pressure of a liquid.

(d) (i) What is meant by a reversible isothermal change?

(ii) State the conditions for achieving a reversible isothermal change.

(e) An ideal gas at 270C and at a pressure of 1.01×105 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 γ= 1.4.

1. (a) Explain the mechanism of heat conduction in solids.

(b) Describe a method of determining the thermal conductivity of cork in the form of a thin sheet.

(c) a window of height 1.0m and width 1.5m contains a double glazed unit consisting of two single glass panes, each of thickness 4.0mm separated by an air gap of 2.0 mm. Calculate the rate at which heat is conducted through the window if the temperatures of the external surfaces of glass are 200C and 300C respectively.

[Thermal conductivities of glass and air are 0.72 Wm-1k-1 and 0.025Wm-1k-1 respectively.]

(d) (i) State Stefan’s law.

(ii) The elements of a 1.0kw electric fire is 30.0cm long and 1.0cm in diameter. If the temperature of the surrounding is 200C, estimate the working temperatures of the element.

[Stefan’s constant σ, = 5.7×10-18 Wm-1K-1]

1. (a) (i) Define specific heat capacity of a substance.

(ii) State how heat losses are minimized in calorimetry.

(b) (i) What is meant by a cooling correction?

(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 mixtures.

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

(c) Describe how you would determine the specific heat capacity of a liquid by the continuous flow method.

SECTION C

1. (a) What is meant by:

(i) Bohr atom

(ii) binding energy of a nucleus?

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

(i) Identify the quantities *m, q, n and h* in this expression.

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

(iii) Draw an energy level diagram for hydrogen to indicate the emission of ultra- violet, visible and infra-red spectral lines.

(c) (i) Explain briefly the sources and absorption of infra-red radiations.

(ii) Describe briefly, the method of detecting infra-red radiations.

(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.

1. (a) (i) What are cathode rays?

(ii) An electron gun operating at 3×103V is used to project electrons into the space between two positively charged parallel plates of length 10cm and separation 5cm. Calculate the deflection of the electrons as they emerge from the region between the charged plates when the potential difference is 1×103V.

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

(ii) Explain why the wave theory of light fails to account for the photoelectric effect and explain hoe Plank’s constant may be obtained from the experiment.

1. (a) What is meant by:

(i) half-life of a radioactive element.

(ii) nuclear fission

(iii) nuclear fusion

(b) An atom of emits an α-particle of energy 5.3MeV. Given that the half-life of is 3.8 days, use the decay law, N =Noe-λt to calculate the:

(i) decay constant

(ii) amount of energy released by 3.0×10-9kg of after 3.8 days.

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

(d) The nucleus of emits an α-particle followed by two β-particles. Show that the final nucleus is an isotope of chlorine.

2001.

SECTION A

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

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

(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.

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

(c) State the conditions under which the following will be conserved in a collision between two bodies:

(i) Linear momentum

(ii) Kinetic energy.

(d) Two pendula of equal length l, 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 Bob A is displaced such that t the String makes an angle θ with the vertical and released.

If A makes a perfectly inelastic collision with B, find the height to which B rises.

1. (a) Define the following terms:

(i) Stress

(ii) Strain

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

Show that the formula is dimensionally consistent.

(c) State the measurements necessary in the determination of Young’s Modulus of a metal wire.

(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.

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

(e) The ends of a uniform wire of length 2.00m are fixed to points A and B which are 2.00m 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 2.0×1011Pa, find:

(i) the strain in the wire,

(ii) the stress in the wire,

(iii) the energy stored in the wire,

State any assumptions made

1. (a) Define surface tension and derive its dimensions.

(b) Explain using the molecular theory the occurrence 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

(ii) Calculate the total pressure within a bubble of air of radius 0.1mm in water if the bubble is formed 10cm below the water surface and surface tension of water is 7.27×10-2Nm-1. (Atmospheric pressure = 1.01×105 Pa.)

1. (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= KηrV, where K is a constant. Show that K is dimensionless.

(b) Write down Bernoulli’s equation for fluid flow, defining all symbols used.

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

H1 = 30.0cm

H2 = 30.0cm

Fig.2

**V1**

If the cross-sectional area of the main pipe is 5.81×10-3m2 and that of the constriction is 2.58×10-3m2, find the velocity V1 of the liquid in the main pipe.

(d) Explain the origin of the lift on an aeroplane at takeoff.

SECTION B

1. (a) Define thermal conductivity of a substance and state its units.

(b) The flux of solar energy incident on earth’s surface is 1.36×103 Wm-2

Calculate:

(i) the temperature of the surface of the sun,

(ii) the total power emitted by the sun,

(iii) the rate of loss of mass by the sun

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

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

(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.

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

(ii) Derive the relation between the principal molar heat capacities CpandCv for an ideal gas.

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

(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 no air escapes, find its temperature immediately after pulling the piston. (Take = 1.4)

(c) (i) Distinguish between un*saturated and saturated vapors.*

(ii) Draw graphs to show the relationship between pressure and temperature for an ideal gas and for saturated water vapor originally at 00C.

(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 constant, the pressure becomes 19.0 KPa. Discuss the applicability of the above results in verifying Boyle’s law.

1. (a) Explain why temperature remains constant during charge of Phase.

(b) Describe with the aid of a labeled diagram, an electric method for determination of specific latent heat of vaporization of a liquid.

(c) Water vapor 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 vapor changes with temperature and account for its main features.

(d) Calculate the work done against the atmosphere when 1kg of water turns into vapor at atmospheric pressure of 1.01×105Pa.

[Density of water = 0.598kgm-3]

SECTION C

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

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

(b)

A

K

M

C

B

1.5V

P

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

(i) Describe and explain how the current shown by the micro-ammeter, 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

(ii) The wavelength of the light was changed to 5.5×10-7m.

1. (a) What is meant by the following:

(i) an alpha particle,

(ii) radioactivity

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

Where e, is the electronic charge, ε0 is the permittivity of free space, m mass of the alpha particle and V is the initial velocity of the particle.

(c) Describe the structure and action of a cloud chamber.

(d) State four uses of radio-active isotopes.

(e) One kilogram of wood from a ship wreck has an activity of 1.2×102 counts per second due to whereas the same amount of wood had an activity of 2.0×102 counts per second.

Find the age of the ship wreck.

(Half-life of = 5.7×103 years)

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

E 0 eV

E4 -0.81 eV

E3 -2.77 eV

E2 -4.87 eV

E1 -21.47 eV

Figure 3

(ii) Figure 3 shows some of the energy levels of neon. Determine the wavelength of the radiation emitted in an electron transition from E4 to E3. In what region of the electro-magnetic spectrum does the radiation lie?

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

(c) State Bragg’s law of X-ray diffraction.

(d) A beam of X-rays of wave length 1.0×10-10m 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 10.20.

Find:

1. the spacing between consecutive planes.
2. The density of sodium Chloride.

2000.

SECTION A

1. (a) (i) State Newton’s laws of motion.

(ii) Define impulse and derive its relationship to linear momentum of the body on which it acts.

(b) A body of mass m1 and velocity u1 collides head on with a body of mass m2 having velocity u2 in the same direction as u1. Use Newton’s laws to show that the quantity m1u1 + m2u2 is conserved.

(c) A ball of mass o.5kg is allowed to drop from rest, from a point a distance of 5.0m 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?

(ii) If the collision lasts 0.01s, find the average force which the floor exerts on the ball.

1. (a) (i) State Archimedes principle.

(ii) What is simple harmonic motion?

(b) A uniform cylindrical rod of length 0.08m, cross sectional area 0.02m2 and density 900 kgm-3 floats vertically in a liquid of density 1000kgm-3. The rod id depressed through a distance of 0.005m and then released.

(i) Show that the rod performs simple harmonic motion.

(ii) Find the frequency of the resultant oscillations.

(iii) Find the velocity of the rod when it is at a distance of 0.004m above the equilibrium position.

(c)

V1

V2

Block of wood of density

Liquid of density ρ1

Liquid of density ρ2

Fig. 1

A block of wood of density ρ floats at the interface between immiscible liquids of densities ρ1 and ρ2 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

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

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

(b) (i) Define the terms time of flight and range as applied to projectiles.

(ii) A projectile is fired in air with speed with speed of Ums-1 at an angle θ to the horizontal. Find the time of flight of the projectile.

(c) State the conditions for equilibrium of a rigid body under the action of coplanar forces.

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

(i) Draw a sketch diagram to show the forces acting on the beam.

(ii) Calculate the tension in the rope.

4. (a) State Kepler’s laws of gravitation.

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

Where G is the universal gravitational constant and ME is the mass of the earth.

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

(c) A satellite of mass 100kg is in a circular orbit at height of 3.59×107m above the earth’s surface.

(i) Find the mechanical energy of the satellite.

(ii) Explain what would happen if the mechanical energy was decreased.

SECTION B

5. (a) (i) Describe Searle’s method of determining the thermal conductivity of a good conductor of heat.

(ii) Why is the method in (a)(i) best suited for a good conductor of heat ?

(b) The two ends of a metal bar of length 1.0m are perfectly lagged up to 20cm from either end. The ends of the bar are maintained at 1000C and 00C respectively.

(i) Sketch a graph of temperature versus distance along the bar

(ii) Explain the features of the graph in (b)(i).

(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 450C while the inside of the house is at 200C. If the thickness of each brick layer is 15cm and of air cavity is 5cm, calculate the temperatures of the walls in contact with the air in the cavity.

6. (a) (i) State Boyle’s Law.

(ii) What is meant by partial pressures?

Tap

A

B

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.

(b) (i) Sketch three differences between ideal gas and real gases .

(ii) Sketch a pressure versus volume curve for a real gas undergoing compression below its critical temperature.

(iii) Explain the main features of the curve.

(c) Two similar cylinders P and Q contain different gasses at the same pressure. When the gas is released from P the pressure remains constant for some time before it starts dropping. When the gas released from Q the pressure continuously drops. Explain the observation above.

(d) Using the expression for the kinetic pressure of an ideal gas, deduce the ideal gas equation if mc2 = KBT

7. (a) (i) State the desirable properties a material must have to be used as a thermometric substance.

(ii) Explain why scales of temperature based on different thermometric properties may not agree.

(b) (i) Draw a well labeled diagram to show the structure of a simple constant volume gas thermometer.

(ii) Describe how a simple constant volume gas thermometer can be used to establish a Celsius scale of temperature.

(iii) State the advantage and disadvantages of mercury in glass thermometer and constant-volume gas thermometer.

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

(d) The mean Kinetic energy of the mole of helium gas at room temperature is 3.74×103J. Calculate room temperature.

SECTION C

1. (a) State the laws of photo electric emission.

(b) (i) Describe an experiment to determine Plank’s Constant.

(ii) Violet light of wavelength 0.4µm is incident on a metal surface of threshold wavelength 0.65µm. Find the maximum speed of emitted electrons.

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

(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.

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

(ii) State the relationship between half-life and decay constant.

(b) The radio isotope decays by emission of a β- particle and γ-ray. Its half-life is 5.3 years.

(i) Find the activity of a source containing 0.10g of.

(ii) In what ways do γ-rays differ from β-particles?

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

(ii) Calculate the mass defect for, given the following information:

Mass of nucleus = 58.93488U

Mass of a proton = 1.00728U

Mass of a neutron = 1.00867U

(d) Describe the structures and action of an ionization chamber.

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

(b)

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Fig. 3

T

P

S1

Q

R

S2

+

−

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 0.6T is directed perpendicularly out of the plane of page as shown above.

(i) Calculate the velocity of the ions which go through slit S2.

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

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

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

1999.

SECTION A

1. (a) What is meant by conservative force? Give two examples.

(b) (i) Explain the terms damped and forced oscillations.

(ii) Sketch displacement-time graphs for underdamped and overdamped oscillations.

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

0.5kg

100Nm-1

50Nm-1

Fig.1

Calculate the:

(i) extension produced

(ii) Tension in each spring

(iii) energy stored in the spring

(iv) frequency of small oscillations when the mass is given a small vertical displacement.

1. (a) (i) What is meant by dimension of a physical quantity?

(ii) Define coefficient of viscosity of a liquid.

(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

, where K is a dimensional constant.

(i) Use the method of dimension to determine the values of x, y and z.

(ii) If the constant K is equal to 6π, obtain 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.

(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.

1. (a) What is meant by 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 meter rule and a retort stand and clamps. Describe how you would determine the acceleration due to gravity.

(c) A 3.0kg block is held in contact with a compressed spring of force constant 120Nm-1. The block rests on a smooth portion of a horizontal surface which is partly rough as shown in figure 2.

3.0kg

smooth

rough

120Nm-1

Fig.2

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

Calculate the:

(i) Maximum kinetic energy of the block

(ii) Compression of the spring before the block was released.

(d) (i) State Bernoulli’s principle.

(ii) An aeroplane has a wing of 40m2. At takeoff, the speeds of air above and below the wings are 120ms-1 and 100ms-1 respectively. Find the lift on the plane if the density of air is 1.3kgm-3.

1. (a) Show that the speed of an object moving in a circle of radius r, with uniform angular velocity ω is *v=rω*.

(b) A rigid body rotates about an axis with angular velocity ω. If the moment of inertia of the body about this axis is *I*, show that the rotational kinetic energy of the body is .

(c) The oxygen atoms in an oxygen molecule at S.T.P are separated by a distance of about 1.2×10-10m. The mass of an oxygen atom is 2.66×10-27kg. The mean molecular speed is 480ms-1 while its angular speed is 6.5×1012 rad s-1.

Calculate for the molecule the:

(i) moment of inertia about its center of mass.

(ii) ratio of the rotational kinetic energy to the mean translation energy.

(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 conservation of energy, the speed of the disc at the bottom of the incline if the length of the incline is *l.*

SECTION B

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

(b) The resistance of a platinum wire at the triple point of water is 5.16Ω. What will its resistance be at 1000C?

(c) Describe, with the aid of a labeled 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 7.0×108m at a temperature of 6000K, estimate the temperature of the surface of mars if its distance from the sun is 2.28×1011m.

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

(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.

(c) Use the kinetic theory of matter to explain why the specific latent heat of vaporization of water is higher at 200C than it is at boiling point.

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

(e) A volume of 4.0×10-3m3 of air is saturated with vapour at 1000C. The air is cooled to 200C at constant pressure of 1.33×105Pa. Calculate the volume of air after cooling, if the saturated vapour pressure of water at 200C is 2.3×103Pa. [Atmospheric pressure = 1.01×105Pa]

1. (a) Define *specific heat capacity.*

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

(c) In a continuous flows calorimeter for measurement of specific heat capacity of a liquid, 3.6×10-3m3 of liquid flows through the apparatus in 10 minutes. When electrical energy is supplied to heating coil at the rate of 44W, a steady difference of 4K is obtained between the temperature of the out flowing and inflowing liquid. When the flow rate is increased to 4.8×10-3m3 of liquid in 10 minutes, the electric power required to maintain the temperature differences is 58W. Find the

(i) Specific heat capacity of the liquid.

(ii) rate of loss of heat to the surroundings.

(d) Explain why the differences between the specific heat capacity at constant pressure Cp, and that at constant volume Cv, is negligible for solids but not for gases. Hence show that for one mole of gas *Cp–Cv= R.*

SECTION C

1. (a) What is meant by work function of a metal?

(b) Describe the main feature of photoelectric emission.

(c) A 100mW beam of light of wavelength 4.0×10-7m 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.

(iii) Calculate the Kinetic energy of each photoelectron if the work function of Caesuim is 2.15eV.

(d) Describe one application of a photo =cell.

1. (a) (i) Explain what is observed when a beam of α-particle is incident on a gold foil.

(ii) A beam of α-particles of energy 4.2MeV is incident normal to a good foil. What is the closest distance of approach by the α-particles to the nucleus of a gold atom? [Atomic number of gold = 79]

(b) Sate Bohr’s postulates of the hydrogen atom.

(c) The energy levels of the Hydrogen atom are given

Joules, where n takes on the values 1, 2, 3,…,…,

(i) Use this result to account for occurrence of emission and absorption line spectra.

(ii) Find the shortest wavelength of radiation which can be emitted by the hydrogen atom.

1. (a) With the aid of a labeled diagram, describe how an X-ray tube works.

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

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

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

1998.

SECTION A

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

(b) Describe how the center of gravity of a piece of cardboard having an irregular shape may be determined.

600

300

450

O

Figure 1

2.83N

6N

4N

x

y

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

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

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

Fig.2

75cm

15cm

ground

Stone

Find the least horizontal force applied through the center of drum, which will cause the drum to roll up the stone of height 15cm.

1. (a) State the laws of solid friction.

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

(c)

6.7kg

12.0kg

1.3kg

Bench

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 12.0kg mass,

(ii) tension in each string.

(d) Explain the occurrence of viscosity in gases.

1. (a) What is meant by Simple Harmonic Motion?

4kg

1.2m

1.2m

3.0m

A

B

Fig.4

(b) A body of mass 4kg rests on a smooth horizontal surface. Attached to the body are two pieces of light elastic strings each of length 1.2m and force constant 6.25Nm-1. The ends are fixed to two points A and B, 3.0m apart as shown in figure 4. The body is then filled through 0.1m towards B and then released.

(i) Show that the body will execute SHM.

(ii) Find the period of oscillation of the body.

(iii) Calculate the speed of the body when it is 0.03m from the equilibrium position.

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

(d) A car travels round a bend banked at an angle of 22.60. 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.

1. (a) (i) Distinguish between lamina and turbulent flow.

(ii) What are the origins of viscosity in liquids?

(iii) Explain the temperature dependence of viscosity of a liquid.

(b) (i) State Bernoulli’s principle.

(ii) Account for the variations of pressure and velocity of a liquid flowing in a horizontal pipe of varying diameter.

(c) (i) State Archimedes principle and use a rectangular block immersed in a liquid to illustrate it.

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

SECTION B

1. (a) Define the specific latent heat of vaporization.

(b) Describe an electrical method of determining the specific latent heat of vaporization.

(c) State any two advantages of the continuous flow method over the method of mixtures for determination of specific heat capacities of liquids.

(d) When electrical power is supplied at a rate of 12.0W to a boiling liquid, a mass of liquid 8.6×10-3 kg evaporates in 30 minutes. On reducing the power to 7.0W, 5×10-3 kg of the liquid evaporates in the same time.

(i) Specific latent heat of vaporization of the liquid.

(ii) Power loss to the surrounding

(e) Explain why evaporation causes cooling.

1. (a) Explain briefly why the center of a fire appears white.

(b) With the aid of a labeled diagram describe how the temperature of a furnace may measured.

(c) The resistance of a platinum thermometer is 5.7, 5.5 and 5.2Ω at boiling point of water, at an unknown temperature and at a freezing point of water respectively. Determine the unknown temperature on the thermodynamic scale.

(d) (i) State Stefan’s law.

(ii) Calculate the rate of loss of heat energy of a black body of area 40m2 at a temperature of 500C, if the radiation it receives from the sun is equivalent to a temperature in space of -2200C.

(e) State one effect of the following radiations on matter.

(i) X-rays

(ii) Infra-red,

(iii) Radio waves

1. (a) (i) What is meant by an ideal gas?

(ii) State three differences between a real and an ideal gas.

(iii) What is meant by kinetic theory of matter?

(iv) Describe briefly an experiment which you can carry out in support of Kinetic theory of matter.

(b) Derive the expression

For a pressure of an ideal gas of density and mean square speed, C2.

(c) An ideal gas of volume 100cm3 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.

SECTION C

1. (a) (i) What are cathode rays?

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

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

(b) (i) State Braggs law.

(ii) An X-ray tube is operated on a potential difference of 100 kV. Calculate the highest possible frequency of the protons.

(c) (i) With the aid of a labeled diagram, describe the operation of a Geiger-Muller tube.

(ii) State briefly the steps taken to measure activity of a source using the Geiger Muller tube.

1. (a) Define the following terms:

(i) nuclear binding energy

(ii) isotopes

(iii) unified atomic mass unit.

(b) Calculate the binding energy per nucleon for

[ Mass of: :

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

(ii) The silver isotope has a half-life of 2.4min.

Initially a sample contains 2.0×106 nuclei of

Find the number of radio-active nuclei left after 1.2min. Assume *N=N0e-λt*

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

(ii) List two hazards caused by radiations.

1. (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 484nm if the work function of caesium is 3×10-19J.

(d) A charged oil drop of radius 7.26×10-7n and of density 88okg m-3 is held stationary in an electric field of intensity 1.72×104 Vm-1 .

How many electronic charges are on the drop?

[Density of air = 1.29kg m-3]

1998.

SECTION A

1. (a) (i) What is meant by scalar and vector quantity?
2. Identify scalar and vector quantities from the following:

Momentum, density, acceleration, impulse, pressure and temperature.

(b) (i) What is meant by uniformly accelerated motion?

(ii) Sketch speed-time and distance time graphs for a body moving with uniform acceleration.

(c) A ball is kicked from a spot 30m from the goal posts with a velocity of 20ms-1 at 300 to the horizontal. The ball just clears the horizontal bar of the goal posts. Find

(i) the height of the goal posts

(ii) the time of flight

1. How far behind the goal posts the ball lands.
2. (a) (i) State Newton’s laws of motion.

(ii) Define linear momentum and state the laws of conservation of linear momentum.

(b) A truck of mass 104kg moving at 10ms-1 rams into a truck of mass 4×103kg 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 coefficient of kinetic friction is 0.25.

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

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

Sphere

10cm

15cm

1. Copy the diagram and show the forces acting on the sphere.
2. Calculate the reaction on the sphere due to the wall.
3. Find the tension in the string.
4. (a) (i) State Newton’s law of gravitation and decide the dimensions of the 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’s radius is 0.27 and that of the moon’s mass is 1.2×10-2?

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

(b) A 103kg 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.

1. (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 steel wire of length 1.6m and diameter 1.0mm, while the other end is fixed. The length of the copper wire is 0.80m while its diameter is 0.5mm. A load of 10kg 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 = 1.0×1011 Nm-2

Young’s Modulus for steel = 2.0×1011 Nm-2 ]

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

SECTION B

1. (a) What assumptions are necessary in the derivations of kinetic theory expression for the pressure of an ideal gas?

(b) A beam of 2×1011 nitrogen atoms, each of mass 2.32×10-26kg is incident normally on a wall of a cubical container of edge 10.0cm. The beam is reflected through 1800. 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 pressure.

(ii) Two containers A and B of volumes 3×103 cm3 and 6×103cm3 respectively contain Helium gas at a pressure of 1.0×103Pa and temperature 300K. Container A is heated to 373K while container B is cooled to 273K. Find the final pressure of the helium gas.

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

1. (a) Show that the work done by an ideal gas in expanding from a volume V1 to a volume V2 x is equal to where P denotes pressure and V the volume.

(b) State the conditions required to effect the following processes

(i) Isothermal process

(ii) Adiabatic process

(c) A fire extinguisher is filled with 1.0kg of compressed nitrogen gas at a pressure of 1.2×106 Pa and a temperature of 200C. If the gas escapes by expanding adiabatically to a pressure of 1.0×105 Pa when the nozzle of the fire extinguisher is opened. Find the

(i) original volume of the gas

(ii) temperature of the expanded gas.

[Take γ= = 1.4]

(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 is results in cooling.

1. (a) (i) Define thermal conductivity.

(ii) Explain the mechanism of heat transfer by conduction.

(b) A wall 6m × 3m consists of two layers A and B of bricks of thermal conductivities 0.6 Wm-1 K-1 and 0.5Wm-1 K-1 respectively. The thickness of each layer is 15.0cm. The inner surface of layer A is at a temperature of 200C while the outer layer of B is at a temperature of 100C. Calculate the

(i) temperature of the interface of A and B

(ii) rate of heat flow through the wall.

(c) Sate the Stefan-Boltzmann law of blackbody radiation.

(d) Consider the sun to be a sphere of radius 7.0×108m whose surface temperature is 5900K.

(i) Find the solar power incident on an area of 1m2 at the top of the Earth’s atmosphere if this is a distance of 1.5×1011m, from the sun. Assume that the sun radiates as a black body.

(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 warming.

SECTION C

1. (a) A high p.d is applied across two electrodes in air conditioned in a closed glass tube. Describe with the aid of labeled 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 3.27×10-15kg is held stationary between two horizontal metal plates across which a p.d of 1.0×103 V is applied. If the separation of the plates is 1.5cm, find the number of electrons on the drop.

(d) With the aid of a labeled diagram describe the principle of operation of an ionization chamber.

1. (a) Draw a well labeled diagram to show the main parts of an X-ray tube.

(b) Describe the energy changes which occur in an X-ray tube in operation.

(c) Explain the production of the following spectra in an X-ray tube

(i) continuous spectrum

(ii) line spectrum

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

(e) A monochromatic beam of X-rays of wavelength 2.0×10-10m is incident on a set of cubic planes in a potassium chloride crystal. First order diffraction maxima are observed at a glancing angle of 18.50. Find the density of potassium chloride if its molecular weight is 75.55.

1. (a) (i) What is meant by nuclear binding energy?

(ii) Calculate the binding energy per nucleon of an α-particle, expressing your result in MeV.

Mass of a proton = 1.0080μ

Mass of a neutron = 1.0087μ

Mass of an α-particle = 4.0026μ

[ μ = 931 MeV]

(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.

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

T =

(c) When decays, the end product is . The half life is 1.4×1017s. Suppose a rock sample contains and in the ratio 1:5 by weight, calculate the

(i) number of atoms in 1.-g of the rock sample.

(ii) age of the rock.

[Assume the radioactive decay law N=Noe-λt]

**1997.**

1 a) I) What is meant by *dimensions of physical quantity?*

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 = , show that the formula is dimensionally consistent.

b) i) State the principle of moments

ii) Explain why it is necessary for a bicycle rider moving around a circular path to lean towards the centre of of the path.

iii) Derive the expression for angle of inclination to the horizontal necessary for a rider moving around a circular track of radius, r without skidding at a speed V, in terms of R,r and V.

c) i) What is meant by parking orbit of a satellite?

ii) Calculate the radius of parking orbit for an earth satellite.

2 a) Define the term momentum

b) A bullet of mass 300 g travelling horizontally at a speed of 8ms-1 hits a body of mass 450 g moving in the same direction as the bullet at 1.5 ms-1. The bullet and body move together after collision. Find the loss in kinetic energy.

c) i) State the work energy theorem.

ii) A ball of mass 500g travelling at a speed of 10ms-1 hits at 600 to the horizontal strikes a vertical wall and rebounds with the same speed at 1200 from the original direction. If the ball is in contact with the wall for 8 X 10-3 s. calculate the average force exerted by the ball.

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. a) A mass hanging on a spring is given a small vertical displacement and then released.

i) Show that the mass performs simple harmonic motion.

ii) Discuss briefly the energy transformations which occur as the mass oscillates

iii) Explain why the oscillation ultimately die down.

b) A mass of 0.2 kg is put on a scale pan of negligible mass hanging on a spring of constant 40 Nm-1. The mass is then depressed 3 cm below the equilibrium position and released. Calculate the:

i) Frequency of the oscillations

ii) Velocity of the mass when it is 1 cm above the equilibrium position.

iii) Maximum amplitude of oscillation for the 0.2 kg mass to stay in contact with the pan throughout.

4) a) Explain why large mercury drops tend to flatten out whereas small drops assume spherical shapes.

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 of the soap solution.

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 2.5 X 10-2. Calculate the excess pressure inside the resulting soap bubble.

c) Explain why raindrops hit the group with less force than they should.

5) a) Define *specific heat capacity* and state its units.

b) i) With the aid of a labelled diagram, describe, describe how the specific

Heat capacity of water can be measured by the continuous flow method.

ii) State the advantages of this method.

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

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 140C. what will it be if the temperature is raised to 400C and atmospheric pressure remains constant at 760 mm of mercury?

( Saturated Vapour Pressure of water at 140C and 400C is 10.5 mm and 49.5 mm of mercury respectively)

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.

b) A vessel containing 1.5 X 10-3 m3 of an ideal gas at a pressure of 8.7 X 10-3 Pa and a temperature 250C 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 = 1.41).

ii) Sketch the p – V graph for the whole process.

iii) Calculate work done during the Isothermal Process.

c) Use the kinetic theory to account for the increase in pressure of a gas when its temperature is increased at constant volume.

7. a) Describe how heat transfer by conduction takes place.

b) i) A well constant of two layers of thicknesses L1 and L2 and thermal conductivities

k1 and K2 respectively. If the surface of the wall are maintained at temperature T1 and T2 respectively. Show that the rate of heat transfer through the wall

where A, is the area of the surface of the wall.

ii) State the assumption made in b(i)

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 aluminum and brass are240 Wm-1k-1 and 112 Wm-1k-1 respectively)

b) i) state Newton’s law of cooling.

ii) Describe an experiment to verify Newton’s law of cooling.

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

SECTION C

8. a) i) Describe briefly the steps involved in the determination of the charge of an

electron by Millikan’s oil drop experiment.

ii) A spherical oil drop of radius 2.0 x 10-6 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 kgm-3.

b) With the aid of a labeled diagram. Describe and give the theory of a mass spectrometer for measuring the charge to mass ratio of positive ions.

c) A stream of singly ionized magnesium atoms is accelerated through a p.d of 50 V and then enters a region of uniform magnetic field of flux density 2.08 x 10-1T. 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.

ii) How do X-rays differ from - particles?

iii) Distinguish between X-ray production and the photoelectric effect.

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

i) prominent lines.

ii) minimum wavelength.

c) Describe briefly the Bragg diffraction of X-rays by crystals and derive the Bragg’s law.

d) A second order diffraction of X-rays at atomic planes a crystal for a glazing angle of 11024’

Calculate the atomic spacing of the planes if the wavelength of X-rays is 4.0 x 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 = A0 )

c) i) Draw the current voltage characteristic for a Geiger- Muller tube.

ii) Identify giving reasons, the part of the characteristic over which the tube is normally operated.

d) What is binding energy of nucleus?

c) Consider the reaction below:

a + + 3 + Energy.

i) find the values of x and y.

ii) Calculate the energy released by one mole of in the above reaction.

iii) Explain why neutrons are preferred to charged for inducing nuclear reactions.

**1996**

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,theacceleration due to gravity