SENIOR SIX

PHYSICS PAPER ONE

P510/1

ASSUME WHERE NECESSARY

Acceleration due to gravity, g	=	$9.81ms^{-2}$
Electron charge ,e	=	$1.6 \times 10^{-19}C$
Stefan's constant, δ	=	$5.7 \times 10^{-8}Wm^{-2}T^{-4}$
Speed of light in vacuum, c	=	$3 \times 10\ 8ms^{-1}$
Universal gas constant, R	=	$8.314Jmol^{-1}k^{-1}$
Radius of the earth	=	$6.4 \times 10^{6}m$
Specific heat capacity of water	=	$4.2 \times 10^{3}Jkg^{-1}k^{-1}$
Planck's constant, h	=	$6.63 \times 10^{-34}Js$
Charge to mass ratio , e/m	=	$1.8 \times 10^{11}Ckg^{-1}$
Avagadro's number, NA	=	$6.02 \times 10^{23}Jmol^{-1}$

Gravitation constant ,G = $6.67 \times 10^{-11}Nmkg^{-2}$

Mass of the earth = $6 \times 10^{24}kg$

1 a(i) State the principle of conservation of linear momentum. (01)

b) A particle **P** of mass ***m1*** moving with a speed u_1 collides head on with a stationary

particle **Q** of mass m_2. If the collision is elastic and the speeds of **P** and **Q** immediately after

collision are V_2 and V_2 respectively, show that for $= 1/2$,

i) $u_1/V_2 = 1/2\ 1+\alpha$ (05)

ii) Particle Q gains $\frac{}{+\ ^2}$ of the total energy of the system.

(03)

c) A bullet of mass ***10g*** fired at short range embeds itself into a block of wood of mass

1.99 x10^{3}kg suspended from a fixed support by means of two inelastic strings each

Of length 1m. Given that the block together with the bullet undergo an angular

displacement of 60^0, Calculate the initial velocity of the bullet.
(05)

d) Show that the speed V of a body moving round a circular track of radius ***r*** with angular

velocity ***w*** is given by ***.***
(03)

e) 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 30^0 to the vertical.

Calculate the tension in the string.
(03)

2 a(i) Define the tem ***power*** and ***work.***
(02)

i) Derive the dimensions of the quantities defined in a(i) above.
(04)

b) An elevator has a mass of ***1000kg*** and can carry a maximum load of ***800kg.*** A constant

frictional force of ***4000N*** retards the motion of the elevator upwards. Calculate

i) the minimum power required to lift the elevator at a constant speed of ***3.0ms^{-1}***. (03)

ii) the average power required to bring the loaded elevator to a constant speed of $6.0ms^{-1}$

if its acceleration is constant at ***1.0ms^{-2}***.
(04)

iii) What power is the motor running the lift delivering at the instant the speed is ***6.0ms^{-1}***

the acceleration is ***1.0ms^{-2}*** ?
(02)

c) A body of mass ***50g*** falls from a height of ***30cm*** onto a horizontal surface and

rebounds to a height of ***20cm.*** If the time of contact of the body and the

horizontal surface was 0***.05s,*** calculate the average force exerted by the body

on the horizontal surface.
(05)

3 a) State Newton's laws of motion.
(03)

b) An object is suspended from one end of a spring balance whose other end is

fixed from the roof of a lift. The balance reads 29.4N when the lift is ascending

and 19.6N when the lift is descending as observed by a person riding in the lift.

i) Explain the differences in the readings.
(03)

ii) Find the acceleration of the lift.
(03)

iii) What will be the reading in each case if the observer in the lift uses a beam balance

to determine the mass of the object ?
(03)

c) A projectile of mass mkg is fired at an angle of 60^0c to the horizontal with a

speed of 400ms^{-1} at the highest point of the trajectory the projectile explodes

into two fragments of equal mass , one of which falls vertically. How far from the

point of projection does the other fragment strike the horizontal plane through

the point of projection?
(08

4 a) (i) Define the terms *work, power* and *energy*.
(03)

(ii) Derive an expression for the work – energy theorem.
(03)

b) A loaded box of mass 2000kg is placed on top of a plane inclined at an

angle of 30^0 to the horizontal. If the body is released use the work-energy

theorem to find the velocity after travelling 15m down the plane given

that the coefficient of kinetic friction between the box and the plane is 0.3. (04)

c (i) State Newton's law of gravitation and deduce the dimensions of the

gravitation constant G. (03)

ii) Show that the acceleration due to gravity on a body below the earth's is

directly proportional to the distance of the body from the centre of the

earth. (04)

d) A satellite of mass 1000kg is launched in a circular orbit at a height of

3.6 x10^7m above the earth's surface . Calculate the period of the satellite. (03)

5 a) Define the term angular velocity. (01)

b) A car of mass m travels round a circular track of radius ***r*** with a velocity

V.

i) Draw a sketch diagram showing the forces acting on the car. (02)

ii) Show that the car does not overturn if $V^2 < {arg}/{2h}$, where a is the

distance between the tyres (wheels), h is the height of the centre of

gravity above the ground and g is the acceleration due to gravity. (05)

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

making an angle 60^0 to the horizontal. Calculate

i) the tension in the string. (02)

ii) the period of motion. (04)

d(i) Define centripetal acceleration. (01)

ii) Derive an expression for the force F on a particle of mass m moving with

speed V in a circle of radius r. (05)

6 a (i) State the law of floatation. (01)

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

b (i) A block of mass 0.1kg is suspended from a spring balance. When the block is immersed in water, the spring balance reads 0.63N. When the block is immersed in a liquid of unknown density, the spring balance reads 0.70N. Find ,

i) the density of the solid. (04)

ii) the density of the liquid. (03)

c) Explain the

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

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

7 a) Define surface tension and derive its dimensions. (03)

b) Explain using the molecular theory the occurrence of surface tension. (04)

c(i) A soap bubble of radius r_1 collides with another soap bubble of radius r_2 .

Show that the radius r of curvature of the common interface is given by

r = $\frac{r_1 r_2}{r_2 - r_1}$ where $r_2 > r_1$ (05)

ii) An air bubble radius 0.1mm is at a depth of 15.0 m below the surface of

water . Calculate the total pressure inside the bubble that atmospheric

pressure is $1.01 \ x \ 10^5 \ Pa.$

(04)

d) A soap bubble of radius 3cm and another of radius of radius 4cm

coalesce under isothermal conditions to form . Calculate the radius of

the resultant bubble formed.

(04)

8 a (i) What do you understand by an ideal gas? (01)

ii) A State the ideal gas laws and use them to deduce the equation of state

(05)

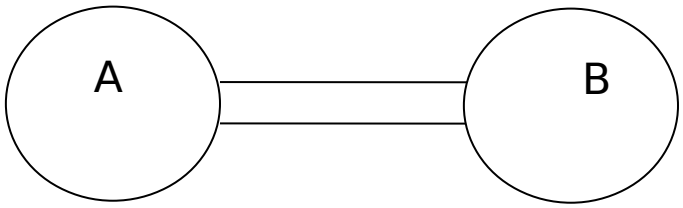
b) Two vessels A and B of equal volume are connected by a narrow tube of

negligible volume . Initially the whole system is filled with 3g of dry air at

a pressure of 1 x 10^5pa and a temperature of 300K. The temperature of

vessel B is then raised to 600K while the temperature of a is kept

constant at 300k.



Find the

i) new pressure in the system. (04)

ii) mass of air in each vessel.
(03)

c) A cubical container of volume 0.1m^3 contains Uranium hexafluoride gas

at a pressure of 1 x 106Pa and a temperature of 300K. Assuming the gas

is ideal, determine

i) the number of moles of gas present.
(03)

ii) the mass of gas present given that the relative molecular mass of

Uranium hexafluoride is 352. (02)

iii) the density of Uranium hexafluoride .
(02)

9 a (i) State Prevost theory of heat exchanges
(01)

ii) A copper sphere of mass 500g and temperature 100^0c is suspended in an

enclosure at a temperature 20^0c. What is the initial rate of heat loss of

the sphere given that the density of copper is $1.01\ x\ 10^5\ Pa$

(05)

b) State Stefan's law of black body radiation.
(01)

c) The flux of solar energy incident on the surface of the earth is

$1.36\ x\ 10^3 Wm^{-2}$

10 a (i) With reference to a constant volume gas thermometer define the Celsius

scale of temperature. (01)

ii) when a particular temperature is measured on a scale based different

properties, it is found to agree only at two points. Explain why this is so

and name the temperatures.
(04)

b) In a constant volume gas thermometer, the following observations were

recorded on a day when the barometric reading was 760mmHg.

	Reading in closed limb(mm)	Reading in closed limb(mm)
Bulb in melting Ice	130	116

Bulb in steam	130	394
Bulb at room temperature	130	161

i) State the thermometric property of the thermometer.
(01)

ii) Calculate the room temperature.
(04)

c (i) State the conditions necessary to achieve a reversible isothermal change and a reversible adiabatic change.
(04)

ii) A cylinder with a piston contains 0.5moles of oxygen at 2×10^5Pa at 300K.The gas first expands at a constant pressure thrice its original volume. It is then compressed isothermally back to its original volume and finally it is cooled at constant volume to its original pressure. Show this on a P-V diagram and calculate the work during the cycle.
(06)

11. a) Define ***specific heat capacity*** (s.h.c) of a substance and state its s.I unit . (02)

b(i) Describe with the aid of a labeled diagram how the s.h.c of a metal can be determined using an electrical method .
(06)

ii) When a block of metal of mass ***o.11kg*** and s.h.c ***400Jkg^{-1}K^{-1}*** is heated to ***100^{0}C*** and quickly transferred to a calorimeter containing ***0.2kg*** of liquid at ***10^{0}C***, the resulting

temperature is ***18^{0}C.*** On repeating the experiment with ***0.4kg*** of liquid in the same

container at the same initial temperature of ***10^{0}c,*** the resulting temperature is ***14.5^{0}c***.

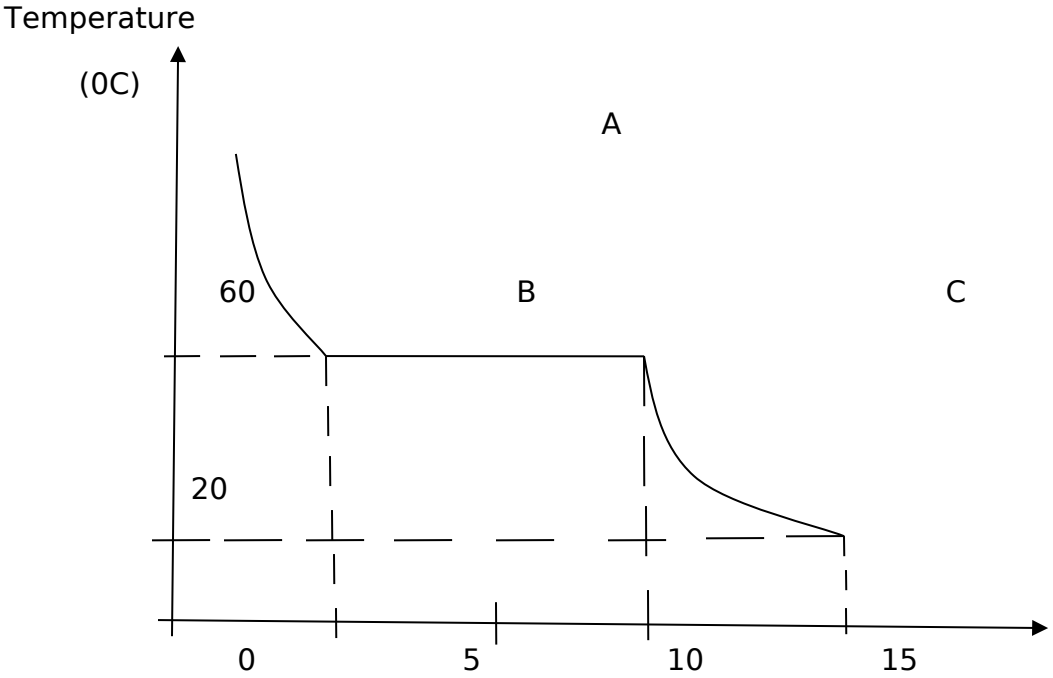
Calculate the s.h.c of the liquid and the heat capacity of the container . (04)

c(i) State ***Newton's law of cooling***. (01)

ii) State any ***two*** factors which affect the rate of cooling of a body. (02)

d) The figure below shows a cooling curve for a substance which starting as a liquid eventually

solidifies.



Additional data:- Room temperature = 20^{0}C

-Mass of liquid = 1.5 x 10 $^{-2}$ Kg

-S.h.c of the liquid = 2000Jkg^{-1}K^{-1}

-slope of tangent to the curve when temperature is 70^{0}C = 10^{0}Cmin^{-1}.

Assuming Newton's law of cooling, Calculate the specific latent heat of fusion of the liquid.

(06)

12. a(i) What is a photon? (01)

ii) Explain using the quantum theory the experimental observations on photo electric effect

(06)

iii) When light of wavelength 450nm falls on certain metal surface and electrons of maximum kinetic energy 0.76eV are emitted . Find the threshold frequency for the metal.

(04)

b) Explain using suitable sketch graphs how x-ray spectra in an x-ray tube are formed.

(06)

c) A beam of X-ray of wavelength 8.42×10^{-11} is incident on a sodium chloride crystal of interplanal separation 2.82 x 10-10m. Calculate the second order diffraction angle. (03)

END.