**KING’S COLLEGE, BUDO**

**PHYSICS DEPARTMENT**

S 5 END OF YEAR EXAMINATION

November 2008

**Paper 1**

**2 hrs 45 min**

This paper consists of seven questions

Attempt **FIVE** questions only.

***Indicate the questions attempted in the following table, preferably in same order as you answered them.***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Questions Attempted |  |  |  |  |  |
| Marks obtained |  |  |  |  |  |

Where necessary, use the following constants:

Gravitational acceleration, g = 9.8 ms-2

Gas constant, R = 8.31 J mol-1K-1

Specific heat capacity of water = 4200 Jkg-1K-1

Stefan’s constant, σ = 5.7 x 10-8 W m-2 K-4

Density of water = 1000 kg m-3

**SECTION A**

**1**. (a) (i) What is meant by the ***dimensions*** of a physical quantity? (1)

(ii) State one use of dimensions (1)

(iii) For a bubble of radius r formed in a liquid of surface tension the force, F, acting in one direction at a point where the pressure is p, is given by

F = 2r + rxp

Find the dimensions of  and the value of x (2)

(b) (i) Define the coefficient of surface tension. (1)

(ii) Lycopodium powder is sprinkled over the surface of water in a dish. A small drop of soap solution is then introduced at the centre of the surface.

Explain what is observed on the surface. (3)

(c) (i) Describe an experiment to investigate the effect of temperature on surface tension of a liquid. (6)

(ii) What is the conclusion in the above experiment? (1)

(d) (i) State the law of floatation. (1)

(ii) A hydrometer floats in pure water with a volume V submerged. When in a liquid of density ρ, it floats with the liquid level at a distance X above the water mark. If the stem has a uniform cross sectional area φ, derive an expression for X in terms of V, ρ, and φ. (4)

**2.** (a) What is meant by

(i) Displacement (1)

(ii) Uniform acceleration (1)

(b) A particle is projected with a velocity u at an angle θ to the horizontal. Derive an expression for its horizontal range. (3)

(c) Two enemy artillery guns P and Q are 4 km apart. P fires a shell at 200 ms-1 while Q fires one at 240 ms-1, each to destroy the enemy gun. If the shells are fired simultaneously and each gun is successfully hit, find

(i) the angle of projection of each shell (3)

(ii) when one is hit, the time that elapses before the other is hit (3)

(iii) the horizontal distance moved by each shell by the time one shell is vertically above the other. (4)

(d) A cyclist riding at 18 kmh-1 passes a car at X just as the car begins to move in the same direction. The car maintains an acceleration of 0.4 ms-2 for 20 s, and then moves uniformly. If the car catches up with the cyclist at Y, find

(i) the time taken between X and Y (3)

(ii) the distance XY (2)

**3.** (a) (i) State the principle of conservation of momentum (1)

(ii) Show how Newton’s laws of motion may be used to arrive at the principle of conservation of momentum. (5)

(b) A sphere of mass 2 kg moving with a velocity of 3 ms-1 impinges directly on another of mass 1 kg moving at 2 ms-1 in the opposite direction. If the coefficient of restitution is 0.5, determine the velocity of each sphere just after impact. (5)

(c) A

P

1 kg

B

2kg

30o

The figure shows a block A of mass 1 kg resting on a horizontal plane. Another block B of mass 2 kg on a plane inclined at an angle of 30o to the horizontal is connected to A by a string passing over a smooth pulley P. All the parts of the string are parallel to the respective plane. The coefficient of friction at each point of contact is 0.3. Find

(i) the acceleration of the blocks (6)

(ii) the tension in the string (3)

**SECTION B**

**4.** (a) (i) Define a **thermometric property** and give two examples. (2)

(ii) Mention the steps involved in establishing a temperature scale. (2)

(iii) State the advantages and disadvantages a thermocouple thermometer has compared to a platinum-resistance one. (3)

(b) Describe how the temperature of a liquid bath may be measured using a platinum resistance thermometer. (A diagram may be optional) (4)

(c) (i) With reference to constant-volume gas thermometer define temperature on the Celsius scale. (2)

(ii) The resistance Rθ of platinum varies with temperature θoC as measured by a constant-volume gas thermometer according to the equation

Rθ = Ro(1 + 8000θθ2)

where is a constant. Calculate the temperature on the platinum scale corresponding to 300oC on this gas scale. (5)

(ii) Explain why the two thermometers do not agree exactly. (2)

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

(ii) State the advantages of the continuous flow method over the method of mixtures in determination of specific heat capacity of a liquid. (3)

(b) In a continuous flow experiment on a liquid of specific heat capacity 4200 Jkg-1K-1 the following results were obtained:

|  |  |  |
| --- | --- | --- |
| Ammeter reading/A | Voltmeter reading/V | Mass of liquid collected per min/g |
| 2.00 | 25.2 | 75.0 |
| 2.52 | 30.0 | 115.9 |

If the inflow temperature was 15oC find

(i) the outflow temperature (4)

(ii) the rate of heat loss (3)

(c) (i) Describe an electrical method for determination of the specific heat capacity of a metal. (6)

(ii) State the assumptions made in the above experiment (2)

(iii) Comment about the accuracy of the results of the experiment in (c) (i) above. (1)

**6.** (a) Define thermal conductivity of a material. (1)

(b) (i) Using molecular theory of matter, explain the mechanism of heat energy transfer in insulators. (3)

(ii) Briefly account for the fact that metals are better conductors of heat than insulators. (3)

(c) The ground floor of a house has an area of 50 m2. The floor is fitted with a carpet 15 mm thick which completely covers the floor. The carpet rests on a layer of concrete 200 mm thick. The top surface of the carpet has a temperature of 15oC and the lower surface of the concrete has a temperature of 10oC.

Thermal conductivity of concrete = 0.75 Wm-1K-1.

Thermal conductivity of the carpet material = 0.06 Wm-1K-1

Calculate

(i) the temperature of the carpet-concrete boundary. (4)

(ii) the rate heat flow through the concrete. (2)

(d) (i) What is meant by a black body? (1)

(ii) A solid copper sphere of diameter 2.0 cm and temperature of 17oC is placed in an enclosure maintained at a temperature of 127oC. Calculate, stating any assumptions made, the initial rate of temperature rise of the sphere. (6)

(Density of copper = 8900 kg m-3, specific heat capacity of copper = 370 J kg-1K-1)

**7.** (a) (i) What is an ideal gas? (1)

(ii) Derive an expression for the ideal gas equation. (5)

(b) 0.16 kg of an ideal gas is confined in a container of volume 0.1 m3 at a temperature of 47oC. If the relative molecular mass of the gas is 32, calculate the pressure exerted by the gas. (5)

(c) State and explain the conditions of an isothermal process. (3)

(d) A gas at a pressure of 1.0 x 105 Pa is compressed adiabatically to half its volume and then allowed to expand isothermally to its original volume.

(i) Sketch the P-V graph for the whole process. (1)

(ii) Find the final pressure of the gas (5)

(Take the ratio of the molar heat capacities Cp/Cv = 1.4)