JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATION 2012/2013

1ST YEAR 1ST SEMESTER EXAMINATION FOR BACHELOR OF EDUCATION SCIENCE

(REGULAR)

COURSE CODE: SPH 1O4

TITLE: THERMAL PHYSICS

DATE: 23/4/2013 **TIME: 14.00-16.00PM**

DURATION: 2 HOURS

INSTRUCTIONS

1. **Answer ALL questions in Section A**
2. **Answer ANY two Questions from Section B**
3. **Use illustrations where possible**

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QUESTION ONE: (COMPULSORY) (30 MARKS)

(a) Explain the *zeroth law* of thermodynamics (2mks)

(b) The temperature difference between the inside and the outside of a room is 67.0^oF. Express this temperature difference on the:

(i) Celsius scale. (3mks)

(ii) Kelvin scale. (2mks)

(c) Rectangular cross-section of aluminium plate of dimension 405 cm x 275 cm is subjected to temperature change from -35^oC to 67^oC. How much will its cross-section area change? (Take coefficient of linear expansion of aluminium, $\alpha = 2.4 \times 10^{-5}\ {}^oC^{-1}$) (4mks)

(d) What do you understand by the following *terms*?

(i) Calorimetry (1mk)

(ii) Phase change (1mk)

(iii) Specific latent heat of vapourisation (1mk)

(e) A 7.00-g lead bullet traveling at 350 m/s is stopped by a large tree. If half the kinetic energy of the bullet is transformed into internal energy and remains with the bullet while the other half is transmitted to the tree, what is the increase in temperature of the bullet? (4mks)

(f) *Explain* the following terms as used in thermal physics:

(i) Black body radiator (2mks)

(ii) Luminosity (2mks)

(iii) Thermal equilibrium (2mks)

(g) The surface of a spherical black body radiator is 2800K. Taking the radius of the black body to be 3.85×10^8 m, calculate the total energy radiated by the black body each second. (Take Stefan-Boltzmann's constant, $\sigma = 5.67 \times 10^{-8} W/m^2/K^4$) (4mks)

(h) Distinguish between *extensive* parameters and *intensive* parameters. (2mks)

QUESTION TWO: (20 MARKS)

(a) Explain the *first law of thermodynamics.* (2mks)

(b) 5 kg of O_2 occupy a volume of 10 m^3 at 300 K. Find the work necessary to halve the volume;

(i) at constant pressure, (4mks)

(ii) at constant temperature. (4mks)

(iii)What is the temperature at the end of process (i)? (3mks)

(iv) What is the pressure at the end of process (ii)? (3mks)

(v) Find also the energy exchanged as heat and the change of internal energy in both cases. (4mks)

QUESTION THREE: (20 MARKS)

(a) What is *ideal gas*? (1mk)

(b) What is the volume occupied by 1 mole of an ideal gas at 0°C and 1 atm pressure? (1 atm pressure=$1.013x10^5$Pa and Universal gas constant, R=8.31 J/mol K) (4mks)

(c) Gas is confined in a tank at a pressure of 10 atm and a temperature of 15°C. If half of the gas is withdrawn and it is raised to 65°C, what is the new pressure in the tank? (5mks)

(d) (i) What is the total random kinetic energy of all the molecules in 1 mole of H_2 at T =300 K? (Avagandro's number, N_A=$6.02x10^{23}$ and Boltzmann's constant, K_B=$1.38x10^{-23}$J/K) (5mks)

(ii) With what speed would a mole of H_2 have to move so that the translational KE of the whole mass would be equal to the random (thermal) KE of its molecules? (Mass per mole of H_2, M=$2.02x10^{-3}$kg and Universal gas constant, R=8.31J/mol K) (5mks)

QUESTION FOUR: (20 MARKS)

(a) Two spheres are made of the same metal and have the same radius, but one is hollow and the other is solid. The spheres are taken through the same temperature increase.

(i) Which sphere expands more and why? (2mks)

(ii) What happens to the hole? Explain. (2mks)

(b) A cylindrical brass sleeve is to be shrink-fitted over a brass shaft whose diameter is 3.212cm at 0°C. The inner diameter of the sleeve is 3.196 cm at 0°C. To what temperature must the sleeve be heated before it will slip over the shaft? (Coefficient of linear expansion of brass, $\alpha = 1.9x10^{-5}\ {}^oC^{-1}$) (4mks)

(c) A steam pipe is covered with 2.50-cm thick insulating material of thermal conductivity 0.500 cal/cm^{o}Cs. The pipe has a circumference of 900 cm and a length of 70.0 m. Neglect losses through the end of the pipe.

(i) How much energy is lost every second when the steam is at 250^{o}C and the surrounding air is at 25.0^{o}C? (5mks)

(ii) Calculate the pipes' thermal resistivity, R. (2mks)

(iii) Calculate the amount of heat energy lost after 1.5 hours. (3mks)

(iii) What amount of heat energy would be lost if the thickness of insulating material were to be doubled under the same temperature variations as in (i)? (2mks)

QUESTION FIVE: (20 MARKS)

(a) Give one condition necessary for heat energy to be transferred from one point to another.

(1mk)

(b) A 0.40-kg iron horse shoe that is initially at 500^{o}C is dropped into a bucket 20 kg of water at 22^{o}C. What is the final equilibrium temperature? Neglect any energy transfer to or from the surroundings. (Specific heat capacity of iron and water are 448J/kg ^{o}C and 4186 J/kg ^{o}C respectively)
(4mks)

(c) A 3.00-gm lead bullet at 30.0^{o}C is fired at a speed of 240 m/s into a large block of ice at 0^{o}C, in which it embeds itself. What quantity of ice melts? (Take: specific latent heat of fusion of water, L_f = 3.33x10^{5} J/kg and specific heat capacity of lead c_b = 128 J/kg^{o}C).
(6mks)

(d) The pressure in a constant-volume thermometer is 0.700 atm at 100°C and 0.512 atm at 0^{o} C. What is the temperature:

(i) When the pressure is 0.0400 atm? (3mks)

(ii) What is the pressure at 450 ^{o} C? (3mks)

(e) Explain the following walls of envelop in a thermodynamic system:

(i) Rigid wall (1mk)

(ii) Impermeable wall (1mk)

(iii) Adiabatic wall (1mk)