MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION SCIENCE

BACHELOR OF MATHEMATICS

SPH 203: THERMAL PHYSICS 1

DATE:14/12/2017 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

Answer question one and any other two questions

Useful information

At s.t.p temperature is 273.15 K and pressure is 1 atm1.01325 x$10^5 pa$, linear thermal coefficient of expansion of steel α is 1.2 x $10^{-6}℃^{-1}$ and volume thermal coefficient of gasoline $\beta = 9.5\ x\ ℃^{-1}$, Stefan-Boltzmann σ = 5.67 x 10-8 W.$m^{-2}K^{-4}$, Wien's constant W = 2897 μm K

QUESTION ONE

a) Distinguish between macroscopic and microscopic quantities (2 marks)

b) Give an example in real life situation that exhibits the Zeroth law of thermodynamics (4 marks)

c) Write down three quantities that describe macroscopic state of a system (3 marks)

d) Explain how the absolute zero temperature -273.15 ℃ is determined (3 marks)

e) An aluminium sphere of radius 4 cm is initially at a temperature 18 ℃ and it is heated such that its diameter increases by 0.2 mm. Find the final temperature attained by the sphere. (4 marks)

f) An automobile has a 60 liter steel tank. The tank is filled with gasoline at 35 ℃. If the automobile is then parked in a cold place until the tank temperature is 7 ℃, what happens to the gasoline in the tank. Does it spill or does the level fall and by how much (4 marks)

g) The maximum wavelength as measured from a terrestrial star A is 569 nm. The temperature of another star B is twice as large as that of star A. What is its temperature (4 marks)

h) State the Zeroth law of thermodynamics (2 marks)

i) A house is constructed of concrete wall 0.5 m thick. If the exterior temperature is 45 ℃ and the interior is 19 ℃. Find the energy transferred through the wall of dimensions 6 m by 3 m in two hours? (4 marks)

QUESTION TWO

a) Consider a rectangular box of volume *V* with *N* molecules, each of mass *m* and having a speed *v* parallel to y axis, show that

i) The total change in momentum (Δp) of the molecules when they strike the face perpendicular to y axis is given by $\Delta p = \frac{N}{V}\, mv_y^2 A\Delta t$ (where Δt- is time interval) (5 marks)

ii) Pressure exerted by the molecules on this face is $P = \frac{N}{V} mv_y^2$ (2 marks)

iii) $PV = 2N(\frac{1}{2}\, mv_{av}^2)$ where v_{av} (2 marks)

iv) Average kinetic energy associated with motion along the x-axis is $K.E = \frac{1}{2}\, kT$ (4 marks)

v) The total translational K.E of *n* moles of gas containing *N* molecules is $(K.E)_{trans} = \frac{3}{2}\, nRT$ (3 marks)

vi) Hence compute root mean square speed (*rms)* speed (4 marks)

QUESTION THREE

a) Derive $PV = kNT$ where *P* –pressure, *V* – volume, *T*- temperature and *N* – Number of molecules, Hence calculate volume of 2 moles of an ideal gas at s.t.p (6 marks)

b) Explain why it is dangerous to dispose of pressurised containers like a doom cans into fire (4 marks)

c) A steel ring with a hole having area of 3.99 cm^2 is to be placed on an aluminum rod with cross sectional area of 4 cm^2. Both ring and rod are initially at a temperature of 35 ℃ and slip inside one another at 60 ℃. At what common cross sectional areas do they slip on one another? (4 marks)

d) A house is constructed of wooden planks 3 cm thick. If the exterior temperature is -10 ℃ and the interior is 15 ℃. Find the energy transferred through the wall of dimensions 3 m by 2 m in one hour? (4 marks)

e) Some water trapped in a volcano undergoes heating and blows off the volcano in a big explosion, give an explanation why this happens. (2 marks)

QUESTION FOUR

a) With an equation define molar specific heat at constant pressure (c_p) and at constant volume (c_v) (4 marks)

b) Molar specific heat at constant volume (c_v) has been found to be smaller than Molar specific heat at constant pressure (c_p). Explain (4 marks)

c) A weather balloon stationed at a constant pressure contains 180 moles of helium gas. It is then heated by the sun from 18 ℃ to 26℃. Calculate the heat energy transferred to the gas. (4 marks)

d) A person with skin temperature of 33 ℃ is in a room at 24 ℃. Calculate the net rate of heat transfer by radiation. (4 marks)

e) A gas sample while it is being compressed in an engine, 20 joules of heat is removed from it by a piston that does 5 joules of work. What is the change in thermal energy of the gas? Does the temperature increase or decrease? (4 marks)

QUESTION FIVE

a) A squared metallic sheet of length L_o undergoes a temperature change Δt to attain a final temperature *L*. Show that its fractional change in area is $\frac{\Delta A}{A_0} = 2\alpha\Delta T$ (6 marks)

b) Show that the fractional change in volume of a liquid is given by $\frac{V-V_o}{V_o} = \beta\Delta T$, where V- is final volume, V_o- initial volume and β is coefficient of volume expansion for fluids (6 marks)

c) A 200 g cube of ice at 0 ℃ is dropped into 2.0 kg of water that was originally at 90 ℃. What is the final temperature of the water after the ice has melted? (8 marks)