MAASAI MARA UNIVERSITY

REGULAR UNIVERSITY EXAMINATIONS
2018/2019 ACADEMIC YEAR
SECOND YEAR SECOND SEMESTER

SCHOOL OF SCIENCE AND INFORMATION SCIENCES
BACHELOR OF SCIENCE IN CHEMISTRY AND
BACHELOR OF EDUCATION SCIENCE

COURSE CODE: CHE 2215
COURSE TITLE: BASIC THERMODYNAMICS

DATE: 25TH APRIL 2019 **TIME: 1100 - 1300 HRS**

INSTRUCTIONS TO CANDIDATES

1. Answer Question **ONE** and any other **TWO** questions
2. Avogardro's costant= 6.022×10^{23} mol^{-1}
3. Gas constant R = $8.314 JK^{-1}mol^{-1}$ = 0.0821 L atm K^{-1} mol^{-1}
4. 1 atm = 1.01325×10^5 Nm^{-2}
5. Gravitational acceleration = 10 NKg^{-1}

*This paper consists of **FOUR** printed pages. Please turn over.*

QUESTION ONE (30 marks) Compulsory

a) Describe the molecules of a perfect gas based on the following parameters;
   (i) Motion (1 mk)
   (ii) Intermolecular distance (1 mk)
   (iii) Intermolecular forces (1 mk)

b) (i) Define pressure and state its SI units (2 mks)

   (ii) Calculate the pressure in Pascal exerted by a mass of 1.5 Kg pressing through the point of a pin whose cross-section area is 3.0×10^{-2} mm^2 (4 mks)

c) (i) State Charles's law (1 mk)

   (ii) A balloon is inflated to a volume of 2.50 L at room temperature, what will be the new volume if the temperature is lowered to -25^{O} C at constant pressure (4 mks)

d) State the volume occupied by 13.7 g of chlorine-71 gas at 45^{O} C and 745 mmHg pressure (5 mks)

(e) A gaseous mixture contains 320 mg methane(16.04 g), 175 mg argon(39.95 g) and 225 mg neon(20.18 g). The partial pressure of neon at 300K is 8.87 kPa. Calculate the volume and the total pressure of the mixture (4 mks)

(f) Define the following terms as used in thermodynamics;
   (i) The system (1 mk)
   (ii) The surrounding (1 mk)
   (iii) The universe (1 mk)

(g) 1 mole of $CaCO_3$ is heated in an open container to 700^{O} C at which temperature it is fully decomposed. How much work has been done in the process? (2 mks)

(h) The internal energy, U, per mole of monoatomic perfect gas is given by:

$U = U(0) + 3/2RT$

Where U(0) is the internal energy at 0K. Calculate the molar specific heat at constant volume, $C_{v,m}$ (2 mks)

QUESTION TWO (20 marks)

a) Define the following terms and state their respective SI units;
   (i) Heat capacity (2 mks)
   (ii) Molar heat capacity (2 mks)
   (iii) Specific heat capacity (2 mks)

b) Calculate the heat energy produced in a resistance wire filament in contact with the water if a current of 1 A from a 50 V source is passed through the filament for 5minutes (3 mks)

c) What is meant by the standard state of a substance? (2 mks)

d) The density of phosphorus (30.97 g) vapour at 310^{O} C and 775 mmHg is 2.64 g/L. What is the molecular formula of the phosphorus? (3 mks)

e) Distinguish between diffusion and effusion of gases (1 mk)

f) Consider an adiabatic reversible expansion of 0.02 mole Ar initially at 25^{O} C from 0.50 dm^3 to 1.00 dm^3. The molar heat capacity of Ar at constant volume is 12.48 J $K^{-1}mol^{-1}$. Calculate the work done. (5 mks)

QUESTION THREE (20 marks)

a) Calculate the height of a column of liquid Y (density = 0.879 gcm^{-3}) in metres required to exert a pressure of 0.970 atm (3 mks)

b) In order for a gas filled balloon to rise in air, the density of the gas in the balloon must be less than that of air.
   (i) Consider air to have a molar mass of 28.96 g mol^{-1}. Determine the density of air at 25^{O} C and 1 atm in gL^{-1} (3 mks)
   (ii) Show by calculation that a balloon filled with Carbon dioxide at temperature of 25^{O} C and 1 atm pressure could not be expected to rise in air (3 mks)

c) At 300 K temperature and 20 atm pressure, the compression factor of a gas is 0.86. Calculate;
   (i) Volume occupied by 8.2 mmol of the gas under these conditions (3 mks)
   (ii) An approximate value of the second virial constant B at 300 K (3 mks)

d) Explain the following observations;
   (i) The pressure of a fixed mass of a gas is inversely proportional to its volume at constant temperature (2 mks)
   (ii) The volume of a fixed mass of a gas is directly proportional to the absolute temperature (2 mks)

e) State the standard conditions of temperature and pressure (1 mk)

QUESTION FOUR (20 marks)

a) Given the following data;

$$S_{(s)} + \frac{3}{2}O_{2(g)} \xrightarrow{yields} SO_{3(g)} \quad \Delta_c H^\theta = -395.2 \text{ Kjmol}^{-1}$$

$$2SO_{2(g)} + O_{2(g)} \xrightarrow{yields} 2SO_{3(g)} \quad \Delta_c H^\theta = 198.2 \text{ Kjmol}^{-1}$$

Calculate $\Delta_r H^\theta$ for the reaction;

$$S_{(s)} + O_{2(g)} \xrightarrow{yields} SO_{2(g)}$$ (3 mks)

b) When 2 moles of sulphur dioxide gas react completely with 1 mole of oxygen gas to form 2 moles of sulphur trioxide gas at 25^{o} C and a constant pressure of 1 atm, 198 kj of energy are released as heat. Calculate ΔU and ΔH (4 mks)

c) Naphthalene burns in oxygen according to the equation;

$$C_{10}H_{8(s)} + 12O_{2(g)} \xrightarrow{yields} 10CO_{2(g)} + 4H_2O_{(l)}$$

The standard enthalpy for this reaction is $\Delta_c H^\theta$ = -5157 Kjmol^{-1}. When 120 mg of naphthalene was burnt in a bomb calorimeter, the temperature was raised by 3.05 K.

Calculate the heat capacity of the calorimeter, given the molar mass of naphthalene is 128.18gmol^{-1} (4 mks)

d) Five moles of an ideal gas at 298 K contracts reversibly and isothermally from a pressure of 10 bar to 1 bar. What are the values of w, q, ΔU and ΔH (4 mks)

e) Water is heated to boiling under pressure of 1.0 atm. When an electric current of 0.5 A from a 12 V supply is passed for 300 s through a resistance in thermal contact with the water, it is found that 0.798 g of water is vaporized. Calculate the molar internal energy and enthalpy changes of the boiling water (5 mks)

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