NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, APPLIED SCIENCES AND NATURAL RESOURCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 6
COURSE CODE: TPH601S	**COURSE NAME:** THERMAL PHYSICS
SESSION: JULY 2022	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SUPPLEMENTARY/SECOND OPPORTUNITY EXAMINATION PAPER	
EXAMINER(S)	MR. VAINO INDONGO
MODERATOR:	DR. SYLVANUS ONJEFU

INSTRUCTIONS	
1.	Write all your answers in the answer booklet provided.
2.	Read the whole question before answering.
3.	Begin each question on a new page.

PERMISSIBLE MATERIALS

Non-programmable Scientific Calculator

THIS EXAMINATION QUESTION PAPER CONSISTS OF 3 PAGES

(INCLUDING THIS FRONT PAGE)

QUESTION 1 [30]

1.1 Briefly explain the following thermodynamic terms: (10)

(a) Surrounding
(b) Open system
(c) Heat
(d) Thermal equilibrium
(e) An isolated system

1.2 On a brisk autumn day (3.0°C) the tires of a car were inflated to a pressure of 2.80×10^5 Pa. The tire gauge reads 1.4×10^5 Pa, but this is the excess above atmospheric pressure, which is about 1.01×10^5 Pa. Assuming that the tires and air inside are in equilibrium with the outside air, what is the Kelvin temperature of the air inside? (2)

1.3 A copper strip is 50.0 mm long at 0°C. How long would it be at 150°C if the coefficient of linear expansion for Brass is 1.7×10^{-5} °C^{-1}? (3)

1.4 (a) Estimate the amount of heat needed to raise the temperature of 50.0 g of lead ($c = 1.28 \times 10^{-2}$ J.kg^{-1} K^{-1}) from 2.3 °C to 196.0 °C. (3)

(b) At 16.0°C, a brass cube has an edge length of 30.0 cm. What is the increase in the cube's volume when it is heated to 81.0°C? The coefficient of linear expansion for brass is given by $\alpha = 19.00 \times 10^{-6}$ °C^{-1}. (5)

1.5 A 2.00 g sample of methanol ($c_m = 2450$ J.kg^{-1} K^{-1}) at 20°C is mixed with 1.00 g of water ($c_w = 4180$ J.kg^{-1} K^{-1}) at 60°C. The system is insulated and attains its equilibrium temperature T_{eq}.

a) Using the definition of specific heat, set up the $Q_{total} = 0$ equation. (3)
b) Calculate the final temperature T_f of the mixture. (4)

QUESTION 2 [24]

2.1 State the 2nd Law of thermodynamics and write its differential form. (5)

2.2 What is isochoric (isometric) process? If 1265 J of heat energy is expelled from a gas confined in an isochoric process, evaluate the change in internal energy of the gas. (4)

2.2 State the molar specific heats of an ideal gas and discuss how these molar specific heats are related. Also, write down the ratio γ in terms of these specific heats. (4)

2.4 An ideal gas undergoes an *isothermal* expansion at temperature T, changing its volume from V_i to V_f. Use an ideal gas law to show that the work done during an

isothermal expansion is given by the equation:

$$W = nRTln\left(\frac{P_i}{P_f}\right) \quad (6)$$

2.5 Draw and label correctly a P-V diagram of three isotherms of temperatures T_1 = 200 K, T_2 = 260 K and T_3 = 230 K. Illustrate an adiabatic curve on the same diagram, cutting through all isotherms. (5)

QUESTION 3 **[31]**

3.1 The efficiency of a particular car engine is 20% when the engine does 8.5 kJ of work per cycle. Assume the process is reversible. Calculate

(a) The energy the engine gains per cycle as heat Q_{gain} from the fuel combustion? (3)

(b) The energy the engine loses per cycle as heat Q_{lost}. (3)

(c) If a tune-up increases the efficiency to 32%, recalculate the

(i) Q_{gain}. (3)

(ii) Q_{lost}. (3)

3.2 Draw and explain the states of the Carnot Cycle (on a *p-V* diagram) including the work done per cycle, temperature, heat transfer. (12)

3.3 Determine the entropy of 1500 g of water vapor at 125°C (Specific heat capacity of ice =2090 $J.kg^{-1}K^{-1}$, water 4200 $J.kg^{-1}K^{-1}$, water vapor steam = 1996 $J.kg^{-1}K^{-1}$, latent heat of fusion of water = $3.33x10^5$ $J.kg^{-1}$ and vaporization is 2260 $J.kg^{-1}$). (7)

QUESTION 4 **[15]**

4.1 Prove that PV^{γ} = constant for adiabatic process (8)

4.2 Derive thermodynamic Maxwell equation based on Gibb's Free Energy. (7)

END OF EXAMINATION!