NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH AND APPLIED SCIENCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE (MAJOR AND MINOR)	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 6
COURSE CODE: TPH601S	**COURSE NAME:** THERMAL PHYSICS
SESSION: JULY 2019	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SECOND OPPORTUNITY/SUPPLEMENTARY EXAMINATION	
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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 PAPER CONSISTS OF 7 PAGES

(INCLUDING THIS FRONT PAGE)

QUESTION 1 **[30]**

Multiple choice questions. Choose only **one** correct answer. Each question carries **2 marks**.

1.1 The zeroth law is a consequence of _____ and allows us to conclude that temperature is a well-defined physical quantity. (2)

A. thermal equilibrium
B. chemical equilibrium
C. physical equilibrium
D. mechanical equilibrium

1.2 A thermodynamic system where mass cannot enter or leave is known as, (2)

A. open system
B. closed system
C. isovolumetric system
D. isobaric system

1.3 A unique combination of temperature and pressure at which solid water (ice), liquid water and water vapor can all coexist is called _____. (2)

A. absolute temperature
B. critical point
C. triple point
D. absolute zero

1.4 According to the first law of thermodynamics, which statement is not correct? (2)

A. Heat energy flows spontaneously from a hot object to a cold object but not vise-versa.
B. The system exchanges energy with the surrounding.
C. It is impossible to construct a heat engine which is 100% efficient.
D. The entropy of an isolated system never increases.

1.5 Which one of the following is a set thermodynamic potentials? (2)

A. internal energy, volume, entropy, temperature
B. internal energy, temperature, volume, helmholtz free energy
C. entropy, enthalpy, gibb's free energy, pressure
D. enthalpy, internal energy, gibb's free energy, helmoholtz free energy

1.6 Which of the following is not a property of the system? (2)

A. Temperature
B. Pressure
C. Specific volume
D. Heat

1.7 The energy that a system possess as a result of its relative position is known as___.(2)

A. gravitational energy
B. kinetic energy
C. temperature
D. potential energy

1.8 An athlete loses 7 J of energy via heat loss during strenuous activity. The athlete consumes enough food during the activity to keep the average internal energy and temperature constant. If the athlete's work efficiency is 65%, what is their energy intake? (2)

A. 12 J
B. 20 J
C. 25 J
D. 19 J

The following questions (1.9 and 1.10) deals with the following figure (Figure 1).

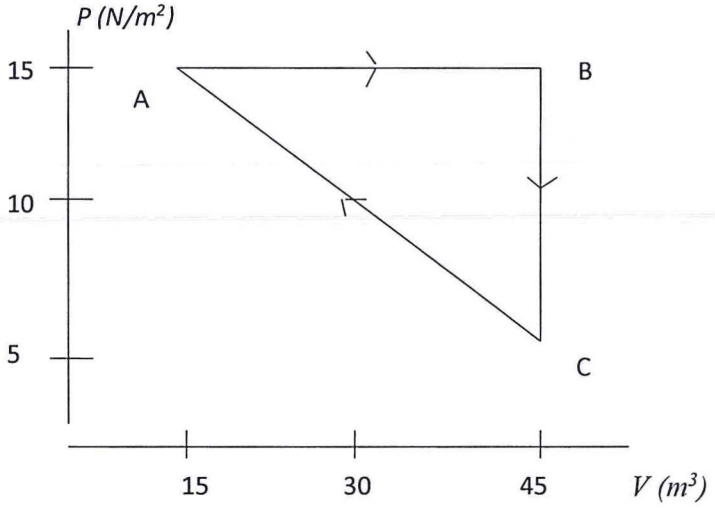

Fig. 1

1.9 The net work done by the system is: (2)

A. +150 J
B. +225 J
C. –225 J
D. –150 J

1.10 The work done through the process C to A (W_{CA}) is: (2)

A. –375 J
B. +375 J
C. +300 J
D. 225 J

1.11 The processes or systems that do not involve heat are called _____. (2)

A. isothermal processes
B. equilibrium processes
C. thermal processes
D. adiabatic processes.

1.12 Internal energy of a perfect gas depends on _____. (2)

A. temperature, specific heats and pressure
B. temperature, specific heats and enthalpy
C. temperature, specific heats and entropy
D. temperature only

1.13 Which of the following variables control the physical properties of perfect gases?(2)

A. pressure
B. volume
C. temperature
D. all of the above

1.14 The general gas equation equation is _____. (2)

A. PV = nRT
B. PV = mRT
C. PV = KiRT
D. $C_p - C_v = R$

1.15 In thermodynamic processes which of the following statements is **not** true? (2)

A. In an adiabatic process $PV\gamma$ = constant.

B. In an adiabatic process the system is insulated from the surroundings.

C. In an isochoric process pressure remains constant.

D. In an isothermal process the temperature remains constant.

QUESTION 2 [20]

2.1 Define the following terms:

2.2.1 Boundary (2)

2.2.2 Isochoric process (2)

2.2.3 Rigid system (2)

2.2.4 Chemical equilibrium (2)

2.2.5 Phase equilibrium (2)

2.2 Study the following temperature scales in figure 2 and find the missing temperature T_x. (3)

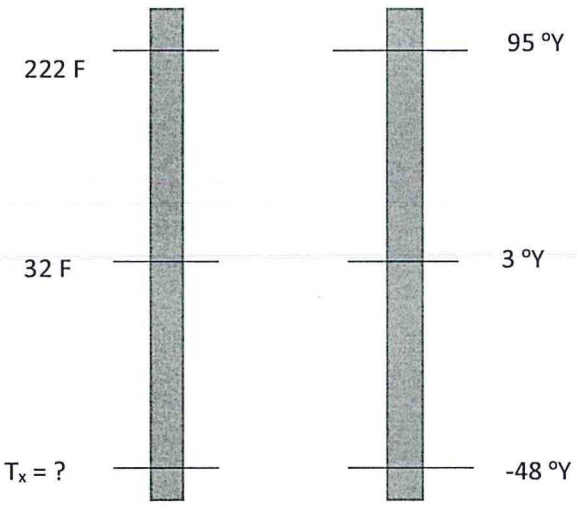

Fig. 2

2.3 Which temperature is hotter, a 20°C or 20 K temperature? (2)

2.4 A brass rod of length 24 cm expands by 2.44 mm when heated from 20°C to 185°C. Calculate

(i) the coefficient of linear expansion of the copper, (3)

(ii) the new length of the rod. (2)

QUESTION 3 **[20]**

3.1 State the first law of thermodynamics and write the law in differential form. (4)

3.2 An aluminium block (c = 9.1 x 10^2 J/kg°C) of mass 0.80 kg at a temperature of 275°C is dropped into an aluminum calorimeter cup of mass 0.20 kg containing 1.00 kg of water (c = 4.2 x 10^3 J/kg°C) at 20°C. The system is insulated and attains equilibrium at a final temperature T_f of 56°C. Use the definition of specific heat capacity, to calculate:

(a) Heat gained by aluminium block. (3)

(b) Heat gained by a cup. (3)

3.3 How much energy does it take to vaporize 0.15 k g of water? Use heat of vaporization as 2260 J/g. (3)

3.4 Consider a system of an ideal gas. Show that the work done in an adiabatic system is given by:

$W = \frac{1}{\gamma-1}(p_1V_1 - p_2V_2)$, where γ is a ratio of molar specific heat at a constant pressure to molar specific heat at constant volume, i.e. $\gamma = \frac{C_p}{C_v}$. V_1, p_1 being initial state and V_2, p_2 is final state of volume and pressure respectively. (7)

QUESTION 4 **[20]**

4.1 Study the following figure (Fig. 3). In process b → d, 600 J of heat is added to the system; in process a → c, 150 J of heat is added to the system.

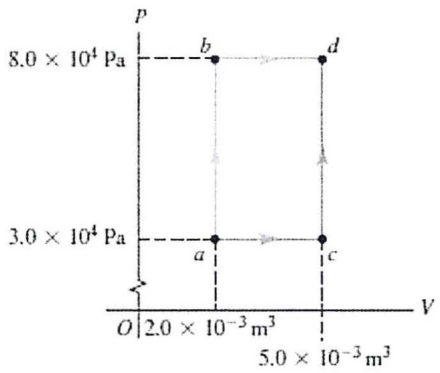

Fig. 3

Find the following;

(a) the internal energy change in process b → d. (4)

(b) the internal energy change in process a → b → d when Q_{ab} = 20 J. (4)

(c) the total work done in process a → c → d. (2)

4.2 Suppose that energy is extracted as heat Q_H from the high temperature reservoir of temperature, T_H = 870 K, and energy is expelled as heat Q_L to the low temperature reservoir of temperature, T_L = 250 K, by the Carnot engine. Calculate

(a) the efficiency of the Carnot engine. (3)
(b) the work done per cycle by the Carnot engine if the heat absorbed is 1200 J. (3)
(c) the heat expelled. (4)

QUESTION 5 **[10]**

5.1 Derive of Maxwell Relation from Helmholtz Free energy, F = U – TS. (10)

END OF MEMO!!!!!!