**NATIONAL UNIVESITY OF SCIENCE AND TECHNOLOGY**

**APPLIED PHYSICS DEPARTMENT**

**SPH 1203– THERMAL PHYSICS**

**BSc HONOURS APPLIED PHYSICS: PART I:**

**APRIL 2014 DURATION: 3HOURS**

ANSWER ALL PARTS OF QUESTION ONE IN SECTION A AND ANY THREE QUESTIONS FROM SECTION B. SECTION A CARRIES 40 MARKS AND SECTION B CARRIES 60 MARKS.

*SHOW ALL YOUR STEPS CLEARLY IN ANY*

**SECTION A**

1. (a) A gas with an initial volume of 0.30$m^{3}$ exerts a pressure

 $p=2x10^{5}Nm^{-2}.$ At this pressure, it expands to a final volume of $0.45m^{3}$.

$ $Find the work done by the gas. [6]

(b) Use a cyclic process of your choice to show that when a system goes through a cyclic process and returns to its initial state the change in the internal energy $∆U=0$ [6]

 (c) Explain, briefly the differences between $ v\_{av} and v\_{rms}$ showing clearly how

 each is calculated. [6]

 (d) Show the following relationships:

 (i) $C\_{p}-C\_{v}=R$, [4]

 (ii) $ Q= C\_{p}dT-Vdp$ [4]

 (e ) In a hydrostatic system an adiabatic process proceeds under the condition

 $pV^{γ}= $A, where A and $γ=\frac{C\_{p}}{C\_{V}}$ are constants and p and V have their usual meaning. [6]

(f) (i) State the equipartition of energy principle. [4]

(ii ) Explain the fact that the heat capacities of some gasses increase with increasing temperature. [4]

**SECTION B**

2. (a) How do you express the First law of Thermodynamics for a composite system like a paramagnetic gas which obeys Curie’s Law. [5]

 (b) From (a) deduce the equation of an isothermal curve for this paramagnetic

 ideal gas [5]

(c) Give an expression for the work done during a quasi-static isothermal change of state. [10]

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3. Given that the distribution of speeds of molecules of gas is given as:

 $dn\_{v}=\frac{4n}{\sqrt{π}}β^{{3}/{2}}v^{2}e^{-βv^{2}}$

1. Define all quantities involved [2]
2. Deduce the most probable speed of the molecules [4]
3. From this distribution show how you would compute the speed of the molecules. [6]
4. Show that the root mean square velocity

 $v\_{rms}= \sqrt{\frac{3p}{ρ}}$ [8]

4. (a) State Kirchhof’s Law defining all the quantities involed. [5]

 (b) State Stefan Bolltzman’s Law defining all the quantities involved. [5]

 (c) Compare any two of the modes of Heat Transfer that you are familiar with

 giving expressions for the rates at which heat is transferred in each of the modes

 of transfer chosen. In your expressions define all the quantities involved. [10]

5. (a) Show that the efficiency of a thermal engine operating according to a reversible Carnot cycle is independent of the working substance and depends only on the two

 temperatures. [6]

 (b) (i) Draw a schematic diagram of an elementary refrigerator showing the role of each section in the cycle., showing in a pV diagram that includes arrows that indicate the direction of the process and that of the heat flow’. [8]

 (ii) Give an expression for the performance of this refrigerator. [6]

6 An ideal gas engine operates in a cycle in which when represented in a pV diagram: 1 an isobar (compression) from the coordinates ($p\_{1}, V\_{1}$) to ($p\_{1},V\_{2}$) 2 an isochor ($p\_{1}, V\_{2}$) to ( $p\_{2} ,V\_{2}$) where $p\_{2}>p\_{1}and V\_{1}> V\_{2}$ and 3 an adiabatic ( $p\_{2}, V\_{2})$ to ($p\_{1} V\_{1}$).

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 a) Make a sketch of this cyclic process. [5]

1. Calculate the work done in one cycle. [5]
2. Indicate which parts of the cycle involve heat flow in or out of the gas and give an expression for heat quantities involved. [5]

d) Give an expression for the efficiency of the engine. [5]

 **END OF EXAMINATION**