**NATIONAL UNIVESITY OF SCIENCE AND TECHNOLOGY**

**APPLIED PHYSICS DEPARTMENT**

**SPH 1203– THERMAL PHYSICS**

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

**MAY 2013 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) (i) Explain, briefly the differences between:*

 *Heat Conduction and Heat Convection. Define the quantities involved in*

 *the laws of each. [6]*

 *(ii) State Stefan Boltzmann Law defining the quantities involved. [4]*

 *(b) 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]*

 *(c) A liquid is irregularly stirred in a well-insulated container and thereby*

 *undergoes a rise in temperature. If we regard the liquid as the system*

1. *Has heat been transferred?*
2. *Has work been done?*

 *(ii) What is the sign of* $∆U$*? [6]*

 *(d) Show that* $C\_{p}-C\_{v}=R$ *[4]*

 *(e) Show that in an adiabatic process this equation holds T*$V^{γ-1}=A$ *where A is a constant. [4]*

 *(f) (i) Given that an hydrostatic system has the thermodynamic coordinates P, V, T show by defining the thermodynamic quantities involved that:*

 *.*$dp= \frac{β\_{p}}{k\_{T}}dT$ *where* $β\_{p and k\_{T}}$ *have their usual meaning. [6]*

***SECTION B***

*2. (a) Explain the first law of thermodynamics [4]*

 *(b ) (i) Draw a schematic diagram of an elementary refrigirator showing*

 *the role of each section in the cycle. [6]*

 *(ii) Show the cycle in a p – V diagram that includes arrows that*

 *indicate the direction of the process and that of the heat flow. [6]*

1. *From (ii) derive an expression for the efficiency of the cycle. [4]*

*3. (a) Make a comparison of a reversible and an irreversible processes. [4]*

 *(b) 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. [10]*

 *(c) Compare the efficiency of the Carnot cycle to that of the Stirling cycle. [6]*

4 a) Show that $pV^{γ}=A$ is the equation of state for an adiabatic transformation of an ideal gas if A is a constant. [6]

 b) For the same final volume, show that a gas which experiences an adiabatic expansion has a final pressure, which is less than if the expansion is isothermal. [10]

 c) Explain what you have just shown in b). [4]

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5. (a) If Maxwell’s distribution of speeds of molecules is given as:

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

1. Find an expression for the most probable speed of the molecules [4]
2. From this distribution show how you would compute the $v\_{rms}$ of the molecules. [6]
3. Express $v\_{rms}$ as a function of pressure and density of the molecules of an ideal gas. [10]

6. (a) State at least four ways in which a substance may be stimulated to emit electromagnetic radiation [4]

 (b) Define the following: Blackbody and temperature gradient. [4]

 (c) Write down an expression for the heat transferred by radiation between two bodies of differing temperatures $(T\_{a} and T\_{b})$ [6]

 (d) Write down the fundamental Law of Heat Conduction defining all the quantities involved. [6]

**END OF EXAMINATION**