Phys2053 Physics & Physical Oceanography,
Memorial University of Newfoundland.
Final Examination

December 10, 2005. Time allowed: 120 minutes 50 points total

NAME:_________________________ STUDENT NUMBER:__________________

ANSWER ALL QUESTIONS. To receive full credit, you must answer questions clearly and completely. Support your answer with a formula or a brief statement of principle when possible. The following equations and constants might be of use.

(I)(a) Buoyancy

1. A plastic sphere floats in water with 50% of its volume submerged. Determine the density of the sphere.
2. The same sphere floats in glycerin with 40% of its volume submerged. Determine the density of glycerin.

(I)(b) Continuity Equation

Water flows down a channel 1.0 m deep and 0.5m wide at a rate of 2.0 metric tonnes per second (1 metric tonne = 1000 kg). At some point the channel widens to 0.8m. How fast does the water flow in the wider channel?

(II) For each statement below state whether True or False. Give a one-sentence justification of your answer.

In a reversible and adiabatic process:

(a) The change in internal energy equals zero.

(b) The entropy change equals zero.

(c) Energy in the form of heat added to the gas equals zero.

(d) Work done on or by the gas is zero.

(e) The temperature does not change.

(III) Fluid Flow

A horizontal pipe of diameter 20 cm has a smooth reduction to a pipe 5 cm in diameter. If the pressure in the larger pipe is $8.0\times10^4 Pa$ and in the smaller pipe is $6.0\times10^4 Pa$, at what rate (m^3 per sec) does water flow through the pipes ? Neglect viscosity.

(IV) Thermal Transfer

(a) A calorimeter consists of 400 g of water at 25°C. A 500g piece of copper at 100°C is thrown into the water, and the equilibrium temperature is found to be 28.3°C. If the copper has mass 63.5 g what is the specific heat capacity of copper in J/kg ?

(b) An ice tray contains 500 g of liquid water at 0°C. Calculate the change in entropy of the water as it freezes slowly and completely at 0°C.

(V) A thermodynamic cycle

A 1.00-mol sample of an ideal monatomic gas is taken through the cycle shown. The process A to B is a reversible ***isothermal*** expansion. Calculate:

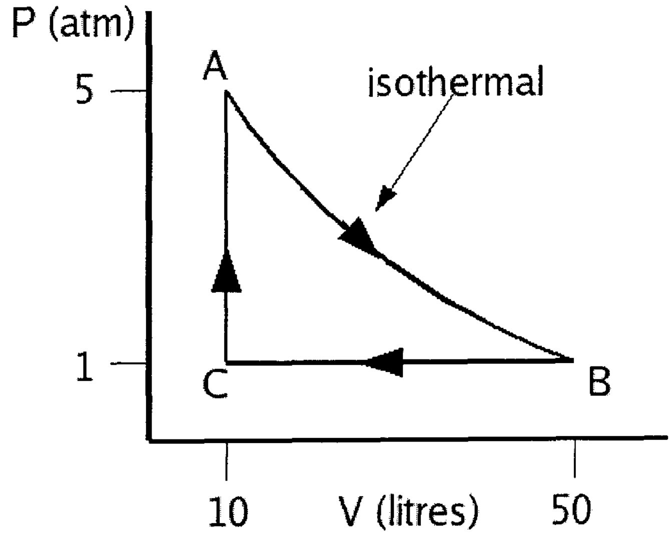
(a) The work done by the gas in 1 cycle.

(b) The temperature at points A, B and C.

(c) the energy ***added*** to or ***removed from*** the gas **in the form of heat** in segments A to B, B to C, and C to A.

(d) The sum of the positive heat inflows in 1 cycle.

(e) The efficiency of the cycle.



EQUATIONS:

$\gamma=\frac{dG}{dA}$	$\Delta p=\frac{2\gamma}{R}$	$v_1 A_1=v_2 A_2$
$F=6\pi\eta a v$	$F=\frac{\eta v A}{y}$	$p+\rho g h+\frac{1}{2}\rho v^2=constant$
$\left[p+a\left(\frac{n}{V}\right)^2\right]\left(\frac{V}{n}-b\right)=RT$	$\frac{pV}{T}=nR=Nk_B$	$pV^{\gamma}=constant$ $\gamma=\frac{C_P}{C_V}$
$e_{Carnot}=1-T_c/T_h$	$\alpha=\frac{1}{L}\frac{dL}{dT}$	$\beta=\frac{1}{V}\frac{dV}{dT}$
$U=nC_VT=\frac{f}{2}Nk_BT=\frac{f}{2}nRT$	$\Delta Q=mc\Delta T$	$\Delta Q=mL$
$\Delta Q_V=nC_V\Delta T$	$\Delta Q_p=nC_p\Delta T$	$P/A=\epsilon\sigma T^4$
$P\equiv\frac{dQ}{dt}=-\kappa A\frac{dT}{dx}$	$P\equiv\frac{dQ}{dt}=-\kappa A\frac{\Delta T}{l}$	$R=\frac{l}{\kappa}$
$\langle v\rangle\equiv\frac{\sum_{i=1}^{N}v_i}{N}$	$v_{rms}=\sqrt{\langle v^2\rangle}=\frac{\sum_{i=1}^{N}v_i^2}{N}$	$KE=\frac{1}{2}m\langle v^2\rangle$
$F(\vec{v})=\left(\frac{m}{2\pi k_BT}\right)e^{-\frac{mv^2}{2k_BT}}$	$\lambda=\tau v_{rms}$	$\tau=\frac{1}{\sqrt{2}n\sigma v_{rms}}$
$S_B-S_A=C_v\ln\left(\frac{T_B}{T_A}\right)+nR\ln\left(\frac{V_B}{V_A}\right)$	$S_B-S_A\geq\int_A^B\frac{dQ^{rev}}{T}$	$\sum_i\frac{Q_i^{rev}}{T_i}=0$

CONSTANTS:

$\rho_{water}=1000$ kg/m³. $\rho_{sea-water}=1030$ kg/m³. $1m^3=1000 litres$. $N_A=6.02\times10^{23}$.

1.0 metric tonne = 1000 kg. $g=9.8 m/s^2$. $c_{water}=4186 J/(kg.K)$.

$L_{water-ice}=3.3\times10^5 J/kg$. $1 cal=4.186 J$. $R=8.315 J/(mole.K)$.

$k_B=1.381\times10^{-23} J/K$. $1 atm.=1.013\times10^5 Pa$.