Principles of Physics I
PHY1321/31AB
MIDTERM 1
Fall2016 Oct 15

uOttawa
L'Université canadienne
Canada's university

Department of Physics

This is 100 minutes long , closed-book evaluation.

I, the undersigned, realize that I should have only **one copy of this questionnaire**, and that by the end of this test I will have **to return** it to the proctor with all other materials provided during the test **(SCANTRON AND EXAM BOOKLET).**

I am also aware of the following:

Failing to return this document results in obtaining 0 for the whole test!

Failing to properly fill out the scantron will result in 0 for the part I of the test!

By signing below I acknowledge that I am aware of the above conditions and will comply with them.

Cellular phones, unauthorized electronic devices or course notes) are not allowed during this exam. Phones and devices must be turned off and put away in your bag. Do not keep them in your possession, such as in your pockets. If caught with such a device or document, the following may occur: you will be asked to leave immediately the exam, academic fraud allegations will be filed which may result in you obtaining a 0 (zero) for the exam.

By signing below, you acknowledge that you have ensured that you are complying with the above statement.

Student ID: ________________________________

STUDENT'S NAME: ________________________________

Student Signature : __________________________

DATE: ____________________

I WANT THE FOLLOWING 4 PROBLEMS FROM PART II TO BE MARKED :__________________

Probability of finding the speed of a particle in the range (v;v+dv)is:

$$P(v)dv = 4\pi\left[\frac{1}{2\pi}\frac{m}{kT}\right]^{\frac{3}{2}} v^2 e^{-\frac{mv^2}{2kT}} dv$$

$$v_{MP} = \left[\frac{2kT}{m}\right]^{\frac{1}{2}} \qquad v_{rms} = \left[\frac{3kT}{m}\right]^{\frac{1}{2}} \qquad v_{avg} = \left[\frac{8kT}{\pi m}\right]^{\frac{1}{2}}$$

$$p = \frac{1}{3}\rho < v^2 > \qquad \rho = \frac{Nm}{V}$$

Gaussian Integrals:

$$\int_0^{+\infty} e^{-ax^2} dx = \frac{1}{2}\sqrt{\frac{\pi}{a}} \qquad \int_0^{+\infty} xe^{-ax^2} dx = \frac{1}{2a} \qquad \int_0^{+\infty} x^2 e^{-ax^2} dx = \frac{1}{4}\sqrt{\frac{\pi}{a^3}}$$

$$\int_0^{+\infty} x^3 e^{-ax^2} dx = \frac{1}{2a^2} \qquad \int_0^{+\infty} x^4 e^{-ax^2} dx = \frac{3}{8}\sqrt{\frac{\pi}{a^5}} \qquad \int_0^{+\infty} \frac{x^3}{e^x - 1} dx = \frac{\pi^4}{15}$$

ΔEint = Q + W

$pV=nRT$

$$\Delta S = \int \frac{dQ}{T}$$

Change	ΔEint	W	Q	ΔS
P = const	$nC_v \Delta T$	$-p(V_f-V_i)$	$nC_p \Delta T$	$nC_p \ln\frac{T_f}{T_i}$
V = const	$nC_v \Delta T$	0	$nC_v \Delta T$	$nC_V \ln\frac{T_f}{T_i}$
T = const	*0*	$-nRT\ln\frac{V_f}{V_i}$	$nRT\ln\frac{V_f}{V_i}$	$nR\ln\frac{V_f}{V_i}$
Q = 0	$nC_v \Delta T$	$\frac{1}{\gamma-1}\left(p_f V_f - p_i V_i\right)$	0	0

$$pV^\gamma = const. \qquad \gamma = \frac{C_P}{C_V} \qquad C_p - C_v = R$$

$$\in_{CRN} = \frac{W}{Q} = \left|\frac{Q_H - Q_L}{Q_H}\right| = 1 - \frac{T_C}{T_H} \qquad \textbf{COP} = \frac{\textbf{what we want}}{\textbf{what we pay for it}}$$

$\Delta L = \alpha L \Delta T$ $\qquad$ $\Delta S = \beta S \Delta T$ $\qquad$ $\Delta V = \gamma V \Delta T$

$P = e\,\sigma\, A\, T^4$; $\sigma = 5.67\times 10^{-8} W/(K^4 m^2)$ $\qquad$ $P = kA\left|\frac{dT}{dx}\right|$

$Q = mc\Delta T$ $\qquad$ $Q = Lm$

c(water) = 4186 J/(kg C); c(ice) = 2090 J/(kg C); c(steam) = 2010J/(kg C)

L(melting) = 3.33×10^5 J/kg $\qquad$ L (vaporization) = 2.26×10^6 J/kg

density of Cu = 8940kg/m^3 ; α(Cu)=$17\times10^{-6}K^{-1}$; c(Cu)= 385J/kgC ;

A(disk)=πR^2, C=πR^2, V=$4/3\pi R^3$, A=$4\pi R^2$

Principles of Physics I
PHY1321/31AB
MIDTERM 1
Fall2016 Oct 15

PART 2 In examination booklets **solve 4 out of 5 problems** below. Each question has the same weight (13p)
For full marks you need a neat diagram (when applicable) and all steps to be clearly demonstrated**.**

1. a) A very powerful octopus uses one sucker of diameter 2.86 cm on each of the two shells of a clam in an attempt to pull the shells apart . Find the minimum force the octopus has to exert in salt water (32.3 m deep) to do this . (Take the salt water density =1kg/liter) (8p)
b) A heat engine operating between 200°C and 80.0°C achieves 20.0% of the maximum possible (5p) efficiency. What energy input will enable the engine to perform 10.0 kJ of work?

2 A 1.00-kg full copper sphere is taken from a forge at 900°C and dropped into 4.00 kg of water at 10.0°C. Assuming that no energy is lost by heat to the surroundings, determine
a) final temperature of the system. (8p)
b) the change of the volume of the copper sphere as result of its temperature change . (2p)
c) the power radiated by the copper sphere just before it was dropped into the water, and after the final temperature was established. (3p)
the specific heats and other useful constants for copper and of water/ice/steam as well as latent heats are given on the formula sheet.

3 A 10.00-L sample of a diatomic ideal gas with specific heat ratio γ= 5/3, confined to a cylinder, is carried through a closed cycle. The gas is initially at 1.00 atm and at 400 K. First, its volume is quadrupoled under constant pressure. Then, it expands isothermally to one fifth of the original pressure.Then the gas is compressed isobarically until its volume reaches 26.26 liters. Finally, the gas is compressed adiabatically to its original volume.

a) Determine the volume of the gas at the end of the isothermal expansion. (2p)
b) Find the temperature of the gas at the start of the adiabatic expansion. (2p)
c) Draw a *PV* diagram of this cycle.(Clearly state the coordinates of all the vertices on PV diagram) (2p)
d) Find the temperature at the end of the cycle. (2p)
e) What was the net work done on the gas for this cycle? (2p)
f) Find the heat transferred to gas from hot reservuar in one cycle (2p)
g) What would be the efficiency of an engine based on this cycle? (1p)

4 Given is one mole of O_2 gas at 27 C. (Molar mass of O_2 is 32g)
a) Use Maxwell Boltzmann distribution to write the case-specific, full expression for the number of O_2 molecules having speeds between 320.5m/s and 321.5m/s. (3P)
b) Find the number of molecules with speeds in that interval (2P)
c) Find the most probable velocity at this temperature. (2P)
c) At what temperature the average velocity of O_2 gas molecules would be the same as in part (b)? (3P)
d) What is the expected value of γ (gamma) for O_2 gas in this temperature? (2P)

5 a) Present detailed **proof of one** of the two below: (4P)
i)using the summary of thermodynamic processes table (from your formula sheet) and known laws of thermodynamics prove that Cp=Cv+R for ideal gas.
ii) using the summary of thermodynamic processes table (from your formula sheet) and known laws of thermodynamics prove that Cp/Cv=γ for ideal gas.
b) Present **one of the following proofs** below: (9P)
i) Using first principles, show that pV^{γ}=const for adiabatic transformation
ii) Using the Maxwell-Bolzmann Speed Distribution P(v)dv obtain Boltzmann Energy Distribution P(E) dE