

CONCORDIA UNIVERSITY
FACULTY OF ENGINEERING AND COMPUTER SCIENCE
DEPARTMENT OF MECHANICAL ENGINEERING

Student's Name: _____

I.D.: _____

PROBLEM I [10 pt]

An ideal gas occupies a volume of 36 m^3 at a pressure of 90 kPa and a temperature of 25°C . Calculate the volume of the gas when the pressure is 101.3 kPa and the temperature 4°C .

ANSWER	
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PROBLEM II [30 pt]

II.1.

Is it reasonable to assume ideal-gas behavior at each of the given states? Why?

- Nitrogen at 20°C and 1 MPa [$T_c = 126.2 \text{ K}$ and $P_c = 3.39 \text{ MPa}$]
- Ammonia at 20°C and 1 MPa [$T_c = 405 \text{ K}$ and $P_c = 11.35 \text{ MPa}$]

II.2.

- Find the quality of steam at 120°C if the vapor occupies 1200 L and the liquid occupies 2 L.

ANSWER	
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II.3.

Determine the power required to overcome the wind drag on a streamlined car traveling at 90 km/h if the drag coefficient C_D is 0.3.

The drag force is given by: $F_d = 0.5 \rho V^2 A C_D$

Where A is the projected area ($A = 2.3 \text{ m}^2$) and ρ is the density of air ($\rho = 1.23 \text{ kg/m}^3$)

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II.4.

Show mathematically that: $C_p - C_v = R$

PROBLEM III [60 pt]

Consider as a system the gas (considered as an ideal gas) in the cylinder (see Figure below); the cylinder is fitted with a piston on which a number of small weights are placed. The initial pressure is 200 kPa, and the initial volume of the gas is 0.04 m³.

- a- Let a Bunsen burner be placed under the cylinder, and let the volume of the gas increase to 0.1 m³ while the pressure remains constant. Calculate the work done by the system during this process.

ANSWER	
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- b- Consider the same system and initial conditions, but at the same time as the Bunsen burner is under the cylinder and the piston is rising, let weights be removed from the piston at such a rate that, during the process:

$$PV = Constant$$

Calculate the work done by the system

ANSWER	
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- c- Consider the same system, but during the heat transfer let the weights be removed at such a rate that:

$$P(V)^n = Constant$$

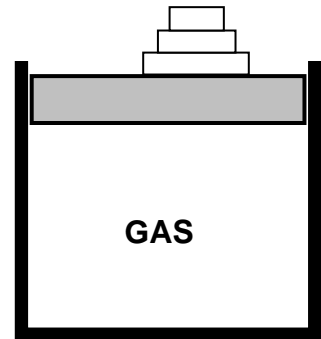
With n=1.3 and the final volume is 0.1 m³

- c.1- Show that the work for this process can be written under the form:

$$W = \frac{P_2V_2 - P_1V_1}{1 - n}$$

- c.2- Compute the work done by the system.

ANSWER	
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- d- Consider the same system with the same initial and final conditions, but let the piston be held by a pin so that the volume remains constant. In addition, let heat be transferred from the system until the pressure drops to 100 kPa. Calculate the work.

ANSWER	
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