UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION

Second Year - Programs 3 and 4

MIE233S - APPLIED SCIENCE

Exam Type: D

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This is a type D examination. The only aids allowed are the course books, class notes, problem sets, quizzes and the midterm exam (and their solutions), and a calculator of any type. All problems are of equal value.

Important Notice:
Please write your solution to problems 1 and 2 in Book 1 and to problems 3, 4, and 5 in Book 2.

Problem 1

For a certain transverse standing wave on a long string, an antinode is at $x = 0$ and a node is at $x = 0.10$ m. The displacement $y(t)$ of the string particle at $x = 0$ is shown in Fig. 1. When $t = 0.50$ s, what are the displacements of the string particle at (a) $x = 0.20$ m and (b) $x = 0.30$ m? At $x = 0.20$ m, what are the transverse velocities of the string particles at (c) $t = 0.50$ s and (d) $t = 1.0$ s? (e) Sketch the standing wave at $t = 0.50$ s for the range $x = 0$ to $x = 0.40$ m.

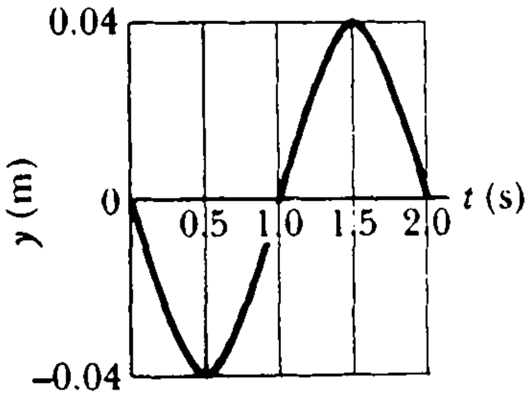

Fig. 1

Problem 2

A certain violin string is 30 cm long between its fixed ends and has a mass of 2.0 g. The "open" string (no applied finger) sounds an A note (440 Hz). (a) To play a C note (523 Hz), how far down the string must one place a finger? (b) What is the ratio of the wavelength of the string waves required for an A note to that required for a C note? (c) What is the ratio of the wavelength of the sound waves for the A note to that for the C note in air? Note that transmitting a sound signal from one medium to another does not generally change its frequency.

Problem 3

An ideal gas undergoes an adiabatic compression from $p = 1.0$ atm, $V = 1.0 \times 10^6$ L, $T = 0.0°$C to $p = 1.0 \times 10^5$ atm, $V = 1.0 \times 10^3$ L. (a) Is the gas monatomic, diatomic, or polyatomic? (b) What is its final temperature? (c) How many moles of gas are present? (d) What is the total translational kinetic energy per mole before and after the compression? (e) What is the ratio of the squares of the rms speeds before and after the compression?

Problem 4

The temperature of 3.00 mol of an ideal diatomic gas is increased by 40.0° C without the pressure of the gas changing. The molecules of the gas rotate but do not oscillate. (a) How much energy is transferred to the gas as heat? (b) What is the change in the internal energy of the gas? (c) How much work is done by the gas? (d) By how much does the translational kinetic energy of the gas increase?

Problem 5

(a) If the work function for a certain metal is 1.8 eV, what is the stopping potential for electrons ejected from the metal when light of wavelength 400 nm shines on the metal? (b) What is the maximum speed of the ejected electrons? Note that the mass of an electron is 9.11×10^{-31} kg.