University of Saskatchewan
Department of Physics and Engineering Physics
E.P. 324.3 Winter 1996
Midterm Test #2 March 7, 1996
Instructor: Dr. D. Steele

Time: 75 minutes

Answer all questions. Calculators and formula sheets may be used. Data you may need are found at the bottom of page 2.

Problem 1 (10 marks)
For the conditions shown, respond to the following questions and statements concerning application of the control-volume equation to the continuity principle.

(a) What is the value of β?
(b) Determine the value of dB_{sys}/dt.
(c) Determine the value of $\Sigma\, \beta\rho \mathbf{V}\bullet\mathbf{A}$.
(d) Determine the value of
$d/dt \int_{cv} \beta\rho\, d\forall$.

Problem 2 (15 marks)
The nozzle in the figure is shaped such that the velocity of flow varies linearly from the base of the nozzle to its tip. The diameters D and d are 3 in. and 1 in., respectively, and the nozzle length L is 18 in.. Assume a horizontal nozzle and one-dimensional flow.

(a) Given a discharge of 0.40 cubic feet per second, what is the convective acceleration midway between the base and the tip? Also, what is the local acceleration at this point?
(b) Now let the discharge vary with time as $Q = 0.20t$, where Q is in cfs and t is in seconds. What is the local acceleration midway along the nozzle when $t = 2$ s?
(c) For the unsteady flow of part (b), what is the pressure gradient midway between the base and the tip?

Problem 3 (10 marks)

A ramjet operates by taking in air at the inlet, providing fuel for combustion, and exhausting the hot gases through the outlet. The mass flow at the inlet and outlet of the ramjet is 50 kg/s (the mass-flow rate of fuel is negligible). The inlet velocity is 200 m/s. The density of the gases at the outlet is 0.25 kg/m^3, and the inlet and outlet areas are 0.5 m^2. Calculate the thrust delivered by the ramjet. The ramjet is not accelerating and the flow within the ramjet is steady.

R_{air} = 287 J/kg•K = 1716 ft•lbf/slug•ºR

ρ_{water} = 1000 kg/m^3 = 1.94 slug/ft^3.

γ_{water} = 9810 N/m^3 = 62.4 lbf/ft^3.

g = 9.81 m/s^2 = 32.2 ft/s^2.