

FEB 18 2003

RESERVE DEPT

# GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff  
School of Mechanical Engineering

**Ph.D. Qualifiers Exam - Spring Semester 2002**

**Manufacturing**

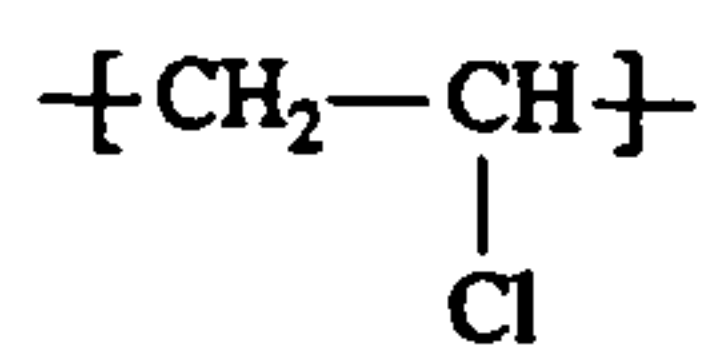
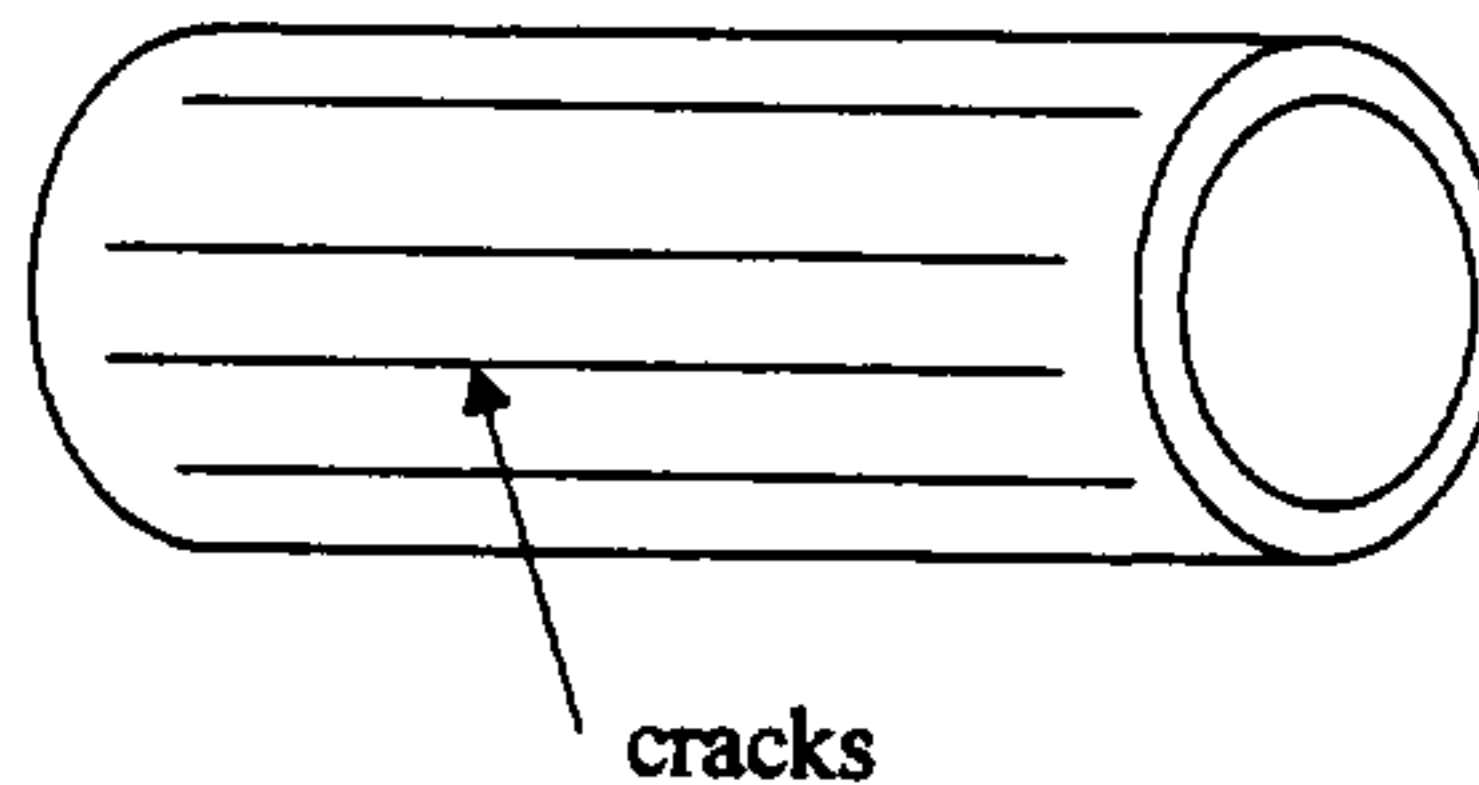
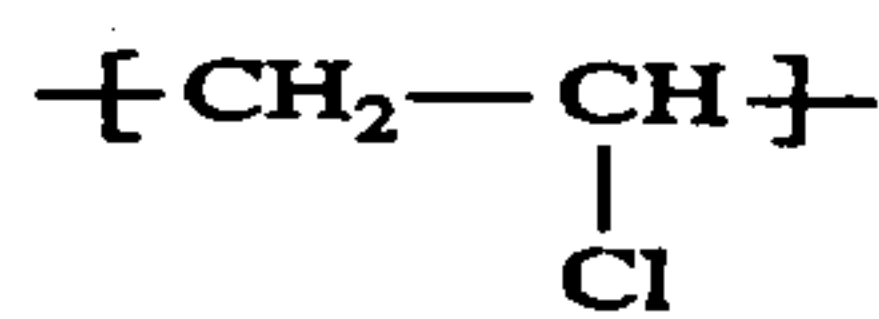
EXAM AREA

**Assigned Number (DO NOT SIGN YOUR NAME)**

- Please sign your name on the back of this page—

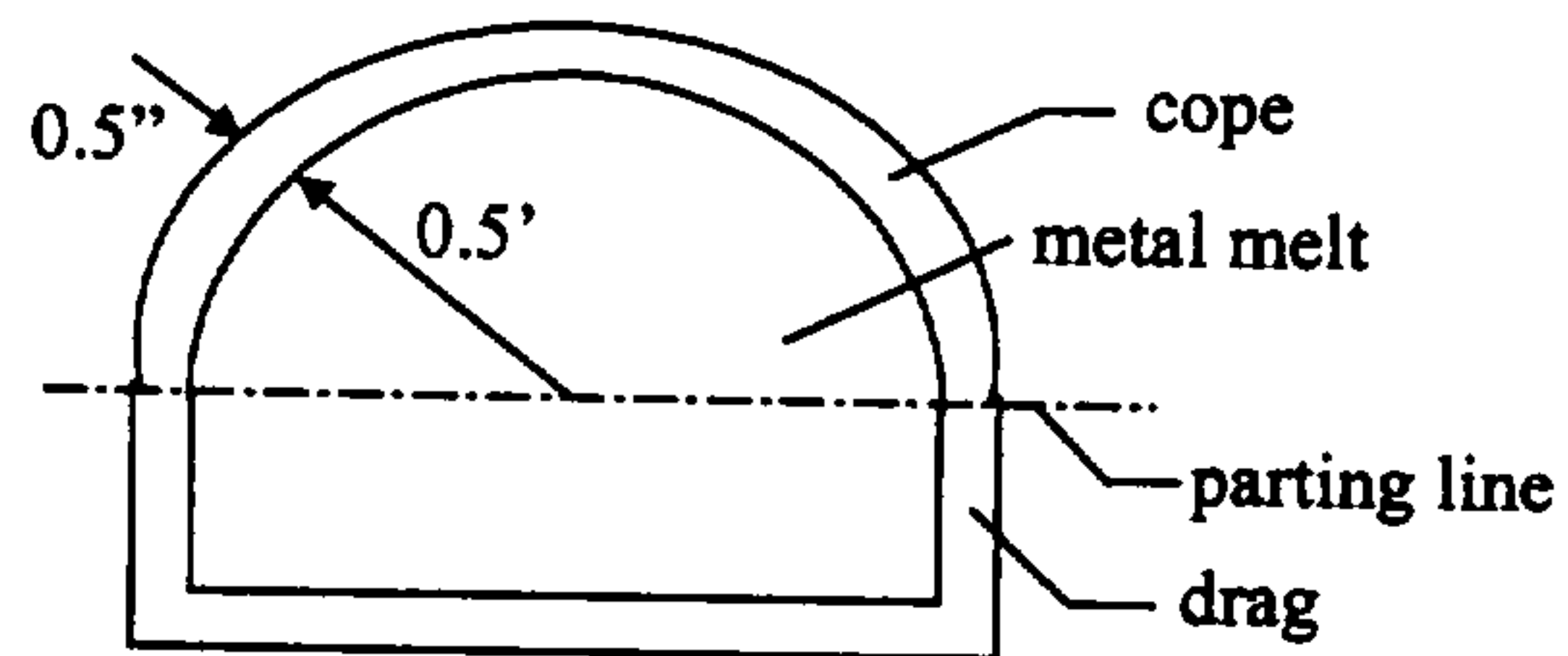
**Note:** All problems are to be answered. Show your work steps clearly. List all relevant assumptions.

- In an orthogonal cutting experiment using a sharp tool with rake angle,  $\alpha = 0$  deg., it was found that the tool-chip contact length,  $l$ , was equal to the deformed chip thickness  $t_c$ . It was also found that the frictional stress along the tool rake face,  $\tau_f$ , was constant and was a constant proportion of  $R$  of the shear strength of the work material on the shear plane,  $\tau_s$ .
  - Derive an expression for the cutting force  $F_c$  in terms of the undeformed chip thickness  $t$ , the width of cut  $w$ ,  $\tau_s$ ,  $R$ , and the shear angle  $\phi$ .
  - Apply the Minimum Work Principle to find the value of the shear angle  $\phi$ .
  - Discuss the limitations of the shear angle result found in (b) in light of the assumptions made while applying the Principle of Minimum Work.
- You are the chief engineer and one of your manufacturing engineers has brought you a piece of extruded tube. When subjected to either internal pressure or external force, it is cracking axially through the thickness of the tube (see figure below). The tube has an outer diameter of 1 inch and an inner diameter of 0.9 inches. It is made from PVC (polyvinyl chloride), which is a semi-crystalline polymer with a melting point of  $212^\circ\text{C}$  and a glass transition temperature of  $87^\circ\text{C}$ . He is at a loss as to what is causing the problem and how to solve it. Determine both for him.



**Note:** a PVC monomer is

3. A metal is to die cast in a two-part mold as shown below. The mold has a 0.5inch thickness and a specific weight of  $200\text{lb}/\text{ft}^3$ . In this case a minimum clamping force of 10lb is needed to keep the mold halves from separation. Being a tooling engineer, you are asked to re-design the mold thickness so that there is no need for clamping force in casting this part.



4. A cylindrical workpiece with initial radius of 10 mm and initial height of 2 mm is open-die forged. A load cell mounted on the press reads the forging force to be 87,142 N as the height becomes 1.9 mm and 104,708 N at 1.8 mm. If the workpiece is to be impact hammered from 2 mm height to 1.5 mm, what will be total work required (in J)? The processes involve very large plastic deformation, thus the yield strength may be considered negligible. Also the effect of friction can be ignored.