

Closed book. Clearly circle your choice. No work needs to be shown for multiple-choice questions. No partial credit is given for multiple-choice questions.

1. A  $1.0 \text{ cm}^2$  cross-sectional area steel bar is heated up such that its length extends by  $0.1 \text{ mm}$ . To extend a  $2.0 \text{ cm}^2$  cross-sectional area steel bar by  $0.1 \text{ mm}$ , it must experience a temperature change \_\_\_\_\_ the temperature change of the  $1.0 \text{ cm}^2$  cross-sectional area steel bar. (The bars have the same length.)
- (A) smaller than.  
 (B) the same as.  
 (C) larger than.  
 (D) (Not enough information is given.)



2. [3.0 points.] A metal container is filled to the brim with a liquid. If the temperature decreases, under which conditions would the liquid overflow? (There are no changes in phase.)
- (A)  $3\alpha_{\text{metal}} > \beta_{\text{liquid}}$ .  
 (B)  $3\alpha_{\text{metal}} = \beta_{\text{liquid}}$ .  
 (C)  $3\alpha_{\text{metal}} < \beta_{\text{liquid}}$ .  
 (D) (Two of the above choices.)  
 (E) (All of the above choices.)  
 (F) (None of the above choices.)

For questions (3)-(5), a  $0.50 \text{ kg}$  iron sample is at a temperature of  $15^\circ \text{C}$ , and  $1.00 \text{ kg}$  of water is at  $35^\circ \text{C}$ .

Specific heat of iron is  $440 \frac{\text{J}}{\text{kg} \cdot \text{K}}$ . Specific heat of water is  $4,190 \frac{\text{J}}{\text{kg} \cdot \text{K}}$ .

3. [3.0 points.] If the  $0.50 \text{ kg}$  iron sample at  $15^\circ \text{C}$  is placed into the  $1.00 \text{ kg}$  of water at  $35^\circ \text{C}$  to reach thermal equilibrium in an insulated container, heat will be transferred:
- (A) from the  $0.50 \text{ kg}$  iron sample to the  $1.00 \text{ kg}$  of water.  
 (B) from the  $1.00 \text{ kg}$  of water to the  $0.50 \text{ kg}$  iron sample.  
 (C) (No heat is exchanged.)  
 (D) (Not enough information is given.)
4. [3.0 points.] After reaching thermal equilibrium, the \_\_\_\_\_ had the greatest change in internal energy.
- (A)  $0.50 \text{ kg}$  iron sample.  
 (B)  $1.00 \text{ kg}$  of water.  
 (C) (There is a tie.)  
 (D) (Not enough information is given.)
5. [3.0 points.] After reaching thermal equilibrium, the \_\_\_\_\_ had the greatest change in temperature.
- (A)  $0.50 \text{ kg}$  iron sample.  
 (B)  $1.00 \text{ kg}$  of water.  
 (C) (There is a tie.)  
 (D) (Not enough information is given.)

Questions (6)-(10) are continued on the back of this page.

Equations and constants:

$$T_c = T - 273.15.$$

$$\alpha \Delta T = \frac{\Delta L}{L}; \quad 3\alpha \Delta T = \beta \Delta T = \frac{\Delta(\text{Volume})}{\text{Volume}}.$$

$$Q = mc\Delta T.$$

11.11.29