

## 2012 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS

Answer Question 5 and Question 6. The Section II score weighting for these questions is 15 percent each.

Your responses to these questions will be scored on the basis of the accuracy and relevance of the information cited. Explanations should be clear and well organized. Examples and equations may be included in your responses where appropriate. Specific answers are preferable to broad, diffuse responses.

Process	$\Delta H^\circ$ (kJ/mol <sub>rxn</sub> )
$\text{Br}_2(l) \rightarrow \text{Br}_2(g)$	30.91
$\text{I}_2(s) \rightarrow \text{I}_2(g)$	62.44

5. At 298 K and 1 atm, the standard state of  $\text{Br}_2$  is a liquid, whereas the standard state of  $\text{I}_2$  is a solid. The enthalpy changes for the formation of  $\text{Br}_2(g)$  and  $\text{I}_2(g)$  from these elemental forms at 298 K and 1 atm are given in the table above.
- (a) Explain why  $\Delta H^\circ$  for the formation of  $\text{I}_2(g)$  from  $\text{I}_2(s)$  is larger than  $\Delta H^\circ$  for the formation of  $\text{Br}_2(g)$  from  $\text{Br}_2(l)$ . In your explanation identify the type of particle interactions involved and a reason for the difference in magnitude of those interactions.
- (b) Predict which of the two processes shown in the table has the greater change in entropy. Justify your prediction.
- (c)  $\text{I}_2(s)$  and  $\text{Br}_2(l)$  can react to form the compound  $\text{IBr}(l)$ . Predict which would have the greater molar enthalpy of vaporization,  $\text{IBr}(l)$  or  $\text{Br}_2(l)$ . Justify your prediction.

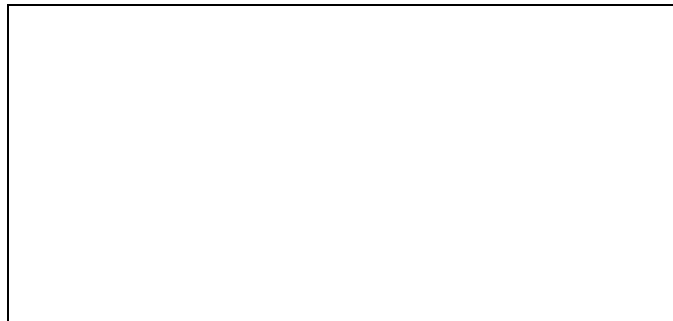
An experiment is performed to compare the solubilities of  $\text{I}_2(s)$  in different solvents, water and hexane ( $\text{C}_6\text{H}_{14}$ ). A student adds 2 mL of  $\text{H}_2\text{O}$  and 2 mL of  $\text{C}_6\text{H}_{14}$  to a test tube. Because  $\text{H}_2\text{O}$  and  $\text{C}_6\text{H}_{14}$  are immiscible, two layers are observed in the test tube. The student drops a small, purple crystal of  $\text{I}_2(s)$  into the test tube, which is then corked and inverted several times. The  $\text{C}_6\text{H}_{14}$  layer becomes light purple, while the  $\text{H}_2\text{O}$  layer remains virtually colorless.

- (d) Explain why the hexane layer is light purple while the water layer is virtually colorless. Your explanation should reference the relative strengths of interactions between molecules of  $\text{I}_2$  and the solvents  $\text{H}_2\text{O}$  and  $\text{C}_6\text{H}_{14}$ , and the reasons for the differences.

**2012 AP<sup>®</sup> CHEMISTRY FREE-RESPONSE QUESTIONS**

(e) The student then adds a small crystal of KI(*s*) to the test tube. The test tube is corked and inverted several times. The I<sup>-</sup> ion reacts with I<sub>2</sub> to form the I<sub>3</sub><sup>-</sup> ion, a linear species.

(i) In the box below, draw the complete Lewis electron-dot diagram for the I<sub>3</sub><sup>-</sup> ion.



(ii) In which layer, water or hexane, would the concentration of I<sub>3</sub><sup>-</sup> be higher? Explain.