



**SCIENCE OLYMPIAD**  
— AT THE —  
**UNIVERSITY OF FLORIDA**

Northern Regional: January 19<sup>th</sup>, 2019

# Thermodynamics C Answer Key

**Name(s):** \_\_\_\_\_

**Team Name:** \_\_\_\_\_

**School Name:** \_\_\_\_\_

**Team Number:** \_\_\_\_\_

**Rank:** \_\_\_\_\_

**Score:** \_\_\_\_\_

Science Olympiad North Florida Regional at the University of Florida  
Thermodynamics Division C Written Test 2019

ANSWER KEY

Section 1: Multiple Choice (2 points each)

- |      |       |       |       |       |       |
|------|-------|-------|-------|-------|-------|
| 1. A | 6. B  | 11. B | 16. C | 21. C | 26. B |
| 2. D | 7. C  | 12. D | 17. A | 22. C | 27. A |
| 3. C | 8. D  | 13. A | 18. C | 23. B | 28. C |
| 4. B | 9. C  | 14. D | 19. D | 24. A | 29. D |
| 5. B | 10. D | 15. A | 20. D | 25. A | 30. A |

Section 2: Free Response (7 points each)

31.  $q(\text{out}) = mC\Delta T = 102.5 \text{ g} * 4.184 \text{ J}/(\text{g } ^\circ\text{C}) * (65.6 ^\circ\text{C} - 35.0 ^\circ\text{C})$   
 $q(\text{in}) = mC\Delta T = 102.5 \text{ g} * 4.184 \text{ J}/(\text{g } ^\circ\text{C}) * (35.0 ^\circ\text{C} - 18.5 ^\circ\text{C})$   
 $q(\text{cal}) = C(\text{cal})\Delta T(\text{cal}) = C(\text{cal}) * (35 ^\circ\text{C} - 18.5 ^\circ\text{C})$   
 $q(\text{out}) - q(\text{in}) = q(\text{cal}) = C(\text{cal})\Delta T(\text{cal})$   
 $C(\text{cal}) = (q(\text{out}) - q(\text{in})) / \Delta T(\text{cal}) = 6046.9 \text{ J} / 16.5 \text{ K} = 366.5 \text{ J} / \text{K}$
32.  $q(\text{out}) = mC\Delta T = 139 \text{ g} * C * (96.4 ^\circ\text{C} - 23.7 ^\circ\text{C})$   
 $q(\text{in}) = mC\Delta T = 70.9 \text{ g} * 4.184 \text{ J}/(\text{g } ^\circ\text{C}) * (23.7 ^\circ\text{C} - 20 ^\circ\text{C})$   
 $q(\text{cal}) = C(\text{cal})\Delta T(\text{cal}) = 12.6 \text{ J}/\text{K} * (23.7 ^\circ\text{C} - 20 ^\circ\text{C})$   
 $q(\text{out}) - q(\text{in}) = q(\text{cal})$   
 $10105.3 * C - 1097.6 = 46.62$   
 $C = 0.1132 \text{ J}/(\text{g } ^\circ\text{C})$
33.  $q(\text{rxn}) = -q(\text{soln}) = -mC\Delta T$   
 $= -(62.4 \text{ mL} + 34.2 \text{ mL}) * 1.07 \text{ g}/\text{mL} * 4.184 \text{ J}/(\text{g } ^\circ\text{C}) * (28.2 ^\circ\text{C} - 25 ^\circ\text{C})$   
 $\text{mol NaCl} = 34.2 \text{ mL} * 1 \text{ L} / 1000 \text{ mL} * 0.5 \text{ mol} / \text{L}$   
 $\Delta H_{\text{rxn}} = q(\text{rxn}) / \text{mol NaCl} = -1383.89 \text{ J} / 0.0171 \text{ mol} = -80.93 \text{ kJ} / \text{mol}$
34.  $q(\text{rxn}) = -q(\text{soln}) = -mC\Delta T$   
 $= -(100.4 \text{ g} + 15.1 \text{ g}) * 4.184 \text{ J}/(\text{g } ^\circ\text{C}) * (31.64 ^\circ\text{C} - 19 ^\circ\text{C})$   
 $\Delta H_{\text{rxn}} = q(\text{rxn}) / \text{g KOH} = -6108.31 \text{ J} / 15.1 \text{ g KOH} = -404.52 \text{ J} / \text{g}$

35.  $q(\text{soln}) = 1.357 \text{ kg} * 1000 \text{ g/ kg} * 4.184 \text{ J/ (g } ^\circ\text{C)} * (32.692 \text{ } ^\circ\text{C} - 23.64 \text{ } ^\circ\text{C})$   
 $q(\text{cal}) = 0.885 \text{ kJ/ } ^\circ\text{C} * 1000 \text{ J/ kJ} * (32.692 \text{ } ^\circ\text{C} - 23.64 \text{ } ^\circ\text{C})$   
 $q(\text{rxn}) = -(q(\text{soln}) + q(\text{cal}))$   
 $\Delta E(\text{rxn}) = q(\text{rxn})/ \text{mol C}_6\text{H}_6 = -(51,394.4 \text{ J} + 8,011.02 \text{ J})/ 0.0173 \text{ mol C}_6\text{H}_6$   
 $= -3433.8 \text{ kJ/ mol}$

36.  $\text{C}_6\text{H}_6 (\text{l}) \rightarrow \text{C}_6\text{H}_6 (\text{g})$   
 $\Delta H^\circ(\text{vap}) = \Delta H_f (\text{g}) - \Delta H_f (\text{l}) = 31 \text{ kJ/ mol} = 31000 \text{ J/ mol}$   
 $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = 0$   
 $T = \Delta H^\circ/ \Delta S^\circ = 31000 \text{ (J/ mol)} / 88 \text{ (J/ (mol K))} = 352.27 \text{ K} = 79.27 \text{ } ^\circ\text{C}$