

Thermodynamics Test

Clio Invitational

January 26, 2013

School Name: _____

Team Number: _____

Variables specified:

s = specific heat

C = heat capacity

H_f = heat of fusion

H_v = heat of vaporization

Given information:

Substance	s (J/g°C)
Carbon (graphite)	0.711
Granite	0.803
Iron	0.4498
Lead	0.128
Silver	0.240
Water (ice)	2.06
Water (steam)	2.02
Water (liquid)	4.18

Substance	H_f (J/g)	H_v (J/g)
Water	334	2260

Answer the following questions to the best of your ability using the information provided. Put your school name and team number on BOTH your test booklet AND answer key. Please fill in ALL of your answers on the answer key to be graded.

1. The heat capacity of a 6 kg bar of metal is 2.01 kJ/°C. What is the specific heat of the metal in units cal/g°C?
 - a. 0.335
 - b. 4.184
 - c. 0.08
 - d. 1.40
2. How many calories are required to raise the temperature of 100.0 g of water by 100°C?
 - a. 9.990×10^3
 - b. 4.180×10^4
 - c. 41.80
 - d. 9.990
3. Water was heated in a pot on a stove from 55°F to 212°F. Calculate the final temperature of the water in Kelvin.
 - a. 70
 - b. 100
 - c. 13
 - d. 87
4. The specific heat of 50 g of copper is 0.385 J/g°C. What is the specific heat of 175 g of copper in J/g°C?
 - a. 19.25
 - b. 67.38
 - c. 48.13
 - d. 0.385
5. How many Calories are in 900 kJ?
 - a. 21.5×10^2
 - b. 215×10^3
 - c. 215
 - d. 2.15×10^5
6. You were given a 15 g sample of an unknown substance at 85°C and added it to a Styrofoam cup holding 400 g of water at 20°C. The final system temperature was 24°C. Which unknown substance were you given?
 - a. Substance A: $s = 7.31 \text{ J/g}^\circ\text{C}$
 - b. Substance B: $s = 0.36 \text{ J/g}^\circ\text{C}$
 - c. Substance C: $s = 4.18 \text{ J/g}^\circ\text{C}$
 - d. Substance D: $s = 5.25 \text{ J/g}^\circ\text{C}$
7. If 7 g of water at 2°C is mixed with 14 g of water at 21°C, what is the final temperature of the mixture?
 - a. 10°C

- b. 15°C
 - c. 20°C
 - d. 25°C
8. Suppose object A has two times the specific heat and two times the mass of object B. If the same amount of heat is applied to both objects, how will the temperature change of A be related to the temperature change of B?
- a. $2 \Delta T_A = \Delta T_B$
 - b. $\Delta T_A = \Delta T_B$
 - c. $\Delta T_A = 4 \Delta T_B$
 - d. $4 \Delta T_A = \Delta T_B$
9. The quantity of heat that will raise the temperature of 1 g of a substance by 1°C is:
- a. Heat capacity
 - b. Specific heat
 - c. Molar heat capacity
 - d. Work
10. If a system performs 60 J of work and receives 30 J of heat, what is the ΔE for this change?
- a. 30 J
 - b. 90 J
 - c. -90 J
 - d. -30 J

Use the following information for questions 11-14.

A 15 g mass of metal was heated to 95°C and dumped into 100 g of water at 30°C. The temperature of the water increased to 32°C.

11. How many joules did the water absorb?
- a. 945
 - b. 836
 - c. 1425
 - d. 200
12. How many joules did the metal lose?
- a. 945
 - b. 836
 - c. 1425
 - d. 200
13. What is the heat capacity of the metal in J/°C?
- a. 22.6
 - b. 0.884

- c. 0.158
 - d. 13.3
14. What is the specific heat of the metal in J/g°C?
- a. 22.6
 - b. 0.884
 - c. 0.158
 - d. 13.3
15. What is the meaning of a positive value for heat?
- a. Substance experienced a fall in temperature.
 - b. The mass of the substance was very large.
 - c. The heat was gained by the substance from the surroundings.
 - d. The specific heat of the substance was very small.
16. What is the SI unit for energy?
- a. kilocalorie
 - b. calorie
 - c. joule
 - d. kilojoule
17. What equation does the First Law of Thermodynamics define?
- a. $q = ms\Delta T$
 - b. $\Delta U = q + w$
 - c. $\Delta H = H^\circ_{\text{products}} - H^\circ_{\text{reactants}}$
 - d. $\Delta T = T_f - T_i$
18. How are heat capacity and specific heat related?
- a. $C = ms\Delta T$
 - b. $C = s/\Delta T$
 - c. $C = ms$
 - d. $C = m\Delta T$
19. A container holding 5.00 kg of water experienced a decrease in temperature from 99.85°C to 94.00°C. How much energy has left the water in kJ?
- a. 29.25
 - b. 122265
 - c. 29250
 - d. 122.27

For questions 20-23:

The temperature of 0.375 kg of water was raised from 216K to 240K. How much energy was transferred into the water in:

20. joules?

- a. 8991
- b. 37620
- c. 8.99
- d. 37.62

21. kilojoules?

- a. 8991
- b. 37620
- c. 8.99
- d. 37.62

22. calories?

- a. 8991
- b. 37620
- c. 8.99
- d. 37.62

23. kilocalories?

- a. 8991
- b. 37620
- c. 8.99
- d. 37.62

24. For an exothermic reaction, ΔH is:

- a. Positive
- b. Negative
- c. Not enough information

25. Calculate the molar heat capacity of silver in J/mol°C.

- a. 25.88
- b. 0.240
- c. 0.002
- d. 6.19

26. A gallon bottle of water with a temperature of 90°C is packaged with a gallon bottle of water at a temperature of 40°C. If no heat escapes to the surroundings, what will the final temperature of each bottle of water be at equilibrium?

- a. 50°C
- b. 55°C
- c. 60°C
- d. 65°C

27. What is the symbol for heat?

- a. w

- b. E
- c. Q
- d. C

28. How much heat (in J) is released by 35 g of water if its temperature is decreased from 90°C to 20°C?

- a. 10241
- b. 10.2
- c. 2450
- d. 146.3

29. True or false: at the site of a state change on a heat curve, heat is applied to the system, but the temperature does not increase.

- a. true
- b. false

30. Calculate the energy needed to heat 3 g of ice at -10°C to steam at 150°C.

- a. 2006 J
- b. 6780 J
- c. 7782 J
- d. 9401 J

31. Water boils at 100°C with a molar heat of vaporization of + 43.9 kJ. What is the entropy change when:
 $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$ at 100°C?

- a. insufficient information.
- b. -439 J/K
- c. +0.439 J/K
- d. -118 J/K

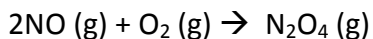
32. Which of the following describes a system that CANNOT be spontaneous?

- a. ΔH is positive and ΔS is negative.
- b. ΔH is positive and ΔS is positive.
- c. ΔH is negative and ΔS is negative.
- d. ΔH is negative and ΔS is positive.

33. Given the following thermochemical data:

$$\text{N}_2\text{O}_4(\text{g}) \rightarrow 2\text{NO}_2(\text{g}) \quad \Delta H = +57.93 \text{ kJ}$$
$$2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g}) \quad \Delta H = -113.14 \text{ kJ}$$

Determine the heat of reaction for:



- a. +171.07 kJ

- b. -55.21 kJ
 - c. -171.07 kJ
 - d. +55.21 kJ
34. If 100mL of water at 50°C are put over a low flame for two minutes...
- a. the average velocity of the particles will increase.
 - b. the temperature will increase.
 - c. the total heat energy of the sample will increase.
 - d. all of the above will occur.
35. Which of the following does not represent an increase in entropy?
- a. a gas changing into a liquid
 - b. a solid changing into a liquid
 - c. a solute dissolving in water
 - d. water being heated
36. Which of the following is not involved in the calculation of heat absorbed as a substance melts?
- a. change in temperature
 - b. heat of fusion of the substance
 - c. mass of the substance
37. A process that absorbs heat from its surroundings is said to be...
- a. endothermic
 - b. exothermic
 - c. thermochemical
 - d. none of the above
38. Given the equation $2\text{Mg (s)} + \text{O}_2 \text{ (g)} \rightarrow 2\text{MgO (s)} + 72.3 \text{ kJ}$, which of the following is true?
- a. $\Delta H = +72.3 \text{ kJ}$
 - b. $\Delta H = -72.3 \text{ kJ}$
 - c. the reaction is endothermic
 - d. the system is drawing heat from the surroundings
39. Given the equation mentioned in the above question, how much heat would be involved in the formation of 4.0 mol of MgO (s)?
- a. 144.6 kJ
 - b. 180 kJ
 - c. 36 kJ
 - d. 72 kJ
40. A metal weighing 50.0 g absorbs 220.0 J of heat when its temperature increases by 120.0°C. What is the specific heat of the metal in J/g°C?

- a. 0.673
 - b. 0.367
 - c. 0.937
 - d. 0.132
41. In which of the following states does a given substance have the highest entropy?
- a. gas
 - b. liquid
 - c. solid
 - d. the entropy for these states are all the same
42. In which of these systems is the entropy decreasing?
- a. a gas condensing to a liquid
 - b. a solid decomposing into a liquid and a gas
 - c. salt dissolving in water
 - d. snow melting
43. The characteristics that make a reaction most likely be spontaneous are...
- a. $-\Delta H$, $-\Delta S$
 - b. $-\Delta H$, $+\Delta S$
 - c. $+\Delta H$, $-\Delta S$
 - d. $+\Delta H$, $+\Delta S$
44. A reaction is most likely to be spontaneous when during the course of a reaction:
- a. the energy content and the entropy decreases
 - b. the energy content and the entropy increase
 - c. the energy content decrease and the entropy increases
 - d. the energy content increase and the entropy decreases
45. Doing which of the following generally increases the entropy of a substance?
- a. Freezing it
 - b. Dissolving it in water
 - c. Condensing it
 - d. All of the above
46. How much heat is released when 108 g of water at 0°C freezes to ice at 0°C ?
- a. 18.0 kJ
 - b. 6.00 kJ
 - c. 649 kJ
 - d. 36.1 kJ
47. The temperature of an 8.0 g sample of metal changed from 25°C to 50°C when it absorbed 420 J of heat. What is the specific heat of the metal (in $\text{J/g}^{\circ}\text{C}$)?
- a. 130

- b. 2.1
- c. 1300
- d. 0.48

48. At room temperature, a reaction is not spontaneous. At an elevated temperature, however, the reaction is spontaneous. Which of the following describes the system?

- | | ΔS | ΔH |
|----|------------|------------|
| a. | positive | positive |
| b. | positive | negative |
| c. | negative | positive |
| d. | negative | negative |

49. Two water-based solutions are mixed and a reaction occurs. The temperature of the water-based solutions increases from 25°C to 27°C. Given that the total mass of the water is 75 grams, what quantity of heat was generated in this reaction to cause the temperature change?

- a. 125 J
- b. 314 J
- c. 6.27 J
- d. 627 J

50. Convert 476 K to Fahrenheit.

- a. 203°F
- b. 397°F
- c. 365°F
- d. 95°F