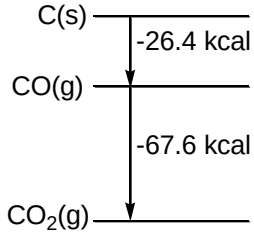
SC2 – O'Malley SAT II Review (Thermochemistry & Equilibrium)

For 1-3: Refer to the following potential energy diagram & the choices below:



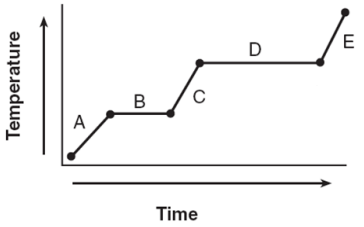
a. -94.0 kcal
b. -26.4 kcal
c. -67.6 kcal
d. $C(s) + \frac{1}{2}O_2(g)$
e. $CO_2(g)$

1. What is the ΔH of the reaction to form CO from $C + O_2$

2. What is the ΔH of the reaction to form CO_2 from $CO + O_2$

3. What is the ΔH of the reaction to form CO_2 from $C + O_2$

For 4 – 6: Refer to the heating curve:

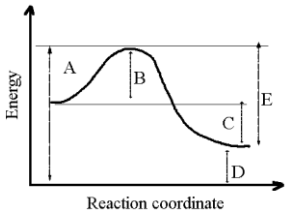


4. In which part of the curve is the state only a solid?

5. In which part is the heat to change the state greatest?

6. In which part is the heat to change the temperature greatest?

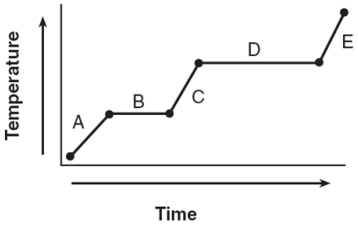
For 7 – 8:



7. Which letter shows the potential energy of the products?

8. Which letter shows the enthalpy change (ΔH) of the reaction?

For 9 – 13: Refer to the heating curve for H_2O below:



9. Where is the temperature of H_2O changing at 1 °C/g•cal?

10. Which region indicates a solid?

11. Which region indicates a liquid?

12. Which region indicates a gas?

13. Which region indicates a liquid and a gas?

Q	Statement I	Because	Statement II
14.	An exothermic reaction has a positive ΔH	Because	Heat is released in an exothermic reaction
15.	A calorimeter can be used to measure the amount of heat lost or absorbed in a process	Because	Calorimeters can be used to measure heat lost or gained by a system and its surroundings
16.	The freezing of water is an exothermic process	Because	Energy is released when covalent bonds are formed
17.	An increase in entropy leads to a decrease in randomness	Because	The low energy state of ordered crystals has a high entropy
18.	An exothermic reaction has a positive ΔH value	Because	Heat must be added to an exothermic reaction for the reaction to occur
19.	Covalent bonds must be broken for a liquid to boil	Because	Heat is released when a liquid changes into a gas
20.	The temperature of a substance always increases as heat energy is added to it	Because	The average kinetic energy of the particles in a system increases with an increase in temperature

21. How much heat is given off when 8 g of hydrogen reacts in: $2H_2 + O_2 \rightarrow 2H_2O$; ΔH = -115.60 kcal
a. -57.8 kcal
b. -115.6 kcal
c. -173.4 kcal
d. -231.2 kcal
e. -462.4 kcal

22. A reaction that absorbs heat is
a. endothermic
b. an equilibrium process
c. spontaneous
d. non-spontaneous
e. exothermic

23. The change in heat energy for a reaction is best expressed as a change in
a. Enthalpy (H)
b. Absolute temperature (T)
c. Specific heat (c)
d. Entropy (S)
e. Kinetic energy (KE)

24. When 1 mole of sulfur burns to form SO_2, 1300 calories are released. When 1 mole of sulfur burns to form SO_3, 3600 calories are released. What is ΔH when 1 mole of SO_2 burns to form SO_3?
a. 3900 cal
b. -1950 cal
c. 1000 cal
d. -500 cal
e. -2300 cal

25. When the temperature of a 20 gram sample of water is increased from 10°C to 30°C, the heat absorbed by the water is
a. 600 cal b. 30 cal
c. 400 cal d. 20 cal
e. 200 cal

26. How many g of CH_4 produce 425.6 kcal in: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 212.8$ kcal
a. 8 g b. 16 g
c. 24 g d. 32 g
e. 64 g

27. 10 g of liquid at 300 K are heated to 350 K. The liquid absorbs 6 kcal. What is the specific heat of the liquid (in cal/g°C)?
a. 6 b. 120
c. 12 d. 600
e. 60

28. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) +$ 800 kJ. If a mole of $O_2(g)$ is consumed in the reaction, what energy is produced?
a. 200 kJ
b. 400 kJ
c. 800 kJ
d. 1200 kJ
e. 1600 kJ

29. What is ΔH_{rxn} for the decomposition of 1 mole of $NaClO_3$? ΔH_f = -85.7 kcal/mol for $NaClO_3(s)$ and ΔH_f = -98.2 kcal/mol for NaCl(s)
a. -183.9 kcal
b. -91.9 kcal
c. +45.3 kcal
d. +22.5 kcal
e. -12.5 kcal

Compound	ΔH_f (kcal/mol)
$H_2O(g)$	-57.8
$C_2H_4(g)$	12.5
$CO_2(g)$	-94.1

30. What is the heat of combustion of one mole of C_2H_4?
a. +316.3 kcal
b. -12.5 kcal
c. -291.3 kcal
d. -316.3 kcal
e. -57.8 kcal

31. Given $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s) +$ 822 kJ, how much heat is released if 0.5 mol of sodium reacts completely with chlorine?
a. 205.5 kJ b. 411 kJ
c. 822 kJ d. 1644 kJ
e. 3288 kJ

Q	Statement I	Because	Statement II
1.	In the system $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ decreasing the pressure will not cause a shift in position of the equilibrium	Because	There is no net change in the number of moles of gas from one side of the reaction to another.
2.	When the temperature of a reaction at equilibrium is increased, the equilibrium will shift to favor the endothermic direction	Because	Endothermic reactions involve heat acting as a reactant and Le Chatelier's principle states that an equilibrium shift will occur to offset temperature changes

3. $BaCl_2$ dissociates in water to give one Ba^{2+} ion and two Cl^- ions. If concentrated HCl is added to this solution:
   a. $[Ba^{2+}]$ increases
   b. $[OH^-]$ increases
   c. $[Ba^{2+}]$ remains constant
   d. $[H^+]$ decreases
   e. the number of moles of undissociated $BaCl_2$ increases

4. Consider: $H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$ The concentrations of H_2, Br_2 and HBr are 0.05 M , 0.03 M, and 500.0 M. The equilibrium constant for this reaction at 400 ^oC is 2.5×10^3. Is this system at equilibrium?
   a. Yes, the system is at equilibrium
   b. No, the reaction must shift to the right in order to reach equilibrium
   c. No, the reaction must shift to the left in order to reach equilibrium
   d. It cannot be determined
   e. The reaction will never be at equilibrium

5. A chemist interested in the reactivity of iodine concentrates his study on the decomposition of gaseous hydrogen iodide: $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ What is the equilibrium expression for this reaction?
   a. $[H_2]^2[I_2]$
   b. $[H_2]$
   c. $[H_2][I_2]/[HI]^2$
   d. $[H_2][I_2]^2$
   e. $[H_2]^2[I_2]^2$

6. An equilibrium expression may be forced to completion by
   a. adding a catalyst
   b. increasing the pressure
   c. increasing the temperature
   d. removing the products from the reaction mixture as they are formed
   e. decreasing the reactant concentration

7. The Haber process is used for producing ammonia from nitrogen and hydrogen. This reaction could be forced to produce more ammonia by
   a. increasing the reaction pressure
   b. decreasing the reaction pressure
   c. adding a catalyst
   d. both b. and c.
   e. none of the above

8. An increase in pressure will change the equilibrium by
   a. shifting to the side where a smaller volume results
   b. shifting to the side where a larger volume results
   c. favoring the endothermic reaction
   d. favoring the exothermic reaction
   e. None of the above

9. Which statement is true for a liquid/gas mixture at equilibrium?
   a. The equilibrium constant is dependent on temperature
   b. The amount of the gas present at equilibrium is independent of pressure
   c. All interchange between the liquid and gas phases has ceased
   d. All of the above
   e. None of the above

10. The equilibrium expression, $K = [CO_2]$ represents the reaction
   a. $C(s) + O_2(g) \rightleftharpoons CO_2(g)$
   b. $CO(g) + \frac{1}{2} O_2(g) \rightleftharpoons CO_2(g)$
   c. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$
   d. $CO_2(g) \rightleftharpoons C(s) + O_2(g)$
   e. $CaO(s) + CO_2(g) \rightleftharpoons CaCO_3(s)$

11. In this equilibrium reaction: A + B $\rightleftharpoons$ AB + heat, in a closed container, how could the forward reaction rate be increased?
   i. Increasing [AB]
   ii. Increasing [A]
   iii. Removing some of AB
   a. i only
   b. iii only
   c. i and iii only
   d. ii and iii only
   e. i, ii and iii

12. An increase in pressure in the reaction $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ would
   a. produce more $I^-(aq)$
   b. produce more H_2
   c. not affect the system
   d. drive it to the right
   e. drive it to the left

1. T, T, CE
2. T, T, CE
3. E
4. C
5. C
6. D
7. A
8. E
9. A
10. C
11. D
12. C

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