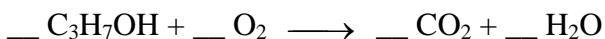


## CHM 120 UNITS 4, 5, 6 PRACTICE PROBLEMS – ANSWERS

### UNIT 4

1. The products of the combustion of propyl alcohol with oxygen gas are shown in the equation below:

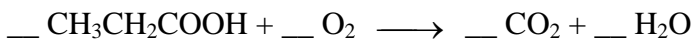


When properly balanced, the equation indicates that \_\_\_\_\_ moles of oxygen gas are required for each mole of  $\text{C}_3\text{H}_7\text{OH}$ .

- A) 3.5 B) 5.5 C) 4.5 D) 8.5 E) 10.0

Ans: C

2. Balance the following expression:

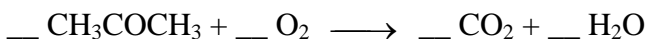


How many moles of  $\text{O}_2$  are required for the complete combustion of 6 moles of propanoic acid?

- A) 3 mol B) 33 mol C) 6 mol D) 21 mol E) 36 mol

Ans: D

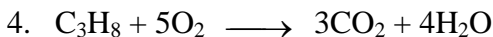
3. The products of the combustion of acetone with oxygen are shown in the following equation:



When properly balanced, the equation indicates that \_\_\_\_\_ mole(s) of  $\text{O}_2$  are required for each mole of  $\text{CH}_3\text{COCH}_3$ .

- A) 1 B) 8 C) 4.5 D) 6 E) 4

Ans: E



How many grams of oxygen are required to burn 5.1 g of  $\text{C}_3\text{H}_8$ ?

- A) 3.7 g B) 69 g C) 44 g D) 19 g E) 52 g

Ans: D



How many moles of potassium carbonate will be produced if 465 g of potassium hydrogen carbonate are heated?

- A) 4.65 B) 3.36 C) 233 D) 2.32 E) 10.9

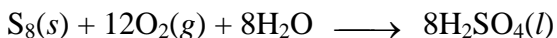
Ans: D

Calculate the number of moles of  $\text{O}_2$  required to react with phosphorus to produce 4.94 g of  $\text{P}_4\text{O}_6$ . (Molecular mass  $\text{P}_4\text{O}_6 = 219.9 \text{ g/mol}$ .)

- A) 0.0225 B) 0.135 C) 0.0674 D) 0.154 E) 0.0449

Ans: C

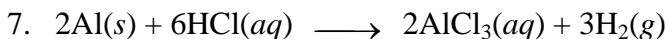
6. Elemental sulfur can be converted to sulfur trioxide by reaction with oxygen in the presence of a catalyst. Upon addition of water, sulfuric acid is produced as represented by the equation:



What minimum mass of sulfur is needed to prepare 238 g of  $\text{H}_2\text{SO}_4(l)$ ?

- A) 728 g B) 77.8 g C) 9.73 g D) 623 g E) 238 g

Ans: B

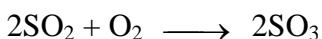


According to the equation above, how many grams of aluminum are needed to completely react with 4.80 mol of hydrochloric acid?

- A) 4.80 g B) 43.2 g C) 389 g D) 129.5 g E) 58.4 g

Ans: B

8. Sulfur trioxide,  $\text{SO}_3$ , is made from the oxidation of  $\text{SO}_2$ , and the reaction is represented by the equation

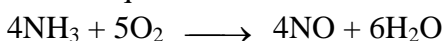


A 22-g sample of  $\text{SO}_2$  gives 18 g of  $\text{SO}_3$ . The **PERCENT YIELD** of  $\text{SO}_3$  is

- A) 28%. B) 10%. C) 16%. D) 65%. E) 100%.

Ans: D

9. Nitric oxide,  $\text{NO}$ , is made from the oxidation of  $\text{NH}_3$ , and the reaction is represented by the equation



An 9.8-g sample of  $\text{NH}_3$  gives 12.0 g of  $\text{NO}$ . The **PERCENT YIELD** of  $\text{NO}$  is

- A) 18%. B) 21%. C) 48%. D) 69%. E) 87%.

Ans: D

10. If 56.6 g of  $\text{O}_2$  are mixed with 56.6 g of  $\text{H}_2$  and the mixture is ignited, what mass of water is produced?

- A) 56.6 g B) 63.7 g C) 100.6 g D) 509 g E) 113 g

Ans: B

11. A 10.0 g sample of magnesium is completely burned in the presence of air to form magnesium oxide. The mass of magnesium oxide must be:

- A) equal to 42.0 g. D) less than 10.0 g.  
B) equal to 26.0 g. E) greater than 10.0 g.  
C) equal to 10.0 g.

Ans: E

12. How many moles of sulfate ions are there in a 0.20-L solution of 0.030 molar  $\text{Al}_2(\text{SO}_4)_3$ ?

- A) 0.0030 B) 0.0060 C) 0.012 D) 0.018 E) 0.024

Ans: D

13. What volume of 0.200-molar  $\text{Na}_2\text{CO}_3$  (FW = 106) solution contains 53.0 g of  $\text{Na}_2\text{CO}_3$ ?

- A) 0.200 L B) 0.400 L C) 0.500 L D) 1.60 L E) 2.50 L

Ans: E

14. How much 0.54 M  $\text{NaCl}$ , "physiologic saline," can be prepared via the dilution of 100 mL of a 6.0 M  $\text{NaCl}$  solution?

- A) 1.1 L B) 910 mL C) 90 mL D) 540 mL E) 1.9 L

Ans: A

15. How many moles of  $\text{KOH}$  are in 27.5 mL of 0.250 M  $\text{KOH}$ ?

- A) 0.00431 B) 0.00688 C) 0.00724 D) 0.00813 E) 0.00921

Ans: B

16. The volume of 0.150-molar  $\text{NaHCO}_3$  (FW = 84.0) solution that contains 6.30 g of  $\text{Na}_2\text{CO}_3$  is

- A) 0.200 L. B) 0.400 L. C) 0.500 L. D) 1.60 L. E) 2.50 L.

Ans: C

17. A 4.00-molar solution of  $\text{H}_3\text{PO}_4$  will contain \_\_\_\_ g of  $\text{H}_3\text{PO}_4$  in 0.500 L of solution.

- A) 196 B) 98.0 C) 49.0 D) 24.0 E) 12.0

Ans: A

18. Calculate the molarity of a solution that contains 50.0 g of  $\text{NaOH}$  in 750.0 mL of solution.

- A) 0.600 M B) 0.800 M C) 1.07 M D) 1.25 M E) 1.67 M

Ans: E

19. A student needs to prepare 2.00 L of 0.100 M  $\text{Na}_2\text{CO}_3$  (molecular mass = 106). The best procedure is to weigh out

- A) 21.2 g  $\text{Na}_2\text{CO}_3$  and add  $\text{H}_2\text{O}$  until the final homogeneous solution has a volume of 2.00 L.  
B) 10.6 g  $\text{Na}_2\text{CO}_3$  and add  $\text{H}_2\text{O}$  until the final homogeneous solution has a volume of 2.00 L.

- C) 21.2 g Na<sub>2</sub>CO<sub>3</sub> and add 2.00 kg of H<sub>2</sub>O.
- D) 10.6 g Na<sub>2</sub>CO<sub>3</sub> and add 2.00 kg of H<sub>2</sub>O.
- E) 21.2 g Na<sub>2</sub>CO<sub>3</sub> and add 2.00 L of H<sub>2</sub>O.

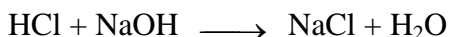
Ans: A

20. 350.0 mL of 2.50 M HCl are added to 400.0 mL of 5.00 M HCl. Assuming that the volumes are additive, the final concentration is

- A) 3.65 M. B) 3.83 M. C) 4.17 M. D) 4.33 M. E) 4.50 M.

Ans: B

21. The titration of HCl with NaOH is represented by the equation



What volume of 0.100 M HCl is required to titrate 50.0 mL of 0.500 M NaOH?

- A) 50.0 mL B) 100. mL C) 200. mL D) 250. mL E) 500. mL

Ans: D

22. What volume of acid must you use to prepare 100 mL of 0.50 M HCl from 2.00 M HCl?

- A) 25.0 mL B) 50.0 mL C) 100. mL D) 200. mL E) 400. mL

Ans: A

23. In order to dilute 40.0 mL of 0.600 M HCl to 0.100 M, the volume of water that would need to be added would be

- A) 80.0 mL. B) 100. mL. C) 160. mL. D) 200. mL. E) 240. mL.

Ans: D

24. How many grams of lithium nitrate, LiNO<sub>3</sub>, are required to prepare  $3.00 \times 10^2$  mL of  $2.00 \times 10^{-1}$  M solution?

- A) 6.32 g B) 4.14 g C) 3.62 g D) 2.08 g E) 1.04 g

Ans: B

25. What volume of 0.025 M sodium bromide, NaBr, contains  $2.0 \times 10^{-4}$  mole of Br<sup>-</sup>?

- A) 0.040 L B) 0.080 L C) 4.0 mL D) 8.0 mL E) 16 mL

Ans: D

26. Which of the following statements best describes what happens when a teaspoon of table salt, NaCl, is dissolved in a cup of warm water: (Section 4.1)

- A) The solid NaCl breaks apart into separate Na and Cl atoms by interacting with the water molecules.
- B) The salt undergoes a chemical change by reacting with the water.
- C) The water molecules surround each ion in the solid NaCl separating the Na ions from the Cl ions.
- D) The heat from the warm water melts the salt making it a liquid.
- E) Nothing happens, salt is insoluble in water.

Ans: C

## UNIT 5

27. If  $\Delta U = -65$  kJ for a certain process, that process

- A) occurs rapidly. D) cannot occur.
- B) is exothermic. E) requires a catalyst.
- C) is endothermic.

Ans: B

28. If  $\Delta U = -53$  kJ for a certain process, that process

- A) occurs slowly. D) is nonspontaneous.
- B) is exothermic. E) is spontaneous.
- C) is endothermic.

Ans: B

29. The quantity of heat needed to raise the temperature of a sample of a substance 1°C is

the sample's

A) heat capacity. B) specific heat. C) enthalpy. D) work. E) calorimetry.

Ans: A

30. The units for heat capacity are

A)  $J/(g \cdot ^\circ C)$ . B)  $(J \cdot ^\circ C)$ . C)  $(J \cdot g)$ . D)  $J/^\circ C$ . E)  $J/g$ .

Ans: D

31. The sign of  $\Delta H$  for the process  $CO_2(s) \longrightarrow CO_2(g)$  is

- positive, and the process is endothermic.
- negative, and the process is endothermic.
- positive, and the process is exothermic.
- negative, and the process is exothermic.
- impossible to predict with confidence because  $\Delta H_f^\circ$  for  $CO_2(s)$  and  $\Delta H_f^\circ$  for  $CO_2(g)$  are not given.

Ans: A

32. The amount of heat needed to raise the temperature of 65.38 g of zinc  $1^\circ C$  is called its

- A) entropy. D) heat of vaporization.  
B) specific heat. E) molar heat capacity.  
C) heat of fusion.

Ans: E

33. What is the molar heat capacity of heptane,  $C_7H_{16}$ , if its specific heat is  $2.25 J/(g \cdot ^\circ C)$ ?

- A)  $175 J/(mol \cdot ^\circ C)$  D)  $250 J/(mol \cdot ^\circ C)$   
B)  $200 J/(mol \cdot ^\circ C)$  E)  $300 J/(mol \cdot ^\circ C)$   
C)  $225 J/(mol \cdot ^\circ C)$

Ans: C

34. A 150.0-g sample of metal at  $80.0^\circ C$  is added to 150.0 g of  $H_2O$  at  $20.0^\circ C$ . The temperature rises to  $23.3^\circ C$ . Assuming that the calorimeter is a perfect insulator, what is the specific heat of the metal? [Specific heat of  $H_2O$  is  $4.18 J/(g \cdot ^\circ C)$ .]

- A)  $-0.48 J/(g \cdot ^\circ C)$  D)  $0.72 J/(g \cdot ^\circ C)$   
B)  $0.24 J/(g \cdot ^\circ C)$  E)  $0.96 J/(g \cdot ^\circ C)$   
C)  $0.48 J/(g \cdot ^\circ C)$

Ans: B

35. Consider the following specific heats of metals.

<u>Metal</u>	<u>Specific Heat</u>
copper	$0.385 J/(g \cdot ^\circ C)$
cobalt	$0.418 J/(g \cdot ^\circ C)$
chromium	$0.447 J/(g \cdot ^\circ C)$
gold	$0.129 J/(g \cdot ^\circ C)$
silver	$0.237 J/(g \cdot ^\circ C)$

100-g samples of each of the metals at  $95^\circ C$  are added to 100 mL of water at  $25^\circ C$ .

Which element will increase the temperature of the water the least?

A) copper B) cobalt C) chromium D) gold E) silver

Ans: D

36. Consider the following specific heats of metals.

<u>Metal</u>	<u>Specific Heat</u>
copper	$0.385 J/(g \cdot ^\circ C)$
magnesium	$1.02 J/(g \cdot ^\circ C)$
mercury	$0.138 J/(g \cdot ^\circ C)$
silver	$0.237 J/(g \cdot ^\circ C)$

lead 0.129 J/(g • °C)

If the same amount of heat is added to 25.0 g of each of the metals, which are all at the same temperature, which metal will have the highest temperature?

A) copper B) magnesium C) mercury D) silver E) lead

Ans: E

37. How much heat is gained by nickel when 500 g of nickel is warmed from 22.4 to 58.4°C? [The specific heat of nickel is 0.444 J/(g • °C).]

A) 2000 J B) 4000 J C) 6000 J D) 8000 J E) 10000 J

Ans: D

38. Which of the following statements is (are) **TRUE**?

The reaction vessel becomes warmer when an endothermic reaction occurs.

An exothermic reaction is characterized by a negative value of  $\Delta H$ .

Heat is evolved when an exothermic reaction occurs.

A) 1 only B) 2 only C) 1 and 2 only D) 2 and 3 only E) 1, 2, and 3

Ans: D

39. The sign of  $\Delta H$  for the process  $\text{NaCl}(s) \longrightarrow \text{NaCl}(l)$  is

a. negative, and the process is endothermic.

b. positive, and the process is exothermic.

c. positive, and the process is endothermic.

d. negative, and the process is exothermic.

e. impossible to predict because  $\Delta H^\circ$  for  $\text{NaCl}(s)$  and  $\Delta H^\circ$  for  $\text{NaCl}(l)$  are not given.

Ans: C

40. Which answer lists all the following responses that are endothermic and none that are exothermic?

1. boiling water
2. freezing water
3. condensation of steam
4. melting ice

A) 1 and 2 only

D) 1, 2, and 3 only

B) 2 and 3 only

E) 2 and 4 only

C) 1 and 4 only

Ans: C

41.  $\Delta H_{\text{fus}}$  for sulfur (S atoms) is 17.7 kJ/mol. How many grams of sulfur can be melted by 22.5 kJ of energy?

A) 9.8 g B) 19.5 g C) 26.2 g D) 40.7 g E) 52.5 g

Ans: D

42. What is the **MOLAR** heat of combustion of benzene,  $\text{C}_6\text{H}_6$ , if combustion of 1.00 g of benzene causes a temperature rise of 5.18°C in a bomb calorimeter that has a heat capacity of 8.07 kJ/°C? (Molar mass  $\text{C}_6\text{H}_6 = 78.1$ .)

A) -41.8 kJ/mol

D) -41,800 kJ/mol

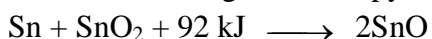
B) -3,260 kJ/mol

E) -48,700 kJ/mol

C) -4,180 kJ/mol

Ans: B

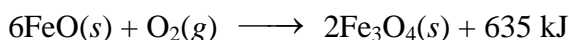
43. What is the change in enthalpy for the production of 1.00 mol SnO?



A) -184 kJ B) -92 kJ C) -46 kJ D) 46 kJ E) 92 kJ

Ans: D

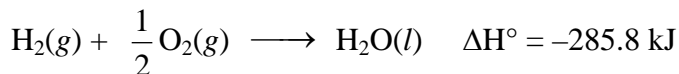
44. What is the change in enthalpy for the reaction of 4.00 mol of iron(II) oxide?



A) -635 kJ B) -423 kJ C) -106 kJ D) 106 kJ E) 635 kJ

Ans: B

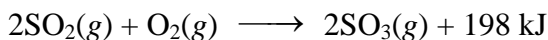
45. What is the quantity of heat evolved when 200.0 g H<sub>2</sub>O(l) is formed from the combustion of H<sub>2</sub>(g) and O<sub>2</sub>(g)?



A) 285.8 kJ B) 1590 kJ C) 3170 kJ D) 4360 kJ E) 57200 kJ

Ans: C

46. What is the change in enthalpy when 1 mol (32.0 g) of sulfur dioxide is oxidized to sulfur trioxide?



A) -198 kJ B) -198/2 kJ C) 198/2 kJ D) 198 kJ E) 198 × 2 kJ

Ans: B

47. From a consideration of the reaction



if 2.00 × 10<sup>2</sup> g of NO<sub>2</sub> were produced, then the amount of heat released should be

A) 114 kJ. B) 124 kJ. C) 248 kJ. D) 314 kJ. E) 496 kJ.

Ans: C

48. This question is concerned with the heat change when nitrogen dioxide is formed from its elements:



Therefore, 66.4 kJ is the quantity of heat that is

- lost to the surroundings when 1 mol of O<sub>2</sub> is consumed.
- lost to the surroundings when 1 mol of NO<sub>2</sub> is formed.
- gained from the surroundings when 2 mol of NO<sub>2</sub> are formed.
- gained from the surroundings when 1 mol of NO<sub>2</sub> is formed.
- lost from the surroundings when 2 mol of NO<sub>2</sub> are formed.

Ans: C

49. Which of the following has (have) a non-zero enthalpy of formation value at 25°C and 1.00 atm?

- O(g)
- O<sub>2</sub>(g)
- O<sub>3</sub>(g)

A) 1 only B) 2 only C) 3 only D) 1 and 3 only E) 1, 2, and 3

Ans: D

50. All the following have a standard enthalpy of formation value of zero at 25°C and 1.00 atm **EXCEPT**

A) CO(g). B) Fe(s). C) C(s). D) F<sub>2</sub>(g). E) Ne(g).

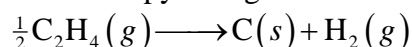
Ans: A

51. Which of the following has a standard enthalpy of formation value of zero at 25°C and 1.0 atm?

A) H<sub>2</sub>O(l) B) C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>(s) C) FeSO<sub>4</sub>(s) D) FeSO<sub>4</sub>(aq) E) S<sub>8</sub>(s)

Ans: E

52. The enthalpy change for the thermochemical equation



is -26.2 kJ. The enthalpy of formation of C<sub>2</sub>H<sub>4</sub>(g) in kilojoules per mole must be

A) -52.4. B) -26.2. C) 26.2. D) 52.4. E) 104.8.

Ans: D

53. The heat of condensation of water at 373 K is  $-40.7$  kJ/mol. When 9.00 g of water vaporizes at 373 K, the value for  $\Delta H$  is  
A)  $-366$  kJ. B)  $-81.4$  kJ. C)  $-20.4$  kJ. D)  $20.4$  kJ. E)  $81.4$  kJ.

Ans: D

54. All the following statements are true for an exothermic reaction **EXCEPT**
- the temperature of the reaction system increases.
  - the temperature of the surroundings increases.
  - heat passes from the reaction system to the surroundings.
  - the products have a higher heat content than the reactants.
  - the enthalpy change for the reaction is negative.

Ans: D

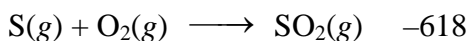
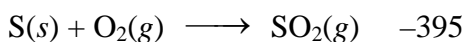
55. At  $25^\circ\text{C}$  when 1.00 g of sulfur is burned at constant pressure in an atmosphere of oxygen to give  $\text{SO}_2$ , 9.28 kJ of heat energy is liberated. The  $\Delta H_f^\circ$  of  $\text{SO}_2$  is

- A)  $-9.28 \times 1.00$  kJ/mol. D)  $-9.28 \times 32.0$  kJ/mol.  
B)  $9.28 \times 1.00$  kJ/mol. E)  $-9.28 \times 64.0$  kJ/mol.  
C)  $9.28 \times 32.0$  kJ/mol.

Ans: D

56. Given the following data,

$\Delta H^\circ$ (kJ/mol)



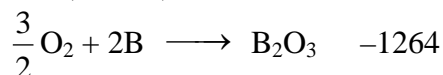
find the heat required for the reaction converting solid sulfur to gaseous sulfur at 298 K and 1 atm pressure.

- A)  $-1013$  kJ/mol D)  $-223$  kJ/mol  
B)  $+618$  kJ/mol E)  $+223$  kJ/mol  
C)  $-618$  kJ/mol

Ans: E

57. Given the following data,

$\Delta H^\circ$ (kJ/mol)

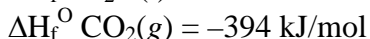
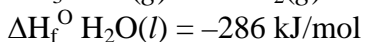


find the heat required for the reaction converting oxygen to ozone at 298 K and 1 atm pressure.

- A)  $-1406$  kJ/mol D)  $-142$  kJ/mol  
B)  $-1264$  kJ/mol E)  $+142$  kJ/mol  
C)  $-2670$  kJ/mol

Ans: E

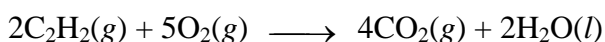
58. Calculate the standard heat of formation of acetaldehyde,  $\text{CH}_3\text{CHO}(g)$ , given the following information:



- A)  $-452$  kJ B)  $-332$  kJ C)  $-166$  kJ D)  $166$  kJ E)  $332$  kJ

Ans: C

59. For the reaction

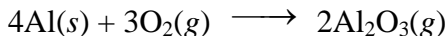


( $\Delta H_f^\circ$  in kilojoules per mole are  $O_2(g)$ , 0;  $C_2H_2(g)$ , +226.7;  $CO_2(g)$ , -393.5;  $H_2O(l)$ , -285.8), the  $\Delta H$  of reaction is

- A)  $2(-285.8) + 4(-393.5) + 2(226.7)$ .      D)  $2(285.8) + 4(393.5) - 2(226.7)$ .  
B)  $2(-285.8) + 4(-393.5) - 2(226.7)$ .      E)  $-285.8 - 393.5 + 226.7$ .  
C)  $2(285.8) + 4(393.5) + 2(226.7)$ .

Ans: B

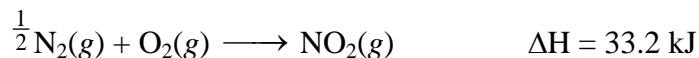
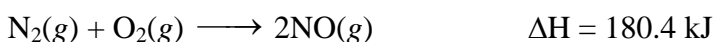
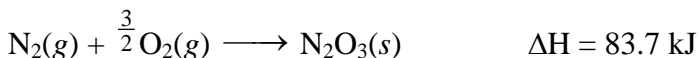
60. Calculate the amount of heat evolved in the complete oxidation of 6.44 g of Al at 25°C and 1 atm pressure. ( $\Delta H_f^\circ$  for  $Al_2O_3$  is -1676 kJ/mol.)



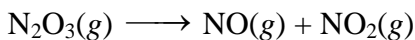
- A) 50. kJ    B) 100. kJ    C) 200. kJ    D) 400. kJ    E) 800. kJ

Ans: C

61. Given the following data:



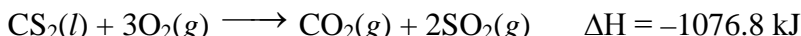
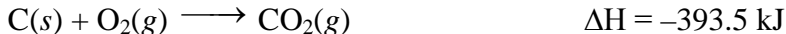
what is  $\Delta H$  for the reaction



- A) -207.1 kJ    B) -39.7 kJ    C) 24.3 kJ    D) 39.7 kJ    E) 207.1 kJ

Ans: D

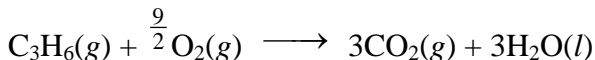
62. Calculate the standard enthalpy of formation of carbon disulfide from its elements given that



- A) -1767.1 kJ    B) -386.5 kJ    C) -89.7 kJ    D) 89.7 kJ    E) 386.5 kJ

Ans: D

63. Calculate the enthalpy change,  $\Delta H^\circ$ , for the combustion of  $C_3H_6(g)$ :



$\Delta H_f^\circ$  values in kilojoules per mole are as follows:  $C_3H_6(g) = 21$ ;  $CO_2(g) = -394$ ;  $H_2O(l) = -286$ .

- A) -2061 kJ    B) -2019 kJ    C) -701 kJ    D) 2019 kJ    E) 2061 kJ

Ans: A

64. Calculate the standard heat of formation,  $\Delta H_f^\circ$ , of  $CH_3OH(l)$  from the measured heat of combustion of  $CH_3OH(l)$  and the other tabulated  $\Delta H_f^\circ$  values:

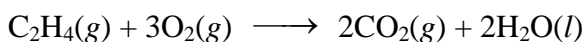
$\Delta H_f^\circ$   $CO_2(g) = -394$  kJ/mol and  $\Delta H_f^\circ$   $H_2O(l) = -286$  kJ/mol.



- A) -478 kJ    B) -239 kJ    C) -178 kJ    D) 239 kJ    E) 478 kJ

Ans: B

65. Using the following data, determine the heat of reaction for the combustion of 1 mol of ethylene,  $C_2H_4$ .





Ans: A

70. All of the following statements are **TRUE EXCEPT**
- the value of  $q$  is positive when heat flows into a system from the surroundings.
  - heat flows from a system into the surroundings in an endothermic process.
  - enthalpy is a state property.
  - energy is a state property.
  - the value of  $q$  is positive in an endothermic process.

Ans: B

71. The heat capacity differs from the specific heat capacity in that it depends on  
A) pressure. B) temperature. C) mass. D) ductility. E) none of these.

Ans: C

72. The phrase “the heat absorbed or released by a system undergoing a chemical change at constant pressure” is
- the definition of a state function.
  - the change in enthalpy of the system.
  - a statement of Hess’s law.
  - the change in internal energy of the system.
  - the temperature change of the system.

Ans: B

## UNIT 6

73. The relationship between the speed, wavelength, and frequency of electromagnetic radiation is

A)  $v = \frac{c}{\lambda}$ . B)  $v = \frac{\lambda}{c}$ . C)  $v = c + \lambda$  D)  $v = \frac{\lambda + c}{\lambda}$ . E)  $v = 1 + \frac{\lambda}{c}$ .

Ans: A

74. Which radiation has the lowest energy?

A) gamma rays B) x-rays C) blue light D) red light E) radio waves

Ans: E

75. Which radiation has the longest wavelength?

A) gamma rays B) x-rays C) blue light D) red light E) microwaves

Ans: E

76. Which of these types of radiation has the highest frequency?

A) radio waves B) infrared C) microwaves D) ultraviolet E) visible

Ans: D

77. Rank the following regions of the electromagnetic spectrum in order of decreasing energy.

- X-rays, Microwaves, Infrared, Ultraviolet
- x-rays, microwaves, infrared, ultraviolet
- microwaves, ultraviolet, infrared, x-rays
- microwaves, infrared, ultraviolet, x-rays
- infrared, microwaves, ultraviolet, x-rays
- x-rays, ultraviolet, infrared, microwaves

Ans: E

78. Calculate the energy (joules per particle) of a photon of wavelength 25.8 nm. (Planck’s constant is  $6.63 \times 10^{-34} \text{ J} \cdot \text{s}$ .)

A)  $1.30 \times 10^{17} \text{ J/particle}$  D)  $7.71 \times 10^{-15} \text{ J/particle}$   
B)  $1.30 \times 10^{13} \text{ J/particle}$  E)  $7.71 \times 10^{-18} \text{ J/particle}$   
C)  $7.71 \times 10^{-11} \text{ J/particle}$

Ans: E

79. According to the quantum theory, what is the energy contained in a single quantum of light with a frequency of  $2.64 \times 10^{14} \text{ s}^{-1}$ ? (Planck’s constant is  $6.63 \times 10^{-34} \text{ J} \cdot \text{s}$ .)



A) Rutherford B) de Broglie C) Bohr D) Thomson E) Heisenberg

Ans: A

89. Which quantum number distinguishes the different shapes of the orbitals?

A)  $n$  B)  $l$  C)  $m_s$  D)  $m_l$  E) any of these

Ans: B

90. All the following statements about the quantum numbers are true **EXCEPT**

- $n$  has integral values from 1 to  $\infty$ .
- $l$  has values from 1 to  $n - 1$ .
- $m_l$  has  $2l + 1$  values.
- $m_l$  has values of  $+l$  to  $-l$ , including zero.
- $m_s$  has values of  $+\frac{1}{2}$  and  $-\frac{1}{2}$ .

Ans: B

91. 28. The angular momentum quantum number is best associated with the

- energy of the orbit.
- energy of the orbital.
- number of orbitals in a sub-energy level.
- orientation in space of an orbital.
- shape of the orbital.

Ans: E

92. How many values are there for the magnetic quantum number when the value of the angular momentum quantum number is 3?

A) 2 B) 3 C) 12 D) 15 E) 7

Ans: E

93. The contribution for which de Broglie is remembered in modern science is

- his statement that an electron can exist in an atom only in discrete energy levels.
- his statement that no electron can have identical values for all four quantum numbers.
- his proposal that particles of matter should be associated with wavelike behavior.
- his statement that elements show periodic repetition of properties.
- his statement that electrons occupy all the orbitals of a given sublevel singly before pairing begins.

Ans: C

94. Which of the following statements is (are) true?

- An excited atom can return to a higher energy level by emitting light energy.
- An atom can be excited to a higher energy level by absorption of light energy.
- The frequency and wavelength of light are inversely proportional.

A) 1 only B) 2 only C) 1 and 3 only D) 2 and 3 only E) 1, 2, and 3

Ans: D

95. Which of the following sets of quantum numbers ( $n, l, m_l, m_s$ ) is **NOT** permissible?

- |                          |                          |
|--------------------------|--------------------------|
| A) 1 0 0 $+\frac{1}{2}$  | D) 2 1 -1 $+\frac{1}{2}$ |
| B) 4 2 -1 $-\frac{1}{2}$ | E) 2 1 0 $+\frac{1}{2}$  |
| C) 2 2 1 $+\frac{1}{2}$  |                          |

Ans: C

96. Which of the following combinations of quantum numbers are permissible?

$n$	$l$	$m_l$	$m_s$
1.	3	3	1 $-\frac{1}{2}$
2.	4	3	0 $-\frac{1}{2}$
3.	3	2	1 $+\frac{1}{2}$

A) 1 only B) 2 only C) 3 only D) 1 and 2 only E) 2 and 3 only

Ans: E

97. All the following statements are true **EXCEPT**
- the  $n = 2$  energy level has d orbitals.
  - the 2p orbitals can have a maximum of 6 electrons.
  - the s orbital has a spherical shape.
  - there are 5 d orbitals in a set.
  - the fourth major energy level has one set of f orbitals.

Ans: A

98. Who postulated that energy is radiated only when an electron falls from a higher energy level to a lower energy level?  
A) Einstein B) Rutherford C) Heisenberg D) Millikan E) Bohr

Ans: E

99. It has been shown experimentally that a beam of electrons can be diffracted. This is evidence that electrons
- |                              |                              |
|------------------------------|------------------------------|
| A) have wave properties.     | D) are lost by atoms.        |
| B) are negative.             | E) have magnetic properties. |
| C) are lighter than protons. |                              |

Ans: A

100. What orbital has the quantum numbers  $n=4, l=2, m_l=-1$ ?

A) s B) p C) d D) f E) g

Ans: C

101. Which of the following orbital representations is (are) allowed?

- 3s
- 3p
- 3d

A) 1 only B) 2 only C) 3 only D) 1 and 2 only E) 1, 2, and 3

Ans: E

102. Which quantum number(s) determine(s) the shape of an atomic orbital?

- n
- l
- $m_l$

A) 1 only B) 2 only C) 3 only D) 1 and 2 only E) 1, 2 and 3

Ans: B

103. Which of the following sets of quantum numbers ( $n, l, m_l, m_s$ ) refers to a 3d orbital?

A) 2 1 0 $+\frac{1}{2}$	D) 4 3 2 $+\frac{1}{2}$
B) 3 2 2 $+\frac{1}{2}$	E) 5 4 3 $+\frac{1}{2}$
C) 4 2 -2 $+\frac{1}{2}$	

Ans: B

104. The number of orbitals having a given value of l is equal to

A)  $2l + 1$ . B)  $2n + 1$ . C)  $2m_l + 1$ . D)  $n + m_l$ . E)  $l + m_l$ .

Ans: A

105. Which one of the orbital occupancy designations shown below does **NOT** make sense?

A)  $2s^1$  B)  $3d^{10}$  C)  $4p^7$  D)  $4f^7$  E)  $2p^6$

Ans: C

106. The value of the quantum number, l, for a 4f electron is

A) 0. B) 1. C) 2. D) 3. E) 4.

Ans: D

107. The maximum number of electrons that can occupy the 5d orbitals is

A) 6. B) 10. C) 14. D) 18. E) 25.

Ans: B

108. What is the maximum number of electrons in  $n = 3$ ?

A) 3 B) 5 C) 7 D) 9 E) 18

Ans: E

109. The number of orbitals in an f ( $l = 3$ ) subenergy level is

A) 1. B) 3. C) 5. D) 7. E) 14.

Ans: D

110. The maximum number of electrons in a 4d subshell is

A) 1. B) 3. C) 5. D) 8. E) 10.

Ans: E

111. A possible value of the magnetic quantum number  $m_l$  for a 5p electron is

A) -5. B) 4. C) 1. D) -3. E) -6.

Ans: C

112. How many orbitals have the following set of quantum numbers:  $n = 3, l = 1$ ?

A) 1 B) 5 C) 3 D) 7 E) 9

Ans: C