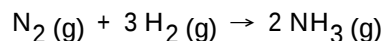


MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) In the synthesis of ammonia gas from nitrogen and hydrogen,

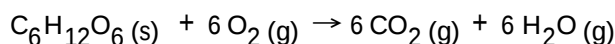


what is the maximum volume, in liters, of NH_3 that can be formed from 15.0 L of H_2 ?

- A) 7.50 B) 30.0 C) 15.0 D) 22.5 E) 10.0

Answer: E

- 2) The heat capacity of a bomb calorimeter is found to be $5.68 \text{ kJ } ^\circ\text{C}^{-1}$. When a 1.652 g sample of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, is burned in the calorimeter, the temperature of the calorimeter increases from 24.56°C to 29.10°C . Calculate the ΔH for the following reaction:



- A) -25.8 kJ
B) -42.6 kJ
C) 25.8 kJ
D) -2.81×10^3 kJ
E) 15.6 kJ

Answer: D

- 3) The correct equation for which the enthalpy change defines the standard enthalpy of formation for $\text{C}_2\text{H}_5\text{OH} (\text{l})$ is:

- A) $\text{CH}_3\text{CHO} (\text{l}) + \text{H}_2 (\text{g}) \rightarrow \text{CH}_3\text{CH}_2\text{OH} (\text{l})$
B) $\text{CH}_2=\text{CH}_2 (\text{g}) + \text{H}_2\text{O} (\text{l}) \rightarrow \text{CH}_3\text{CH}_2\text{OH} (\text{l})$
C) $2 \text{C} (\text{gr}) + 6 \text{H} (\text{g}) + \text{O} (\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH} (\text{l})$
D) $2 \text{C} (\text{gr}) + 3 \text{H}_2 (\text{g}) + \frac{1}{2} \text{O}_2 (\text{g}) \rightarrow \text{C}_2\text{H}_5\text{OH} (\text{l})$
E) $4 \text{C} (\text{gr}) + 6 \text{H}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightarrow 2 \text{CH}_3\text{CH}_2\text{OH} (\text{l})$

Answer: D

- 4) A 258-mL sample of MEK, an industrial solvent, is found to have a mass of 0.599 g at 0.988 atm and 100°C . What is the molar mass of MEK?

- A) 58.0 B) 72.0 C) 88.0 D) 98.0 E) 122

Answer: B

- 5) What is the definition of a compound in Dalton's Atomic Theory?

- A) All compounds are alike in mass and other properties.
B) Compounds are formed when atoms of different elements unite in the same proportions.
C) The relative numbers of each kind of atom in a compound form a simple ratio.
D) All compounds contain the same numbers of protons and neutrons.
E) Compounds are composed of divisible small particles.

Answer: C

6) Which is correct regarding an endothermic reaction?

- A) The sign of the ΔH is positive.
- B) The reaction liberates heat.
- C) The temperature increases when the reaction is carried out in a calorimeter.
- D) The reaction does not occur.
- E) The enthalpy of the reactants is higher than the enthalpy of the products.

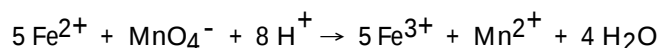
Answer: A

7) When 10 g samples of the following materials absorb 100 J of heat, the temperature increase indicated is observed. Which material has the largest specific heat?

- A) water, 2 K
- B) wood, 6 K
- C) cement, 11 K
- D) glass, 12 K
- E) copper, 26 K

Answer: A

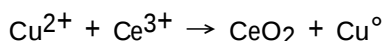
8) A 1.45 g sample of an iron ore is dissolved in acid and the iron obtained is $\text{Fe}^{2+}(\text{aq})$. To titrate the solution, 21.6 mL of 0.102 M $\text{KMnO}_4^- (\text{aq})$ is required. What is the percent of iron in the ore?



- A) 57.6
- B) 84.8
- C) 61.5
- D) 42.4
- E) 8.6

Answer: D

9) After balancing the following redox equation, the sum of the stoichiometric coefficients on the right hand side of the equation is:



- A) 3.
- B) 7.
- C) 11.
- D) 9.
- E) 2.

Answer: C

10) The mass of sodium chloride relative to the mass of a carbon-12 atom is expressed as the term:

- A) molecular mass
- B) formula mass
- C) empirical mass
- D) structural mass
- E) atomic mass

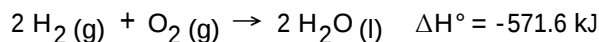
Answer: B

11) The density of an unknown element in the gaseous state is 1.60 g L^{-1} at 300 K and 1 atm. Which of the following could be the element?

- A) O_2
- B) He
- C) Cl_2
- D) Ne
- E) Ar

Answer: E

12) In light of the following thermochemical equation,



what volume of $\text{H}_2 (\text{g})$, measured at 27°C and 745 torr, must be burned in excess oxygen to release 1000. kJ of heat to the surroundings?

- A) 22.0 L B) 109 L C) 44.0 L D) 5.21×10^{-3} L E) 87.9 L

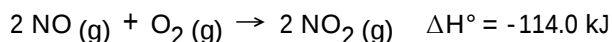
Answer: E

13) Which reaction classification is incorrectly labeled?

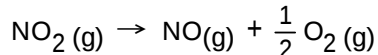
- A) $\text{Ni}^{2+} (\text{aq}) + \text{S}^{2-} (\text{aq}) \rightarrow \text{NiS} (\text{s})$, neutralization
B) $\text{H}^+ (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l})$, neutralization
C) $\text{CH}_3\text{COOH} (\text{aq}) + \text{OH}^- (\text{aq}) \rightarrow \text{H}_2\text{O} (\text{l}) + \text{CH}_3\text{COONa} (\text{aq})$, acid-base
D) $3 \text{CH}_3\text{CH}_2\text{OH} (\text{l}) + \text{Cr}_2\text{O}_7^{2-} (\text{aq}) + 8 \text{H}^+ (\text{aq}) \rightarrow 3 \text{CH}_3\text{CHO} (\text{aq}) + 2 \text{Cr}^{3+} (\text{aq}) + 7 \text{H}_2\text{O} (\text{l})$,
oxidation-reduction
E) $12 \text{H}_2\text{O} (\text{l}) + 2 \text{P}_4 (\text{s}) \rightarrow 5 \text{PH}_3 (\text{g}) + 3 \text{H}_3\text{PO}_4 (\text{aq})$, disproportionation

Answer: A

14) Given the thermochemical equation:



calculate ΔH° for the following reaction:



- A) +128 kJ B) +57.0 kJ C) -57.0 kJ D) +114.0 kJ E) -114 kJ

Answer: B

15) Calculate the molarity of Br^- ions in 250. mL of a solution containing 25.9 g NaBr and 0.155 moles of HBr.

- A) 1.00
B) 1.626
C) 1.55
D) 0.155
E) Additional information is necessary.

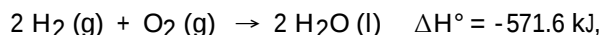
Answer: B

16) Equal moles of H_2 , N_2 , O_2 , and He are placed into separate containers at the same temperature. Assuming each gas behaves ideally, which container has the highest pressure?

- A) N_2
B) He
C) H_2
D) O_2
E) They would all exhibit the same pressure.

Answer: E

17) Given the following equation,



which statement is incorrect?

- A) The equation forming gaseous water would have a different ΔH° .
- B) ΔH° for the reverse reaction is +571.6 kJ.
- C) The standard heat of formation of liquid water is -571.6 kJ/mol.
- D) ΔH° for forming one mole of liquid water is -285.8 kJ.
- E) ΔH° for the reaction of one-half mole of oxygen is -285.8 kJ.

Answer: C

18) When an exothermic reaction is carried out in a coffee-cup calorimeter, what statement is correct?

- A) The $q_{\text{H}_2\text{O}}$ is negative.
- B) The temperature of the water decreases.
- C) The reaction absorbs heat from the water.
- D) The enthalpy of the products is lower than that of the reactants.
- E) The enthalpy change for the reaction is positive.

Answer: D

19) Which of the following reactions is not a redox reaction? Some of the reactions may not be balanced.

- A) $\text{Ni}^{2+} + \text{Fe}^{3+} \rightarrow \text{Fe}^{2+} + \text{Ni}$
- B) $2 \text{Al} + \text{Fe}_2\text{O}_3 \rightarrow 2 \text{Fe} + \text{Al}_2\text{O}_3$
- C) $\text{Bi}^{3+} + \text{Fe}^{3+} \rightarrow \text{BiO}_3^- + \text{Fe}^{2+}$
- D) $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
- E) $\text{NH}_3 + \text{NO} \rightarrow \text{N}_2 + \text{H}_2\text{O}$

Answer: D

20) A sample of hydrogen gas is contained in a balloon. The volume of the balloon is 2.15 L at 15°C. The temperature is changed until the volume of the balloon is 3.25 L. What is the new temperature of the gas in °C?

- A) 191
- B) 162
- C) 435
- D) 23
- E) -82

Answer: B

21) Which statement is incorrect regarding reduction?

- A) Reduction is a "gain" of electrons.
- B) Reduction is an increase in oxidation state.
- C) Reduction is always accompanied by oxidation.
- D) Reduction is the loss of O atoms.
- E) none of these

Answer: B

22) Consider 0.1 M solutions of the following substances. Which would have the greatest electrical conductivity?

- A) HCl
- B) $\text{Ca}(\text{OH})_2$
- C) CH_3COOH
- D) CH_3NH_2
- E) NH_4Br

Answer: B

23) A sample of neon gas has a volume of 2.50 L at 780. torr and 24°C. How many neon atoms are in the sample?

- A) 5.72×10^{24}
- B) 4.81×10^{25}
- C) 6.32×10^{22}
- D) 6.02×10^{23}
- E) none of the above

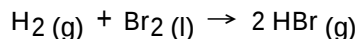
Answer: C

24) Given a 100 g sample of each of the following liquids at 25°C, which would have the highest temperature after a 1.00 g of iron (sp heat = $0.449 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$) at 50°C was added?

- A) methanol (sp heat = $2.51 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$)
- B) mercury (sp heat = $0.139 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$)
- C) ethanol (sp heat = $2.46 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$)
- D) ethylene glycol (sp heat = $2.35 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$)
- E) water (sp heat = $4.184 \text{ J g}^{-1} \text{ }^{\circ}\text{C}^{-1}$)

Answer: B

25) The standard enthalpy change for the following reaction is -72.8 kJ.



What is the standard enthalpy of formation of hydrogen bromide?

- A) -145.6 kJ
- B) -72.8 kJ
- C) 72.8 kJ
- D) -36.4 kJ
- E) none of the above

Answer: D

26) In the reaction $\text{Cu}(\text{s}) + 2 \text{Ag}^+(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2 \text{Ag}(\text{s})$, the reducing agent (if any) is

- A) Ag^+ .
- B) Ag.
- C) Cu^{2+} .
- D) Cu.
- E) none of these (not a redox reaction)

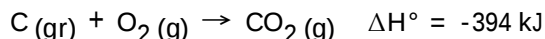
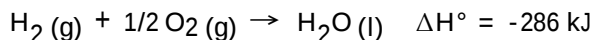
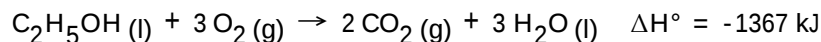
Answer: D

27) HCl and NH_3 react to form a white solid, NH_4Cl . If cotton plugs saturated with aqueous solutions of each are placed at the ends of a glass tube 60.0 cm long, calculate the distance from the HCl end that the white ring will form.

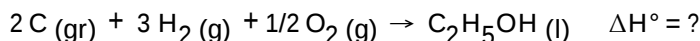
- A) 35.7 cm
- B) 24.3 cm
- C) 29.6 cm
- D) 40.9 cm
- E) 19.1 cm

Answer: B

28) Use the following thermochemical equations



to calculate the enthalpy change for the reaction



A) -279 kJ

B) +2047 kJ

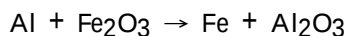
C) +687 kJ

D) +279 kJ

E) +680 kJ

Answer: A

29) How many grams of iron are formed by the reaction of 6.0 g Al with excess iron oxide, according to the following unbalanced equation?



A) 12

B) 0.22

C) 6.0

D) 24

E) 18

Answer: A

30) A 125-mL tank is charged with oxygen until the pressure is 75.0 atm at 25°C. Calculate the moles of oxygen in the tank.

A) 0.383

B) 0.00378

C) 4.57

D) 383

E) 0.505

Answer: A

31) Which statement is not correct?

A) Internal energy, E, is a state function.

B) Heat and work are state functions.

C) The enthalpy change is the heat of reaction at constant pressure.

D) Enthalpy is a state function.

E) Heat is given off to the surroundings in an exothermic reaction.

Answer: B

32) Vinegar is an aqueous solution of acetic acid, CH₃COOH. A 5.00 mL sample of a particular vinegar requires 26.90 mL of 0.175 M NaOH for its titration. What is the molarity of acetic acid in the vinegar?

A) 1.04

B) 0.175

C) 0.471

D) 0.520

E) 0.942

Answer: E

33) Which of the following is an example of an object possessing potential energy?

A) a bird perched in a tree

B) a rock on a beach

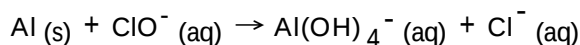
C) a penny on the floor

D) a snake in the grass

E) a boulder in a valley

Answer: A

- 34) When the following reaction is balanced in base with lowest ratio coefficients, what is the coefficient of H_2O and on which side is the water?



- A) 3 on left
- B) 2 on left
- C) 0, H_2O doesn't appear in the balanced equation.
- D) 1 on right
- E) 2 on right

Answer: A

- 35) Equal volumes of an unknown gas and nitrogen (N_2) gas take 5.37 min and 3.55 minutes, respectively, to effuse through a small hole. Calculate the molar mass (in g/mol) of the unknown gas.

- A) 128
- B) 42.4
- C) 64.1
- D) 18.5
- E) 12.2

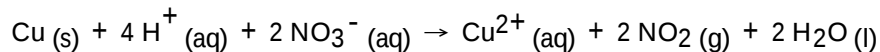
Answer: C

- 36) What is the change in internal energy of a system that absorbs 635 J of heat and does 249 J of work?

- A) 635 J
- B) 386 J
- C) -386 J
- D) 884 J
- E) -635 J

Answer: B

- 37) Considering the following reaction, what statement is incorrect?



- A) NO_3^- is the oxidizing agent.
- B) NO_3^- is reduced.
- C) Cu^{2+} is the result of an oxidation.
- D) Cu is oxidized.
- E) Cu is the oxidizing agent.

Answer: E

- 38) Which of the following is not a strong electrolyte?

- A) NaCl
- B) KBr
- C) HOCl_2
- D) CH_2Cl_2
- E) HCl

Answer: D

- 39) When nitroglycerin explodes, it decomposes to a mixture of different gases. Hence, nitroglycerin is :

- A) an ion
- B) a compound and is also a molecule
- C) a molecule
- D) a compound
- E) an element

Answer: B

- 40) At 25°C and constant pressure, carbon monoxide gas combines with oxygen gas to give carbon dioxide gas with the evolution of 10.1 kJ per gram of carbon monoxide consumed. What is the value of ΔH for the balanced reaction?

A) 283 kJ/mol B) -141 kJ/mol C) -283 kJ/mol D) -566 kJ/mol E) 141 kJ/mol

Answer: D

- 41) A sample of hydrogen gas was collected over water at 21°C and at a pressure equal to the atmospheric pressure of 748 mm Hg. The volume of the sample was 512 mL. How many grams of H_2 are in the sample? The vapor pressure of water at 21°C is 18.7 mm Hg.

A) 0.0422 g B) 15.5 g C) 0.0411 g D) 0.0203 g E) 15.9 g

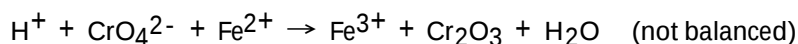
Answer: C

- 42) When heat is absorbed by the system from the surroundings, the process is said to be _____, and the sign of process is _____.

A) exothermic; negative
B) endothermic; positive
C) endothermic; negative
D) spontaneous; positive
E) exothermic; positive

Answer: B

- 43) How many liters of a 3.85 M solution of Fe^{2+} are needed to titrate 250.0 mL of a 0.125 M CrO_4^{2-} solution?



A) 0.0487 B) 4.87 C) 4.06 D) 0.0244 E) 8.12

Answer: D

- 44) Which of the following is an example of an object possessing kinetic energy?

A) a stick of dynamite
B) a boulder resting on a cliff
C) water at the top of a dam
D) a ball rolling downhill
E) a bird perched in a tree

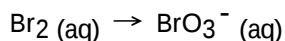
Answer: D

- 45) Which of the following aqueous solutions has the highest total concentration of H^+ ions?

A) 1.2 M NaOH B) 55.6 M H_2O C) 0.25 M HCl D) 1.0 M CH_4 E) 0.20 M NaH

Answer: C

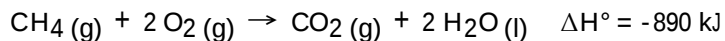
- 46) When the following half reaction (unbalanced) occurs, the number of electrons transferred per mole of Br_2 is:



A) 1. B) 8. C) 5. D) 10. E) 2.

Answer: D

47) What mass of CH₄ (g) must be burned to release 334 kJ of heat to the surroundings?



A) 0.375 g

B) 0.426 g

C) 55.6 g

D) 6.00 g

E) 2.66 g

Answer: D

48) A gas sample containing N₂ and O₂ was found to contain 72% N₂. If the pressure of the sample was 2.0 atm, what is the partial pressure of O₂?

A) 1.44 atm

B) 0.43 atm

C) 0.28 atm

D) 0.56 atm

E) 0.72 atm

Answer: D

49) Which of the following is NOT a component of internal energy?

A) reactivity

B) vibrations

C) rotations

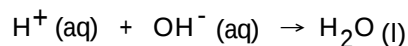
D) intermolecular forces

E) translations

Answer: A

50) Given the following data, what is the enthalpy of the reaction at 25°C shown below?

($\Delta H_f^\circ (\text{H}^+) = 0.0 \text{ kJ/mol}$; $\Delta H_f^\circ (\text{OH}^-) = -230.0 \text{ kJ/mol}$; $\Delta H_f^\circ (\text{H}_2\text{O}) = -285.8 \text{ kJ/mol}$)



A) 55.8 kJ/mol

B) -515.8 kJ/mol

C) 515.8 kJ/mol

D) -55.8 kJ/mol

E) 230.0 kJ/mol

Answer: D