Hess's Law and related questions

1. Numerical response question

Left justify your answer in the boxes provided.

Balance the reaction below, and then find the <u>molar enthalpy</u> of combustion for butane in $\frac{kJ}{mol}$

±_____

__$C_4H_{10(g)}$ + __$O_{2(g)}$ ➜ __$CO_{2(g)}$ + __$H_2O_{(g)}$

Express the answer to the nearest whole number

2. Numerical response question

Left justify your answer in the boxes provided.

Consider the <u>unbalanced</u> equation given below.

_____$C_8H_{18(l)}$ + _____$O_{2(g)}$ ➜ _____$CO_{2(g)}$ + ____$H_2O_{(g)}$

<u>Balance the equation.</u> Find the <u>molar heat of enthalpy</u> for the combustion of the octane.

<u>Molar heat of enthalpy for combustion</u> ($C_8H_{18(l)}$) is ± _____ $\frac{kJ}{mol}$

Round the solution to the <u>nearest whole number</u>.

3. Numerical response question

Left justify your answer in the boxes provided.

In a chemistry experiment, Ryan placed a piece of magnesium ribbon into a beaker of hydrochloric acid. Duncan determined that the overall reaction for this experiment would be

$Mg_{(s)}$ + 2$HCl_{(g)}$ ➜ $H_{2(g)}$ + $MgCl_{2(aq)}$

The enthalpy change for this reaction if 1.00 mol of magnesium ribbon is used will be _____ kJ. Round the answer to the **<u>nearest whole number.</u>**

Use the **<u>first box</u>** to show if the **<u>reaction releases energy or consumes energy</u>**. Put a 1 in box one if the reaction is endothermic. Put a 2 in box one if the reaction is exothermic.

4. The molar heat of combustion of ethyne is _____ $\frac{kJ}{mol}$. Assume the products are gaseous.

a	+227.4
b	-862.7
c	1300.2
d	-1256.2

5. Use the following information to answer the question.

$NaOH\ (s) \rightarrow Na^{+}\ (aq) + OH^{-}\ (aq)$ $\quad \Delta H = -45\ kJ$

The **FALSE** statement below is

a	sodium ions and hydroxide ions have less potential energy than NaOH (s)
b	the crystallization of sodium hydroxide is an exothermic process
c	the temperature of the water would rise as the solid NaOH (s) dissolves
d	solid sodium hydroxide is less stable than aqueous sodium hydroxide

6. Consider the following balanced equation:

$4HNO_3(aq) + 5N_2H_4(g) \rightarrow 7N_2(g) + 12H_2O\ (g)$ $\quad \Delta H = -2462\ kJ$

Which statement is **correct** for the given reaction?

a	205.2 kJ of energy is absorbed per mole of H_2O (g) used.
b	351.7 kJ of energy is absorbed per mole of N_2 (g) formed
c	615.5 kJ of energy is released per mole of HNO_3 (aq) used.
d	492.4 kJ are released per mole of N_2H_4 (g) formed.

7. The <u>molar heat</u> of combustion when sucrose ($C_{12}H_{22}O_{11}(s)$) undergoes complete combustion to form liquid water and carbon dioxide is _____ $\frac{kJ}{mol}$

a	-2226.1
b	-5639.7
c	-5155.7
d	-5956.8

8. When propene, $C_3H_6(g)$ undergoes complete combustion in air to produce carbon dioxide and water vapor, the heat of combustion is -1.30 x 10^3 $\frac{kJ}{mol}$. Based on this information, the molar heat of formation of propene is _____ $\frac{kJ}{mol}$

a	665
b	-606
c	-738
d	-1.90 x 10^3

9. A mass of ethanol is combusted to form liquid water and carbon dioxide. If 400 kJ of energy is released, the mass of ethanol consumed is _____ g

a	13.5
b	14.9
c	45.9
d	35.4

10. Consider the following balanced reaction.

$$\mathbf{2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(g) \qquad \Delta H = -6271.0\ kJ}$$

The heat released when a 6.50 g sample of oxygen is consumed is _____ kJ.

a	42.5
b	84.9
c	1.72×10^2
d	1.29×10^3

11. Consider the following balanced reaction.

$$\mathbf{6CO_2(g) + 6H_2O(l) + 2802.5\ kJ \rightarrow C_6H_{12}O_6(s) + 6O_2(g)}$$

A ____ mol sample of $CO_2(g)$ is required to react so that 2.2×10^3 kJ of energy is absorbed by the reaction.

a	6.0
b	4.7
c	1.3
d	7.6

12. How much heat is released if 2.00 mol of pentane ($C_5H_{12}(l)$) undergoes complete combustion to form water liquid and carbon dioxide? Express the answer in MJ.

a	7.02
b	3.51
c	3.34
d	1.67

13. The heat of formation of substance R is +60.7$ $\frac{kJ}{mol}$ l and of substance T is -23.5 $\frac{kJ}{mol}$.

The ΔH for the reaction R ➜ T will be _____ kJ

a	-84.2
b	-37.2
c	+37.2
d	+84.2

14. A chart of standard heats of formation is given for three unknown <u>compounds.</u>

Unknown Compounds	Heat of formation $\frac{kJ}{mol}$
X	-22.5
Y	+78.3
Z	-54.8

Given: **X + 3 Y ➜ 2 Z + 2 W** **ΔH = -561.7 kJ**

The standard molar heat of formation of Compound W is _____ $\frac{kJ}{mol}$

a	-239.4
b	-119.9
c	-884.0
d	-442.0

15. Ethanol, ($C_2H_5OH(l)$) is a very versatile compound that has applications in the fuel, chemical and pharmaceutical industries. Some properties of ethanol can be studied in the lab by applying thermodynamic principles.

The correctly balanced equation for the combustion of ethanol is _____

a	$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$	ΔH = 1234.8 kJ
b	$C_2H_5OH(l) + O_2(g) \rightarrow CO_2(g) + 3H_2O(g)$	ΔH =- 1234.8 kJ
c	$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$	ΔH = -1234.8 kJ
d	$C_2H_5OH(l) + 5O_2(g) \rightarrow 2C(s) + 3H_2(g) + ½ O2(g)$	ΔH = 1234.8 kJ

16. Consider the equation given below.

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g) \qquad \Delta H = -2043.9\ kJ$$

In this reaction the reactants have _____ energy than the products, and if energy is included as a term in the equation it would be a _____

a	Less	Reactant
b	Less	Product
c	More	Reactant
d	More	Product

17. Cellular respiration provides energy for cells.

$$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) + 2802.5\ KJ$$

If 100 kJ of energy is provided, the moles of glucose that have been combusted is ____ mol

Express the answer as m.np x 10^{-w} mol

	m	**n**	**p**	**w**
a	5	9	5	3
b	2	8	0	3
c	3	5	7	2
d	6	4	3	0

18. The following reaction occurs in a bomb calorimeter.

$$C_2H_5OH(l) + 3\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) + 1366.8\ kJ$$

A sample of _____ mmol of ethanol must be burned to raise the temperature of 500 g of water from 15.0°C to 35.0°C

a	76.6
b	53.6
c	30.7
d	23.0

19. Ashleigh and Samantha find a table that shows the molar enthalpy for formation for a series of compounds. The information is given below:

Compound	Molar enthalpy of formation $\frac{kJ}{mol}$
$VCl_2(s)$	-452.0
$VCl_3(s)$	-580.7

The girls speculate about the enthalpy for the reaction:

$Cl_2(g) + 2VCl_2(s) \rightarrow 2VCl_3(s)$

They find the ΔH for this balanced reaction to be _____

a	-257.4 $\frac{kJ}{mol}$
b	-257.4 kJ
c	-128.7 kJ
d	-128.7 $\frac{kJ}{mol}$

20. Consider the reaction given below.

$C_2H_2(g) \rightarrow 2C(s) + H_2(g) + 227.4\ kJ$

In the reaction represented by the equation above, energy is _____the surroundings because the bonds in the products contain _____energy than the reactants.

a	Absorbed from	More potential
b	Absorbed from	More kinetic
c	Released to	less potential
d	Released to	less kinetic

21. A sample of FeO(s) is oxidized to $Fe_2O_3(s)$ using excess oxygen inside the reaction chamber of a bomb calorimeter.

The **correct** observation that will be made about the water surrounding the reaction chamber of the calorimeter is _____

a	temperature of the water will rise because the reaction is endothermic
b	temperature of the water will fall because the reaction is endothermic
c	temperature of the water will rise because the reaction is exothermic
d	temperature of the water will fall because the reaction is exothermic

22. Use the following balanced reaction given below.

$$\mathbf{C_2H_4(OH)_2(l) + \frac{5}{2}\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g) + 1181.2\ kJ}$$

The molar enthalpy of **formation** for $C_2H_4(OH)_2(l)$ is _____ $\frac{kJ}{mol}$

a	-463.2
b	-331.2
c	502.3
d	-482.9

23. Use the balanced reaction given below

$$\mathbf{CH_3COOH(l) + 2\ (g) \rightarrow 2CO_2(g) + 2H_2O(l)\ \ \Delta H = -874.30\ kJ}$$

Choose the correct statement below if 1.00 g of $CH_3COOH(l)$ reacts.

a	13.1 kJ of energy is released to the surroundings.
b	13.1 kJ of energy is absorbed by the reaction
c	14.6 kJ of energy is absorbed by the reaction
d	14.6 kJ of energy is released to the surroundings

24. Consider the balanced reaction given below.

$$NH_3(g) + \frac{7}{4} O_2(g) \rightarrow NO_2(g) + \frac{3}{2} H_2O(g)$$

The ΔH for this reaction is _____ kJ.

a	-349.6
b	-283.6
c	-441.4
d	-375.4

25. Consider the balanced reaction given below.

$$SnCl_4(s) + 2\,H_2O(g) \rightarrow SnO_2(s) + 4HCl(g)$$

The ΔH for this reaction is _____ kJ

a	-136.1
b	+136.1
c	+48.1
d	-48.1

26. Consider the balanced reaction given below.

$$CH_3COOH(l) + 2O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$$

The ΔH for this reaction is _____ kJ.

a	-786.3
b	-874.3
c	-1027.9
d	-1159.0

27. Consider the reaction given below.

$H_2O(?) + SO_3(g) \rightarrow H_2SO_4(l) + 174.3\ kJ$

The physical state of the water is not known. Using the given, information, the molar heat of formation of the water in this reaction will be _____ $\frac{kJ}{mol}$

a	-40.7
b	-244
c	-271
d	-253

28. Consider the balanced equation below.

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

The ΔH for this reaction is _____ kJ

a	-116.2
b	-58.1
c	+58.1
d	+116

29. Which reaction requires energy to occur?

a	$2Al(s) + \frac{3}{2} O_2(g) \rightarrow Al_2O_3(s) + 1675.7\ kJ$
b	$Sn(s) + Cl_2(g) \rightarrow SnCl_2(s)$ $\Delta H = -325.1$ kJ
c	$SO_3(g) \rightarrow SO_2(g) + ½\ O_2(g)$ $\Delta H = 98.9$ kJ
d	$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ $\Delta H = -571.6$ kJ

30. Consider the following reaction.

$$\mathbf{CH_3OH(l) + \frac{3}{2}\ O_2(g) \rightarrow CO_2(g) + 2H_2O(g)}$$

The molar enthalpy of **<u>combustion</u>** for methanol is _____ $\frac{kJ}{mol}$

a	-637.9
b	-148.9
c	-725.9
d	-1161.1

31. Consider the reaction below.

$$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$$

The heat of reaction per mole of ammonia in the reaction is _____ $\frac{kJ}{mol}$

a	-452.8
b	-360.8
c	-176.2
d	-268.0

32. The amount of energy available from the combustion of 1.00 mol of $CH_4(g)$ into gaseous products is _____ .

a	0.710 MJ
b	803 kJ
c	0.878 GJ
d	952 kJ

33. Methane, the main component of natural gas, is used as a fuel source to fire bricks. Assuming it requires 4.00 MJ of heat to warm a single brick to its firing temperature, what mass of methane will be consumed in heating a single brick to its firing temperature? Assume products to be carbon dioxide and water vapor.

a	40.0 g
b	80.0 g
c	72.0 g
d	400 g

Answers:

1. 2657
2. 5074
3. 2457
4. D
5. B
6. C
7. B
8. B
9. A
10. B
11. B
12. A
13. A
14. B
15. C
16. D
17. C
18. C
19. B
20. C
21. C
22. B
23. D
24. B
25. C
26. A
27. B
28. A
29. C
30. A
31. C
32. B
33. B