

Theory of Thermodynamics

1. Numerical response question

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Left justify your answer in the boxes provided.

Choose from the list of descriptors in the box below to answer this question.

Number	Descriptor
1	Endothermic
2	Exothermic

Determine the type of energy condition for each reaction listed below

- Respiration _____
- Explosion of dynamite _____
- Formation of ethyne _____
- Combustion of benzene _____

Express the numbers in ascending order

2. Numerical response question

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Left justify your answer in the boxes provided.

Use the following word(s) to complete the sentences below.

Number	Word(s)
1	Potential
2	Kinetic
3	A rearrangement of bonds
4	An increase in Molecular motion

The energy changes that occur when butane undergoes combustion are primarily due to changes in _____ energy resulting from _____.

When water is heated, the energy change that occurs is primarily due to _____ or an increase of _____ energy.

3. If nitric acid is formed from its elements

a	the reaction is endothermic
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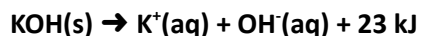
b	energy is released
c	energy is absorbed
d	ΔH is positive

4. A commercial cold-pack consists of an outer pouch containing $\text{NH}_4\text{NO}_3(\text{s})$ and an inner pouch containing water. When the contents of the pouches are mixed, a cooling effect is observed.

When the cold-pack is activated to treat an injury, the reaction _____

a	releases energy and the injury is cooled
b	releases energy and the injury is warmed
c	absorbs energy and the injury is cooled
d	absorbs energy and the injury is warmed

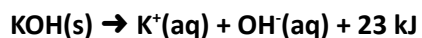
5. Use the following information to answer the question.



The TRUE statement below is

a	potassium ions and hydroxide ions have less potential energy than $\text{KOH}(\text{s})$
b	the crystallization of potassium hydroxide is an exothermic process
c	the temperature of the water would fall as the solid dissolves
d	solid potassium hydroxide more stable than aqueous sodium hydroxide

6. Use the following information to answer the question.



The FALSE statement below is _____

a	the crystallization of potassium hydroxide is an endothermic process
b	the temperature of the water would rise as the solid dissolves
c	solid potassium hydroxide is less stable than aqueous sodium hydroxide
d	potassium ions and hydroxide ions have more potential energy than $\text{KOH}(\text{s})$

7. The ΔH value for a reaction is negative if _____

a	The reaction is exothermic
b	The reaction is endothermic
c	Energy is absorbed during the reaction
e	The products have a larger potential enthalpy than do the reactants.

8. The burning of natural gas ($\text{CH}_4(\text{g})$) to heat a home is an example of a(n) _____ reaction

a	Decomposition reaction
b	Oxidation reduction reaction
c	Endothermic reaction
e	Formation reaction

9. During the reaction to produce a very small amount of a chemical, there is a large decrease in the temperature of a large water sample in the calorimeter.

The ΔH for the reaction should be a _____ value.

a	Large	Positive
b	Large	Negative
c	Small	Positive
d	Small	negative

10. When solid ammonium chloride ($\text{NH}_4\text{Cl}(\text{s})$) is added to water, the solution feels cooler to the touch. Which statement below is **false**?

a	The dissolving of $\text{NH}_4\text{Cl}(\text{s})$ is endothermic
b	Heat is released when $\text{NH}_4\text{Cl}(\text{s})$ is dissolved.
c	The ΔH for the reaction is positive
d	The potential energy of the reactants is less than the potential energy of the products.

11. A suitable hypothesis for an experiment related to energy is that an endothermic change can be defined as one in which _____ .

a	the temperature of the surrounding decreases
b	a spontaneous process tends toward a state of lower energy
c	less energy is involved in breaking bonds than in bond formation
d	energy is transferred from the reacting system to its surroundings

12. An exothermic reaction may be defined as a reaction in which

a	The ΔH value is positive
b	Energy is released by the reaction
c	Energy is absorbed from the surroundings
d	The energy is written on the reactant side of the balanced equation.

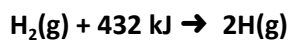
13. Potassium metal is dropped into a beaker of water and the reaction given below occurs.



Which statement is TRUE for this reaction?

a	The reaction is endothermic
b	The ΔH of the reaction is negative
c	The reaction is non spontaneous
d	The potential energy of the products is higher than the potential energy of the reactants.

14. Consider the equation below.



The correct statement below is _____.

a	The reaction is exothermic
b	The ΔH of the reaction is negative
c	The enthalpy of 2H(g) is lower than the enthalpy of $\text{H}_2\text{(g)}$
d	The equation represents the energy required to break the bond between two hydrogen atoms in one mole of hydrogen gas

15. For which fossil fuel was the Sun the original source of energy?

a	$\text{O}_2\text{(g)}$
b	U -235 isotope
c	$\text{H}_2\text{(g)}$
d	U – 238 isotope

16. From an environmental point of view and assuming the technology is available, the BEST fuel to burn in a car engine is _____

a	Hydrogen
b	Methane
c	Gasoline
d	propane

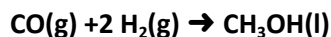
17. Which of the following processes is always endothermic?

a	Neutralization
b	Photosynthesis
c	Oxidation
d	reduction

18. Because Alberta has a plentiful supply of coal, many electric power generating stations in the Edmonton area burn coal as a source of energy. Coal can also be converted into other fuels. For example water gas, a mixture of CO(g) and H₂(g) is produced by passing steam over red-hot coal (C(s)).



The water gas mixture can then be converted to methanol as shown below.



The production of water gas is an _____ reaction. The conversion of water gas to methanol involves the _____ of energy

a	Endothermic	Release
b	Endothermic	Addition
c	Exothermic	Release
d	Exothermic	addition

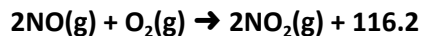
19. A major industrial problem is the corrosion of metals into their respective oxides. Which metallic oxide requires the LEAST amount of energy, per mole, to be refined back into its pure metal?

a	CuO(s)
b	PbO ₂ (s)
c	Fe ₂ O ₃ (s)
d	Al ₂ O ₃ (s)

20. Toluene is reacted with nitric acid to produce TNT (trinitrotoluene) a powerful explosive. The reaction requires sulfuric acid (H₂SO₄(aq)) to act as a catalyst. Without the catalyst, the reaction would

a	Have a larger ΔH
b	Have a smaller ΔH
c	React more slowly
d	React more quickly

21. Use the following information to answer the next question



If this reaction takes place in a bomb calorimeter, as the amount of reactants increases, the temperature of the water in the calorimeter will _____ because the reaction is _____.

a	Increase	endothermic
b	Increase	Exothermic
c	Decrease	Endothermic
d	Increase	exothermic

22. During cellular respiration, energy that originated from the _____ is converted to _____ energy and released into our bodies.

a	Sun	Chemical
b	Sun	Thermal
c	Plant	Chemical
d	Plant	thermal

23. Use the following information to answer the next question.

Fuel	$\frac{\text{kJ}}{\text{mol}}$ Molar enthalpy of combustion
Methane	-890.5
Propane	-2219.9
Pentane	-3508.8
Octane	-5470.1

One interpretation that applies to the data in the above table is that the **greater the number** of carbon atoms in a fossil fuel molecule, the _____

a	lower the moles of oxygen required for complete combustion
b	greater the strength of each covalent bond
c	lower the amount of carbon dioxide released during combustion
d	greater the energy released for combustion

24. Some "cold packs" and "hot packs" contain two pouches: a small pouch containing solid ionic crystals and a larger pouch containing water. When the small pouch is broken, the crystals dissolve in the water in the larger pouch.

- If the crystals are ammonium nitrate, the temperature of the water decreases.
- If the crystals are calcium chloride, the temperature of the water increases.

Choose all the correct statements in the list below for a pack that involves **water and ammonium nitrate**.

1	The potential energy of the products is greater than the potential energy of the reactants.
2	The reaction is endothermic.
3	The pack is a "hot pack"
4	The ΔH for the reaction will be negative.
5	The reaction is exothermic.
6	The pack is a 'cold pack.

a	1, 3, 5
b	2, 3, 4
c	3, 4, 5
d	1, 2, 6

25. Use the following information to answer the next question.

Fuel	Molar enthalpy of combustion $\frac{kJ}{mol}$
ethanol	-1366.7
Benzoic acid	3226.7
butane	-2877.3
Octane	-5470.1

The hydrocarbon fuel that releases the **most** energy **per carbon** is _____

a	Benzoic acid
b	Butane
c	Ethanol
d	octane

26. Use the following information to answer the next question.

Fuel	Molar enthalpy of combustion $\frac{kJ}{mol}$
ethanol	-1366.7
Benzoic acid	3226.7
butane	-2877.3
Octane	-5470.1

The hydrocarbon fuel that releases the least energy per carbon is _____

a	Benzoic acid
b	Butane
c	Ethanol
d	octane

27. Crude oil is transformed plant and animal matter. The energy of the crude oil originates from

a	Plants
b	Animals
c	Sun
d	Decay process

28. Carly and Tyana compare the molar enthalpies of combustion for a series of alkane fuels.

Molar enthalpy of combustion $\frac{kJ}{mol}$	Alkane fuels
-890.5	Methane
-2877.3	Butane
-5470.1	octane

A correct interpretation of this data is _____.

a	As the number of carbons in the molecule increases, the potential energy of the fuel decreases
b	As the number of carbons in the molecule decreases, the molar enthalpy of combustion increases
c	As the number of carbons in the molecule increases, the moles of greenhouse gases produced increases
d	As the number of carbons in the molecule decreases, the fuel becomes more stable

29. An endothermic reaction is one where _____.

a	heat is transferred from the system into the surroundings
b	heat is transferred from the surroundings into the system
c	there is no transfer of heat
d	the products of the system have less energy than the reactants of the system

30. A 2.5 g sample of methane is formed from its elements.

For this reaction, the oxidizing agent is _____ the reducing agent is _____
and _____ kJ of energy will be _____.

a	Hydrogen	Carbon	17	Released
b	Hydrogen	Carbon	17	Absorbed
c	Carbon	Hydrogen	12	Released
d	Carbon	Hydrogen	12	absorbed

Solutions:

1. 2212
2. 1342
3. B
4. C
5. A
6. D
7. A
8. B
9. A
10. B
11. A
12. B
13. B
14. D
15. C
16. A
17. B
18. A
19. A
20. C
21. B
22. B
23. D
24. D
25. B
26. A
27. C
28. C
29. B
30. C