

LIGHTNING ROUND 2

TOSS-UP

1) ENERGY *Multiple Choice* Which of the following terms correctly describes a reaction with a NEGATIVE delta G value?

- W) non-spontaneous
- X) exothermic
- Y) exergonic
- Z) endergonic

ANSWER: Y) EXERGONIC

TOSS-UP

2) ENERGY *Multiple Choice* Which of the following best describes a reaction that has a positive change in enthalpy and a positive change in entropy?

- W) spontaneous at all temperatures
- X) spontaneous at high temperatures
- Y) spontaneous at low temperatures
- Z) never spontaneous

ANSWER: X) SPONTANEOUS AT HIGH TEMPERATURES

TOSS-UP

3) ENERGY *Short Answer* By name or number, identify which of the following statements are true.

- I. Any isothermal process is also adiabatic.
- II. The change in enthalpy is 0 for all isothermal processes.
- III. The most work is done by a gas on its surroundings if the gas expands against an external pressure reversibly.

ANSWER: III only

TOSS-UP

4) ENERGY *Multiple Choice* What process is used commercially in the United States to produce ammonia?

W) Ostwald process

X) Hall process

Y) Haber process

Z) Claus process

ANSWER: Y) Haber process

TOSS-UP

5) ENERGY *Short Answer* What process, patented in 1902, is used to commercially produce nitric acid from ammonia?

ANSWER: OSTWALD PROCESS

TOSS-UP

6) ENERGY *Short Answer* What law of thermodynamics states that the internal energy of an isolated system is constant?

ANSWER: FIRST LAW OF THERMODYNAMICS

TOSS-UP

7) ENERGY *Short Answer* What theorem states that the average value of each quadratic contribution to the energy of a molecule in a sample at a temperature T is equal to $0.5kT$, where k is the Boltzmann constant?

ANSWER: EQUIPARTITION THEOREM

TOSS-UP

8) ENERGY *Short Answer* If the molar heat capacity of an ideal gas at constant volume is equal to $3R/2$, where R is the gas constant, what is the molar heat capacity of this ideal gas at constant pressure in terms of R ?

ANSWER: $5R/2$ (ACCEPT $2.5R$)

TOSS-UP

9) ENERGY *Multiple Choice* What value does a bomb calorimeter measure?

- W) ΔH
- X) ΔU
- Y) ΔG
- Z) ΔS

ANSWER: X) ΔU

TOSS-UP

10) ENERGY *Short Answer* Order the following compounds from greatest lattice enthalpy to least lattice enthalpy: LiF, LiBr, LiCl, LiI

ANSWER: LiF, LiCl, LiBr, LiI

TOSS-UP

11) ENERGY *Short Answer* What law states that the overall reaction enthalpy of a reaction is the sum of the reaction enthalpies of the steps into which the reaction can be divided?

ANSWER: HESS'S LAW

TOSS-UP

12) ENERGY *Short Answer* What is the name for the cycle that consists of a closed series of reactions used to express the enthalpy of formation of an ionic solid in terms of contributions that include the lattice enthalpy?

ANSWER: BORN-HABER CYCLE

TOSS-UP

13) ENERGY *Short Answer* By name or number, identify which of the following properties of a process must be negative for the reaction to be considered spontaneous:

- I. Change in enthalpy of the system.
- II. Change in Gibbs free energy of the system.
- III. Change in entropy of the system.

ANSWER: II only

TOSS-UP

14) ENERGY *Short Answer* Using the Boltzmann formula, what is the entropy of a tiny solid made up of four diatomic molecules of carbon monoxide at a temperature of 0 K?

ANSWER: 0

TOSS-UP

15) ENERGY *Multiple Choice* Ammonia has a negative standard Gibbs free energy of formation. Which of the following statements can be said for ammonia?

- W) Ammonia is thermodynamically stable relative to nitrogen and hydrogen.
- X) Ammonia is thermodynamically unstable relative to nitrogen and hydrogen.
- Y) Ammonia is impossible to produce from nitrogen and hydrogen.
- Z) The equilibrium with nitrogen and hydrogen as reactants and ammonia as product proceeds to the left.

ANSWER: W) Ammonia is thermodynamically stable relative to nitrogen and hydrogen.

TOSS-UP

16) ENERGY *Multiple Choice* What is the area under a curve on a pressure-volume diagram?

- W) work
- X) change in internal energy
- Y) change in Gibbs free energy
- Z) change in enthalpy

ANSWER: W) WORK

TOSS-UP

17) ENERGY *Short Answer* Order the following values from least to greatest for water: standard enthalpy of sublimation, standard enthalpy of fusion, standard enthalpy of vaporization

ANSWER: ENTHALPY OF FUSION, ENTHALPY OF VAPORIZATION, ENTHALPY OF SUBLIMATION

TOSS-UP

18) ENERGY *Short Answer* What law describes the change in the standard enthalpy change of a reaction with temperature?

ANSWER: KIRCHOFF'S LAW

TOSS-UP

19) ENERGY *Multiple Choice* What property of a system is defined as the energy transferred as heat reversibly divided by the absolute temperature at which the transfer takes place?

- W) ΔH
- X) ΔU
- Y) ΔS
- Z) ΔG

ANSWER: Y) ΔS

TOSS-UP

20) ENERGY *Short Answer* What inequality states that the change in entropy of a system is greater than or equal to the energy transferred as heat divided by the absolute temperature?

ANSWER: CLAUSIUS INEQUALITY

TOSS-UP

21) ENERGY *Short Answer* What equation allows us to calculate the vapor pressure at any temperature given the standard enthalpy of vaporization and one of the pressures?

ANSWER: CLAUSIUS-CLAPEYRON EQUATION

TOSS-UP

22) ENERGY *Multiple Choice* Trouton's rule states that standard entropies of vaporization of various liquids are all close to what value?

- W) 65 J/Kmol (READ AS: 65 JOULES PER KELVIN MOLE)
- X) 75 J/Kmol
- Y) 85 J/K mol
- Z) 95 J/K mol

ANSWER: Y) 85 J/Kmol

TOSS-UP

23) ENERGY *Short Answer* Given a phase diagram of a substance that has a curve with a negative slope between the solid and liquid regions, order the solid, liquid and gas phases from most dense to least dense.

ANSWER: LIQUID, SOLID, GAS

TOSS-UP

24) ENERGY *Multiple Choice* If the equilibrium constant of an equilibrium is much less than 1, what can we infer about the change in Gibbs free energy for the forward reaction?

- W) It will be spontaneous.
- X) It will be negative.
- Y) It will be positive.
- Z) It will be zero.

ANSWER: X) IT WILL BE NEGATIVE

TOSS-UP

25) ENERGY *Short Answer* What is the name for the dense fluid that exists above the critical temperature and pressure of a substance?

ANSWER: SUPERCRITICAL FLUID