

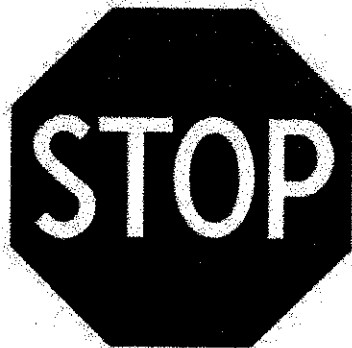
Chem Lab- Huntley Invitational 2017

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High School: _____

Team #: _____ Varsity or JV? _____

Competitors' Names:



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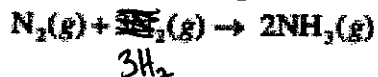
Good luck!

Questions 1–4 refer to the following gases at 0°C and 1 atm.

- a. He
- b. Xe
- c. O₂
- d. CO₂
- e. CO

1. Which gas has the greatest density?
2. Which gas has particles with the average speed closest to those of N₂ molecules at STP?
3. Which gas has the greatest rate of effusion?
4. Which gas has the lowest rate of effusion?
5. At 298 K and 1 atm, a 0.5-mol sample of O₂ (g) and a separate 0.75-mol sample of CO₂ (g) have the same:
 - a. Mass
 - b. Density
 - c. Average molecular speed
 - d. Average molecular kinetic energy
 - e. Number of atoms
6. ~~The temperature at which 32.0 g of O₂ gas will occupy 22.4 L at 4.0 atm is closest to:
 - a. 90 K
 - b. 273 K
 - c. 550 K
 - d. 950 K
 - e. 1,900 K~~ *not scored*

7. Gases N₂ (g) and H₂ (g) are added to a previously evacuated container and react at a constant temperature according to the following chemical equation:



If the initial pressure of N₂ (g) was 1.2 atm, and that of H₂ (g) was 3.8 atm, what is the partial pressure of NH₃ (g) when the partial pressure of N₂ (g) has decreased to 0.9 atm?

- a. 0.30 atm
- b. 0.60 atm
- c. 0.9 atm
- d. 1.8 atm
- e. 3.8 atm

8. Equal masses of Ne and Ar are placed in a rigid, sealed container. If the total pressure in the container is 1.2 atm, what is the partial pressure of Ar?
- 0.20 atm
 - 0.40 atm
 - 0.60 atm
 - 0.80 atm
 - 2.40 atm
9. A 2-L container will hold approximately 3 grams of which of the following gases at 0°C and 1 atm?
- CO₂
 - H₂O
 - Cl₂
 - O₂
 - NH₃
10. HCl and NH₃ gases are released into opposite ends of a 1-meter (100-cm), vertical glass tube at 25°C. Their reaction quickly produces a white fog of ammonium chloride. If the two gases are released at exactly the same time, which of the following most closely approximates where the ammonium chloride fog would form?
- 20 cm from the side where NH₃ was released
 - 40 cm from the side where NH₃ was released
 - In the middle (50 cm from either side)
 - 65 cm from the side where NH₃ was released
 - 80 cm from the side where NH₃ was released
11. A 2-L container will hold about 7 g of which of the following gases at 0°C and 1 atm?
- SO₂
 - CO₂
 - N₂
 - Cl₂
 - C₄H₈
12. Which of the following best explains why a hot-air balloon rises?
- The rate of diffusion of the hot air inside the balloon is greater than the rate of diffusion of the colder air surrounding the balloon.
 - The pressure on the walls of the balloon is greater than the atmospheric pressure.
 - The difference in temperature and pressure between the air inside and outside the balloon creates an upward acting current.
 - The average density of the balloon is less than that of the surrounding air.
 - The higher pressure of the surrounding air pushes on the sides of the balloon, squeezing it up to higher altitudes.

13. A rigid metal container contains Ne gas. Which of the following is true of the gas in the tank when additional Ne is added at a constant temperature?
- The pressure of the gas decreases.
 - The volume of the gas increases.
 - The total number of gas particles remains the same.
 - The average speed of the gas particles remains the same.
 - The average distance between the gas particles increases.
14. Equal numbers of moles of Ar (g), Kr (g), and Xe (g) are placed in a rigid glass vessel at room temperature. If the container has a pin hole-sized leak, which of the following will be true regarding the relative values of the partial pressures of the remaining gases after some effusion has occurred?
- $P_{\text{Ar}} < P_{\text{Kr}} < P_{\text{Xe}}$
 - $P_{\text{Xe}} < P_{\text{Kr}} < P_{\text{Ar}}$
 - $P_{\text{Kr}} < P_{\text{Ar}} < P_{\text{Xe}}$
 - $P_{\text{Ar}} < P_{\text{Xe}} < P_{\text{Kr}}$
 - $P_{\text{Ar}} = P_{\text{Kr}} = P_{\text{Xe}}$
15. Which of the following gases has the greatest average molecular speed at 298 K?
- He
 - H₂
 - N₂
 - O₂
 - Ne
16. Three gases, 1.6 g He (4 g mol⁻¹), 4 g Ar (40 g mol⁻¹), and 26 g Xe (131 g mol⁻¹), are added to a previously evacuated rigid container. If the total pressure in the tank is 2.1 atm, the partial pressure of Xe (g) is closest to:
- 0.2 atm
 - 0.3 atm
 - 0.4 atm
 - 0.6 atm
 - 0.8 atm
17. Equal masses of two substances, A & B, each absorb 25 Joules of energy. If the temperature of A increases by 4 degrees and the temperature of B increases by 8 degrees, one can say that:
- the specific heat of A is double that of B.
 - the specific heat of B is double that of A.
 - the specific heat of B is negative.
 - the specific heat of B is triple that of A.

18. If 25 J are required to change the temperature of 5.0 g of substance A by 2.0°C, what is the specific heat of substance A?
- 250 J/g°C
 - 63 J/g°C
 10. J/g°C
 - 2.5 J/g°C
19. Consider the thermal energy transfer during a chemical process. When heat is transferred to the system, the process is said to be _____ and the sign of ΔH is _____.
- exothermic, positive
 - endothermic, negative
 - exothermic, negative
 - endothermic, positive
20. Calculate the amount of heat needed to change 25.0 g ice at 0°C to water at 0°C. The heat of fusion of $H_2O = 333 \text{ J/g}$.
- 56.5 kJ
 - 8.33 kJ
 - 7.06 kJ
 - 463 kJ
21. Which one of the following is an endothermic process?
- ice melting
 - water freezing
 - boiling soup
 - Hydrochloric acid and barium hydroxide are mixed at 25°C: the temperature increases.
 - Both A and C
22. Which one of the following is an exothermic process?
- ice melting
 - water evaporating
 - boiling soup
 - condensation of water vapor
 - Ammonium thiocyanate and barium hydroxide are mixed at 25°C: the temperature drops.

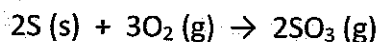
23. A sample of calcium carbonate [CaCO₃ (s)] absorbs 45.5 J of heat, upon which the temperature of the sample increases from 21.1°C to 28.5°C. If the specific heat of calcium carbonate is 0.82 J/g-K, what is the mass (in grams) of the sample?

- a. 3.7
- b. 5.0
- c. 7.5
- d. 410
- e. 5.0 x 10³

24. The temperature of a 12.58 g sample of calcium carbonate [CaCO₃ (s)] increases from 23.6°C to 38.2°C. If the specific heat of calcium carbonate is 0.82 J/g-K, how many joules of heat are absorbed?

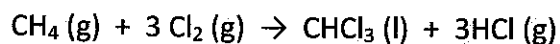
- a. 0.82
- b. 5.0
- c. 7.5
- d. 410
- e. 151

25. The value of ΔH° for the reaction below is -790 kJ. The enthalpy change accompanying the reaction of 0.95 g of S is _____ kJ.



- a. 23
- b. -23
- c. -12
- d. 12
- e. -790

26. The value of ΔH° for the reaction below is -336 kJ. Calculate the heat (kJ) released to the surroundings when 23.0 g of HCl is formed.



- a. 177
- b. 2.57 x 10³
- c. 70.7
- d. 211
- e. -336

27. The density of _____ is 0.900 g/L at STP.

- a. CH₄
- b. Ne
- c. CO
- d. N₂
- e. NO

28. The volume of a sample of gas (2.49 g) was 752 mL at 1.98 atm and 62°C. The gas is _____.

- a. SO₂
- b. SO₃
- c. NH₃
- d. NO₂
- e. Ne

29. The density of air at STP is 1.285 g/L. Which of the following cannot be used to fill a balloon that will float in air at STP?

- a. CH₄
- b. NO
- c. Ne
- d. NH₃
- e. HF

30. 10.0 grams of argon and 20.0 grams of neon are placed in a 1200.0 ml container at 25.0°C. The partial pressure of neon is _____ atm.

- a. 20.4
- b. 8.70
- c. 0.700
- d. 3.40
- e. 5.60



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Good luck!

Task

Measure the heat of reaction for:



Materials

- 2 Styrofoam cups
- 1 scoopula
- 2 weigh boats
- calcium metal (1.0 g – 2.0 g)
- deionized water
- a balance

Procedure

1. Determine and record the mass of the double Styrofoam cup.
2. Add approximately ~~200~~⁵⁰ grams of deionized water to your double Styrofoam cup. Record the exact mass added.
3. Measure the temperature of the water in the cup.
4. Use the weigh boats and scoopula to measure out 1.00 g of calcium metal.
5. Add the calcium to the water a few small pieces at a time.
6. Stir the mixture in an attempt to keep the calcium below the surface of the water.
7. When all the calcium has been added and the reaction is no longer visibly occurring, measure and record the highest temperature reached by the mixture.
8. Determine the mass of the final mixture and record.

Data

Use this space to keep track of the data you need to record in the lab. Make sure data is clearly labeled/ identified.

Answer for #1: _____

Answer for #2: _____

Answer for #3: _____