name_____

1. [2 pts each] **Clearly** assign each statement as TRUE or FALSE. If we can't tell which you mean, it's wrong.

True **For a given sample of a gas at a <u>fixed volume</u>, pressure increases as temperature increases.
P↑ T↑   T↑

False "STP" specifies ~~a one-mole~~ sample of a gas at one atmosphere and ~~0 K~~.

True ** Both diffusion and effusion are faster at higher temperatures. — happen faster as molecules move faster.

False **If ΔH of a reaction is positive, then the system loses energy. ← describes exothermic rxn
→ describes endothermic rxn

True **The ΔH^0_f value for F_2 (g) is zero. — element in stable state

False The longer the wavelength of a photon, the ~~greater~~ its energy.

False **The melting of ice is exothermic. energy has to be added to ice from surroundings to melt it.

True The 4d subshell (sublevel) can hold 10 electrons. any d subshell has 5 orbitals and can hold up to 10 e⁻.

False A single 4d orbital can hold 10 electrons. any single orbital can hold 2 e⁻.

False **A photon of red light has more energy than a photon of violet light.
ROYGBIV — red is at low-E end of visible spectrum.

False When an electron in an atom relaxes from n=3 to n=1, a photon is absorbed by the atom.
relaxation emits a photon. Excitation absorbs a photon.

True **The s subshell occurs in every shell.

True **The 2d subshell is not a possible subshell. The n=2 shell has only s and p subshells.

False **The energy of the electron in the n=3 shell of a hydrogen atom is 7.27×10^{-19} J.
$E = -2.18 \times 10^{-18} \left(\frac{1^2}{3^2}\right) = -2.42 \times 10^{-19}$ J

True The reverse of an endothermic reaction is always exothermic.

2. [10 pts] Three 5-L flasks (labeled A, B and C) each contain a sample of gas (H_2, He or CH_4, respectively) at 273 K and 1 atm. For each of the following quantities or values, circle the best choice.
✓
T   P   Same V, T, and P ⟹ same n

a. lowest density: Same n weighs less (Flask A (H_2)) Flask B (He)   Flask C (CH_4)   all same

b. lowest average kinetic energy: same T,   Flask A (H_2)   Flask B (He)   Flask C (CH_4) (all same)
same avg E

c. greatest mass: Same n, CH_4 weighs most   Flask A (H_2)   Flask B (He) (Flask C (CH_4)) all same

d. greatest average molecular speed: (Flask A (H_2)) Flask B (He)   Flask C (CH_4)   all same
at same T & same avg E, smaller particles move faster

e. greatest pressure: problem specifies same P Flask A (H_2)   Flask B (He)   Flask C (CH_4) (all same)

**3. [10 pts] Write the formation equation (the reaction corresponding to the ΔH^0_f) for $HClO_3$ (l). For full credit, include appropriate phase labels on all species.

reminder: phase labels?

$\frac{1}{2} H_2 (g) + \frac{1}{2} Cl_2 (g) + \frac{3}{2} O_2 (g) \longrightarrow HClO_3 (l)$

ΔH^0_f : formation of 1 mol of substance, from elements in stable states.

name_____

4. **[6] A sample of methane gas is confined in a 1.1 L container at 432 torr and 87 °C. Calculate the number of moles of gas present. **Show your work** below, and write your final answer in the space provided. (No credit will be earned if the setup is not clearly shown.)

$n = \frac{PV}{RT} = \frac{(0.5684 \, atm)(1.1 \, L)}{(0.08206 \frac{L \cdot atm}{K \cdot mol})(360 K)} = \boxed{0.021 \, mol}$ (2 sig figs)

Answer: __0.021__ moles

$P = 432 \, torr \times \frac{1 \, atm}{760 \, torr} = 0.5684 \, atm$ (keep an extra sig fig here since other steps are also ×/÷)

$T = 273 + 87 °c \over 360 K$

**5. [6 pts] Pb^{2+} (aq) + 2 Cl^- (aq) → $PbCl_2$ (s)
Pb 207.2
2Cl 70.90 ← 2(35.45)
278.10

A 41.0-mL sample of a solution of 0.237 M $Pb(NO_3)_2$ is added to 60.0 mL of a solution of 0.250 M NH_4Cl. How many grams of precipitate can be produced, according to the balanced reaction equation above? **Show your work** below, and write your final answer in the space provided. (No credit will be earned if the setup is not clearly shown.)

Answer: __2.08__ g (3 sig. figs.)

$Pb(NO_3)_2$:
$0.0410 \, L \times \frac{0.237 \, mol \, Pb^{2+}}{L} \times \frac{278.1 \, g \, PbCl_2}{1 \, mol \, Pb^{2+}} = 2.70 \, g \, PbCl_2$

NH_4Cl:
$0.0600 \, L \times \frac{0.250 \, mol \, Cl^-}{L} \times \frac{278.1 \, g \, PbCl_2}{2 \, mol \, Cl^-} = \boxed{2.08 \, g \, PbCl_2}$ ⟸ NH_4Cl is limiting.

6. **(a) [6 pts] Balance the following equation by writing appropriate coefficients into the spaces provided. All reactants and products are shown. (You may use as much scratch space as you like, but please make sure you write your final answers clearly and legibly in the spaces provided.)

Final, graded answer:

__2__ $S_2O_6^{2-}$ + __4__ H^+ + __1__ IO^- → __4__ SO_2 + __1__ IO_3^- + __2__ H_2O

Scratch space (will not be graded):

2 $S_2O_6^{2-}$ + 4 H^+ + IO^- → 4 SO_2 + IO_3^- + 2 H_2O
+10 -12 = -2   +1 -2 = -1   +4 -4   +5 -6 = -1
-4e⁻
1e⁻ × 2 = 2e⁻ × 2 = 4e⁻

(b) [2 pts each] For the reaction provided in part (a), identify:

element reduced __S__   element oxidized __I__   reductant (reducing agent) __IO⁻__

(c) [2 pts] In the reaction provided in part (a), one species is a gas. Which one is it? __SO_2__ (we know water is a liquid under standard lab conditions; all other species are ions)