Name___*Key*_____ (print) Name _____ (sign)

Please show work for partial credit and full credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded   legibly. If you run out of space, continue on the empty back pages but clearly label where the remaining answers can be found. (If I can't find your answer or cannot read it, I obviously cannot grade it.) Return the entire exam inclduing the periodic table. (Please count your exam pages and make sure there are   real pages and the periodic table.)

NA = not attempt

It is your responsibility **to return the entire exam package (with periodic table assembly** inside the rest of the exam.) **directly into Dr. Hahn's hands.** If you do not and the exam disappears or sits around for days NOT in Dr. Hahn's possession, that exam will count as an UNEXCUSED missed exam.

BA = bad attempt

$PV = nRT$, $R = 0.08206$ (L atm) / (mol K) $(P_2 V_2)/(P_1 V_1) = T_2/T_1$ $T_T = T_a + T_b + ...$

760 mm Hg = 1 atm., $^\circ C + 273.15 = $ Kelvin $M = $ moles / liter $X_a = n_a / (n_a + n_b + n_c ...)$

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts each, 20 pts total)

1) A sample of pure oxygen gas has a pressure of 795 torr. What is the pressure of the oxygen in units of atmospheres?

1) __*A*__

$795/760 = 1.05$

  A) 1.05 atm
  B) 1.01 atm
  C) 0.760 atm
  D) 0.795 atm
  E) 0.604 atm

2) Identify the correct *net ionic equation* for the reaction that occurs when solutions of HNO_3 and KOH are mixed?

2) __*A*__

  A) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ — *all acid/base has net ionic*
  B) $HNO_3(aq) + KOH(aq) \rightarrow H_2O(l) + KNO_3(aq)$
  C) $HNO_3(aq) + OH^-(aq) \rightarrow H_2O(l) + NO_3^-(aq)$
  D) $HNO_3(aq) + KOH(aq) \rightarrow H_2O(l) + KNO_3(s)$
  E) $K^+(aq) + NO_3^-(aq) \rightarrow KNO_3(aq)$

3) Which of the following describes Dalton's Law?

3) __*C*__

  A) The temperature of a gas is proportional to its volume.
  B) Only one variable can be changed from an initial state to a final state for a gas.
  C) The total pressure of a gas mixture is the sum of the partial pressures of each gas in the mixture.
  D) The pressure of a gas is proportional to its volume.

4) Electrons in an orbital with $l = 3$ are in a/an

    A) f orbital.
    B) d orbital.
    C) g orbital.
    D) s orbital.
    E) p orbital.

4) _A_

$$s \quad p \quad d \quad f$$
$$0 \quad 1 \quad 2 \quad 3$$

5) Which of the following describes Dalton's Law?

    A) The total pressure of a gas mixture is the sum of the partial pressures of each gas in the mixture.
    B) Only one variable can be changed from an initial state to a final state for a gas.
    C) The pressure of a gas is proportional to its volume.
    D) The temperature of a gas is proportional to its volume.

5) _A_

6) In the following diagram of a wave

6) _B_
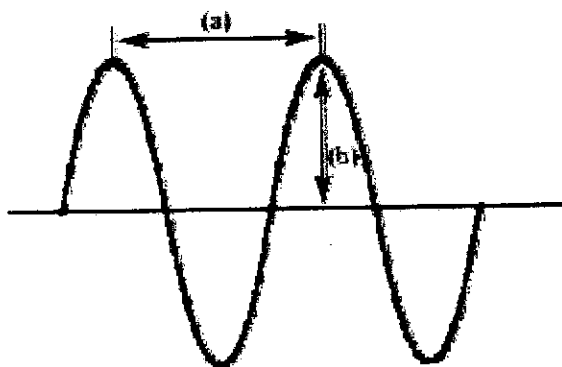
    A) (a) is wavelength and (b) is frequency
    B) (a) is wavelength and (b) is amplitude
    C) (a) is frequency and (b) is amplitude
    D) (a) is amplitude and (b) is frequency
    E) (a) is amplitude and (b) is wavelength

7) A sample of pure nitrogen has a temperature of 15°C. What is the temperature of the nitrogen in units of Kelvin?

$$15 + 273 = 288$$

    A) 288.15 K
    B) 288.2 K
    C) 290 K
    D) 300 K
    E) 288 K

7) _E_

8) Calculate the volume occupied by 56.5 g of argon gas at STP. (Ar = argon)

    A) 1,270 L   B) 22.4 L   C) 31.7 L   D) 34.6 L   E) 1,380 L

8) _C_

$$(56.5 g / 39.95) = n = 1.414 \qquad STP = 0°C + 273.15$$
$$PV = nRT \qquad\qquad\qquad\qquad 1 \, atm$$
$$V = [(1.4)(0.08206)(273.15)] / 1 = 31.38$$

9) What is the maximum number of electrons in an atom that can have the following set of   9) ___D___
quantum numbers?

$n = 4$ $l = 3$ $m_l = -2$ $m_s = +1/2$

  A) 0   B) 10   C) 6   (D) 1   E) 2

10) "No two electrons in an atom can have the same four quantum numbers" is a statement   10) ___A___
of

  (A) the Pauli exclusion principle.
  B) de Broglie's relation.
  C) Dalton's atomic theory.
  D) Hund's rule.
  E) Bohr's equation.

Part II: **Short Answers** (42 pts) Show work on all questions for partial and full credit even on questions which do not specify. (in addition to the equations in Part I, the following equation may be useful: $M_{initial}V_{initial} = M_{final}V_{final}$)

1. Circle the following which are (weak acids . (6 pts)
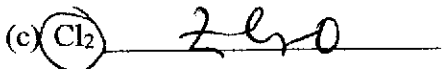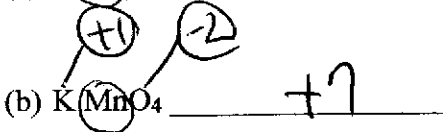
(H F)   H Br   H I   (CH₃COO H)   HNO₃   H₂SO₄

2. Calculate or give the oxidation state of the circled element in the following molecule. Show work if needed. (6 pts total, 2 pts each)

(handwritten annotations) BA each -1   gave grouy # -1   grouy 7 -8 = -1   matt -½

(a) H(Cl) ___ -1
+1   -2

(b) K(Mn)O₄ ___ +7

$$(+1) + Mn + 4(-2) = Zero$$
$$Mn = 8 - 1 = +7$$

(c) (Cl₂) ___ Zero

(handwritten) Wrong sign   -½

3. (a). Calculate the concentration (in Molarity = M) made up by using 3.7 grams of Li Br (FW of Li Br = 86.85 g/mole) dissolved to make up 0.500 Liters of solution. Show work. (5 pts))

$$(3.7 g Li Br / 86.85) / (0.500 \ell) = 0.085 M$$

(handwritten) 2 pt   2 pt   1 pt

(b)If you dilute the solution by adding enough water to make up a total of 1.2 Liters of solution, what is the new concentration? Show work. (5 pts)

$$M_i V_i = M_f V_f$$

$M_i = 0.085 m$ $V_i = 0.500 \ell$, $V_f = 1.2 \ell$

$$(M_f)(1.2 \ell) = (0.085 m)(0.500 \ell)$$

(handwritten) BA -2 ½

$$M_f = \frac{(0.085 m)(0.500 \ell)}{(1.2 \ell)} = 0.035 M$$

4. If you have an angular momentum quantum number (ℓ) of 2, what are the possible values of the magnetic quantum number (m_ℓ)? (5 pts)
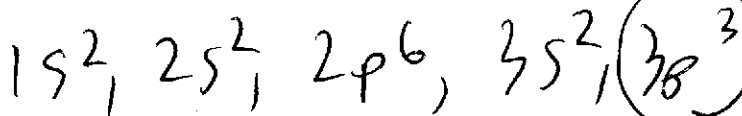
$$M\ell = -\ell \ldots +\ell$$

$$M\ell = -2, -1, 0, +1, +2$$

BA
$-2 \frac{1}{2}$

gave
0,1,2

gave only
2

5. What is the electron configuration for the element phosphorus (P)?

(a) Show electron configuration in the format $1s^2, 2s^2$ etc. ...... (5 pts)

$$1s^2, 2s^2, 2p^6, 3s^2, 3p^3$$

1 pt each

(b) Show orbitals diagrams in the format $\uparrow\downarrow$ $\uparrow$ etc..... (5 pts)
$1s$ $2s$

$\uparrow$ $\uparrow$ $\uparrow$
$3p$

$\uparrow\downarrow$
$3s$

$\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$
$2p$

$\uparrow\downarrow$
$2s$

$\uparrow\downarrow$
$1s$
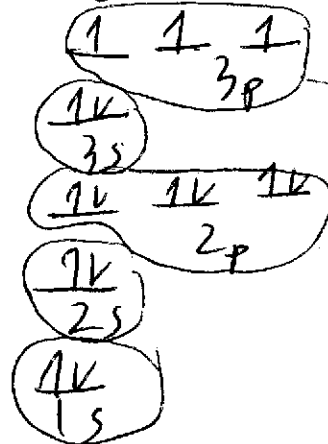
1 pt each

6. If you have a mixture of gases consisting of 1.2 moles of H_2, 2.7 moles of He, what is the mole fraction (X) of H_2? (5 pts)

$$X_{H_2} = \frac{1.2 \, mol \, H_2}{1.2 \, mol \, H_2 + 2.7 \, mol \, He} = 0.31 \, mole \, fraction \, H_2$$
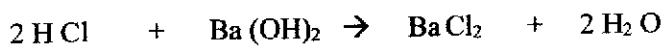
$$3.9$$

BA $-2 \frac{1}{2}$ gave no -1

Part III: Long Answers (38 pts) Show work on all questions for partial and full credit even on questions which do not specify.

1.   If we are doing a titration by combining   H Cl   with Ba (OH)$_2$ using 1.23 M of the H Cl with 1.01 M of the Ba (OH)$_2$ starting with 1.33 Liter of the HCl , how many liters of ~~KOH~~ will you need ?   (20 pts)

$$Ba(OH)_2$$

$$2 \, HCl \quad + \quad Ba\,(OH)_2 \;\rightarrow\; BaCl_2 \quad + \quad 2\, H_2O$$

(5 pt)

$$1.33 \, \cancel{\ell} \atop HCl \; soln.$$

$\times$

(4 pt)

$$\frac{1.23 \, mol \, HCl}{1 \, \ell \, HCl \; soln.}$$

$\times$

(4 pt)

$$\frac{1 \, mol \, Ba(OH)_2}{2 \, mol \, HCl}$$

$\times$

(4 pt)

$$\frac{1 \, \ell \, Ba(OH)_2 \; soln.}{1.01 \, mol \, Ba(OH)_2}$$

$= \quad 0.810 \, \ell \quad$ (3 pt)

$$Ba(OH)_2 \; soln.$$

$$\boxed{BA = 70 \, pt}$$

2. You have a gas at 35.2 °C in a 2.2 liter at 790.2 mm Hg in a container with a movable piston. You heat the gas sample and remeasure the volume to be 4.9 liters with a new temperature of 75.2 °C What is the new volume of the gas? (18 pts)

(Convert it)

$T_1 = 35.2 °C + 273.15 = 308.35 K$ (2pt)

$V_1 = 2.2 l$ (2pt)

$P_1 = 790.2 mmHg / 760 = 1.0397 atm$ (2pt)

1.040 atm

$V_2 = 4.9 l$ (2pt)

$T_2 = 75.2 °C + 273.15 = 348.35 K$ (2pt)

$P_2 = ?$

$$\frac{P_2 V_2}{P_1 V_1} = \frac{T_2}{T_1}$$ (4pt) (plug in) (BA = 2pt)

$$\frac{P_2 (4.9 l)}{(1.040 atm)(2.2 l)} = \frac{(348.35 K)}{(308.35 K)}$$

(math -1)

$$\frac{P_2 (4.9)}{2.288 atm} = 1.1297$$

$$P_2 = \frac{(1.1297)(2.288 atm)}{(4.9)} = 0.528 atm$$ (2pt)

Name_____K. ey_____(print) Name _____(sign)

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It is your responsibility to return the entire exam package (with periodic table assembly inside the rest of the exam.) **directly into Dr. Hahn's hands.** If you do not and the exam disappears or sits around for days, NOT in Dr. Hahn's possession, that exam will count as an UNEXCUSED missed exam.   *BA = bad attempt*

$PV = nRT$, $R = 0.08206$ (L atm) / (mol K) $(P_2 V_2)/(P_1 V_1) = T_2/T_1$ $T_T = T_a + T_b + ...$
760 mm Hg = 1 atm.,   °C + 273.15 = Kelvin   M = moles / liter $x_a = n_a / (n_a + n_b + n_c ...)$

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts each, 20 pts total)

1) What is the maximum number of electrons in an atom that can have the following set of   1) __C__
quantum numbers?
n = 4 l = 3 m_l = –2 m_s = +1/2
   A) 6   B) 10   C) 1   D) 2   E) 0

2) "No two electrons in an atom can have the same four quantum numbers" is a statement   2) __E__
of
   A) Hund's rule.
   B) Bohr's equation.
   C) Dalton's atomic theory.
   D) de Broglie's relation.
   E) the Pauli exclusion principle.

3) A sample of pure nitrogen has a temperature of 15°C. What is the temperature of the   3) __E__
nitrogen in units of Kelvin?
   A) 290 K
   B) 288.2 K
   C) 288.15 K
   D) 300 K
   E) 288 K

4) Electrons in an orbital with l = 3 are in a/an   4) __D__
   A) d orbital.
   B) s orbital.
   C) g orbital.
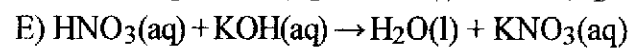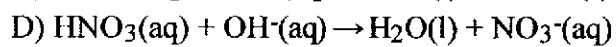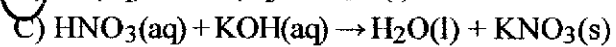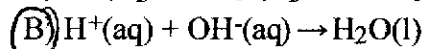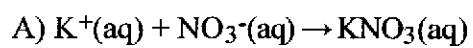   D) f orbital.
   E) p orbital.

5) Which of the following describes Dalton's Law?   5) __C__
    A) Only one variable can be changed from an initial state to a final state for a gas.
    B) The temperature of a gas is proportional to its volume.
    C) The total pressure of a gas mixture is the sum of the partial pressures of each gas
       in the mixture.
    D) The pressure of a gas is proportional to its volume.

6) A sample of pure oxygen gas has a pressure of 795 torr. What is the pressure of the   6) __D__
   oxygen in units of atmospheres?
    A) 1.01 atm
    B) 0.795 atm
    C) 0.760 atm
    D) 1.05 atm
    E) 0.604 atm

7) Calculate the volume occupied by 56.5 g of argon gas at STP. (Ar = argon)   7) __E__
    A) 1,380 L   B) 1,270 L   C) 34.6 L   D) 22.4 L   E) 31.7 L

8) Which of the following describes Dalton's Law?   8) __A__
    A) The total pressure of a gas mixture is the sum of the partial pressures of each gas
       in the mixture.
    B) The pressure of a gas is proportional to its volume.
    C) Only one variable can be changed from an initial state to a final state for a gas.
    D) The temperature of a gas is proportional to its volume.

9) In the following diagram of a wave   9) __E__
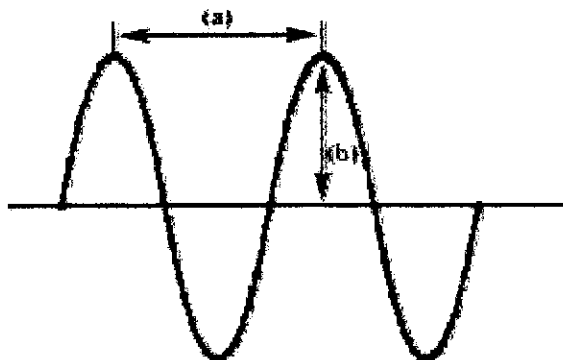
    A) (a) is frequency and (b) is amplitude
    B) (a) is wavelength and (b) is frequency
    C) (a) is amplitude and (b) is frequency
    D) (a) is amplitude and (b) is wavelength
    E) (a) is wavelength and (b) is amplitude

10) Identify the correct *net ionic equation* for the reaction that occurs when solutions of   10) __B__
    HNO_3 and KOH are mixed?

    A) $K^+(aq) + NO_3^-(aq) \rightarrow KNO_3(aq)$

    B) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

    C) $HNO_3(aq) + KOH(aq) \rightarrow H_2O(l) + KNO_3(s)$

    D) $HNO_3(aq) + OH^-(aq) \rightarrow H_2O(l) + NO_3^-(aq)$

   E) $HNO_3(aq) + KOH(aq) \rightarrow H_2O(l) + KNO_3(aq)$

Part II: **Short Answers** (42 pts) Show work on all questions for partial and full credit even on questions which do not specify. (in addition to the equations in Part I, the following equation may be useful: $M_{initial} V_{initial} = M_{final} V_{final}$)

1. Circle the following which are strong acids . (6 pts)

H F′   (H Br)   (H I)   CH₃COO H   (HNO₃)   (H₂SO₄)

2. Calculate or give the oxidation state of the circled element in the following molecule. Show work if needed. (6 pts total, 2 pts each)

(BA −1 each) (gives # answer)

(a) (N₂) zero − element

(b) K(Cl) −1 (group 7−8 = −1)

(c) K₂(SO₄)   ↗⁻²   +6

↘ +1
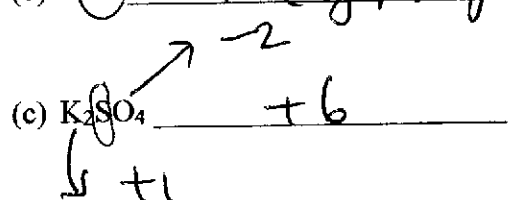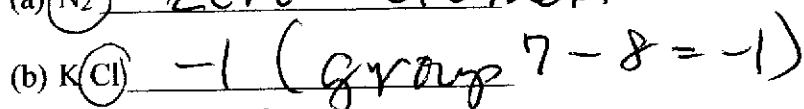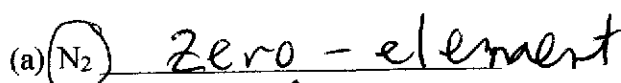
$2(H) + S + 4(-2) = zero$

$S = 8 - 2 = 6$ (math −½ pt)

3. (a). Calculate the concentration made up by using 8.9 grams of Li Br (FW of Li Br = 86.85 g/mole) dissolved to make up 0.750 Liters of solution. Show work. (5 pts)) (concentration in M)

molarity

(3pt) $\dfrac{8.9g / 86.85g/mol}{0.750 \ell}$ = (0.1366) (1 pt)

(2 pt)   2 s.f. = 0.14 M

(b)If you dilute the solution by adding enough water to make up a total of 1.3 Liters of solution, what is the new concentration ? Show work. (5 pts)

$M_i V_i = M_f V_f$

$M_i = 0.14 m \quad V_i = 0.750 \ell \quad V_f = 1.3 \ell$

$(0.14)(0.75) = M_f (1.3 \ell)$

(BA −2 ½ pt)

$M_f = \dfrac{(0.14 m)(0.75 \ell)}{(1.3 \ell)} = 0.081 m$

4. If you have n (principal quantum number) = 3, what are the possible values of angular momentum quantum number (ℓ) (5 pts)

$$\ell = 0, \cdots (n-1)$$
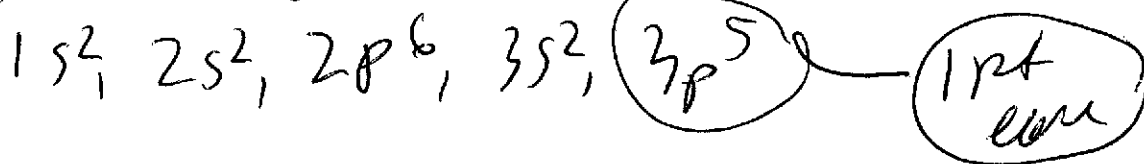
$$\ell = 0, 1, 2$$
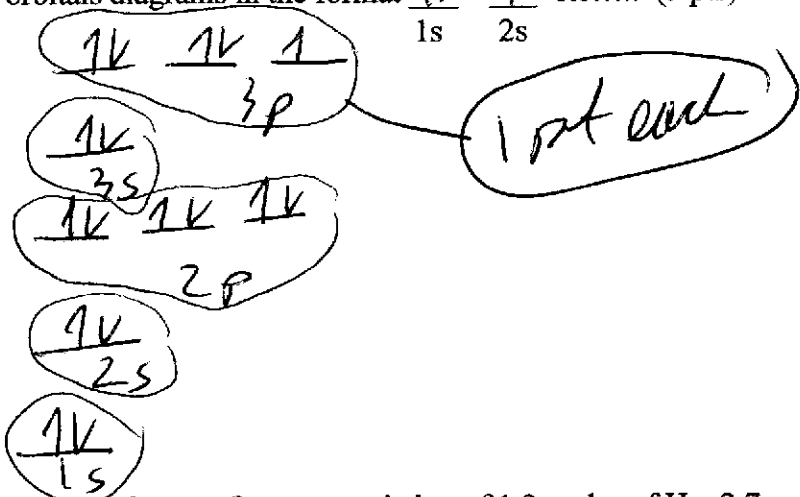
$\frac{1}{2}A - 2\frac{1}{2}$

gave $-2, -1$

gave only 2

5. What is the electron configuration for the element ~~phosphorus~~ chlorine (Cl) ?

(a) Show electron configuration in the format $1s^2, 2s^2$ etc. ...... (5 pts)

$$1s^2, 2s^2, 2p^6, 3s^2, \boxed{3p^5} \quad 1 \text{ pt each}$$

(b) Show orbitals diagrams in the format $\underline{\uparrow\downarrow}$ $\underline{\uparrow}$ etc..... (5 pts)
 1s 2s

$\underline{\uparrow\downarrow}$ $\underline{\uparrow\downarrow}$ $\underline{\uparrow}$
 3p 1 pt each

$\underline{\uparrow\downarrow}$
 3s

$\underline{\uparrow\downarrow}$ $\underline{\uparrow\downarrow}$ $\underline{\uparrow\downarrow}$
 2p

$\underline{\uparrow\downarrow}$
 2s

$\underline{\uparrow\downarrow}$
 1s

6. If you have a mixture of gases consisting of 1.2 moles of H_2 , 2.7 moles of He, what is the mole fraction (X) of He ? (5 pts)

$$X = \frac{2.7 \text{ mol He}}{1.2 \text{ mol } H_2 + 2.7 \text{ mol He}} = 0.69 \text{ mole fraction}$$

$$3.9$$

$\frac{1}{2}A - 2\frac{1}{2}$ gave $2_0 - 1$

Part III: **Long Answers** (38 pts) Show work on all questions for partial and full credit even on questions which do not specify.

1. If we are doing a titration by combining H_2SO_4 with $NaOH$ using 2.52 M of the H_2SO_4 with 2.55 M of the K OH starting with 5.25 Liters of the H_2SO_4, how many liters of ~~NaOH~~ will you need? (20 pts)

KOH

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

$$\left(\frac{5.25\ \ell}{H_2SO_4\ soln}\right) \times \frac{2.52\ mol\ H_2SO_4}{1.00\ \ell\ H_2SO_4\ soln} \times \frac{2\ mol\ NaOH}{1\ mol\ H_2SO_4} \times \frac{1\ \ell\ NaOH}{2.55\ mol\ NaOH}$$

(5 pt)   (4 pt)   (4 pt)   (4 pt)

$= 10.3\ \ell\ NaOH$

(3 pt)

$\beta A - 10 \beta t$

2. You have 1.2 moles of a gas at 25.2 °C. If that gas occupies 2.5 milliliters volume, what is the pressure of the gas? (18 pts)

$n = 1.2$ mole (3 pt)

$$PV = nRT$$

$T = 25.2\,^{\circ}C + 273.15 = 298.35\,K$ (3 pt)

$V = 2.5\,ml \times \dfrac{l}{1000\,ml} = 2.5 \times 10^{-3}\,l$ (3 pt)

$P = ?$ (3 pt) R (3 pt)

$$(P)(2.5 \times 10^{-3}\,l) = (1.2\,mol)\left(0.08206\,\dfrac{l\,atm}{mol\,K}\right)(298.35\,K)$$

$$P = \dfrac{(1.2\,mol)\left(0.08206\,\dfrac{l\,atm}{mol\,K}\right)(298.35\,K)}{(2.5 \times 10^{-3}\,l)}$$

4 pt plug in

$P = 11752.6\,atm$

$P = 1.2 \times 10^{4}\,atm$ (2 pt)
$(2\ s.f.)$

BA −9 pt