You may use any calculator. You may NOT use cell phone or tablet.

CHEM 1101 MIDTERM 2 Winter 2017 – 90 MINUTES

- **PRINT** your name and student number on your booklet. **UNDERLINE YOUR LAST NAME.**
- **SPACE OUT YOUR ANSWERS** – If we can't read it, you won't get marks for it. We will mark answers on the lined side of the page only – you can use the other side for rough work if you wish.

10% 1. Draw and label a band diagram for calcium ***(use at least half a page)***

See the class notes

2. a) Draw and label a band diagram for silicon ***(use at least half a page for each of a, b and c)***

See the class notes

b) Draw and label a band diagram for silicon doped with arsenic. Indicate whether this is an intrinsic or extrinsic semiconductor, and an n-type or a p-type. Explain your choice briefly.

See the class notes. Extrinsic n-type since As has more valence electrons than the silicon substrate

25% c) Draw and label a band diagram for a 50:50 mixture of gallium and arsenic.

See the class notes

d) ***Explain*** briefly (you do not need to draw another band diagram unless you want to) what you would add to the 50:50 mixture of part c) in order to turn it into a p-type semiconductor.

Some extra gallium, since that has fewer valence electrons than the average of 50:50 gallium:arsenic

3. You have 6.00 kilograms of fluorine gas in an 50.0 L cylinder at 22°C.

a) Determine its pressure if it is behaving ideally 76.5 atm

20% b) Determine its real pressure given that for fluorine gas, a=1.156 L^2atm/mol^2; b=0.029 L/mol

72.6 atm

c) Determine the percent error (and state whether you would be too high or too low) that arises if you use the ideal gas equation instead of the van der Waals equation to determine the pressure of fluorine at these conditions. 5% high

d) Comment briefly on whether using the ideal gas equation under these conditions would pose a safety hazard if your gas cylinder is rated for a maximum pressure of 75 atm. No safety hazard in this case. Think about it!

4. Mercury (Hg) has a normal boiling point of 356.7 °C and a standard heat of vaporization of 59.17 kJ/mol. If you place 1.6 kg of mercury in a closed bottle at 24 °C, determine:

25% a) The vapour pressure in the bottle 3×10^{-6} atm

b) The mass of mercury that will have evaporated at 24 °C, if the head space in the bottle is 1.8 L.

5×10^{-5} g

5. a) Draw and label a Born-Haber diagram for magnesium nitride. (***use at least half a page!***) *See the class notes*

20% b) Given the data on the data page, determine the crystal lattice energy of magnesium nitride.
– 12 677 kJ (or kJ/mol; either one is OK)

Data and Equations:

$PV = nRT$ $\qquad \ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H^0_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$ $\qquad R = 8.314\ J/K\cdot mol$

$\left[P + \frac{an^2}{V^2}\right][V - nb] = nRT$ $\qquad T(K) = T(^0C) + 273$ $\qquad R = 0.08206\ L\cdot atm/K\cdot mol$

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$\Delta H°_{sub}$ (Mg)	=	146 kJ/mol	E.A.$_1$ (N)	=	7 kJ/mol
I.E.$_1$(Mg)	=	737.7 kJ/mol	E.A.$_2$ (N)	=	603 kJ/mol
I.E.$_2$(Mg)	=	1450.7 kJ/mol	E.A.$_3$ (N)	=	1509 kJ/mol
I.E.$_3$(Mg)	=	7732.5 kJ/mol	B.D.E.(N_2)	=	935 kJ/mol
$\Delta H_f°$ (Mg_3N_2)	=	– 500.82 kJ/mol			