GIBBS FREE ENERGY OF A DISSOLUTION REACTION SMART WORKSHEET

PART A. STANDARDIZATION OF HYDROCHLORIC ACID

	Units
Mass of Na_2CO_3	g
V_i (initial buret reading)	mL
V_f (final buret reading)	mL
$V_f - V_i$	mL
Molarity of HCl	mol L^{-1}

CALCULATING THE MOLARITY OF HYDROCHLORIC ACID

The molar mass of $NaCO_3$ is 105.99 $g\ mol^{-1}$

Part A, table 1: Lab data and molarity of hydrochloric acid calculation

	Trial 1	Trial 2	Trial 3 (*optional*)	Trial 4 (*optional*)	Trial 5 (*optional*)	Unit
Mass of Na_2CO_3	0.2120	0.2090				g
V_i (initial buret reading)	20.00	20.00				mL
V_f (final buret reading)	32.32	32.10				mL
1. $V_f - V_i$	12.32	12.10				mL
2. Molarity of HCl *Unrounded*	0.324706	0.325931				mol L^{-1}
3. Molarity of HCl *Rounded*	0.3247	0.3259				mol L^{-1}

Note: Make sure you have completed table for all trials that you have recorded data for before you proceed. Columns for trials 1 and 2 must be completed to proceed. You will only be able to use the data from completed trials columns in subsequent calculations.

Have you completed the table above for all the trials you collected data for? Yes

CALCULATING THE AVERAGE MOLARITY OF HYDROCHLORIC ACID

	First trial	Second trial
Two best trials selected for averaging	1	2

Part A, table 2: Calculating the average molarity of hydrochloric acid

	Unrounded	Rounded
3. Average molarity of HCl	0.325319	0.3253

YOUR PROGRESS ON THE STANDARDIZATION OF HYDROCHLORIC ACID SECTION

CORRECT 15 / 24 POINTS AWARDED 51 / 52 AUTOSOLVED 0 / 24 NOT FINISHED 18 / 40

PART B. ANALYSIS OF THE SATURATED BORAX SOLUTIONS

TEMPERATURE DATA

$$\mathrm{Temperature(K)} = \mathrm{Temperature(^\circ C)} + 273.15$$

Part B, table 1: Decanting temperature data and average temperature calculation in degrees Celsius

Target decanting temperature ($^\circ$C)	Actual decanting temperature ($^\circ$C)		4. T_{average} ($^\circ$C)	
	Trial 1	Trial 2	Unrounded	Rounded
20.0	20.5	20.5	20.50	20.5
30.0	29.0	29.0	29.00	29.0
40.0	39.0	39.0	39.00	39.0
50.0	50.0	50.0	50.00	50.0
60.0	60.0	60.0	60.00	60.0

Part B, table 2: Average temperature calculation in kelvin and inverse temperature calculation

T_{average} ($^\circ$C)	5. T_{average} (K)		6. $1/T_{\mathrm{average}}$ (K^{-1})	
Unrounded	Unrounded	Rounded	Unrounded	Rounded
20.50	293.65	293.7	0.00340541	0.003405
29.00	302.15	302.2	0.00330961	0.003310
39.00	312.15	312.2	0.00320359	0.003204
50.00	323.15	323.2	0.00309454	0.003095
60.00	333.15	333.2	0.00300165	0.003002

VOLUME DATA

Part B, table 3: Trial 1 volume data and buret volume calculation

Target decanting temperature ($^\circ$C)	Trial 1		
	V_i	V_f	$V_f - V_i$
20.0	20.00	24.11	4.11
30.0	20.00	25.82	5.82
40.0	20.00	29.25	9.25
50.0	20.00	36.00	16.00

60.0	20.00	44.40	24.40

Part B, table 4: Trial 2 volume data, buret volume calculation and average buret volume calculation

Target decanting temperature ($^\circ C$)	Trial 2			9. $\Delta V_{average}$	
	V_i	V_f	8. $V_f - V_i$	Unrounded	Rounded
20.0	20.00	24.11	4.11	4.110	4.11
30.0	20.00	25.82	5.82	5.820	5.82
40.0	20.00	29.25	9.25	9.250	9.25
50.0	20.00	36.00	16.00	16.000	16.00
60.0	20.00	44.40	24.40	24.400	24.40

DETERMINATION OF K_{sp}

Part B, table 5: Solubility product constant calculations

Target decanting temperature ($^\circ C$)	10. $[B_4O_5(OH)_4{}^{2-}]$		11. K_{sp}		12. $\ln(K_{sp})$	
	Unrounded	Rounded	Unrounded	Rounded	Unrounded	Rounded
20.0	0.133698	0.134	0.00955949	0.00956	-4.6502	-4.650
30.0	0.189325	0.189	0.0271446	0.0271	-3.6066	-3.607
40.0	0.300903	0.301	0.108978	0.109	-2.2166	-2.217
50.0	0.520480	0.520	0.563991	0.564	-0.5727	-0.573
60.0	0.793732	0.794	2.00024	2.00	0.6933	0.693

GRAPH CALCULATIONS

- The gas constant, R is 8.31446 $\mathrm{J\,mol^{-1}\,K^{-1}}$
- Important Information: Submit a properly-set-up Excel graph of $\ln(K_{sp})$ (y-axis) vs $1/T$ (x-axis). Include equation of fitted trendline (6 sig. figs for slope and intercept), and value of R^2.
- Note: Pay close attention to the sign.

Part B, table 6: Calculations from your graph plotted in Excel

	Unrounded	Rounded	Units
Trendline slope	-13426.3	-1.34×10^4	K
Trendline intercept	40.9335	40.9	unitless
$\Delta H_{dissolution}$	111.626	112	$\mathrm{kJ\,mol^{-1}}$
$\Delta S_{dissolution}$	340.321	3.40×10^2	$\mathrm{J\,mol^{-1}\,K^{-1}}$
$\Delta G_{dissolution}$ at 25 $^\circ C$	10.1593	1.0×10^1	$\mathrm{kJ\,mol^{-1}}$