ACIDS, BASES, AND TITRATION CURVES II SMART WORKSHEET

PART A: TITRATION OF PHOSPHORIC ACID

DATA

	Data	Unit
Average molarity of NaOH used in experiment 8	0.2646	mol/L

	Trial 1	Trial 2	Units
Volume $\mathrm{H_3PO_4}$ dispensed	10.00	10.00	mL
Volume NaOH added to reach first equivalence point (from 2nd derivative analysis on LabQuest)	4.00	5.30	mL
Volume NaOH added to reach second equivalence point (from 2nd derivative analysis on LabQuest)	11.55	12.62	mL
pH halfway to first equivalence point (from titration curve analysis on LabQuest)	0.92	1.17	unitless
pH halfway between the first and second equivalence points (from titration curve analysis on LabQuest)	6.46	6.63	unitless

$\mathrm{p}K_\mathrm{a}$ ANALYSIS

The acid dissociation constants for phosphoric acid are:

- K_{a1} = 0.0075
- K_{a2} = 6.2 × 10^{-8}
- K_{a3} = 4.2 × 10^{-13}

	Unrounded	Rounded	Units
1. Average experimental $\mathrm{p}K_{a1}$ of $\mathrm{H_3PO_4}$	1.04500	1.05	unitless
2. Average experimental $\mathrm{p}K_{a2}$ of $\mathrm{H_3PO_4}$	6.54500	6.55	unitless
3. Actual $\mathrm{p}K_{a1}$ of $\mathrm{H_3PO_4}$	2.12494	2.12	unitless
4. Actual $\mathrm{p}K_{a2}$ of $\mathrm{H_3PO_4}$	7.20761	7.21	unitless
5. % error of your average $\mathrm{p}K_{a1}$	50.8221	50.8	unitless
6. % error of your average $\mathrm{p}K_{a2}$	9.19320	9.2	unitless

ANALYSIS OF CONCENTRATION OF $\mathrm{H_3PO_4}$

	Trial 1	Trial 2	Units

7. Concentration of H_3PO_4 (use data for second equivalence point) *Unrounded*	0.152807	0.166963	mol/L
Concentration of H_3PO_4 (use data for second equivalence) *Rounded*	0.1528	0.1670	mol/L

	Value	Units
8. average $[H_3PO_4]$ *Unrounded*	0.159900	mol/L
average $[H_3PO_4]$ *Rounded*	0.1599	mol/L

YOUR PROGRESS ON 'PART A: TITRATION OF PHOSPHORIC ACID'

CORRECT 25 / 25 | POINTS AWARDED 96 / 96 | AUTOSOLVED 0 / 25 | NOT FINISHED 0 / 36

PART B: TITRATION OF AN UNKNOWN DIPROTIC ACID

Code of unknown acid: B

	Trial 1	Trial 2	Units
Mass of unknown acid	0.1434	0.1595	g
Volume $NaOH$ added to reach first equivalence point	7.82	8.31	mL
Volume $NaOH$ added to reach second equivalence point	16.51	17.74	mL

MOLAR MASS ANALYSIS

	Trial 1	Trial 2	Units
9. Molar mass of unknown acid (use your second equivalence point data) *Unrounded*	65.6511	67.9590	g/mol
10. Molar mass of unknown acid (use your second equivalence point data) *Rounded*	65.65	67.96	g/mol

	Value	Units
11. Average molar mass of unknown acid *Unrounded*	66.8050	g/mol
12. Average molar mass of unknown acid *Rounded*	66.81	g/mol

pH DATA

	Trial 1	Trial 2	Units
pH halfway to first equivalence point (from analysis of LabQuest titration curve)	0.89	0.89	unitless
pH halfway between 1st and 2nd equivalence points (from analysis of LabQuest titration curve)	5.54	5.65	unitless

pK_a ANALYSIS

	Unrounded	Rounded	Units
13. Average experimental $\mathrm{p}K_{\mathrm{a1}}$	0.890000	0.89	unitless
14. Average experimental $\mathrm{p}K_{\mathrm{a2}}$	5.59500	5.60	unitless

YOUR PROGRESS ON 'PART B: TITRATION OF AN UNKNOWN DIPROTIC ACID'

CORRECT 15 / 15 | POINTS AWARDED 60 / 60 | AUTOSOLVED 0 / 15 | NOT FINISHED 0 / 26

PART C: IDENTIFICATION OF UNKNOWN ACID

Compare experimental molar mass and $\mathrm{p}K_{\mathrm{a1}}$ to information for 2 possible unknowns.

Acid	$\mathrm{p}K_{\mathrm{a1}}$	Molar mass ($\mathrm{g\,mol^{-1}}$)
Oxalic acid dihydrate	1.27	126.07
Maleic acid	1.92	116.1

Closest match: maleic acid

Closest match of data	Only one of your pH or molar mass values is closest to that of maleic acid	1
Correct identification	Well done, you correctly identified the unknown acid	2

(Report your rounded value to 3 significant figures)

Make sure to use the literature molar mass of the correct acid in the % error calculation. The acid you selected for the 'Closest match' may not be the correct acid.

	Unrounded	Rounded
15. % error in molar mass of unknown acid	42.4591	42.5

Quality of data	% difference above 10%	0

YOUR PROGRESS ON 'PART C: IDENTIFICATION OF UNKNOWN ACID'

CORRECT 5 / 5 | POINTS AWARDED 13 / 24 | AUTOSOLVED 0 / 5 | NOT FINISHED 0 / 3

YOUR OVERALL PROGRESS

Visual status toggles for statistics by question type

☐ Units ☐ Calculations ☐ Rounding ☐ Quality of data

CORRECT ANSWERS	POINTS AWARDED	AUTOSOLVED	NOT FINISHED
42	169	0	0
42	180	47	44