PRACTICE SET 7

Passage V: Titrating Unknown Weak Acids

7 questions (29–35) · suggested time 11 minutes

1. Read the passage and answer all 7 questions on your own. No notes, no calculator.
2. Check your answers with the key on the last page.
3. Watch the walkthrough video to see how each question is broken down.

Passage V

Five students (A-E) used volumetric analysis to determine the molar mass of a weak acid of unknown composition. Table 1 lists the acids issued by the instructor as unknowns (unk).

Table 1 Weak Acids

Name	Formula
Acetic	$HC_2H_3O_2$
Benzoic	$HC_7H_5O_2$
Bromobenzoic	$HC_7H_4BrO_2$
Chlorobenzoic	$HC_7H_4ClO_2$
Methylbenzoic	$HC_8H_7O_2$
Succinic	$H_2C_4H_4O_4$

The instructor prepared a solution of NaOH(aq) by dissolving 8 g of NaOH(s) (MM = 40.00) in 2 L of H_2O, as shown in Equation 1. The temperature of the solution rose during the mixing process.

$$NaOH(s) + H_2O(\ell) \rightarrow NaOH(aq)$$

Equation 1

Passage continues on next page

The NaOH(*aq*) was standardized by each student by titration against a pure sample of KHP (potassium acid phthalate, MM = 204.2), as shown in Equation 2.

$$KHP(aq) + NaOH(aq) \rightarrow KNaP(aq) + H_2O(\ell)$$

Equation 2

Each unknown was dissolved in approximately 30 mL of water or water-ethanol and titrated with the standardized NaOH(*aq*), as shown for benzoic acid in Equation 3.

$$HC_7H_5O_2(aq) + NaOH(aq) \rightarrow NaC_7H_5O_2(aq) + H_2O(\ell)$$

Equation 3

Table 2 shows some of the data collected by the students.

Table 2 Partial Data of Students A-E

	A	B	C	D	E
Mass KHP	0.5500 g				
Moles KHP		0.002752			
Vol NaOH vs KHP		25.02 mL	25.20 mL		
M NaOH			0.1022	0.1056	
Mass unknown					
Vol NaOH vs unknown					
Moles unknown					
Equivalent Wt unknown	122.2	201.0	156.1	136.2	59.1
Unknown					Succinic

29 How many moles of KHP are present in the sample of KHP of student A?

(A) 2.752×10^{-1} mol

(B) 2.693×10^{-2} mol

(C) 2.693×10^{-3} mol

(D) 3.712×10^{2} mol

Continued on next page

30 Which of the following changes in state functions occurred during the dissolution shown in Equation 1?

I. $\Delta H < 0$

II. $\Delta G > 0$

III. $\Delta S > 0$

(A) I only

(B) II only

(C) I and III only

(D) II and III only

31 What is the approximate molarity of the solution prepared by the instructor?

(A) 0.1 *M*

(B) 0.2 *M*

(C) 0.4 *M*

(D) 4.0 *M*

32 At the stoichiometric (equivalence) point in a titration of benzoic acid with NaOH(*aq*) shown by Equation 3, the pH is:

(A) < 4.

(B) > 4 and < 7.

(C) = 7.

(D) > 7.

33 What is the conjugate base of chlorobenzoic acid?

(A) OH^-

(B) H_2O

(C) $C_7H_4ClO^-$

(D) $C_7H_4ClO_2^-$

Continued on next page

34 Student E accounted for the equivalent weight found for succinic acid by analyzing its titration with NaOH(*aq*) and concluding that it is:

- (A) diprotic and requires one-half the number of moles of NaOH expected for a monoprotic acid.
- (B) diprotic and requires twice the number of moles of NaOH expected for a monoprotic acid.
- (C) triprotic and requires one-third the number of moles of NaOH expected for a monoprotic acid.
- (D) triprotic and requires three times the number of moles of NaOH expected for a monoprotic acid.

35 If a student did NOT remove all the moisture from the KHP before the titration with NaOH(*aq*), then the molarity determined for the NaOH(*aq*) would be:

- (A) too high because the actual number of moles of KHP titrated would be less than the number used in the calculations.
- (B) too low because the actual number of moles of KHP titrated would be more than the number used in the calculations.
- (C) too low because the actual number of moles of KHP titrated would be less than the number used in the calculations.
- (D) unaffected because the weighed KHP was dissolved in water, making any moisture in the sample unimportant.

Finished all 7 questions?

Only check the key once you've committed to an answer for every question.

YOUR ANSWERS

29	30	31	32	33	34	35	Score / 7
____	____	____	____	____	____	____	

Q	ANSWER	
29	C	2.693×10^{-3} mol
30	C	I and III only
31	A	0.1 *M*
32	D	> 7.
33	D	$C_7H_4ClO_2^-$
34	B	diprotic and requires twice the number of moles of NaOH expected for a monoprotic acid.
35	A	too high because the actual number of moles of KHP titrated would be less than the number used in the calculations.

NOW WATCH THE WALKTHROUGH

Breaking Down AAMC Passage-Based Questions (Chemistry Passage Part 4)

Every question broken down step by step: where the information is in the passage, and why each wrong option is wrong.