

Name: \_\_\_\_\_

This is a practice test for CH 233 midterm I. There are 13 multiple choice/short answer and 7 free response questions and is representative of what could be expected on the actual midterm. Please treat it as a real examination, with no outside help from notes, internet, or peers. A lot of these questions will require you to reference the cover sheet for tabulated data. Take 80 + 20 minutes to complete this practice test and remember to keep in mind significant figures. Once done, let James know for the answer key. Good luck!

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A	3A	4A	5A	6A	7A	8A										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H Hydrogen 1.008	He Helium 4.003	Li Lithium 6.941	Be Beryllium 9.012	B Boron 10.81	C Carbon 12.01	N Nitrogen 14.01	O Oxygen 16.00	F Fluorine 19.00	Ne Neon 20.18	Na Sodium 22.99	Mg Magnesium 24.31	Al Aluminum 26.98	Si Silicon 28.09	P Phosphorus 30.97	S Sulfur 32.07	Cl Chlorine 35.45	Ar Argon 39.95
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K Potassium 39.10	Ca Calcium 40.08	Sc Scandium 44.96	Ti Titanium 47.87	V Vanadium 50.94	Cr Chromium 52.00	Mn Manganese 54.94	Fe Iron 55.85	Co Cobalt 58.93	Ni Nickel 58.69	Cu Copper 63.55	Zn Zinc 65.38	Ga Gallium 69.72	Ge Germanium 72.64	As Arsenic 74.92	Se Selenium 78.96	Br Bromine 79.90	Kr Krypton 83.80
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb Rubidium 85.47	Sr Strontium 87.62	Y Yttrium 88.91	Zr Zirconium 91.22	Nb Niobium 92.91	Mo Molybdenum 95.96	Tc Technetium (98)	Ru Ruthenium 101.07	Rh Rhodium 102.91	Pd Palladium 106.42	Ag Silver 107.87	Cd Cadmium 112.41	In Indium 114.82	Sn Tin 118.7	Sb Antimony 121.76	Te Tellurium 127.60	I Iodine 126.90	Xe Xenon 131.29
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs Cesium 132.91	Ba Barium 137.33	La Lanthanum 138.91	Hf Hafnium 178.49	Ta Tantalum 180.95	W Tungsten 183.84	Re Rhenium 186.21	Os Osmium 190.23	Ir Iridium 192.22	Pt Platinum 195.08	Au Gold 196.97	Hg Mercury 200.59	Tl Thallium 204.38	Pb Lead 207.2	Bi Bismuth 208.98	Po Polonium (209)	At Astatine (210)	Rn Radon (222)
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Fr Francium (223)	Ra Radium (226)	Ac Actinium (227)	Rf Rutherfordium (261)	Db Dubnium (262)	Sg Seaborgium (266)	Bh Bohrium (264)	Hs Hassium (269)	Mt Meitnerium (268)	Ds Darmstadtium (271)	Rg Roentgenium (272)	Cn Copernicium (285)		Fl Flerovium (289)		Lv Livermorium (293)		
58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ce Cerium 140.12	Pr Praseodymium 140.91	Nd Neodymium 144.24	Pm Promethium (145)	Sm Samarium 150.36	Eu Europium 151.96	Gd Gadolinium 157.25	Tb Terbium 158.93	Dy Dysprosium 162.50	Ho Holmium 164.93	Er Erbium 167.26	Tm Thulium 168.93	Yb Ytterbium 173.05	Lu Lutetium 174.97	76	77	78	79
90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107
Th Thorium 232.04	Pa Protactinium 231.04	U Uranium 238.03	Np Neptunium (237)	Pu Plutonium (244)	Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)	Lr Lawrencium (262)	108	109	110	111



**Oregon State**  
University

## 1. Ionization Constants for Acids at 25°C

Name	Formula	$K_{a1}$	$K_{a2}$	$K_{a3}$
Acetic	$\text{HC}_2\text{H}_3\text{O}_2$	$1.8 \times 10^{-5}$		
Acetylsalicylic	$\text{HC}_9\text{H}_7\text{O}_4$	$3.3 \times 10^{-4}$		
Adipic	$\text{H}_2\text{C}_6\text{H}_8\text{O}_4$	$3.9 \times 10^{-5}$	$3.9 \times 10^{-6}$	
Arsenic	$\text{H}_3\text{AsO}_4$	$5.5 \times 10^{-3}$	$1.7 \times 10^{-7}$	$5.1 \times 10^{-12}$
Arsenous	$\text{H}_3\text{AsO}_3$	$5.1 \times 10^{-10}$		
Ascorbic	$\text{H}_2\text{C}_6\text{H}_6\text{O}_6$	$8.0 \times 10^{-5}$	$1.6 \times 10^{-12}$	
Benzoic	$\text{HC}_7\text{H}_5\text{O}_2$	$6.5 \times 10^{-5}$		
Boric	$\text{H}_3\text{BO}_3$	$5.4 \times 10^{-10}$		
Butanoic	$\text{HC}_4\text{H}_7\text{O}_2$	$1.5 \times 10^{-5}$		
Carbonic	$\text{H}_2\text{CO}_3$	$4.3 \times 10^{-7}$	$5.6 \times 10^{-11}$	
Chloroacetic	$\text{HC}_2\text{H}_2\text{O}_2\text{Cl}$	$1.4 \times 10^{-3}$		
Chlorous	$\text{HClO}_2$	$1.1 \times 10^{-2}$		
Citric	$\text{H}_3\text{C}_6\text{H}_5\text{O}_7$	$7.4 \times 10^{-4}$	$1.7 \times 10^{-5}$	$4.0 \times 10^{-7}$
Cyanic	$\text{HCNO}$	$2 \times 10^{-4}$		
Formic	$\text{HCHO}_2$	$1.8 \times 10^{-4}$		
Hydrazoic	$\text{HN}_3$	$2.5 \times 10^{-5}$		
Hydrocyanic	$\text{HCN}$	$4.9 \times 10^{-10}$		
Hydrofluoric	$\text{HF}$	$3.5 \times 10^{-4}$		
Hydrogen chromate ion	$\text{HCrO}_4^-$	$3.0 \times 10^{-7}$		
Hydrogen peroxide	$\text{H}_2\text{O}_2$	$2.4 \times 10^{-12}$		
Hydrogen selenate ion	$\text{HSeO}_4^-$	$2.2 \times 10^{-2}$		
Hydrosulfuric	$\text{H}_2\text{S}$	$8.9 \times 10^{-8}$	$1 \times 10^{-18}$	

Name	Formula	$K_{a1}$	$K_{a2}$	$K_{a3}$
Hydrotelluric	$\text{H}_2\text{Te}$	$2.3 \times 10^{23}$	$1.6 \times 10^{-11}$	
Hypobromous	$\text{HBrO}$	$2.8 \times 10^{-9}$		
Hypochlorous	$\text{HClO}$	$2.9 \times 10^{-8}$		
Hypoiodous	$\text{HIO}$	$2.3 \times 10^{-11}$		
Iodic	$\text{HIO}_3$	$1.7 \times 10^{-1}$		
Lactic	$\text{HC}_3\text{H}_5\text{O}_3$	$1.4 \times 10^{-4}$		
Maleic	$\text{H}_2\text{C}_4\text{H}_2\text{O}_4$	$1.2 \times 10^{-2}$	$5.9 \times 10^{-7}$	
Malonic	$\text{H}_2\text{C}_3\text{H}_2\text{O}_4$	$1.5 \times 10^{-3}$	$2.0 \times 10^{-6}$	
Nitrous	$\text{HNO}_2$	$4.6 \times 10^{-4}$		
Oxalic	$\text{H}_2\text{C}_2\text{O}_4$	$6.0 \times 10^{-2}$	$6.1 \times 10^{-5}$	
Paraperiodic	$\text{H}_5\text{IO}_6$	$2.8 \times 10^{-2}$	$5.3 \times 10^{-9}$	
Phenol	$\text{HC}_6\text{H}_5\text{O}$	$1.3 \times 10^{-10}$		
Phosphoric	$\text{H}_3\text{PO}_4$	$7.5 \times 10^{-3}$	$6.2 \times 10^{-8}$	$4.2 \times 10^{-13}$
Phosphorous	$\text{H}_3\text{PO}_3$	$5 \times 10^{-2}$	$2.0 \times 10^{-7}$	
Propanoic	$\text{HC}_3\text{H}_5\text{O}_2$	$1.3 \times 10^{-5}$		
Pyruvic	$\text{HC}_3\text{H}_3\text{O}_3$	$4.1 \times 10^{-3}$		
Pyrophosphoric	$\text{H}_2\text{P}_2\text{O}_7$	$1.2 \times 10^{-1}$	$7.9 \times 10^{-3}$	$2.0 \times 10^{-7}$
Selenous	$\text{H}_2\text{SeO}_3$	$2.4 \times 10^{-3}$	$4.8 \times 10^{-9}$	
Succinic	$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$	$6.2 \times 10^{-5}$	$2.3 \times 10^{-6}$	
Sulfuric	$\text{H}_2\text{SO}_4$	Strong acid	$1.2 \times 10^{-2}$	
Sulfurous	$\text{H}_2\text{SO}_3$	$1.6 \times 10^{-2}$	$6.4 \times 10^{-8}$	
Tartaric	$\text{H}_2\text{C}_4\text{H}_4\text{O}_6$	$1.0 \times 10^{-3}$	$4.6 \times 10^{-6}$	
Trichloroacetic	$\text{HC}_2\text{Cl}_3\text{O}_2$	$2.2 \times 10^{-1}$		
Trifluoroacetic acid	$\text{HC}_2\text{F}_3\text{O}_2$	$3.0 \times 10^{-1}$		

## 3. Ionization Constants for Bases at 25°C

Name	Formula	$K_b$
Ammonia	$\text{NH}_3$	$1.76 \times 10^{-5}$
Aniline	$\text{C}_6\text{H}_5\text{NH}_2$	$3.9 \times 10^{-10}$
Bicarbonate ion	$\text{HCO}_3^-$	$2.3 \times 10^{-8}$
Carbonate ion	$\text{CO}_3^{2-}$	$1.8 \times 10^{-4}$
Codeine	$\text{C}_{18}\text{H}_{21}\text{NO}_3$	$1.6 \times 10^{-6}$
Diethylamine	$(\text{C}_2\text{H}_5)_2\text{NH}$	$6.9 \times 10^{-4}$
Dimethylamine	$(\text{CH}_3)_2\text{NH}$	$5.4 \times 10^{-4}$
Ethylamine	$\text{C}_2\text{H}_5\text{NH}_2$	$5.6 \times 10^{-4}$
Ethylenediamine	$\text{C}_2\text{H}_8\text{N}_2$	$8.3 \times 10^{-5}$
Hydrazine	$\text{H}_2\text{NNH}_2$	$1.3 \times 10^{-6}$
Hydroxylamine	$\text{HONH}_2$	$1.1 \times 10^{-8}$

Name	Formula	$K_b$
Ketamine	$\text{C}_{13}\text{H}_{16}\text{ClNO}$	$3 \times 10^{-7}$
Methylamine	$\text{CH}_3\text{NH}_2$	$4.4 \times 10^{-4}$
Morphine	$\text{C}_{17}\text{H}_{19}\text{NO}_3$	$1.6 \times 10^{-6}$
Nicotine	$\text{C}_{10}\text{H}_{14}\text{N}_2$	$1.0 \times 10^{-6}$
Piperidine	$\text{C}_5\text{H}_{10}\text{NH}$	$1.33 \times 10^{-3}$
Propylamine	$\text{C}_3\text{H}_7\text{NH}_2$	$3.5 \times 10^{-4}$
Pyridine	$\text{C}_5\text{H}_5\text{N}$	$1.7 \times 10^{-9}$
Strychnine	$\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2$	$1.8 \times 10^{-6}$
Triethylamine	$(\text{C}_2\text{H}_5)_3\text{N}$	$5.6 \times 10^{-4}$
Trimethylamine	$(\text{CH}_3)_3\text{N}$	$6.4 \times 10^{-5}$

**Multiple Choice Section (13 questions)**

1) Which is not a Lewis base?

- a)  $\text{OH}^-$
- b)  $\text{F}^-$
- c)  $\text{C}_2\text{O}_4^{2-}$
- d)  $\text{Cu}^{2+}$
- e)  $\text{NH}_3$

2) What is the pH of 0.750 acetic acid,  $\text{CH}_3\text{COOH}_{(\text{aq})}$ ?

- a) 0.750
- b) 0.00367
- c) 2.43
- d) 1.75
- e) 6.25

3) What is the conjugate acid of  $\text{HCO}_3^-$ ?

- a)  $\text{H}_3\text{O}^+$
- b)  $\text{H}_2\text{O}$
- c)  $\text{CO}_3^{2-}$
- d)  $\text{OH}^-$
- e)  $\text{H}_2\text{CO}_3$

4) Which, if any, of the following species is in the greatest concentration in a 0.100-molar solution of  $\text{H}_2\text{SO}_4$  in water?

- a)  $\text{H}_2\text{SO}_4$
- b)  $\text{H}_3\text{O}^+$
- c)  $\text{HSO}_4^-$
- d)  $\text{SO}_4^{2-}$
- e) All species are in equilibrium and therefore have the same concentration.

5) Arrange by increasing basicity:



6) A general chemistry student creates a buffer by adding 0.5 mol of solid sodium hydroxide to 1.0 L of 1.0 M acetic acid. What can be said about the pH of the buffer?

- a) The pH will be equal to the pKa for acetic acid
- b) The pH will be greater than the pKa for acetic acid
- c) The pH will be less than the pKa for acetic acid
- d) The pH will be equal to the pKa of acetic acid minus 0.30
- e) The pH will be less than the value in answer d.
- f) Not enough info

7) A student titrates 2.884 g of an unknown monoprotic acid to the equivalence point with 62.55 mL of 0.2447 M NaOH. What is the molar mass of the acid?

- a) 0.005307 g/mol
- b) 53.07 g/mol
- c) 530.7 g/mol
- d) 73.72 g/mol
- e) 188.4 g/mol

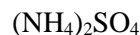
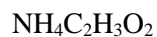
8) What is the molar solubility of  $\text{Al}(\text{OH})_3(\text{aq})$ ?  $K_{\text{sp}} = 1.3 \times 10^{-33}$

- a)  $6.0 \times 10^{-9} \text{ M}$
- b)  $2.6 \times 10^{-9} \text{ M}$
- c)  $4.6 \times 10^{-9} \text{ M}$
- d)  $2.08 \times 10^{-17} \text{ M}$
- e)  $6.9 \times 10^{-10} \text{ M}$

9) Which of the following pairs will create a buffer system? There may be more than one.

- a)  $\text{HClO}$  and  $\text{LiClO}_2^-$
- b)  $\text{HF}$  and  $\text{KF}$
- c)  $\text{CH}_3\text{NH}_2$  and  $\text{CH}_3\text{NH}_3\text{Cl}$
- d)  $\text{NH}_3$  and  $\text{NH}_4\text{Cl}$
- e)  $\text{HNO}_3$  and  $\text{NaNO}_3$
- f)  $\text{HClO}_4$  and  $\text{NaClO}_4$

10) Which many of the following compounds are acidic? There may be more than one.



11) With respect to acids and bases, (select all that are true)

a) A  $\text{CH}_3\text{NH}_3\text{Br}$  solution is acidic

b)  $\text{NO}_2^-$  is a stronger base than  $\text{H}_2\text{AsO}_3^-$

c) Adding some solid sodium acetate,  $\text{NaC}_2\text{H}_3\text{O}_2$ , to aqueous  $\text{HC}_2\text{H}_3\text{O}_2$  will decrease the pH

d) Titration of a weak acid with a strong base will have a pH below 7 at the equivalence point

e)  $\text{CaCO}_3$  is more soluble in an acidic solution than in pure water

12) Consider the titrations of the pairs of aqueous acids and bases listed on the left. For which pair is the pH at the equivalence point stated incorrectly?

<b>Acid-Base Pair</b>	<b>pH at Equivalence Point</b>
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(a) $\text{HCl} + \text{NH}_3$	less than 7
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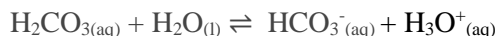
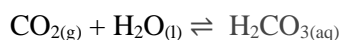
(b) $\text{HNO}_3 + \text{Ca}(\text{OH})_2$	equal to 7
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(c) $\text{HClO}_4 + \text{NaOH}$	equal to 7
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(d) $\text{HClO} + \text{NaOH}$	less than 7
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(e) $\text{CH}_3\text{COOH} + \text{KOH}$	greater than 7
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13) Carbon dioxide dissolves in water according to the equation:



$\text{CO}_2$  levels in the atmosphere have increased about 20% over the last century. Given that Earth's oceans are exposed to atmospheric  $\text{CO}_2$ , which of the following best predicts the effects of increased  $\text{CO}_2$  levels on the pH of the Earth's oceans now?

- a) The pH of Earth's oceans now is higher than the pH of Earth's oceans a century ago
- b) The pH of Earth's oceans now is the same than the pH of Earth's oceans a century ago
- c) The pH of Earth's oceans now is lower than the pH of Earth's oceans a century ago
- d) The increase in  $\text{CO}_2$  levels in Earth's oceans has no effect on its pH

**Free Response Questions (7 questions, multiple parts)**

- 14) Find the  $K_b$  for some unknown weak base that is 0.150M and has a pH of 10.7.
- 15) A 52.60 mL aqueous Jamesonniium, HJ, acid solution has a pH of 6.6. How many hydronium ions are present in this solution?
- 16) Ammonium carbonate,  $(\text{NH}_4)_2\text{CO}_3$ , is a leavening agent sometimes used for cooking as a substitute for baking powder. What is the pH of 0.200 mol ammonium carbonate in a 0.800L solution?
- 17) A 100. mL sample of 0.35 M propanoic acid ( $\text{C}_2\text{H}_5\text{COOH}$ ) is mixed with 0.50 M sodium propanoate.
- What is the pH of this solution?
  - To this solution, 0.0040 moles of solid NaOH are added. Calculate the pH of the resulting solution.
  - If the concentrations of both the acid and the conjugate base were doubled, how would pH be affected? Explain how the capacity of the buffer is affected by this change in concentrations of the acid and base.

18) A student adds 4.40 grams of sodium formate,  $\text{NaCHO}_2$  to 500. mL 0.250M formic acid,  $\text{HCHO}_2$ .

a) Will the pH increase, decrease or stay the same?

b) What is the final pH?

19) Blood is buffered by 0.012M carbonic acid,  $\text{H}_2\text{CO}_3$ , and 0.024M bicarbonate ion ( $\text{HCO}_3^-$ ,  $\text{pK}_a = 6.1$ ).

Assuming that the volume of blood in an adult is 5 liters, what mass of HCl can be neutralized by the buffer before the system reaches a fatal pH of below 7?

20) Consider 25.00 mL sample of 0.320M propanoic acid,  $\text{HC}_3\text{H}_5\text{O}_2$ , analyte being titrated by 0.750M LiOH.

a) Calculate the pH before any titrant is added

b) What is the pH of the solution after 5.00mL of titrant is added?

c) What is the pH at the equivalence point?