2019-20 Practice Midterm

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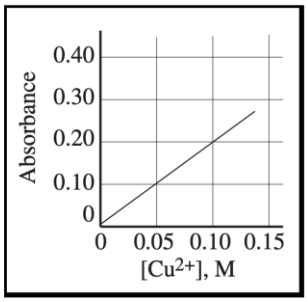
Skip #2-7

1. A 20.0 mL sample of a Cu^{2+} solution was diluted to 250.0 mL. A portion of this solution was found to have an absorbance of 0.15 under the same conditions that were used to generate the given absorbance vs. $[Cu^{2+}]$ graph. What was the concentration of Cu^{2+} ions in the original sample?



(A) 0.0060 M **(B)** 0.075 M
(C) 0.30 M **(D)** 0.94 M

2. A student performed an experiment to determine the ratio of H_2O to $CuSO_4$ in a sample of hydrated copper(II) sulfate by heating it to drive off the water and weighing the solid before and after heating. The formula obtained experimentally was $CuSO_4 \cdot 5.5H_2O$ but the accepted formula is $CuSO_4 \cdot 5H_2O$. Which error best accounts for the difference in results?

(A) During heating some of the hydrated copper(II) sulfate was lost.
(B) The hydrated sample was not heated long enough to drive off all the water.
(C) The student weighed out too much sample initially.
(D) The student used a balance that gave weights that were consistently too high by 0.10 g.

3. Which combination of solutions of HCl and NaOH would produce the largest ΔT?

(A) 50 mL of 1 M HCl with 50 mL of 1 M NaOH
(B) 50 mL of 2 M HCl with 50 mL of 2 M NaOH
(C) 100 mL of 1 M HCl with 50 mL of 2 M NaOH
(D) 100 mL of 1 M HCl with 100 mL of 1 M NaOH

4. Which substance is the least soluble in H_2O?

(A) K_2CO_3 **(B)** $KHCO_3$
(C) $Ca(HCO_3)_2$ **(D)** $CaCO_3$

5. When 6 M hydrochloric acid is added to an unknown white solid, a colorless gas is produced. What is a possible identity for this solid?

(A) calcium nitrate **(B)** copper(II) chloride
(C) potassium sulfate **(D)** sodium carbonate

6. Which compound is most soluble in water?

(A) AgCl **(B)** Ag_2CO_3 **(C)** $BaCl_2$ **(D)** $BaCO_3$

7. A 65.25 g sample of $CuSO_4 \cdot 5H_2O$ ($M = 249.7$) is dissolved in enough water to make 0.800 L of solution. What volume of this solution must be diluted with water to make 1.00 L of 0.100 M $CuSO_4$?

(A) 3.27 mL **(B)** 81.6 mL
(C) 209 mL **(D)** 306 mL

8. For which reaction at equilibrium does a decrease in volume of the container cause a decrease in product(s) at constant temperature?

(A) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$
(B) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
(C) $HCl(g) + H_2O(l) \rightleftharpoons H_3O^+(aq) + Cl^-(aq)$
(D) $SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$

9. Use the thermodynamic information:

$\frac{1}{2} N_2(g) + \frac{1}{2}O_2(g) \rightarrow NO(g)$ $\Delta H^\circ = 90.4$ kJ/mol
$\frac{1}{2} N_2(g) + O_2(g) \rightarrow NO_2(g)$ $\Delta H^\circ = 33.8$ kJ/mol
$2NO_2(g) \rightarrow N_2O_4(g)$ $\Delta H^\circ = -58.0$ kJ/mol

to calculate ΔH° in kJ/mol for the reaction:
$2NO(g) + O_2(g) \rightarrow N_2O_4(g)$

(A) –171.2 **(B)** –114.6 **(C)** 114.6 **(D)** 171.2

10. Which reaction proceeds with the greatest increase in entropy?

(A) $H_2(g) + O_2(g) \rightarrow H_2O_2(l)$
(B) $Br_2(l) + F_2(g) \rightarrow 2BrF(g)$
(C) $Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$
(D) $4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O(g)$

11. All of the following are expected to affect the rate of an irreversible chemical reaction EXCEPT

(A) adding a catalyst.
(B) removing some products.
(C) increasing the temperature.
(D) decreasing the reactant concentration.

12. For the reaction,

$$N_2H_4(l) \rightarrow N_2(g) + 2H_2(g) \quad \Delta H^\circ = -50.6 \text{ kJ}.$$

This reaction is

(A) spontaneous at all temperatures.

(B) non-spontaneous at all temperatures.

(C) spontaneous only at low temperatures.

(D) spontaneous only at high temperatures.

13. 50.0 mL of 0.10 M HCl is mixed with 50.0 mL of 0.10 M NaOH. The solution temperature rises by 3.0 °C. Calculate the enthalpy of neutralization per mole of HCl.

Solution Values	
C_p	4.18 J·g^{-1}·°C^{-1}
density	1.0 g·mL^{-1}

(A) -2.5×10^2 kJ **(B)** -1.3×10^2 kJ

(C) -8.4×10^1 kJ **(D)** -6.3×10^1 kJ

14. What is the standard enthalpy of formation of ethylene, C_2H_4, if its standard enthalpy of combustion is –1411 kJ•mol^{-1}?

substance	ΔH_f°, kJ•mol^{-1}
CO_2(g)	–394
H_2O(l)	–286

(A) 1411 kJ•mol^{-1} **(B)** 51 kJ•mol^{-1}

(C) –337 kJ•mol^{-1} **(D)** –445 kJ•mol^{-1}

15. For which substances and conditions can $S^\circ = 0$?

I. elements at 0 K

II. compounds at 0 K

III. gases at 298 K

(A) **I** only **(B)** **III** only

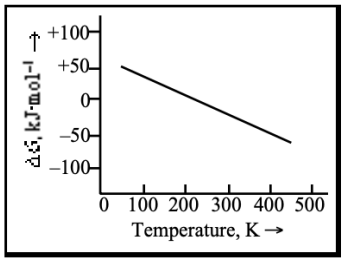
(C) **I** and **II** only **(D)** **I** and **III** only

16. Which substance has the greatest molar entropy at 298 K?

(A) NO_2(g) **(B)** N_2O_4(l)

(C) N_2O_4(g) **(D)** N_2O_5(s)

17. What can be concluded about the values of ΔH and ΔS from this graph?



(A) $\Delta H > 0$, $\Delta S > 0$ **(B)** $\Delta H > 0$, $\Delta S < 0$

(C) $\Delta H < 0$, $\Delta S > 0$ **(D)** $\Delta H < 0$, $\Delta S < 0$

18. Consider this gas phase reaction.

$$Cl_2(g) + CHCl_3(g) \rightarrow HCl(g) + CCl_4(g)$$

The reaction is found experimentally to follow this rate law.

$$\text{rate} = k\,[CHCl_3]\,[Cl_2]^{1/2}$$

Based on this information, what conclusions can be drawn about this proposed mechanism?

Step **1**. $Cl_2(g) \rightleftharpoons 2Cl(g)$

Step **2**. $Cl(g) + CHCl_3(g) \rightarrow HCl(g) + CCl_3(g)$

Step **3**. $Cl(g) + CCl_3(g) \rightarrow CCl_4(g)$

(A) Step **1** is the rate-determining step.

(B) Step **2** is the rate-determining step.

(C) Step **3** is the rate-determining step.

(D) The rate-determining step cannot be identified.

19. This is the rate law for a reaction that consumes **X**.

$$\text{rate} = k\,[\mathbf{X}]^2$$

Which plot gives a straight line?

(A) [**X**] *vs.* time **(B)** ln [**X**] *vs.* time

(C) 1 / [**X**] *vs.* time **(D)** 1 / ln [**X**]^2 *vs.* time

20. $6I^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3I_2(aq) + Br^-(aq) + 3H_2O(l)$

These data were obtained when this reaction was studied.

[I^-], M	[BrO_3^-], M	[H^+], M	Reaction rate, mol·L^{-1}·s^{-1}
0.0010	0.0020	0.010	8.0×10^{-5}
0.0020	0.0020	0.010	1.6×10^{-4}
0.0020	0.0040	0.010	1.6×10^{-4}
0.0010	0.0040	0.020	1.6×10^{-4}

What are the units of the rate constant for this reaction?

(A) s^{-1} **(B)** mol·L^{-1}·s^{-1}

(C) L·mol^{-1}·s^{-1} **(D)** L^2·mol^{-1}·s^{-1}

21. Which statement is true about a reactant that appears in the balanced equation for a reaction but does not appear in the rate equation?

(A) It is an inhibitor.

(B) It is not part of the reaction.

(C) Its concentration is too low to be important.

(D) It takes part in the reaction after the rate-determining step.

22. Which change will decrease the rate of the reaction between $I_2(s)$ and $H_2(g)$?

(A) Increasing the partial pressure of $H_2(g)$

(B) Adding the $I_2(s)$ as one piece rather than as several small ones

(C) Heating the reaction mixture

(D) Adding a catalyst for the reaction

23. For the reaction:
$(CH_3)_3CBr(aq) + OH^-(aq) \rightarrow (CH_3)_3COH(aq) + Br^-(aq)$
it is found that halving the concentration of $(CH_3)_3CBr$ causes the reaction rate to be halved but halving the concentration of OH^- has no effect on the rate. What is the rate law?

(A) Rate = $k[(CH_3)_3CBr]^{1/2}[OH^-]$

(B) Rate = $k[(CH_3)_3CBr]^2[OH^-]$

(C) Rate = $k[(CH_3)_3CBr]^{1/2}$

(D) Rate = $k[(CH_3)_3CBr]$

24. The commercial production of ammonia is represented by the equation $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$.
If the rate of disappearance of $H_2(g)$ is 1.2×10^{-3} mol/min, what is the rate of appearance of $NH_3(g)$?

(A) 2.4×10^{-3} mol/min **(B)** 1.8×10^{-3} mol/min

(C) 1.2×10^{-3} mol/min **(D)** 8.0×10^{-4} mol/min

25. The hypothetical reaction $2A + B \rightarrow C + D$
is catalyzed by E as indicated in the possible mechanism below.

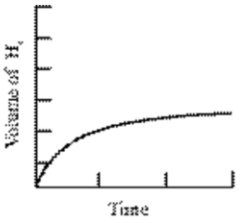
(Step 1) $A + E \rightleftharpoons AE$ (fast)
(Step 2) $AE + A \rightarrow A_2 + E$ (slow)
(Step 3) $A_2 + B \rightarrow C + D$ (fast)

Which rate law best agrees with this mechanism?

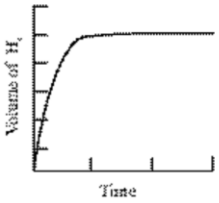
(A) Rate = k[A][B] **(B)** Rate = k[A][E]

(C) Rate = $k[A]^2[E]$ **(D)** Rate = $k[A]^2[B]$

26. The plot shows the volume of H_2 gas produced as a function of time by the reaction of a given mass of magnesium turnings with excess 1 M HCl. What graph results from the reaction of an equal mass of magnesium turnings with excess 2 M HCl? (Assume all graphs are plotted on the same scale as the one shown above.)



(A)



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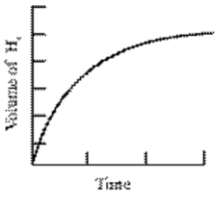
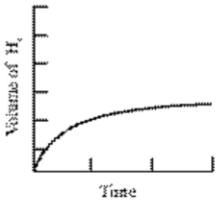
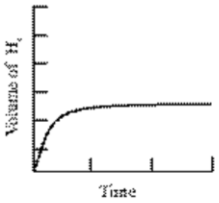


(C)



(D)



27. One proposed mechanism for the hydrolysis of an ester is shown below.

$RCOOR' + H_3O^+ \rightarrow RCOHOR'^+ + H_2O$
$RCOHOR'^+ + H_2O \rightarrow RC(OH)OR'(OH_2)^+$
$RC(OH)OR'(OH_2)^+ + H_2O \rightarrow RCOOH + R'OH + H_3O^+$

Which species is considered an intermediate?

(A) $RCOHOR'^+$ **(B)** H_3O^+

(C) $RCOOR'$ **(D)** R'OH

28. For this first-order isomerization reaction,

$$CH_3NC \rightarrow CH_3CN,$$

how do the properties of the reaction in the table below vary as the reaction proceeds?

	Rate of reaction $-\frac{\Delta[CH_3NC]}{\Delta t}$, $(M \cdot s^{-1})$	Half-life, (s)
(A)	remains the same	decreases
(B)	decreases	remains the same
(C)	remains the same	remains the same
(D)	decreases	decreases

(A) A **(B)** B **(C)** C **(D)** D

ANSWER KEY:

#	Answer	Source
1	D	2000 Local #15
2	A	2010 Local #5
3	B	2000 Local #26
4	C	2000 Local #3
5	D	2005 Local #1
6	C	2007 Local #1
7	C	2011 Local #4
8	A	2007 Local #31
9	A	2010 Local #20
10	B	2005 Local #23
11	B	2005 Local #25
12	A	2005 Local #24
13	A	2002 National #21
14	B	2011 Local #21
15	C	2002 National #20
16	C	2012 National #22
17	A	2002 National #22
18	B	2002 National #29
19	C	2002 National #25
20	C	2002 National #28
21	D	2011 Local #28
22	B	2011 Local #30
23	D	2005 Local #28
24	D	2010 Local #26
25	C	2012 National #29
26	D	2007 Local #25
27	A	2012 Local #30
28	B	2012 Local #28