

# Study Guide 4

Student: \_\_\_\_\_

1. Which of the following is *not* true of molecular orbitals?
  - A. The number of molecular orbitals formed is always equal to the number of atomic orbitals combined.
  - B. A molecular orbital can accommodate up to two electrons.
  - C. When electrons are added to orbitals of the same energy, the most stable arrangement is predicted by Hund's rule.
  - D. Low-energy molecular orbitals fill before high-energy molecular orbitals fill.
  - E. For any substance, the number of electrons in molecular orbitals is equal to the sum of all the valence electrons on the bonding atoms.
2. Consider the species  $\text{N}_2^-$ ,  $\text{N}_2$ , and  $\text{N}_2^+$ . Which of these species will be paramagnetic?
  - A.  $\text{N}_2$  and  $\text{N}_2^-$
  - B.  $\text{N}_2^+$  and  $\text{N}_2$
  - C.  $\text{N}_2^+$  and  $\text{N}_2^-$
  - D. Only  $\text{N}_2^-$
  - E. None are paramagnetic
3. Helium atoms do not combine to form  $\text{He}_2$  molecules, yet He atoms do attract one another weakly through
  - A. dipole-dipole forces.
  - B. ion-dipole forces.
  - C. dispersion forces.
  - D. dipole-induced dipole forces.
  - E. hydrogen bonding.
4. Which one of the following substances will have both dispersion forces and dipole-dipole forces?
  - A. HCl
  - B.  $\text{BCl}_3$
  - C.  $\text{Br}_2$
  - D.  $\text{H}_2$
  - E.  $\text{CO}_2$

5. Which one of the following substances should exhibit hydrogen bonding in the liquid state?

- A.  $\text{PH}_3$
- B.  $\text{H}_2$
- C.  $\text{H}_2\text{S}$
- D.  $\text{CH}_4$
- E.  $\text{NH}_3$

6. Which of the following substances should have the highest boiling point?

- A.  $\text{CH}_4$
- B.  $\text{Cl}_2$
- C. Kr
- D.  $\text{CH}_3\text{Cl}$
- E.  $\text{N}_2$

7. Which of the following would be expected to have the *highest* vapor pressure at room temperature?

- A. ethanol, bp =  $78^\circ\text{C}$
- B. methanol, bp =  $65^\circ\text{C}$
- C. water, bp =  $100^\circ\text{C}$
- D. acetone, bp =  $56^\circ\text{C}$

8. Krypton has a *higher* melting point than argon because of its

- A. hydrogen bonding.
- B. stronger dispersion forces.
- C. permanent dipole moment.
- D. ionic bonds.
- E. greater ionization energy.

9. Identify the dominant (strongest) type of intermolecular force present in each of the following compounds.

- A.  $\text{RbCl(s)}$  \_\_\_\_\_
- B.  $\text{H}_2\text{S(g)}$  \_\_\_\_\_
- C.  $\text{NH}_3(\text{l})$  \_\_\_\_\_
- D.  $\text{Cl}_2(\text{l})$  \_\_\_\_\_

\_\_\_\_\_

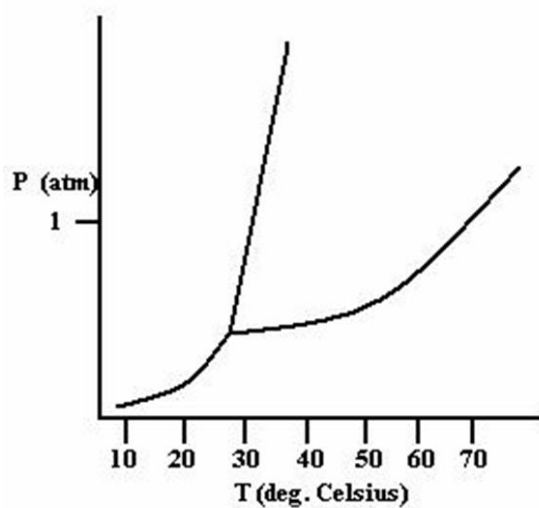
10. Circle the member of each pair that would have the stronger intermolecular forces of attraction.

- A.  $\text{H}_2\text{S}$  or  $\text{H}_2\text{Se}$
  - B.  $\text{HF}$  or  $\text{HCl}$
  - C.  $\text{CH}_4$  or  $\text{CH}_3\text{OH}$
  - D.  $\text{NH}_3$  or  $\text{PH}_3$
  - E.  $\text{SF}_4$  or  $\text{C}_{10}\text{H}_{22}$
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11. Circle the member of each pair that would have the higher boiling point.

- A.  $\text{C}_3\text{H}_8$  or  $\text{CH}_3\text{OCH}_3$
  - B.  $\text{CCl}_4$  or  $\text{CH}_4$
  - C.  $\text{CH}_3\text{Cl}$  or  $\text{CH}_4$
  - D.  $\text{H}_2\text{Se}$  or  $\text{H}_2\text{O}$
  - E.  $\text{NH}_3$  or  $\text{CH}_4$
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12. Using the following phase diagram of a certain substance, in what phase is the substance at  $50^\circ\text{C}$  and 1 atm pressure?



13. Which response lists all the following pairs that are miscible liquids.

Pair # 1. octane ( $C_8H_{18}$ ) and water

Pair # 2. acetic acid ( $CH_3COOH$ ) and water

Pair # 3. octane ( $C_8H_{18}$ ) and carbon tetrachloride( $CCl_4$ )

A. 1, 3

B. 1, 2

C. 3

D. 2

E. 2, 3

14. Which of the following liquids would make a good solvent for iodine,  $I_2$ ?

A. HCl

B.  $H_2O$

C.  $CH_3OH$

D.  $NH_3$

E.  $CS_2$

15. Which of the following compounds should be soluble in  $CCl_4$ ?

A. NaCl

B.  $H_2O$

C. NaOH

D.  $C_8H_{18}$

E. None of these

16. Which of the following gives the molarity of a 17.0% by mass solution of sodium acetate,  $CH_3COONa$  (molar mass = 82.0 g/mol) in water? The density of the solution is 1.09 g/mL.

A.  $2.26 \times 10^{-6} M$

B. 0.207 M

C. 2.07 M

D. 2.26 M

E. 2.72 M

17. What is the molarity of a solution of 10% by mass cadmium sulfate,  $\text{CdSO}_4$  (molar mass = 208.46 g/mol) by mass? The density of the solution is 1.10 g/mL.
- A. 0.528 M
  - B. 0.436 M
  - C. 0.479 M
  - D. 0.048 M
  - E. 22.9 M
18. What is the percent  $\text{CdSO}_4$  by mass in a 1.0 molal aqueous  $\text{CdSO}_4$  solution?
- A. 0.001 %
  - B. 0.10 %
  - C. 17.2 %
  - D. 20.8 %
  - E. 24.4 %
19. How many grams of water are needed to dissolve 27.8 g of ammonium nitrate  $\text{NH}_4\text{NO}_3$  in order to prepare a 0.452 m solution?
- A. 769 g
  - B. 36.2 g
  - C. 100. g
  - D. 0.157 g
  - E. 157 g
20. Calculate the molality of a 20.0% by mass ammonium sulfate  $(\text{NH}_4)_2\text{SO}_4$  solution. The density of the solution is 1.117 g/mL.
- A. 0.15 m
  - B. 1.51 m
  - C. 1.70 m
  - D. 1.89 m
  - E. 2.10 m

21. The density of a 20.3 M CH<sub>3</sub>OH (methanol) solution is 0.858 g/mL. What is the molality of this solution? H<sub>2</sub>O is the solvent.
- A. 17.4 m
  - B. 20.8 m
  - C. 23.7 m
  - D. 70.0 m
  - E. 97.6 m
22. For dilute solutions, the two concentration units, molarity and molality, have almost the same values.
- True    False
23. Calculate the mass of solute in the following solution: 50.0 mL of 0.0300 M C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>.
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24. For the reaction  $\text{BrO}_3^- + 5\text{Br}^- + 6\text{H}^+ \rightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$  at a particular time,  $-\Delta[\text{BrO}_3^-]/\Delta t = 1.5 \times 10^{-2} \text{ M/s}$ . What is  $-\Delta[\text{Br}^-]/\Delta t$  at the same instant?
- A. 13 M/s
  - B.  $7.5 \times 10^{-2} \text{ M/s}$
  - C.  $1.5 \times 10^{-2} \text{ M/s}$
  - D.  $3.0 \times 10^{-3} \text{ M/s}$
  - E. 330 M/s
25. The reaction  $\text{A} + 2\text{B} \rightarrow \text{products}$  has been found to have the rate law,  $\text{rate} = k[\text{A}][\text{B}]^2$ . While holding the concentration of A constant, the concentration of B is increased from  $x$  to  $3x$ . Predict by what factor the rate of reaction increases.
- A. 3
  - B. 6
  - C. 9
  - D. 27
  - E. 30

26. It takes 42.0 min for the concentration of a reactant in a first-order reaction to drop from 0.45 M to 0.32 M at 25°C. How long will it take for the reaction to be 90% complete?
- A. 13.0 min
  - B. 86.0 min
  - C. 137 min
  - D. 222 min
  - E. 284 min
27. A certain first-order reaction  $A \rightarrow B$  is 25% complete in 42 min at 25°C. What is the half-life of the reaction?
- A. 21 min
  - B. 42 min
  - C. 84 min
  - D. 120 min
  - E. 101 min
28. A certain first-order reaction  $A \rightarrow B$  is 25% complete in 42 min at 25°C. What is its rate constant?
- A.  $6.8 \times 10^{-3} \text{ min}^{-1}$
  - B.  $8.3 \times 10^{-3} \text{ min}^{-1}$
  - C.  $3.3 \times 10^{-2} \text{ min}^{-1}$
  - D.  $-3.3 \times 10^{-2} \text{ min}^{-1}$
  - E.  $11 \text{ min}^{-1}$
29. The reaction  $2\text{NO}_2(\text{g}) \rightarrow 2\text{NO}(\text{g}) + \text{O}_2(\text{g})$  is suspected to be second order in  $\text{NO}_2$ . Which of the following kinetic plots would be the most useful to confirm whether or not the reaction is second order?
- A. a plot of  $[\text{NO}_2]^{-1}$  vs. t
  - B. a plot of  $\ln [\text{NO}_2]$  vs. t
  - C. a plot of  $[\text{NO}_2]$  vs. t
  - D. a plot of  $\ln [\text{NO}_2]^{-1}$  vs. t
  - E. a plot of  $[\text{NO}_2]^2$  vs. t

30. The Arrhenius equation is  $k = A e^{-(E_a/RT)}$ . The slope of a plot of  $\ln k$  vs.  $1/T$  is equal to
- A.  $-k$
  - B.  $k$
  - C.  $E_a$
  - D.  $-E_a/R$
  - E.  $A$
31. The activation energy for the reaction  $\text{CH}_3\text{CO} \rightarrow \text{CH}_3 + \text{CO}$  is 71 kJ/mol. How many times greater is the rate constant for this reaction at 170°C than at 150°C?
- A. 0.40
  - B. 1.1
  - C. 2.5
  - D. 4.0
  - E. 5.0
32. The activation energy for the following reaction is 60. kJ/mol.
- $$\text{Sn}^{2+} + 2\text{Co}^{3+} \rightarrow \text{Sn}^{4+} + 2\text{Co}^{2+}$$
- By what factor (how many times) will the rate constant increase when the temperature is raised from 10°C to 28°C?
- A. 1.002
  - B. 4.6
  - C. 5.6
  - D. 2.8
  - E. 696