Academic Challenge
Chemistry Test (Sectional) – 2021

1. Decantation is

   A. a process in which the more volatile liquid is boiled off.
   B. dissolving a solid into a liquid.
   C. separating a solid from a liquid by pouring off the liquid.
   D. pouring a mixture through filter paper to separate the solid from the liquid.
   E. heating a mixture of two solids to fuse them together.

2. Select the correct formula for sodium chlorate

   A. $NaC\ell O_3$ B. $NaC\ell O_2$ C. $NaC\ell O$ D. $NaC\ell O_4$ E. $NaC\ell O_5$

3. Choose the bond below that is the **weakest**.

   A. Na-Cℓ B. I-I C. C=N D. Li-F E. C=O

4. Which of the following processes have a $\Delta S > 0$?

   A. $CH_3OH(\ell) \rightarrow CH_3OH(s)$
   B. $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$
   C. $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3\ H_2(g)$
   D. $Na_2CO_3(s) + H_2O(g) + CO_2(g) \rightarrow 2\ NaHCO_3(s)$
   E. All of the above processes have a $\Delta S > 0$

5. Calculate the pOH of a solution that contains 3.9×10^{-4} M H_3O^+ at 25 ^oC.

   A. 4.59
   B. 3.41
   C. 10.59
   D. 9.41
   E. 0.59

6. Which choice describes the change in condition to go from a liquid to a gas?

   A. increase heat or reduce pressure
   B. increase heat or increase pressure
   C. cool or reduce pressure
   D. cool or increase pressure
   E. none of the choices

7. Identify the number of electron groups around the central atom with trigonal bipyramidal shape.

   A. 1 B. 2 C. 3 D. 4 E. 5

8. What is the correct name for FeS?

   A. ferrous sulfide
   B. ferrous sulfate
   C. ferric sulfide
   D. ferric sulfate
   E. iron sulfide

9. Choose the reaction that illustrates ΔH_f^o for $Ca(NO_3)_2$.

   A. $Ca^{2+}(aq) + 2\ NO_3^-(aq) \rightarrow Ca(NO_3)_2(aq)$
   B. $Ca(s) + N_2(g) + 3\ O_2(g) \rightarrow Ca(NO_3)_2(s)$
   C. $Ca(s) + 2\ N(g) + 6\ O(g) \rightarrow Ca(NO_3)_2(s)$
   D. $Ca(NO_3)_2(aq) \rightarrow Ca^{2+}(aq) + 2\ NO_3^-(aq)$
   E. $Ca(NO_3)_2(s) \rightarrow Ca(s) + N_2(g) + 3\ O_2(g)$

10. A gas is at 35.0 ^oC and 4.50 L. What is the temperature at 9.00 L if there is no change in the pressure and number of moles?

    A. 70.0 ^oC
    B. 616 ^oC
    C. 1.16 ^oC
    D. 343 ^oC
    E. 17.5 ^oC

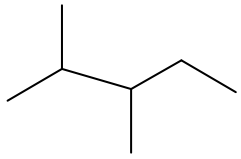
11. Identify the missing particle in the following nuclear equation. $^{228}_{90}Th \rightarrow {}^{4}_{2}He + ?$

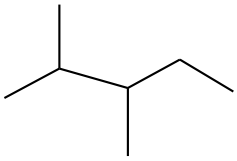
    A. $^{232}_{92}U$
    B. $^{232}_{89}Ac$
    C. $^{232}_{89}Ac$
    D. $^{228}_{88}Ra$
    E. $^{224}_{88}Ra$

12. What is the strongest type of intermolecular force present in NH_2CH_3?

    A. ion-dipole
    B. dipole-dipole
    C. dispersion
    D. hydrogen bonding
    E. none of these choices

13. Name the compound below on the right.

A. 2-methyl-3-methylyhexane B. 2,3-dimethylpentane C. Heptane D. 3,4-dimethylpentane E. 2,4-dimethylpropane	



14. Determine the pH in a 0.235 M NaOH solution at 25 ^{o}C.

A. 13.76
B. 0.24
C. 0.63
D. 12.0
E. 13.37

15. Consider the following gas-phase equilibrium:

$$H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g)$$

At a certain temperature, the equilibrium constant (K_c) is 4.0. A student started with an equimolar quantity of H_2 and I_2 and no HI. When equilibrium was established, he determined the HI amount to be 0.20 mole. How many mole of H_2 was present at beginning?

A. 0.10 mol
B. 0.20 mol
C. 0.30 mol
D. 4.0 mol
E. need to know the volume of the reaction vessel

16. The equilibrium concentrations in the following reaction are as follows: [A] = 2.4 x 10^{-2} *M*, [B] = 4.6 x 10^{-3} *M*, and [C] = 6.2 x 10^{-3} *M*. What is the value of K_c?

$$C(g) \rightleftharpoons 2\ A(g) + B(g)$$

A. 56
B. 1.8 x 10^{-2}
C. 4.3 x 10^{-4}
D. 2.3 x 10^{3}
E. 5.8 x 10^{2}

17. What is the mole fraction of water in a solution prepared by dissolving 325 g sucrose ($C_{12}H_{22}O_{11}$) in 242 g H_2O?

A. 0.0660
B. 0.427
C. 14.2
D. 0.0707
E. 0.934

18. What is the wavelength (in nanometers) of a cell phone signal operating at 1.12 GHz?

A. 2.68×10^{8} nm
B. 2.68 nm
C. 2.68×10^{11} nm
D. 2.68×10^{7} nm
E. 2.68×10^{-10} nm

19. Using the equation below, if one reacts 29.0 g of glucose ($C_6H_{12}O_6$) with 27.0 g of oxygen gas, what mass of water will be produced?

$$C_6H_{12}O_6(s) + 6\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(\ell)$$

A. 17.4 g of water
B. 32.6 g of water
C. 2.20 g of water
D. 15.2 g of water
E. 13.0 g of water

20. When a 1.50-g sample of a nonelectrolyte is dissolved in enough solvent to yield a 800.0-mL solution at 27.0 ºC, the osmotic pressure was recorded as 2.10 torr. What is the molar mass of this compound?

A. 1.36×10^{-4} g/mol
B. 16.7 g/mol
C. 1.67×10^{4} g/mol
D. 21.7 g/mol
E. 9.10×10^{-5} g/mol

21. On the periodic table, as the atomic number increases from 11 to 17, what happens to the electron affinity?

A. It increases only
B. It increases, then decreases
C. It remains constant
D. It decreases, then increases
E. It decreases only

22. The electron configuration of chromium is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$. This unique configuration would appear to violate the letter of what rule/principle?

A. Hund's Rule
B. Afbau Principle
C. Pauli Exclusion Principle
D. First Law of Thermodynamics
E. None of the above

23. The solubility of a salt in water usually increases with increasing temperature because the process is

A. exothermic so the higher temperature favors dissolution.
B. endothermic so dissolution occurs faster.
C. exothermic so dissolution occurs faster.
D. endothermic so the higher temperature favors dissolution.
E. neither exothermic nor endothermic.

24. Which of the following elements will have the lowest ionization energy?

A. C B. P C. N D. O E. Si

25. Balance the chemical equation below and select the appropriate coefficients below.

___ $C_6H_5CH_3(\ell)$ + ___ $O_2(g)$ → ___ $CO_2(g)$ + ___ $H_2O(\ell)$

A. 1, 8, 4, 6
B. 1, 9, 7, 4
C. 2, 8, 4, 6
D. 2, 9, 7, 4
E. The equation is balanced as written.

26. What quantity is associated with the brightness of light?

A. amplitude
B. frequency
C. wavenumber
D. node
E. wavelength

27. How many unpaired electrons are found in the electron configuration of the iron the compound $FeC\ell_2$?

A. zero
B. one
C. six
D. four
E. three

28. All but one of the following equalities are exact. Which one is NOT exact?

A. 2.54 cm = 1 inch
B. 1,000,000,000 mm = 1,000 km
C. 1,000 cubic mm = 1 mL
D. 10,000 m = 6.214 miles
E. 12 inches = 1 foot

29. A compound was identified as having an empirical formula of C_2H_2N. Mass spectrometry determined its molar mass to be approximately 80 g/mol. What is the most likely chemical formula for this compound?

A. C_2H_2N
B. $C_4H_4N_2$
C. $C_3H_2N_3$
D. CHN
E. $C_6H_6N_3$

30. Assume the following steps were performed by a chemistry student:
1) tare a small flask on an analytical balance,
2) transfer 10.00 mL of water from a glass burette to the flask and record the actual mass,
3) calculate what the mass of that quantity of water should be by multiplying the density of water at room temperature times the volume of water transferred,
4) calculate the percent error between the calculated mass and the actual mass. What is the main point of this exercise?

A. To determine the minimum usable volume for that burette
B. To verify the maximum reliable capacity of the burette
C. To evaluate the precision of the burette
D. To test the repeatability of the burette
E. To evaluate the accuracy of the burette

31. What is the total number of nucleons in a phosphorus isotope containing 17 neutrons?

A. 15 B. 17 C. 30 D. 32 E. 47

32. The following reaction was studied using the initial rates method:

$$BrO_3^- + 5\ Br^- + 6\ H^+ \rightarrow 3\ Br_2 + 3\ H_2O$$

The rate of the reaction doubled when doubling the first two reactants and quadrupled when doubling the hydrogen ion concentration. What is the rate law for this reaction?

A. Rate = $k[BrO_3^-]^2[Br^-]^2[H^+]$
B. Rate = $k[BrO_3^-][Br^-]^2[H^+]$
C. Rate = $k[BrO_3^-]^2[Br^-]^2[H^+]^4$
D. Rate = $k[BrO_3^-][Br^-]^5[H^+]^6$
E. Rate = $k[BrO_3^-][Br^-][H^+]^2$

33. In the following electrochemical cell diagram, what material is being used to create the positive electrode?

$$Cu(s)\ |\ Cu^{2+}(aq)\ ||\ Ag^+(aq)\ |\ Ag(s)$$

A. $Cu^{2+}(aq)$ B. $Cu(s)$ C. $Ag(s)$ D. $Ag^+(aq)$ E. $Pt(s)$
B. $Ag^+(s)$

34. How many different electrons within a single atom could share this set of quantum numbers: $n = 3; l = 1$?

A. 1
B. 2
C. 6
D. 8
E. >8

35. At room temperature and neutral pH calcium phosphate has a K_{sp} of approximately 1 x 10^{-26}. What does this suggest?

A. Calcium and phosphate ions dissociate from one another very easily.
B. An aqueous solution of calcium phosphate would make an excellent electrolyte.
C. Calcium phosphate is a molecular compound.
D. The K_{sp} of calcium phosphate is greater than that of sodium chloride. K_{sp}
E. The concentration of total ions in a 1.0 M solution of calcium phosphate would be much less than 0.01 M.

36. Which component of the following unbalanced reaction is the reducing agent?

$$MnO_4^- + H_2C_2O_4 + H^+ \rightarrow CO_2 + Mn^{2+} + H_2O$$

A. MnO_4^-
B. $H_2C_2O_4$
C. H^+
D. CO_2
E. Mn^{2+}

37. A solution containing 1.50 moles of aluminum ions would have how many moles of oxide ions assuming there are no other ions present?

A. 0.750
B. 1.50
C. 2.25
D. 3.00
E. 4.50

38. How would the free energy of the reactants and products in an exergonic reaction differ when in the presence of a catalyst?

A. The free energy of both the reactants and products would be unchanged.
B. The free energy of both the reactants and products would change.
C. The free energy of the reactants only would change.
D. The free energy of the products only would change.
E. The free energy of either the reactants or the products could change depending on the nature of the catalyst.

39. What is the approximate mass percent of oxygen in ammonium sulfate?

    A. <1%
    B. 12%
    C. 41%
    D. 48%
    E. 56%

40. It is commonly known that the energy of a photon is proportional to the frequency of that photon. What is the proportionality constant that equates these two variables?

    A. Planck's constant
    B. Boltzmann's constant
    C. The speed of light
    D. The cosmological constant
    E. The charge-to-mass ratio for an electron