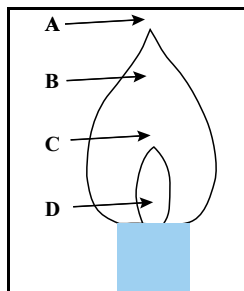


DIRECTIONS

- When you have selected your answer to each question, blacken the corresponding space on the answer sheet using a soft, #2 pencil. Make a heavy, full mark, but no stray marks. If you decide to change an answer, erase the unwanted mark very carefully.
- There is only one correct answer to each question. Any questions for which more than one response has been blackened **will not be counted**.
- Your score is based solely on the number of questions you answer correctly. **It is to your advantage to answer every question.**

- Which element is a gas at 25 °C and 1 atm pressure?
(A) chlorine (B) phosphorus
(C) silicon (D) sulfur
- Which combustion product is produced THE LEAST by gasoline-powered vehicles?
(A) CO₂ (B) H₂O (C) NO₂ (D) SO₂
- Which element has the highest electrical conductivity at room temperature?
(A) Ge (B) Se (C) Sn (D) Te
- How should a student prepare 100 mL of a 1.0 M H₂SO₄ solution from a 10. M H₂SO₄ solution?
(A) Add 90 mL of H₂O to 10 mL of 10 M H₂SO₄.
(B) Add 10 mL of 10 M H₂SO₄ to 90 mL of H₂O.
(C) Add 10 mL of 10 M H₂SO₄ to 80 mL of H₂O, stir and dilute to 100 mL after allowing to cool.
(D) Add 80 mL of H₂O to 10 mL of 10 M H₂SO₄, stir and dilute to 100 mL after allowing to cool.

- Which letter in the diagram depicts the hottest portion of a Bunsen burner flame?



- (A) A (B) B (C) C (D) D

- What is the proper technique to test the odor of a vapor in a test tube?
(A) Hold the test tube near the nose and sniff.
(B) Use a micropipet to capture some of the gas and sniff that.
(C) Hold the test tube above the nose and pour the gas toward it.
(D) Hold the test tube near the nose and waft the gas toward it with a hand.
- For which compound are the empirical and molecular formulas the same?
(A) C₆H₅COOH (B) C₆H₄(COOH)₂
(C) HOCCOOH (D) CH₃COOH

- What volume of liquid A has the same mass as 80.0 cm³ of liquid B?

Density (g/cm ³)	
Liquid A	0.660
Liquid B	1.59

- (A) 40.0 cm³ (B) 97.0 cm³
(C) 160. cm³ (D) 193 cm³

- How many water molecules are in a 0.10 g sample of CuSO₄·5H₂O (MM = 249.7)?
(A) 1.2 x 10²¹ (B) 2.4 x 10²¹
(C) 2.4 x 10²² (D) 1.2 x 10²³
- Acetylene, C₂H₂, reacts with O₂ to produce CO₂ and H₂O. What is the O₂/C₂H₂ ratio in the balanced equation?
(A) 2/1 (B) 3/2 (C) 5/2 (D) 3/1

- Mg(OH)₂ in the form of Milk of Magnesia is used to neutralize excess stomach acid. How many moles of stomach acid can be neutralized by 1.00 g of Mg(OH)₂?

Molar Mass (g/mol)	
Mg(OH) ₂	58.33

- (A) 0.0171 (B) 0.0343 (C) 0.686 (D) 1.25

26. What is the order of a reaction for which the units of k are $\text{L} \cdot \text{mol}^{-1} \cdot \text{s}^{-1}$ and the units of the rate are $\text{mol} \cdot \text{L}^{-1} \cdot \text{s}^{-1}$?

(A) zero order (B) first order
(C) second order (D) some other order

27. For the reaction $\text{A} + \text{B} \rightarrow \text{C}$, the rate law is: $\text{Rate} = k[\text{A}]^2$. Which change(s) will increase the rate of the reaction?

I Increasing the concentration of A
II Increasing the concentration of B

(A) I only (B) II only
(C) Both I and II (D) Neither I nor II

28. Which does NOT change with time for a first-order reaction?

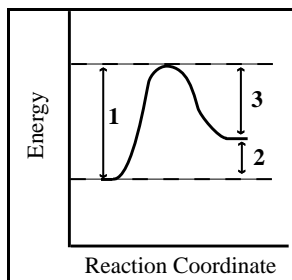
(A) the amount of reactant that disappears in each half-life
(B) the concentration of the reactant
(C) the length of each half-life
(D) the rate of the reaction

29. The rates of which reactions are increased when the temperature is raised?

I endothermic reactions
II exothermic reactions

(A) I only (B) II only
(C) Both I and II (D) Neither I nor II

30. When a catalyst is added to the system represented by this energy-reaction coordinate diagram, which dimensions in the diagram are changed?



(A) 1 and 2 only (B) 1 and 3 only
(C) 2 and 3 only (D) 1, 2, 3

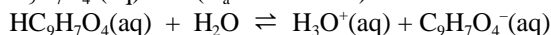
31. Which statement is true for a reaction at equilibrium?

(A) All reaction ceases.
(B) The reaction has gone to completion.
(C) The rates of the forward and reverse reactions are equal.
(D) The amount of product equals the amount of reactant.

32. For the hypothetical reaction, $2\text{A}(\text{s}) + \text{B}(\text{g}) \rightleftharpoons 3\text{C}(\text{g})$ what is the equilibrium expression?

(A) $K = \frac{[\text{C}]^3}{[\text{A}]^2[\text{B}]}$ (B) $K = \frac{3[\text{C}]}{2[\text{A}][\text{B}]}$
(C) $K = \frac{[\text{C}]^3}{[\text{A}]^2 + [\text{B}]}$ (D) $K = \frac{[\text{C}]^3}{[\text{B}]}$

33. Acetylsalicylic acid (aspirin) behaves as an acid according to the equation shown. Calculate K_b for the $\text{C}_9\text{H}_7\text{O}_4^-(\text{aq})$ ion. ($K_a = 3.0 \times 10^{-4}$)



(A) 3.0×10^{-17} (B) 3.3×10^{-11}
(C) 9.0×10^{-8} (D) 3.3×10^3

34. What will happen to the pH of a buffer solution when a small amount of a strong base is added? The pH will

(A) increase slightly
(B) decrease slightly
(C) remain exactly the same
(D) become 7.0

35. When a solution of NH_3 ($K_b = 1.8 \times 10^{-5}$) is titrated with a strong acid the indicator used should change color near a pH of

(A) 1 (B) 5 (C) 9 (D) 13

36. When solid silver chloride ($\text{MM} = 143.4$) is added to 100. mL of H_2O , 1.9×10^{-4} grams dissolves. What is the K_{sp} for silver chloride?

(A) 1.3×10^{-5} (B) 3.7×10^{-6}
(C) 3.7×10^{-8} (D) 1.8×10^{-10}

37. In which species does the underlined element have an oxidation number of +2?

(A) $\underline{\text{S}}\text{O}_2\text{Cl}_2$ (B) $\underline{\text{Fe}}(\text{CN})_6^{4-}$
(C) $\text{H}\underline{\text{N}}\text{O}_2$ (D) $\underline{\text{Ni}}(\text{CO})_4$

38. Which transformation is an oxidation?

(A) $\text{VO}_3^- \rightarrow \text{VO}_2^+$
(B) $\text{CrO}_2^- \rightarrow \text{CrO}_4^{2-}$
(C) $\text{SO}_3 \rightarrow \text{SO}_4^{2-}$
(D) $\text{NO}_3^- \rightarrow \text{NO}_2^-$

39. $\text{Sn}^{2+}(\text{aq}) + \text{NO}_3^-(\text{aq}) + \text{H}^+(\text{aq}) \rightarrow \text{Sn}^{4+}(\text{aq}) + \text{NO}(\text{g}) + \text{H}_2\text{O}$
What is the coefficient for $\text{H}^+(\text{aq})$ when the equation above is balanced correctly with the smallest integer coefficients?
(A) 2 (B) 4 (C) 6 (D) 8
40. In electrochemical cells the cathode is always the electrode where
(A) oxidation occurs.
(B) reduction occurs.
(C) positive ions are formed.
(D) negative ions are formed.
41. $2\text{Ga}(\text{s}) + 6\text{H}^+(\text{aq}) \rightarrow 2\text{Ga}^{3+}(\text{aq}) + 3\text{H}_2(\text{g})$
The potential of the cell for the reaction given is 0.54 V. If the concentrations of the ions are 1.0 M and the pressure of $\text{H}_2(\text{g})$ is 1 atm, what is E° for the half-reaction $\text{Ga}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Ga}(\text{s})$?
(A) -0.54 V (B) -0.27 V
(C) 0.27 V (D) 0.54 V
42. All of the following affect the number of moles of metal deposited during electrolysis EXCEPT the
(A) current used (B) electrolysis time
(C) charge on the ion (D) molar mass
43. The emission spectrum of hydrogen in the visible region consists of
(A) a continuous band of light.
(B) a series of equally spaced lines.
(C) a series of lines that are closer at low energies.
(D) a series of lines that are closer at high energies.
44. Which atom in its ground state has the most unpaired electrons?
(A) Ge (B) As (C) Se (D) Br
45. An monoatomic ion that has 18 electrons and a +2 charge
(A) has 16 protons. (B) has the symbol Ar^{2+} .
(C) has 18 neutrons. (D) is isoelectronic with Ar.
46. Which atom has the largest atomic radius?
(A) Li (B) K (C) As (D) Br
47. What is the maximum number of electrons that occupy the $n = 3$ level?
(A) 6 (B) 8 (C) 10 (D) 18
48. How does the reducing ability of the elements vary across the period from Na to Ar? It
(A) decreases steadily.
(B) increases steadily.
(C) decreases then increases.
(D) increases then decreases.
49. Which species contains only covalent bonds?
(A) H_2SO_4 (B) NH_4NO_3
(C) NaOCl (D) K_2CrO_4
50. How many valence electrons are in the pyrophosphate ion, $\text{P}_2\text{O}_7^{4-}$?
(A) 48 (B) 52 (C) 54 (D) 56
51. Which species has the largest F-A-F bond angle where A is the central atom?
(A) BF_3 (B) CF_4 (C) NF_3 (D) OF_2
52. The triple bond in carbon monoxide consists of
(A) 3 sigma bonds
(B) 2 sigma bonds and 1 pi bond
(C) 1 sigma bond and 2 pi bonds
(D) 3 pi bonds
53. The boiling points of the halogens, F_2 , Cl_2 , Br_2 and I_2 , increase in that order. This is best attributed to differences in
(A) covalent bond strengths.
(B) dipole forces.
(C) London dispersion forces.
(D) colligative forces.
54. Which species is polar?
(A) CO_2 (B) SO_2 (C) SO_3 (D) O_2
55. Which formula represents n-butane?
(A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ (B) $\text{CH}_2=\text{CHCH}_2\text{CH}_3$
(C) $(\text{CH}_3)_2\text{CHCH}_3$ (D) $(\text{CH}_3)_3\text{CH}$
56. How many structural isomers have the formula $\text{C}_3\text{H}_6\text{Cl}_2$?
(A) 1 (B) 2 (C) 3 (D) 4
57. What is the hybridization of the carbon atom in a carboxyl group?
(A) sp (B) sp^2 (C) sp^3 (D) dsp^3

58. A reaction in which a carboxylic acid reacts with an alcohol to form an organic compound and water is called

- (A) esterification (B) hydrolysis
(C) neutralization (D) saponification

59. What substance is formed when $\text{CF}_2=\text{CF}_2$ is polymerized?

- (A) Polyethylene (B) Polyurethane
(C) PVC (D) Teflon

60. Most enzymes are a type of

- (A) carbohydrate (B) lipid
(C) nucleic acid (D) protein

END OF TEST

Olympiad 2004 Local Section

KEY

Number	Answer	Number	Answer
1.	A	31.	C
2.	D	32.	D
3.	C	33.	B
4.	C	34.	A
5.	C	35.	B
6.	D	36.	D
7.	A	37.	B
8.	D	38.	B
9.	A	39.	D
10.	C	40.	B
11.	B	41.	A
12.	D	42.	D
13.	C	43.	D
14.	C	44.	B
15.	A	45.	D
16.	A	46.	B
17.	A	47.	D
18.	D	48.	A
19.	A	49.	A
20.	B	50.	D
21.	D	51.	A
22.	A	52.	C
23.	B	53.	C
24.	A	54.	B
25.	D	55.	A
26.	C	56.	D
27.	A	57.	B
28.	C	58.	A
29.	C	59.	D
30.	B	60.	D