

Directions for the First Year Chemistry Olimpiad Local Section Exam

When you have selected your answer to each question, blacken the corresponding space on the answer sheet using a #2 pencil. If you decide to change an answer, erase the unwanted make very carefully.

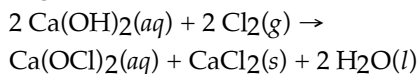
There is only one correct answer to each question. Any questions for which more than one response is given **will not** be counted.

Your score will be based on the number of correctly answered questions. It is to your advantage to answer every question.

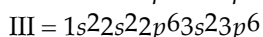
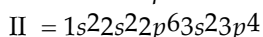
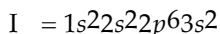
- 1) A sailor circumnavigated the earth and covered 4,264,000 meters. Express this number in standard scientific notation.
- a) 4.264×10^7 m b) 4.264×10^{-6} m
c) 4.264×10^6 m d) 4.264×10^{-7} m
- 2) Name the product(s) of the complete combustion of any hydrocarbon.
- a) CO₂ only
b) CO + H₂O
c) H₂O only
d) CO₂ + H₂O
e) CO only
- 3) What is the **sum** of the coefficients when the following equation is balanced using the lowest, whole numbered coefficients?
- $$\underline{\hspace{1cm}} \text{PH}_3(\text{g}) + \underline{\hspace{1cm}} \text{O}_2(\text{g}) \rightarrow \underline{\hspace{1cm}} \text{P}_4\text{O}_{10}(\text{s}) + \underline{\hspace{1cm}} \text{H}_2\text{O}(\text{g})$$
- a) 10 b) 22 c) 12 d) 19
- 4) An autoclave is used to sterilize surgical equipment because
- a) it allows water to boil at 100°C at pressures greater than 1 atm.
b) it allows water to boil at temperatures less than 100°C.
c) it provides very high temperatures and very low pressures.
d) it allows water to boil at temperatures above 100°C.
e) it allows water to boil at 100°C at pressures less than 1 atm.
- 5) Elements in a periodic group have similar
- a) masses.
b) densities.
c) chemical properties.
d) physical properties.
- 6) What is the mass of 0.500 mol of dichlorodifluoromethane, CF₂Cl₂?
- a) 4.14×10^{-3} g b) 242 g
c) 60.5 g d) 121 g
- 7) Oil does not dissolve in water because
- a) oil is polar.
b) oil is hydrated.
c) oil is nonpolar.
d) water is nonpolar.
e) water is saturated.
- 8) A basketball is inflated to a pressure of 1.50 atm in a 20.0°C garage. What is the pressure of the basketball outside where the temperature is -5.00°C?
- a) 1.58 atm b) 1.42 atm
c) 1.64 atm d) 1.37 atm
- 9) Methane and oxygen react to form carbon dioxide and water. What mass of water is formed if 3.2 g of methane reacts with 12.8 g of oxygen to produce 8.8 g of carbon dioxide?
- a) 16.0 g b) 8.8 g
c) 14.8 g d) 7.2 g
- 10) Which of the following is **not** explained by Dalton's atomic theory?
- a) conservation of mass during a chemical reaction
b) the existence of more than one isotope of an element
c) the law of multiple proportions
d) the law of definite proportions
- 11) Which of the following have their valence electrons in the same shell?
- a) He, Ne, F b) N, As, Bi
c) B, Si, As d) K, As, Br

- 12) How many milliliters of a 9.0 M H_2SO_4 solution are needed to make 0.25 L of a 3.5 M H_2SO_4 solution?
- a) 97 mL b) 0.097 mL
c) 0.64 mL d) 640 mL
- 13) 10 g of nitrogen is reacted with 5.0 g of hydrogen to produce ammonia according to the chemical equation shown below. Which one of the following statements is **false**?
- $$\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$$
- a) 2.8 grams of hydrogen are left over.
b) The theoretical yield of ammonia is 15 g.
c) Nitrogen is the limiting reactant.
d) Hydrogen is the excess reactant.
- 14) Which of the following statements does not describe a **physical** property of chlorine?
- a) The color of chlorine gas is green.
b) The freezing point of chlorine is -101°C .
c) The density of chlorine gas at standard temperature and pressure is 3.17 g/L.
d) Chlorine combines with sodium to form table salt.
- 15) A solution with a pH of 4 is
- a) extremely basic.
b) moderately acidic.
c) extremely acidic.
d) neutral.
e) slightly basic.
- 16) Write a balanced net ionic equation for the reaction of $\text{Pb}(\text{NO}_3)_2(\text{aq})$ with $\text{NaI}(\text{aq})$.
- a) $\text{Pb}^{2+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq}) + 2 \text{Na}^{+}(\text{aq}) + 2 \text{I}^{-}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2 \text{Na}^{+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq})$
b) $\text{Pb}^{2+}(\text{aq}) + 2 \text{I}^{-}(\text{aq}) \rightarrow \text{PbI}_2(\text{s})$
c) $\text{Pb}^{2+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq}) + 2 \text{Na}^{+}(\text{aq}) + 2 \text{I}^{-}(\text{aq}) \rightarrow \text{Pb}^{2+}(\text{aq}) + 2 \text{I}^{-}(\text{aq}) + 2 \text{Na}^{+}(\text{aq}) + 2 \text{NO}_3^{-}(\text{aq})$
d) $\text{Pb}(\text{NO}_3)_2(\text{aq}) + 2 \text{NaI}(\text{aq}) \rightarrow \text{PbI}_2(\text{s}) + 2 \text{NaNO}_3(\text{aq})$
- 17) The conjugate acid of NO_2^{-} is _____.
- a) H^{+}
b) H_2O
c) OH^{-}
d) HNO_2
e) HNO_3
- 18) According to the kinetic theory of gases, a gas can be compressed much more than a liquid or solid because
- a) a gas is composed of very small particles.
b) the particles of a gas are very far apart.
c) gas particles move faster when the temperature increases.
d) gas particles move rapidly.
e) gas particles do not attract or repel one another.
- 19) Identify the chemical symbol of element Q in ${}_{34}^{80}\text{Q}$.
- a) Hg b) Br c) Pd d) Se
- 20) The first ionization energy of gallium is greater than that of aluminum and the first ionization energy of thallium is greater than that of indium. A possible explanation for this is:
- a) This is the normal trend in ionization energy.
b) Ga follows a series of transition elements and Tl follows both a series of transition elements and inner transition elements which are poor shielders of nuclear charge.
c) Both Ga and Tl follow transition elements which are excellent shielders of nuclear charge.
d) Both Ga and Tl prefer to lose three electrons rather than one.

- 28) How many grams of CaCl_2 are formed when 35.00 mL of 0.237 M Ca(OH)_2 reacts with excess Cl_2 gas?



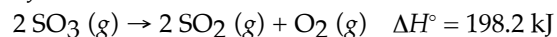
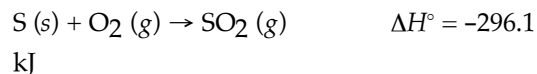
- a) 1.84 g b) 2.17 g
c) 0.460 g d) 0.921 g
- 29) The equilibrium constant for the production of carbon dioxide from carbon monoxide and oxygen is $K_c = 2 \times 10^{11}$. This means that the reaction mixture at equilibrium is likely to consist of
- a) mostly products.
b) mostly starting materials.
c) an equal mixture of products and reactants.
d) twice as much product as starting material.
e) twice as much starting material as product.
- 30) Consider the following electron configurations for neutral atoms:



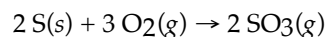
Which atom would be expected to have the largest **third** ionization energy?

- a) atom I
b) atom II
c) atom III
d) All of these atoms would be expected to have the same third ionization energy.
- 31) When dissolved in water, of HClO_4 , Ca(OH)_2 , KOH , HI , which are acids?
- a) HClO_4 and HI
b) Ca(OH)_2 and KOH
c) only KOH
d) only HI

- 32) Given:

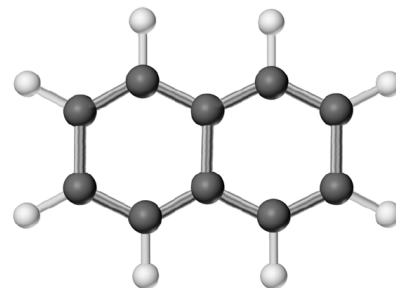


Find ΔH° for :



- a) +97.9 kJ b) -790.4 kJ
c) -97.9 kJ d) -394.0 kJ
- 33) The first law of thermodynamics
- a) defines chemical energy.
b) provides a criterion for the spontaneity of a reaction.
c) defines entropy.
d) is a statement of conservation of energy.
- 34) An interpretation of the results of many tests is called
- a) a hypothesis. b) an experiment.
c) a prediction. d) a theory.

- 35) Give the molecular formula corresponding to the following ball-and-stick molecular representation of naphthalene (gray = C, unshaded = H). In writing the formula, list the atoms in alphabetical order.



- a) C_5H_4 b) $\text{C}_{10}\text{H}_{10}$
c) C_{10}H_8 d) CH

- 36) What is the geometry around the central atom in the following molecular model of SO_2 ?



- a) linear
b) bent
c) trigonal planar
d) trigonal pyramidal
- 37) In general, at room temperature
- a) ionic compounds are all solids, but covalent compounds may be solids, liquids, or gases.
b) ionic compounds are all solids and covalent compounds are all gases.
c) ionic compounds are all solids, and covalent compounds are liquids or gases.
d) covalent compounds are all gases, but ionic compounds may be solids, liquids, or gases.
- 38) Which of the following two atoms are isotopes?
- a) $^{24}_{12}\text{Mg}$ and $^{12}_6\text{C}$ b) $^{40}_{18}\text{Ar}$ and $^{40}_{20}\text{Ca}$
c) $^{35}_{17}\text{Cl}$ and $^{80}_{35}\text{Br}$ d) $^{12}_6\text{C}$ and $^{13}_6\text{C}$

- 39) According to Henry's law, the solubility of a gas in a liquid
- a) increases as the gas pressure above the liquid increases.
b) depends on the liquid polarity.
c) remains the same as the temperature increases.
d) decreases as the gas pressure above the liquid increases.
e) depends on the liquid density.

- 40) What is the chemical formula for iron(II) phosphate?

- a) Fe_3P_2 b) Fe_2PO_4
c) Fe_2P d) $\text{Fe}_3(\text{PO}_4)_2$

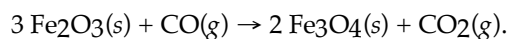
- 41) How many moles of CaCl_2 are in 250. mL of a 3.00 M of CaCl_2 solution?

- a) 0.750 mol
b) 1.33 mol
c) 750. mol
d) 3.00 mol
e) 83.3 mol

- 42) What is the concentration, in mass/mass %, of a solution prepared from 500. g NaCl and 2.50 kg of water?

- a) 16.7%
b) 20.0%
c) 0.050%
d) 1.67%
e) 0.167%

- 43) Use the given standard enthalpies of formation to calculate ΔH° for the following reaction



Species	ΔH°_f kJ/mol
$\text{Fe}_2\text{O}_3(\text{s})$	-824.2
$\text{Fe}_3\text{O}_4(\text{s})$	-1118.4
$\text{CO}(\text{g})$	-110.5
$\text{CO}_2(\text{g})$	-393.5

- a) -5213.4 kJ b) -47.2 kJ
c) -577.2 kJ d) +47.2 kJ

- 44) Which of the following elements is a good conductor of heat and electricity?

- a) neon b) carbon
c) chlorine d) zinc

54) Calculate the molarity of 60.05 g of acetic acid, $C_2H_4O_2$, dissolved in 0.250 L of solution.

- a) 0.250 M
- b) 15.0 M
- c) 4.00 M
- d) 0.100 M
- e) 1.00 M

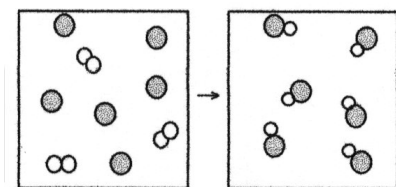
55) What is the empirical formula for perfluoropropane if the compound contains 81% fluorine and 19% carbon by mass?

- a) C_2F_8
- b) C_3F_8
- c) CF_3
- d) $C_{19}F_{81}$

56) All of the following are fundamental SI units except the

- a) meter.
- b) second.
- c) gram.
- d) Kelvin.

57) What is the balanced chemical equation for the reaction of element A (unshaded spheres) with element B (shaded spheres) as represented below?



- a) $A_2 + 2B \rightarrow 2AB$
- b) $A_2 + B \rightarrow AB$
- c) $A + B \rightarrow AB$
- d) $A + 3B \rightarrow 3AB$

58) To the correct number of significant figures, what is the temperature reading on the following Celsius thermometer?



- a) $15.67^\circ C$
- b) $16^\circ C$
- c) $15.6^\circ C$
- d) $15^\circ C$

59) Some assumptions from the kinetic molecular theory are listed below. Which one is most frequently cited to explain diffusion of a gas?

- a) A gas consist of tiny particles moving in random straight line motion.
- b) The volume of the particles is negligible compared to the volume of the gas.
- c) Collisions of gas particles are elastic and total kinetic energy of the gas is constant.
- d) The average kinetic energy of gas particles is proportional to the Kelvin temperature.

60) According to the Arrhenius concept, if HNO_3 were dissolved in water, it would act as

- a) a base
- b) an acid
- c) a proton acceptor
- d) a source of H^- ions
- e) a source of hydroxide ions

