VIRGINIA STANDARDS OF LEARNING

Spring 2005 Released Test

END OF COURSE CHEMISTRY

CORE 1

Periodic Table of the Elements

Atomic mass — 28.0855 — Selected Oxidation States: - 4, + 2, + 4
Symbol — Si
Atomic number — 14
Electron configuration — *[Ne]3s²3p²
Name — Silicon

* The bracketed area represents the electron configuration of a noble gas.

Group 1 … 18 | Period 1 … 7

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00794 +1 -1 **H** 1 *1s* Hydrogen																	4.00260 **He** 2 *1s²* Helium
2	6.941 +1 **Li** 3 *1s²2s¹* Lithium	9.01218 +2 **Be** 4 *1s²2s²* Beryllium						Transition Elements					10.81 +3 **B** 5 *1s²2s²2p¹* Boron	12.0111 -4 +2 +4 **C** 6 *1s²2s²2p²* Carbon	14.0067 -3 -2 -1 +1 +2 +3 +4 +5 **N** 7 *1s²2s²2p³* Nitrogen	15.9994 -2 **O** 8 *1s²2s²2p⁴* Oxygen	18.998403 -1 **F** 9 *1s²2s²2p⁵* Fluorine	20.179 0 **Ne** 10 *1s²2s²2p⁶* Neon
3	22.98977 +1 **Na** 11 *[Ne]3s¹* Sodium	24.305 +2 **Mg** 12 *[Ne]3s²* Magnesium											26.98154 +3 **Al** 13 *[Ne]3s²3p¹* Aluminum	28.0855 -4 +2 +4 **Si** 14 *[Ne]3s²3p²* Silicon	30.97376 -3 +3 +5 **P** 15 *[Ne]3s²3p³* Phosphorus	32.06 -2 +4 +6 **S** 16 *[Ne]3s²3p⁴* Sulfur	35.453 -1 +1 +3 +5 +7 **Cl** 17 *[Ne]3s²3p⁵* Chlorine	39.948 0 **Ar** 18 *[Ne]3s²3p⁶* Argon
4	39.0983 +1 **K** 19 *[Ar]4s¹* Potassium	40.08 +2 **Ca** 20 *[Ar]4s²* Calcium	44.9559 +3 **Sc** 21 *[Ar]3d¹4s²* Scandium	47.88 +2 +3 +4 **Ti** 22 *[Ar]3d²4s²* Titanium	50.9415 +2 +3 +4 +5 **V** 23 *[Ar]3d³4s²* Vanadium	51.996 +2 +3 +6 **Cr** 24 *[Ar]3d⁵4s¹* Chromium	54.9380 +2 +3 +4 +7 **Mn** 25 *[Ar]3d⁵4s²* Manganese	55.847 +2 +3 **Fe** 26 *[Ar]3d⁶4s²* Iron	58.9332 +2 +3 **Co** 27 *[Ar]3d⁷4s²* Cobalt	58.69 +2 +3 **Ni** 28 *[Ar]3d⁸4s²* Nickel	63.546 +1 +2 **Cu** 29 *[Ar]3d¹⁰4s¹* Copper	65.39 +2 **Zn** 30 *[Ar]3d¹⁰4s²* Zinc	69.72 +3 **Ga** 31 *[Ar]3d¹⁰4s²4p¹* Gallium	72.59 +2 +4 **Ge** 32 *[Ar]3d¹⁰4s²4p²* Germanium	74.9216 -3 +3 +5 **As** 33 *[Ar]3d¹⁰4s²4p³* Arsenic	78.96 -2 +4 +6 **Se** 34 *[Ar]3d¹⁰4s²4p⁴* Selenium	79.904 -1 +1 +5 **Br** 35 *[Ar]3d¹⁰4s²4p⁵* Bromine	83.80 0 +2 **Kr** 36 *[Ar]3d¹⁰4s²4p⁶* Krypton
5	85.4678 +1 **Rb** 37 *[Kr]5s¹* Rubidium	87.62 +2 **Sr** 38 *[Kr]5s²* Strontium	88.9059 +3 **Y** 39 *[Kr]4d¹5s²* Yttrium	91.224 +4 **Zr** 40 *[Kr]4d²5s²* Zirconium	92.9064 +3 +5 **Nb** 41 *[Kr]4d⁴5s¹* Niobium	95.94 +3 +6 **Mo** 42 *[Kr]4d⁵5s¹* Molybdenum	(98) +4 +6 +7 **Tc** 43 *[Kr]4d⁵5s¹* Technetium	101.07 +3 **Ru** 44 *[Kr]4d⁷5s¹* Ruthenium	102.906 +3 **Rh** 45 *[Kr]4d⁸5s¹* Rhodium	106.42 +2 +4 **Pd** 46 *[Kr]4d¹⁰5s⁰* Palladium	107.868 +1 **Ag** 47 *[Kr]4d¹⁰5s¹* Silver	112.41 +2 **Cd** 48 *[Kr]4d¹⁰5s²* Cadmium	114.82 +3 **In** 49 *[Kr]4d¹⁰5s²5p¹* Indium	118.71 +2 +4 **Sn** 50 *[Kr]4d¹⁰5s²5p²* Tin	121.75 -3 +3 +5 **Sb** 51 *[Kr]4d¹⁰5s²5p³* Antimony	127.60 -2 +4 +6 **Te** 52 *[Kr]4d¹⁰5s²5p⁴* Tellurium	126.905 -1 +1 +5 +7 **I** 53 *[Kr]4d¹⁰5s²5p⁵* Iodine	131.29 0 +2 +4 +6 **Xe** 54 *[Kr]4d¹⁰5s²5p⁶* Xenon
6	132.905 +1 **Cs** 55 *[Xe]6s¹* Cesium	137.33 +2 **Ba** 56 *[Xe]6s²* Barium	138.906 +3 **La** 57 *[Xe]5d¹6s²* Lanthanum	178.49 +4 **Hf** 72 *[Xe]4f¹⁴5d²6s²* Hafnium	180.948 +5 **Ta** 73 *[Xe]4f¹⁴5d³6s²* Tantalum	183.85 +6 **W** 74 *[Xe]4f¹⁴5d⁴6s²* Tungsten	186.207 +4 +6 +7 **Re** 75 *[Xe]4f¹⁴5d⁵6s²* Rhenium	190.2 +3 +4 **Os** 76 *[Xe]4f¹⁴5d⁶6s²* Osmium	192.22 +3 +4 **Ir** 77 *[Xe]4f¹⁴5d⁷6s²* Iridium	195.08 +2 +4 **Pt** 78 *[Xe]4f¹⁴5d⁹6s¹* Platinum	196.967 +1 +3 **Au** 79 *[Xe]4f¹⁴5d¹⁰6s¹* Gold	200.59 +1 +2 **Hg** 80 *[Xe]4f¹⁴5d¹⁰6s²* Mercury	204.383 +1 +3 **Tl** 81 *[Xe]4f¹⁴5d¹⁰6s²6p¹* Thallium	207.2 +2 +4 **Pb** 82 *[Xe]4f¹⁴5d¹⁰6s²6p²* Lead	208.980 +3 +5 **Bi** 83 *[Xe]4f¹⁴5d¹⁰6s²6p³* Bismuth	(209) +2 +4 **Po** 84 *[Xe]4f¹⁴5d¹⁰6s²6p⁴* Polonium	(210) **At** 85 *[Xe]4f¹⁴5d¹⁰6s²6p⁵* Astatine	(222) 0 **Rn** 86 *[Xe]4f¹⁴5d¹⁰6s²6p⁶* Radon
7	(223) +1 **Fr** 87 *[Rn]7s¹* Francium	226.025 +2 **Ra** 88 *[Rn]7s²* Radium	227.028 +3 **Ac** 89 *[Rn]6d¹7s²* Actinium	(261) **Rf** 104 *[Rn]5f¹⁴6d²7s²* Rutherfordium	(262) **Db** 105 *[Rn]5f¹⁴6d³7s²* Dubnium	(263) **Sg** 106 *[Rn]5f¹⁴6d⁴7s²* Seaborgium	(262) **Bh** 107 *[Rn]5f¹⁴6d⁵7s²* Bohrium	(265) **Hs** 108 *[Rn]5f¹⁴6d⁶7s²* Hassium	(266?) **Mt** 109 *[Rn]5f¹⁴6d⁷7s²* Meitnerium	(269?) 110									

Mass numbers in parentheses are those of the most stable or most common isotope.

Metals ← → Nonmetals

Lanthanoid Series	140.12 +3 +4 **Ce** 58 *[Xe]4f¹5d¹6s²* Cerium	140.908 +3 **Pr** 59 *[Xe]4f³6s²* Praseodymium	144.24 +3 **Nd** 60 *[Xe]4f⁴6s²* Neodymium	(145) +3 **Pm** 61 *[Xe]4f⁵6s²* Promethium	150.36 +2 +3 **Sm** 62 *[Xe]4f⁶6s²* Samarium	151.96 +2 +3 **Eu** 63 *[Xe]4f⁷6s²* Europium	157.25 +3 **Gd** 64 *[Xe]4f⁷5d¹6s²* Gadolinium	158.925 +3 **Tb** 65 *[Xe]4f⁹6s²* Terbium	162.50 +3 **Dy** 66 *[Xe]4f¹⁰6s²* Dysprosium	164.930 +3 **Ho** 67 *[Xe]4f¹¹6s²* Holmium	167.26 +3 **Er** 68 *[Xe]4f¹²6s²* Erbium	168.934 +3 **Tm** 69 *[Xe]4f¹³6s²* Thulium	173.04 +2 +3 **Yb** 70 *[Xe]4f¹⁴6s²* Ytterbium	174.967 +3 **Lu** 71 *[Xe]4f¹⁴5d¹6s²* Lutetium
Actinoid Series	232.038 +4 **Th** 90 *[Rn]6d²7s²* Thorium	231.036 +4 +5 **Pa** 91 *[Rn]5f²6d¹7s²* Protactinium	238.029 +3 +4 +5 +6 **U** 92 *[Rn]5f³6d¹7s²* Uranium	237.048 +3 +4 +5 +6 **Np** 93 *[Rn]5f⁴6d¹7s²* Neptunium	(244) +3 +4 +5 +6 **Pu** 94 *[Rn]5f⁶7s²* Plutonium	(243) +3 +4 +5 +6 **Am** 95 *[Rn]5f⁷7s²* Americium	(247) +3 **Cm** 96 *[Rn]5f⁷6d¹7s²* Curium	(247) +3 +4 **Bk** 97 *[Rn]5f⁹7s²* Berkelium	(251) +3 **Cf** 98 *[Rn]5f¹⁰7s²* Californium	(252) **Es** 99 *[Rn]5f¹¹7s²* Einsteinium	(257) **Fm** 100 *[Rn]5f¹²7s²* Fermium	(258) **Md** 101 *[Rn]5f¹³7s²* Mendelevium	(259) **No** 102 *[Rn]5f¹⁴7s²* Nobelium	(260) **Lr** 103 *[Rn]5f¹⁴6d¹7s²* Lawrencium

Revised November 2004

DIRECTIONS

Read each question carefully and choose the best answer. Then mark the space on the answer sheet for the answer you have chosen.

SAMPLE

Which of the following is a balanced equation?

A $H_2 + Br_2 \rightarrow 2HBr$
B $H_2 + Br_2 \rightarrow HBr$
C $H_2 + 2Br_2 \rightarrow 2HBr$
D $2H_2 + Br_2 \rightarrow HBr$

1 How many valence electrons does a neutral atom of silicon have?

A 3
B 4
C 5
D 6

2 The correct name for P_2O_5 is —

F phosphorus (V) pentoxide
G phosphorus oxide
H phosphorus (II) oxide
J diphosphorus pentoxide

3 $2KOH + H_2SO_4 \rightarrow 2H_2O + K_2SO_4$

What mass of potassium hydroxide is required to react completely with 2.70 g of sulfuric acid to produce potassium sulfate and water?

A 4.73 g
B 3.09 g
C 2.36 g
D 1.54 g

4 Which of the following best describes sublimation?

F A solid melting to a liquid
G A solid melting to a liquid, which then evaporates
H The movement of gaseous particles so that they fill the space they occupy
J A solid forming a gas

5 The reaction times for three trials of an experiment are 90.3, 90.2, and 90.5 seconds. Which average time is expressed using the correct number of significant figures?

A 90.3
B 90.33
C 90
D 90.333

GO ON

6 $\underline{?}\ Al + \underline{?}\ HCl \rightarrow \underline{?}\ AlCl_3 + \underline{?}\ H_2$

Which set of coefficients will balance this equation?

F 1, 3, 1, 1
G 2, 3, 2, 6
H 2, 6, 2, 3
J 3, 6, 3, 2

7 At room temperature, chlorine exists as a gas, bromine exists as a liquid, and iodine exists as a solid. The physical states of these elements indicate that melting point —

A decreases from top to bottom with group 17 elements
B is independent of periodic position
C increases from top to bottom within group 17 elements
D is constant within group 17 elements

8 **Some Selected Polyatomic Ions**

Positive Ions		Negative Ions	
Names	**Symbols**	**Names**	**Symbols**
ammonium	NH_4^+	acetate	CH_3COO^-
mercury (II)	Hg^{2+}	cyanide	CN^-
		oxalate	$C_2O_4^{2-}$
		phosphate	PO_4^{3-}
		thiosulfate	$S_2O_3^{2-}$

Using the table above, what is the correct formula for ammonium phosphate?

F NH_4PO_4
G $(NH_4)_2(PO_4)_3$
H $(NH_4)_3PO_4$
J $NH_4(PO_4)_3$

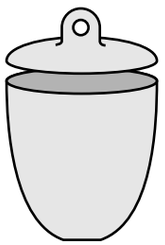
9

Element	Protons	Neutrons	Electrons
1	20	20	20
2	40	40	40
3	20	10	10
4	20	20	40

Which represents an atom of calcium?

A 1
B 2
C 3
D 4

10



What is the name of the lab equipment shown above?

F Watch glass
G Crucible
H Beaker
J Evaporating dish

11 A scientist has found the following isotope of oxygen:

$^{19}_{8}O$

How many neutrons are present in this isotope?

A 8
B 11
C 19
D 27

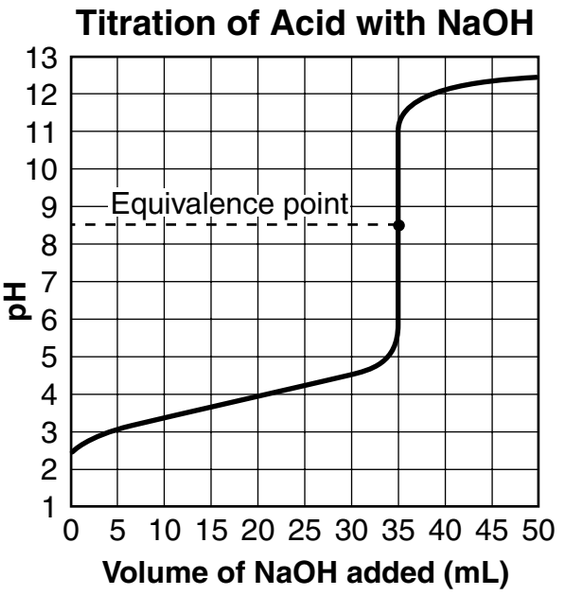
12 The melting point of a white solid substance was determined in four repeated trials to be 56.0°C, 55.0°C, 57.5°C, 55.5°C. What temperature should be reported as the melting point as a result of these trials?

F 55.0°C
G 55.5°C
H 56.0°C
J 57.5°C

13 Which half-reaction represents reduction?

A $Cu^0 \rightarrow Cu^{+2} + 2e^-$
B $Fe^{+2} \rightarrow Fe^{+3} + 1e^-$
C $Ag^{+1} + 1e^- \rightarrow Ag^0$
D $Al^0 \rightarrow Al^{+3} + 3e^-$

14



Indicators for Titrations

Indicator	pH Range	Color Change
Bromocresol green	4.0 – 5.6	Pink - Blue
Indigo carmine	11.4 – 13.0	Blue - Yellow
Neutral red	6.8 – 8.0	Pink - Red - Yellow
Phenolphthalein	8.0 – 10.1	Colorless - Pink

Which is the *best* indicator for giving a color change at the equivalence point?

F Bromocresol green
G Indigo carmine
H Neutral red
J Phenolphthalein

GO ON

15 $N_2 + 3H_2 \longrightarrow 2NH_3$

If 6 liters of hydrogen gas are used, how many liters of nitrogen gas will be needed for the above reaction at STP?

A 2 liters
B 3 liters
C 4 liters
D 12 liters

16 Which of the following best represents the reaction between hydrochloric acid and sodium hydroxide?

F $2HCl + 2NaOH \rightarrow Na(OH)_2 + H_2Cl_2$
G $HCl_2 + 2Na(OH)_2 \rightarrow 2H_2O + 2NaCl + OH^-$
H $HCl + NaOH \rightarrow H_2O + NaCl$
J $2HCl + Na(OH)_2 \rightarrow 2H_2 + Na^+ + Cl^- + O_2$

17 The freezing point and the boiling point of water can be altered by a variety of techniques. Which of the following has *little* or *no* effect on the boiling point of water?

A Increasing the air pressure above the liquid
B Adding alcohol to the water
C Adding sodium chloride to the water
D Increasing the amount of water

18 Formaldehyde (H_2CO) reacts with oxygen to form CO_2 and H_2O. How many moles of CO_2 will be produced from reacting 2 moles of H_2CO with oxygen?

F 1
G 2
H 4
J 8

19

Solution	A	B	C	D
pH	2	6	9	12

Which pair of solutions would be acidic if mixed in equal quantities?

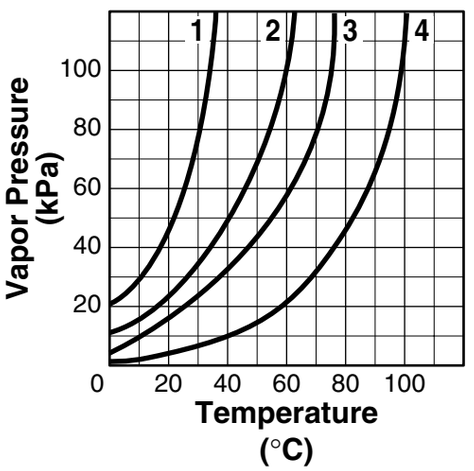
A A and B
B B and C
C B and D
D C and D

20 The elements that are characterized by the presence of an incomplete *d* sublevel are called —

F transition elements
G alkali earth metals
H halogens
J lanthanoids

GO ON

21



Standard atmospheric pressure is 101.3 kPa. According to the graph, which of these four liquids boils at the lowest temperature?

A 1
B 2
C 3
D 4

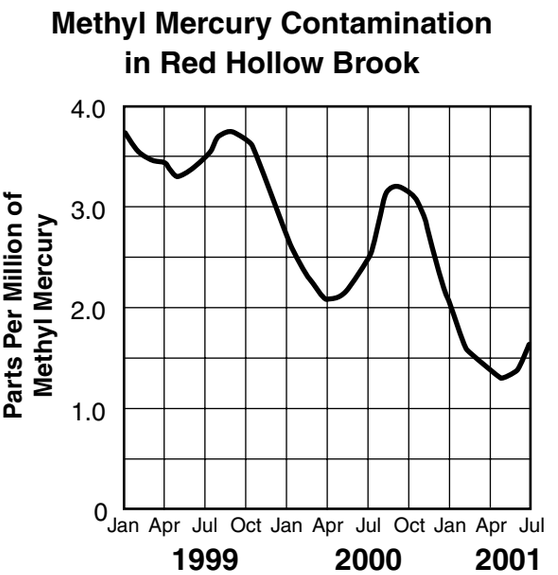
22 The net charge on an aluminum ion is +3 because there are —

F 10 protons and 13 electrons in the atom
G 13 protons and 10 neutrons in the nucleus
H 10 neutrons and 13 electrons in the atom
J 13 protons and 10 electrons in the atom

23 The type of formula that shows the arrangements of atoms and bonds is called —

A empirical
B chemical
C molecular
D structural

24



Methyl mercury, found in some stream sediments, is highly toxic to animal life. Using the graphed results of the study shown, the best analysis of the data reveals that the methyl mercury concentration in the stream sediment is —

F steadily increasing, accelerating in the fall of each year
G increasing overall but reaches a minimum in the winter
H constantly declining throughout each month of the year
J decreasing but reaches a maximum at the end of summer

GO ON

25 Which of the following is a mixture?

A Carbon
B Glucose
C Distilled water
D Air

26

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

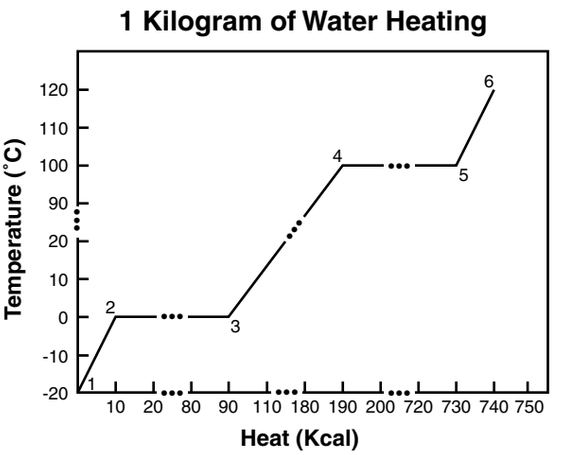
What is the mole ratio of C_4H_{10} to CO_2 in the reaction shown?

F 1:4
G 2:13
H 4:5
J 13:8

27 One indicator that electrons in atoms are limited to specific energy levels is that —

A atoms move faster when heated
B the light given off by atoms is all at the same wavelength
C the Doppler effect shows a shift in wavelength for H-atom light
D light emitted from excited atoms occurs only at specific wavelengths

28



Between points 2 and 3, energy is being used to —

F melt ice
G heat water
H evaporate water
J heat water vapor

29 A container holds 20.0 grams of neon gas. Under the same conditions, how many grams of xenon would the container hold?

A 108 g
B 131 g
C 262 g
D 370 g

GO ON

30 $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

In the combustion of ethane, how many moles of CO_2 can be produced from 1.00 mole of C_2H_6?

F 0.500 mole
G 1.00 mole
H 2.00 moles
J 4.00 moles

31 What is the molecular formula of a substance that has an empirical formula of C_2H_5 and a molecular mass of 58 g/mole?

A C_2H_5
B C_5H_2
C C_4H_{10}
D C_6H_{15}

32 According to Boyle's law, the relationship between the pressure and volume of a gas at constant temperature is —

F numerically equivalent
G inversely proportional
H positively correlated
J totally unrelated

33 $H_2SO_4 + KOH \rightleftharpoons H_2O + K^+ + HSO_4^-$

Which is the base in the reaction?

A H_2O
B KOH
C K^+
D H_2SO_4

34 Charles' Law states that if a given quantity of gas is held at a constant pressure, then its volume is directly proportional to the absolute temperature. This law explains why —

F the pressure of a gas increases when volume decreases
G a gas-filled balloon expands when it is heated
H solids require heat in order to change into gases
J some gases only react with each other at high temperatures

35 What is a possible cause of a large percentage of error in an experiment where MgO is produced from the combustion of magnesium?

A Not all of the Mg has completely reacted.
B The same balance was used throughout the experiment.
C The students were careful in their measurements.
D The students were careful not to spill the contents.

36 $Na_2CO_3 + Ca(OH)_2 \rightarrow 2NaOH + CaCO_3$

Which type of reaction is represented here?

F Single replacement
G Double replacement
H Synthesis
J Decomposition

37 The amount of energy needed to raise one gram of a substance one degree Celsius is a characteristic property known as —

A heat of formation
B heat of vaporization
C molar heat of fusion
D specific heat capacity

38 The empirical formula for C_6H_{12} is —

F C_3H_6
G C_2H_4
H CH_3
J CH_2

39 $2HCl(g) \rightleftharpoons H_2(g) + Cl_2(g)$

Which condition will cause a shift in the equilibrium of the above reaction?

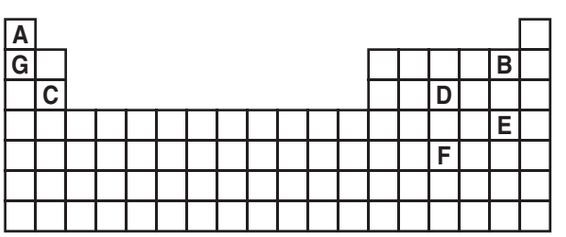
A Double the concentration of reactants and products
B Increase the reaction temperature
C Reduce the concentration of products and reactants by 10%
D Keep the reaction temperature constant

40 $2O_3\ (g) \rightarrow 3$ ____ (g)

Which completes the chemical equation above?

F O_2
G O_3
H ClO
J ClO_2

41

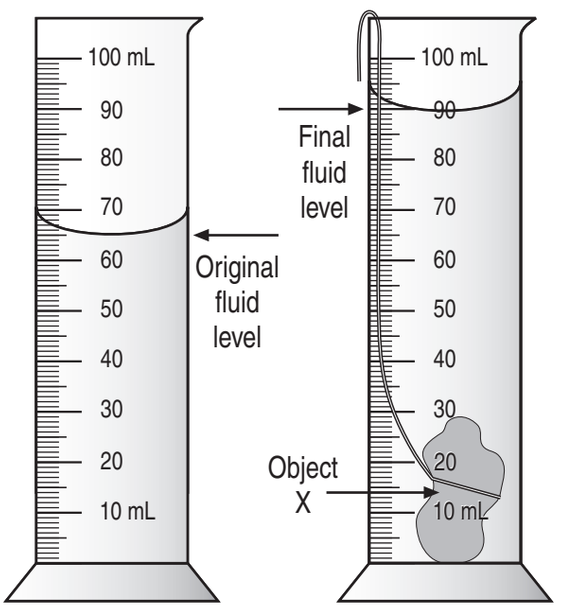


An alien astronaut landed on Earth and created the periodic table shown. The astronaut was trying to determine what type of bond would be present in several compounds. The type of bond in a compound containing G and E would be —

A a metallic bond
B a nonmetallic bond
C a covalent bond
D an ionic bond

GO ON

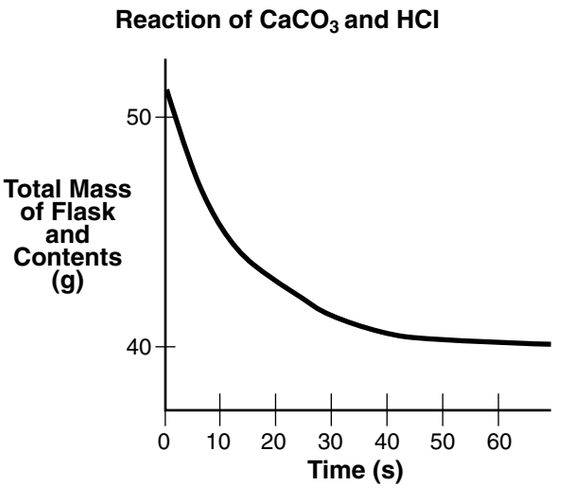
42



The volume of Object X is approximately —

F 20 mL
G 25 mL
H 30 mL
J 35 mL

43



$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Calcium carbonate was placed in a flask on a balance, and dilute hydrochloric acid was added. Carbon dioxide that was produced escaped from the flask. The total mass of the flask and its contents was recorded every 10 seconds. The diagram above shows a plot of the results. Between which of the following times was the reaction the fastest?

A 0 and 10 seconds
B 10 and 20 seconds
C 20 and 30 seconds
D 30 and 40 seconds

44 How many liters are equivalent to five milliliters?

F 0.005 L
G 0.05 L
H 500 L
J 5000 L

GO ON

45 The following data were collected. The volume of the gas is known to be 2.20 L.

Gas Volume Data

Trial	Measured Volume (L)
1	5.20
2	5.20
3	5.19
4	5.20
5	5.20

This data reflects —

A low precision and low accuracy
B low precision and high accuracy
C low accuracy and high precision
D high accuracy and high precision

46 The total pressure of an O_2-Ar-He gas mixture is 755 mmHg. If the partial pressure of Ar is 174 mmHg and the partial pressure of He is 389 mmHg, then the partial pressure of O_2 is —

F 192 mmHg
G 282 mmHg
H 366 mmHg
J 563 mmHg

47 Bonding between two elements of equal electronegativity would be —

A 100% covalent
B primarily ionic
C 50% ionic
D metallic in character

48 The molar mass (gram formula mass) for the compound sodium thiosulfate, $Na_2S_2O_3$, is —

F 71 grams
G 153 grams
H 158 grams
J 254 grams

GO ON

49 The correct formula for copper (I) bromide is —

A $CuBr$

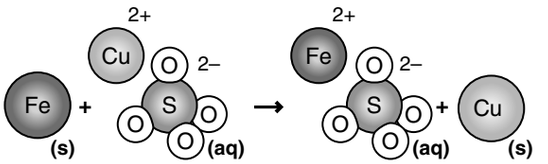
B $CuBr_2$

C Cu_2Br

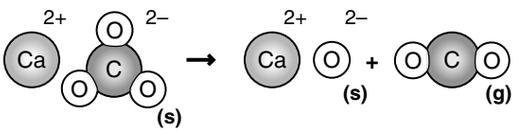
D Cu_2Br_3

50 Which of the following models a synthesis reaction?

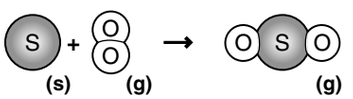
F



G



H



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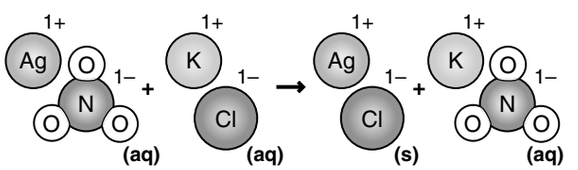

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