

VIRGINIA STANDARDS OF LEARNING

Spring 2005 Released Test

END OF COURSE CHEMISTRY

CORE 1

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Periodic Table of the Elements

 Atomic mass — 28.0855 - 4
+ 2
 Selected Oxidation States
+ 4

 Symbol — **Si**

 Atomic number — **14**

 Electron configuration — $[Ne]3s^23p^2$

Name — Silicon

4.00260
He
2
$1s^2$ Helium

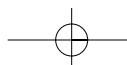
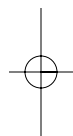
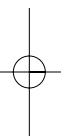
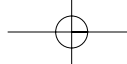
Group 1

Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18								
1	Transition Elements												10.81 B 5	12.0111 C 6	14.0067 N 7	15.9994 O 8	18.998403 F 9	20.179 Ne 10								
2													6.941 Li 3	9.01218 Be 4	22.98977 Na 11	24.305 Mg 12	39.0983 K 19	40.08 Ca 20	44.9559 Sc 21	47.88 Ti 22	50.9415 V 23	51.996 Cr 24	54.9380 Mn 25	55.847 Fe 26	58.9332 Co 27	58.69 Ni 28
3	85.4678 Rb 37	87.62 Sr 38	88.9059 Y 39	91.224 Zr 40	92.9064 Nb 41	95.94 Mo 42	(98) Tc 43	101.07 Ru 44	102.906 Rh 45	106.42 Pd 46	107.868 Ag 47	112.41 Cd 48	114.82 In 49	118.71 Sn 50	121.75 Sb 51	127.60 Te 52	126.905 I 53	131.29 Xe 54								
4	132.905 Cs 55	137.33 Ba 56	138.906 La 57	178.49 Hf 72	180.948 Ta 73	183.85 W 74	186.207 Re 75	190.2 Os 76	192.22 Ir 77	195.08 Pt 78	196.967 Au 79	200.59 Hg 80	204.383 Tl 81	207.2 Pb 82	208.980 Bi 83	(209) Po 84	(210) At 85	(222) Rn 86								
5	(223) Fr 87	226.025 Ra 88	227.028 Ac 89	(261) Rf 104	(262) Db 105	(263) Sg 106	(262) Bh 107	(265) Hs 108	(266?) Mt 109	110																
6	Lanthanoid Series												140.12 Ce 58	140.908 Pr 59	144.24 Nd 60	(145) Pm 61	150.36 Sm 62	151.96 Eu 63	157.25 Gd 64	158.925 Tb 65	162.50 Dy 66	164.930 Ho 67	167.26 Er 68	168.934 Tm 69	173.04 Yb 70	174.967 Lu 71
7	Actinoid Series												232.038 Th 90	231.036 Pa 91	238.029 U 92	237.048 Np 93	(244) Pu 94	(243) Am 95	(247) Cm 96	(247) Bk 97	(251) Cf 98	(252) Es 99	(257) Fm 100	(258) Md 101	(259) No 102	(260) Lr 103

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

Metals
←
→
Nonmetals

Revised November 2004



Chemistry

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 $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$
- B $\text{H}_2 + \text{Br}_2 \rightarrow \text{HBr}$
- C $\text{H}_2 + 2\text{Br}_2 \rightarrow 2\text{HBr}$
- D $2\text{H}_2 + \text{Br}_2 \rightarrow \text{HBr}$

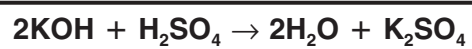
1 How many valence electrons does a neutral atom of silicon have?

- 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



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

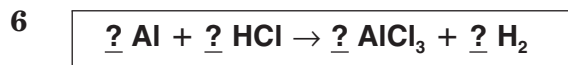
- A 4.73 g
- B 3.09 g
- C 2.36 g
- D 1.54 g

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



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	$\text{C}_2\text{O}_4^{2-}$
		phosphate	PO_4^{3-}
		thiosulfate	$\text{S}_2\text{O}_3^{2-}$

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

- F NH_4PO_4
- G $(\text{NH}_4)_2(\text{PO}_4)_3$
- H $(\text{NH}_4)_3\text{PO}_4$
- J $\text{NH}_4(\text{PO}_4)_3$

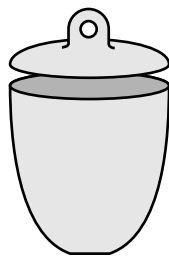
9

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:



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?

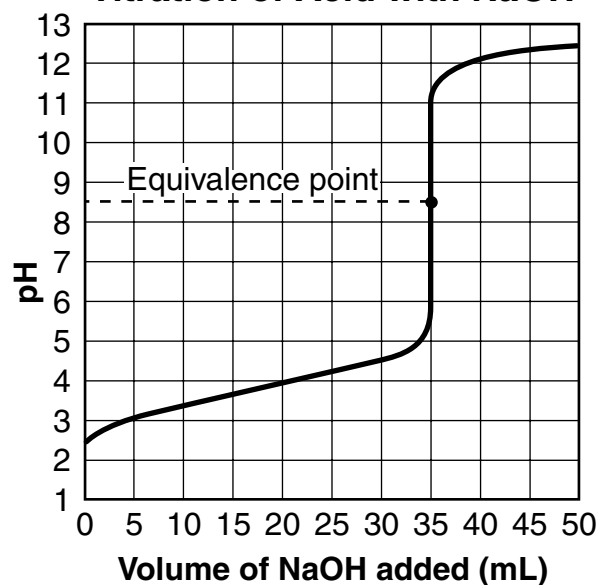
- F 55.0°C
- G 55.5°C
- H 56.0°C
- J 57.5°C

13 Which half-reaction represents reduction?

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

14

Titration of Acid with NaOH



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



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 $2\text{HCl} + 2\text{NaOH} \rightarrow \text{Na}(\text{OH})_2 + \text{H}_2\text{Cl}_2$
- G $\text{HCl}_2 + 2\text{Na}(\text{OH})_2 \rightarrow 2\text{H}_2\text{O} + 2\text{NaCl} + \text{OH}^-$
- H $\text{HCl} + \text{NaOH} \rightarrow \text{H}_2\text{O} + \text{NaCl}$
- J $2\text{HCl} + \text{Na}(\text{OH})_2 \rightarrow 2\text{H}_2 + \text{Na}^+ + \text{Cl}^- + \text{O}_2$

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

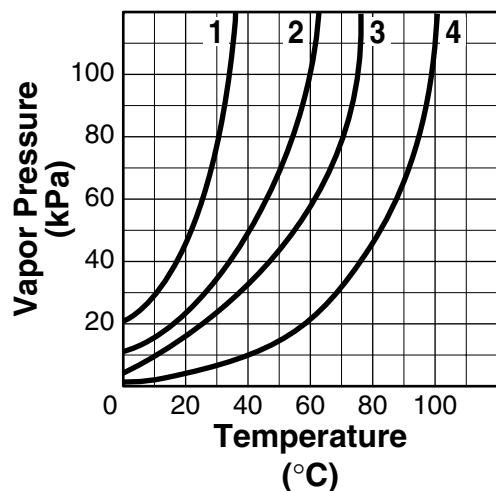
Which pair of solutions would be acidic if mixed in equal quantities?

- 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

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

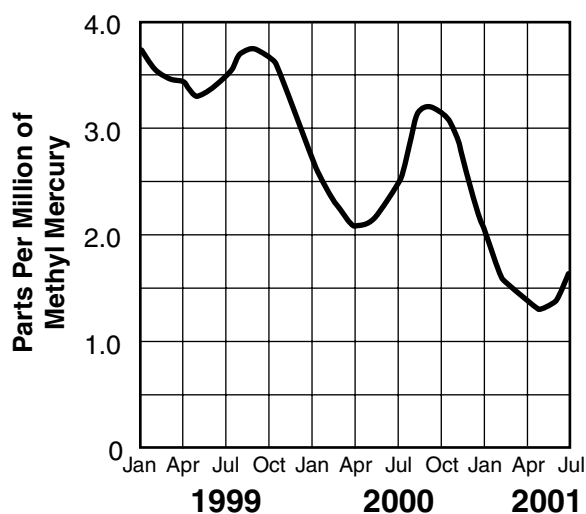
22 The net charge on an aluminum ion is +3 because there are —

- 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 Contamination in Red Hollow Brook



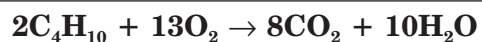
Methyl mercury, found in some stream sediments, is highly toxic to animal life. Using the graphed results of the study shown, the best analysis of the data reveals that the methyl mercury concentration in the stream sediment is —

- 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

25 Which of the following is a mixture?

- A Carbon
- B Glucose
- C Distilled water
- D Air

26



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

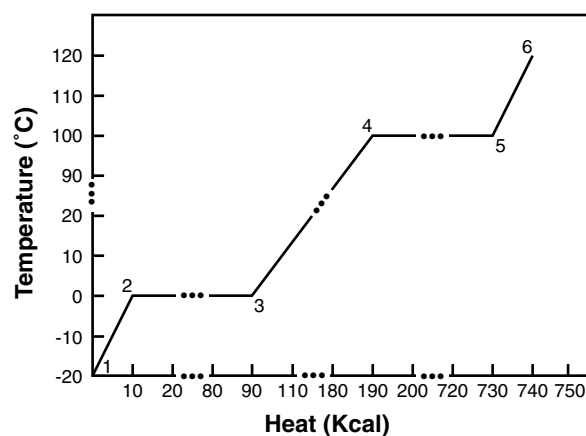
- F 1:4
- G 2:13
- H 4:5
- J 13:8

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

1 Kilogram of Water Heating



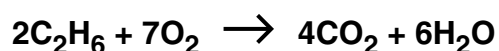
Between points 2 and 3, energy is being used to —

- 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

30



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



Which is the base in the reaction?

- A H_2O
- B KOH
- C K^+
- D H_2SO_4

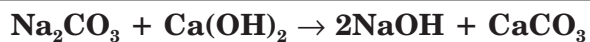
34 Charles' Law states that if a given quantity of gas is held at a constant pressure, then its volume is directly proportional to the absolute temperature. This law explains why —

- 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



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 $2\text{HCl}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{Cl}_2(\text{g})$

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 $2\text{O}_3(\text{g}) \rightarrow 3 \text{ ____ } (\text{g})$

Which completes the chemical equation above?

- F O_2
- G O_3
- H ClO
- J ClO_2

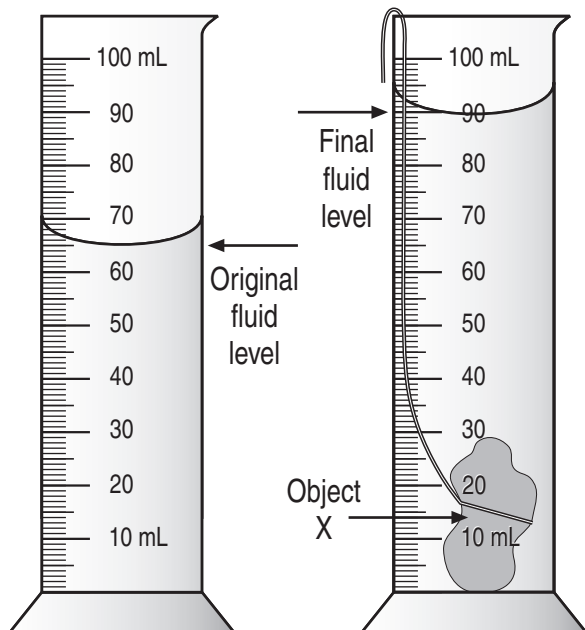
41

A																				
G																			B	
	C																	D		
																			E	
																		F		

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

42

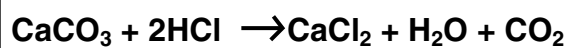
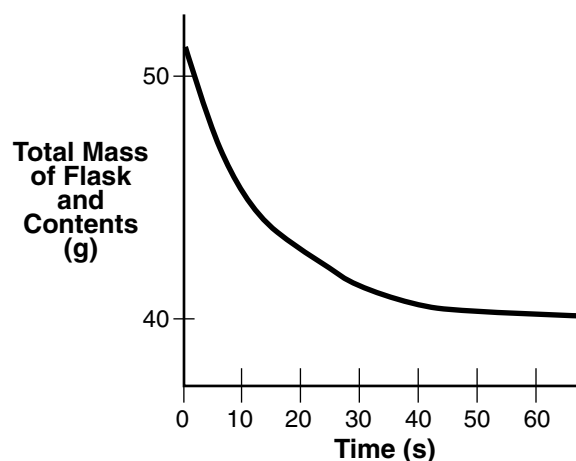


The volume of Object X is approximately —

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

43

Reaction of CaCO_3 and HCl



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

- 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 O₂-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 O₂ 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

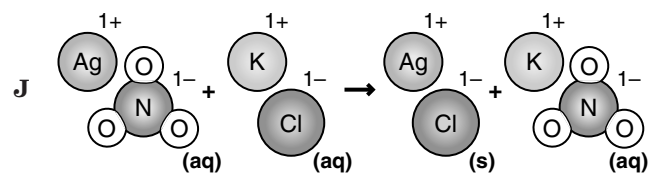
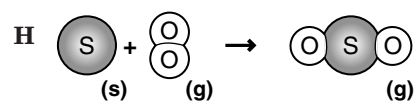
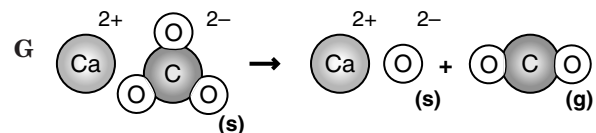
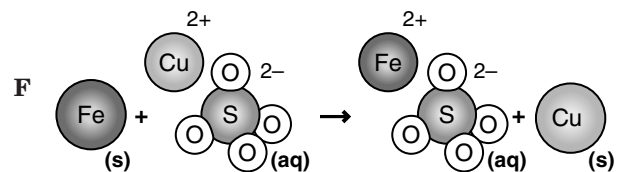
- 48 The molar mass (gram formula mass) for the compound sodium thiosulfate, Na₂S₂O₃, is —

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

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

- A CuBr
- B CuBr₂
- C Cu₂Br
- D Cu₂Br₃

50 Which of the following models a synthesis reaction?



Answer Key

Test Sequence	Correct Answer	Reporting Category	Reporting Category Description
1	B	002	Atomic Structure and Periodic Relationships
2	J	003	Nomenclature, Chemical Formulas, and Reactions
3	B	004	Molar Relationships
4	J	005	Phases of Matter and Kinetic Molecular Theory
5	A	001	Scientific Investigation
6	H	003	Nomenclature, Chemical Formulas, and Reactions
7	C	002	Atomic Structure and Periodic Relationships
8	H	003	Nomenclature, Chemical Formulas, and Reactions
9	A	002	Atomic Structure and Periodic Relationships
10	G	001	Scientific Investigation
11	B	002	Atomic Structure and Periodic Relationships
12	H	001	Scientific Investigation
13	C	003	Nomenclature, Chemical Formulas, and Reactions
14	J	001	Scientific Investigation
15	A	004	Molar Relationships
16	H	003	Nomenclature, Chemical Formulas, and Reactions
17	D	005	Phases of Matter and Kinetic Molecular Theory
18	G	004	Molar Relationships
19	A	004	Molar Relationships
20	F	002	Atomic Structure and Periodic Relationships
21	A	005	Phases of Matter and Kinetic Molecular Theory
22	J	002	Atomic Structure and Periodic Relationships
23	D	003	Nomenclature, Chemical Formulas, and Reactions
24	J	001	Scientific Investigation
25	D	002	Atomic Structure and Periodic Relationships
26	F	001	Scientific Investigation
27	D	002	Atomic Structure and Periodic Relationships
28	F	005	Phases of Matter and Kinetic Molecular Theory
29	B	004	Molar Relationships
30	H	004	Molar Relationships
31	C	003	Nomenclature, Chemical Formulas, and Reactions
32	G	005	Phases of Matter and Kinetic Molecular Theory
33	B	004	Molar Relationships
34	G	005	Phases of Matter and Kinetic Molecular Theory
35	A	001	Scientific Investigation
36	G	003	Nomenclature, Chemical Formulas, and Reactions
37	D	005	Phases of Matter and Kinetic Molecular Theory
38	J	003	Nomenclature, Chemical Formulas, and Reactions
39	B	004	Molar Relationships
40	F	003	Nomenclature, Chemical Formulas, and Reactions
41	D	003	Nomenclature, Chemical Formulas, and Reactions
42	G	001	Scientific Investigation
43	A	003	Nomenclature, Chemical Formulas, and Reactions
44	F	001	Scientific Investigation
45	C	001	Scientific Investigation
46	F	005	Phases of Matter and Kinetic Molecular Theory
47	A	003	Nomenclature, Chemical Formulas, and Reactions
48	H	003	Nomenclature, Chemical Formulas, and Reactions
49	A	003	Nomenclature, Chemical Formulas, and Reactions
50	H	003	Nomenclature, Chemical Formulas, and Reactions