Sample Scoring Key for Parts A and B

Multiple-Choice Questions

(1) 1
(2) 4
(3) 2
(4) 3
(5) 1
(6) 2
(7) 4
(8) 3
(9) 2
(10) 3
(11) 1
(12) 2
(13) 3
(14) 4
(15) 3
(16) 2
(17) 1
(18) 3
(19) 2
(20) 3
(21) 2
(22) 1
(23) 2
(24) 1
(25) 4
(26) 1
(27) 1
(28) 2
(29) 3
(30) 1
(31) 1
(32) 1
(33) 3
(34) 4
(35) 3

(36) 3
(37) 4
(38) 4
(39) 2
(40) 2
(41) 3
(42) 2
(43) 4
(44) 4
(45) 4
(46) 1
(47) 2
(48) 2
(49) 2
(50) 4

Part B

Scoring Guide

51 [4] ***a*** Allow 1 credit for a correct setup. Acceptable responses include, but are not limited to, this example:

23.0 + 35.5 = 58.5

(Do not allow credit if numbers are not rounded correctly to the nearest tenth.)

Allow 1 credit for a correct response and appropriate unit label. Acceptable responses include, but are not limited to, this example:

58.5 g

(Accept any response that is consistent with student setup.)

b Allow 1 credit for a correct setup. Acceptable responses include, but are not limited to, this example:

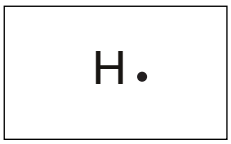
1.84 g x 1.00 mole/58.5 g = 0.0315 mole

Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, this example:

0.0315 mole

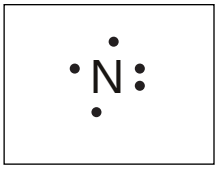
(Accept any response that is consistent with student setup.)
(The label "mole" is not needed in the response.)

52 [3] ***a*** Allow 1 credit for a correct diagram. Acceptable responses include, but are not limited to, this example:



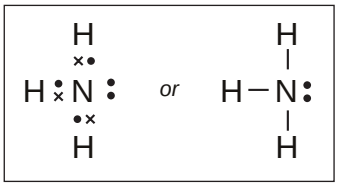
(Diagram must have capital letter for the symbol; the dot, or other symbol for the electron, can be on any side of the symbol.)

b Allow 1 credit for a correct diagram. Acceptable responses include, but are not limited to, this example:



(Diagram must have capital letter for the symbol and have a total of five (5) valence electrons.)

c Allow 1 credit for a correct diagram. Acceptable responses include, but are not limited to, these examples:



(Diagram must have capital letter for the symbol and have three shared pairs and one unshared pair of valence electrons.)

53 [2] ***a*** Allow 1 credit for **decomposition** or **analysis**.

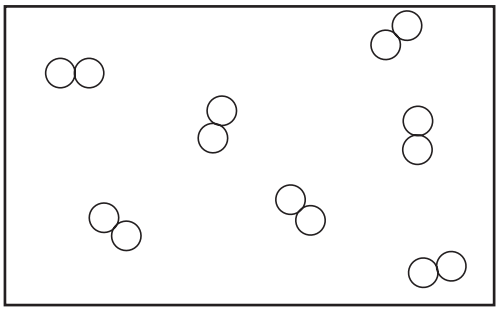
b Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

The particles in the gas product are less organized than the particles in the solid reactant.

increasing randomness

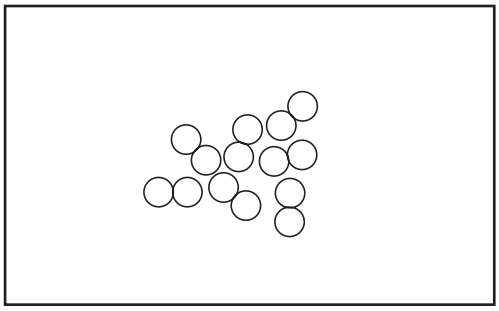
A gas is more chaotic than a solid.

54 [4] ***a*** Allow 1 credit for a correct diagram. Acceptable responses include, but are not limited to, this example:



(Diagram must have at least six " ◯◯ " molecules, which are far apart from each other and show no regular pattern or arrangement.)

b Allow 1 credit for a correct diagram. Acceptable responses include, but are not limited to, this example:



(Diagram must have at least six " ◯◯ " molecules, which are closer together than the molecules in *part a* and show no regular pattern or arrangement.)

c Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

The particles in nitrogen gas are farther away from each other than the particles in the liquid nitrogen.

spacing of particles

Gas particles have greater entropy (randomness) than the particles in the liquid.

(Do not accept responses relating to speed or shape or size of particles.)

d Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples

Two dimensional models do not show geometric relationships.

not 3-D

Real particles are three-dimensional.

The model does not show momentary dipoles.

55 [4] ***a*** Allow 1 credit for ***BC*** *or* ***B*** to ***C***.

b Allow 1 credit for **44^{o} C** ±**2**.

c Allow 1 credit for **point *A*** *or* **time zero** *or* **60^{o} C**.

d Allow 1 credit for **solidification** *or* **freezing** *or* **crystallization.**

Part C

Scoring Guide

56 [2] ***a*** Allow 1 credit for:

4 Fe(s) + **3** $O_2(g) \rightarrow$ **2** Fe_2O_3 (s)

b Allow 1 credit for **product** or **right** or **right side of the equation.**

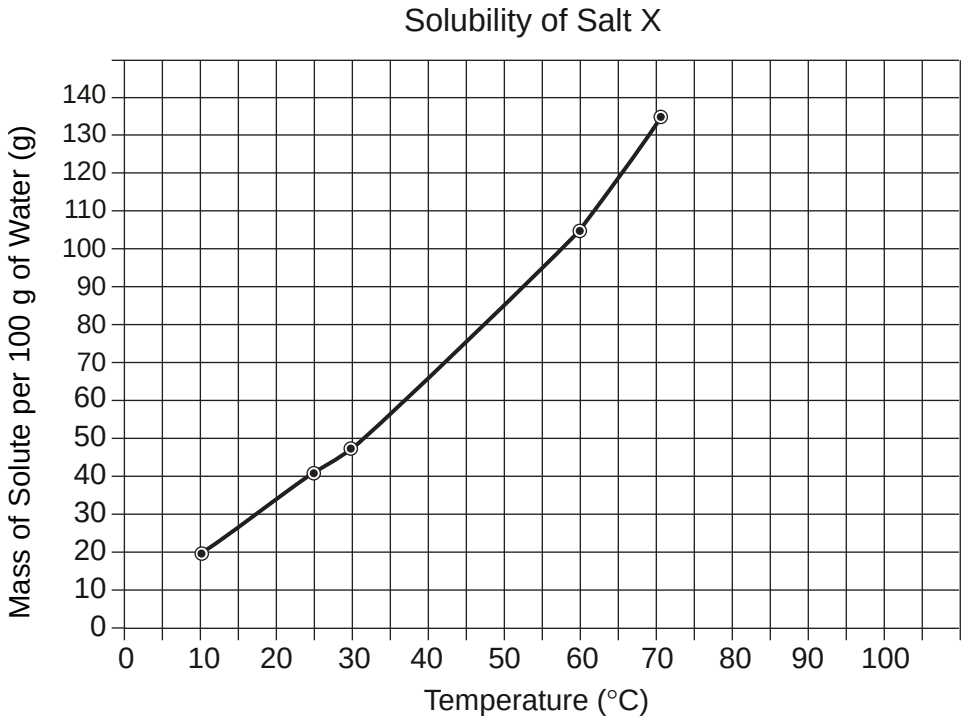
57 [5] ***a*** Allow 1 credit for **potassium nitrate (KNO_3)**.

b Allow 1 credit for a linear scale and appropriate scale divisions. Appropriate units include, but are not limited to, these examples:

mass of solute per 100g of H_2O (g)

grams solute (g)

mass solute (g)



c Allow 1credit for all five points being plotted accurately (±0.3 grid space) and best-fit curve being drawn. No penalty if each point is not surrounded with a small circle.

d Allow 1 credit for **85g** or **85 grams** or any response that is consistent with the student's graph.

e Allow 1 credit for **no effect on the solubility of the salt**.

58 [4] *a* Allow 1 credit for **<u>118</u>** neutrons.

Allow 1 credit for **<u>79</u>** electrons

b Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

The atom's internal structure is mostly empty space.

mostly empty space

c Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

The nucleus of the gold atoms have a positive charge.

Both the nucleus of the gold atoms and the alpha particles have the same charge.

positive charge

59 [2] Allow 1 credit for *each* of two different correct factors. Acceptable responses include, but are not limited to, these examples:

the starting size (surface area) of the magnesium strips

the concentration of the HCl(aq)

the starting temperature of the magnesium strips

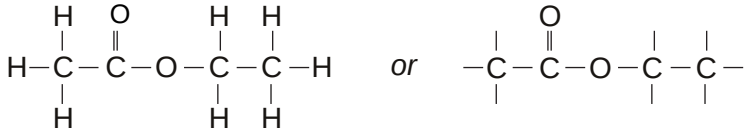
the amount of magnesium

the nature of reactants

the volume HCl(aq)

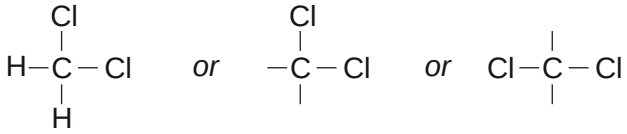
the absence/presence of a catalyst

60 [6] ***a*** Allow 1 credit for a correct diagram. Acceptable responses include, but are not limited to, these examples:



b Allow 1 credit for **esters**.

c Allow 1 credit for a correct diagram. Acceptable responses include, but are not limited to, these examples:



d Allow 1 credit for **halide**.

e Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples which come from the article:

ethyl acetate because the companies can label the beans "naturally decaffeinated"

or

because it occurs naturally in orange rinds and many other fruits

dichloromethane because neither of these solvents provide a process that is really "natural decaffeination"

or

because the ethyl acetate's "naturally decaffeinated" label is misleading

f Allow 1 credit for a correct response. Acceptable responses include, but are not limited to, these examples:

polar The solvents used in the decaffeinating processes are all polar; since caffeine dissolves in all of the solvents, the caffeine must be polar.

nonpolar The solvents used in the decaffeinating processes are all nonpolar; since caffeine dissolves in all of the solvents, the caffeine must be nonpolar.

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2002 Edition • Reference Tables for Physical Setting/Chemistry

Table A
Standard Temperature and Pressure

Name	Value	Unit
Standard Pressure	101.3 kPa 1 atm	kilopascal atmosphere
Standard Temperature	273 K 0°C	kelvin degree Celsius

Table B
Physical Constants for Water

Heat of Fusion	333.6 J/g
Heat of Vaporization	2259 J/g
Specific Heat Capacity of H_2O (ℓ)	4.2 J/g•K

Table C
Selected Prefixes

Factor	Prefix	Symbol
10^3	kilo-	k
10^{-1}	deci-	d
10^{-2}	centi-	c
10^{-3}	milli-	m
10^{-6}	micro-	μ
10^{-9}	nano-	n
10^{-12}	pico-	p

Table D
Selected Units

Symbol	Name	Quantity
m	meter	length
kg	kilogram	mass
Pa	pascal	pressure
K	kelvin	temperature
mol	mole	amount of substance
J	joule	energy, work, quantity of heat
s	second	time
L	liter	volume
ppm	part per million	concentration
M	molarity	solution concentration

Table E
Selected Polyatomic Ions

H_3O^+	hydronium	CrO_4^{2-}	chromate
Hg_2^{2+}	dimercury (I)	$Cr_2O_7^{2-}$	dichromate
NH_4^+	ammonium	MnO_4^-	permanganate
$C_2H_3O_2^-$ CH_3COO^-	acetate	NO_2^-	nitrite
		NO_3^-	nitrate
CN^-	cyanide	O_2^{2-}	peroxide
CO_3^{2-}	carbonate	OH^-	hydroxide
HCO_3^-	hydrogen carbonate	PO_4^{3-}	phosphate
$C_2O_4^{2-}$	oxalate	SCN^-	thiocyanate
ClO^-	hypochlorite	SO_3^{2-}	sulfite
ClO_2^-	chlorite	SO_4^{2-}	sulfate
ClO_3^-	chlorate	HSO_4^-	hydrogen sulfate
ClO_4^-	perchlorate	$S_2O_3^{2-}$	thiosulfate

Table F
Solubility Guidelines

Ions That Form *Soluble* Compounds	Exceptions
Group 1 ions (Li^+, Na^+, etc.)	
ammonium (NH_4^+)	
nitrate (NO_3^-)	
acetate ($C_2H_3O_2^-$ or CH_3COO^-)	
hydrogen carbonate (HCO_3^-)	
chlorate (ClO_3^-)	
perchlorate (ClO_4^-)	
halides (Cl^-, Br^-, I^-)	when combined with Ag^+, Pb^{2+}, and Hg_2^{2+}
sulfates (SO_4^{2-})	when combined with Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, and Pb^{2+}

Ions That Form *Insoluble* Compounds	Exceptions
carbonate (CO_3^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
chromate (CrO_4^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
phosphate (PO_4^{3-})	when combined with Group 1 ions or ammonium (NH_4^+)
sulfide (S^{2-})	when combined with Group 1 ions or ammonium (NH_4^+)
hydroxide (OH^-)	when combined with Group 1 ions, Ca^{2+}, Ba^{2+}, or Sr^{2+}

Table G Solubility Curves

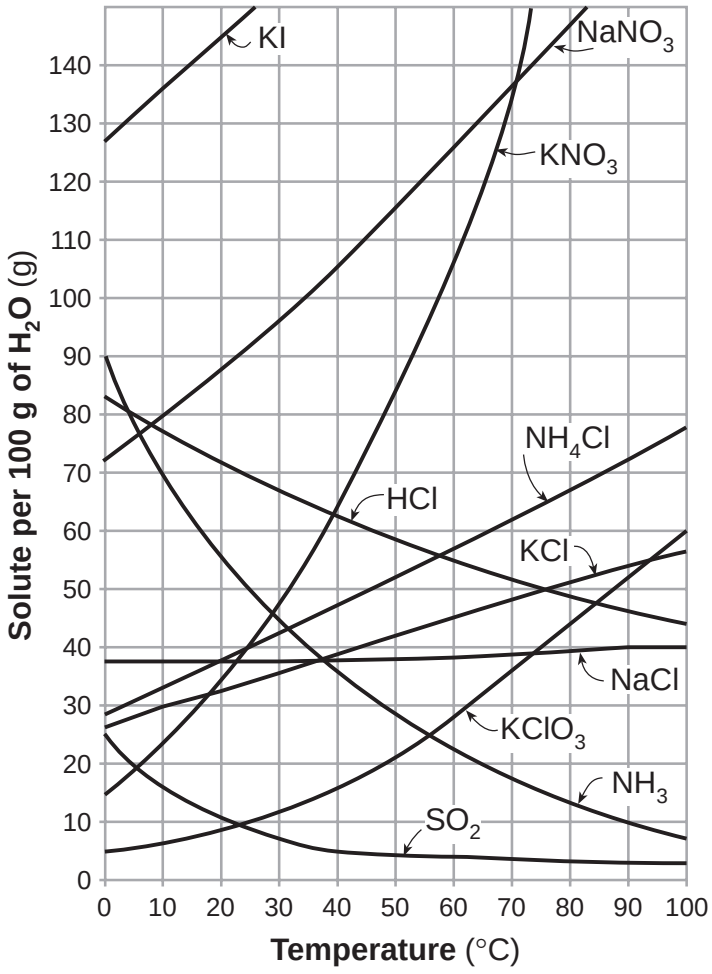


Table H
Vapor Pressure of Four Liquids

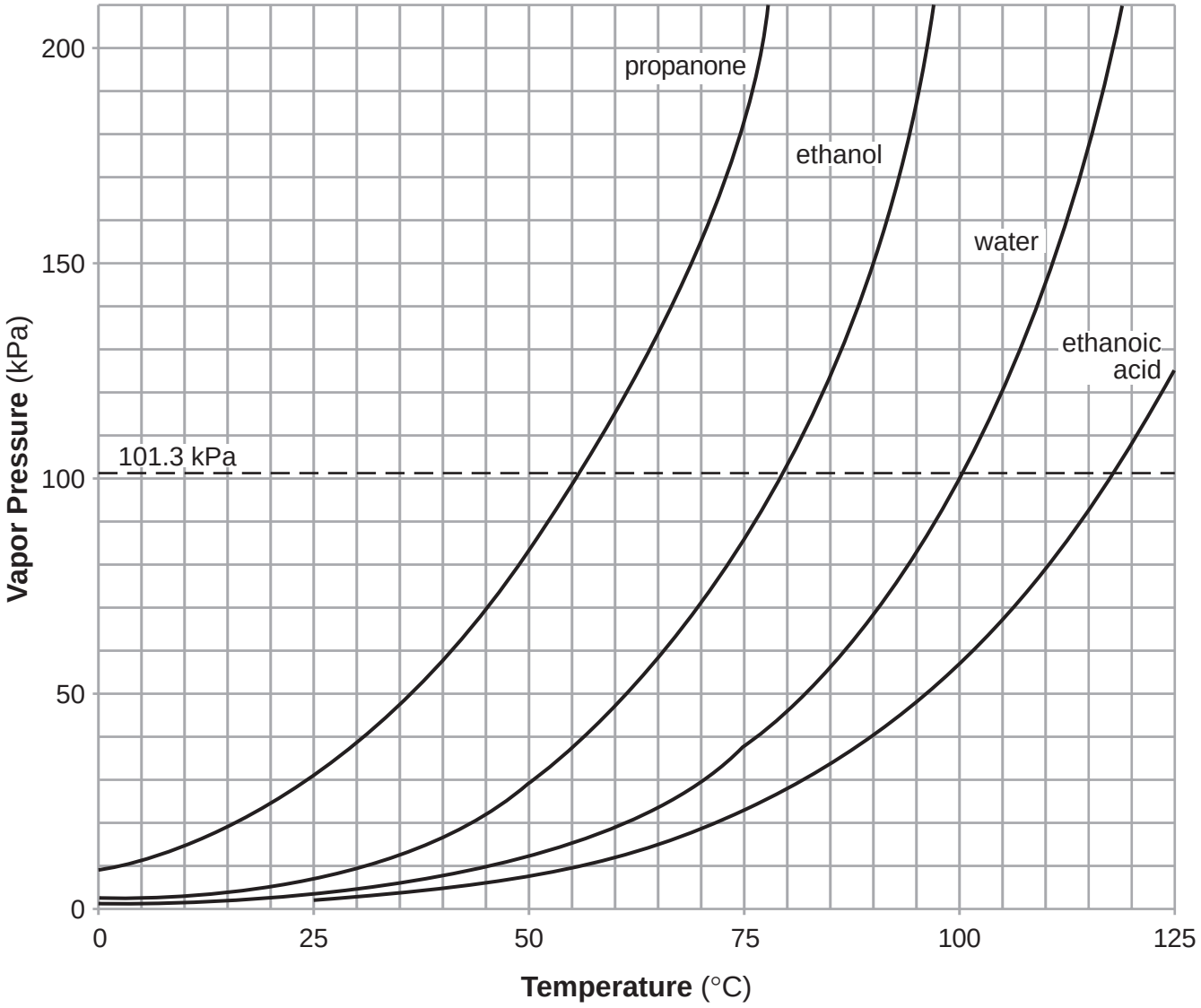


Table I
Heats of Reaction at 101.3 kPa and 298 K

Reaction	ΔH (kJ)*
$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$	–890.4
$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$	–2219.2
$2C_8H_{18}(\ell) + 25O_2(g) \longrightarrow 16CO_2(g) + 18H_2O(\ell)$	–10943
$2CH_3OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 4H_2O(\ell)$	–1452
$C_2H_5OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(\ell)$	–1367
$C_6H_{12}O_6(s) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(\ell)$	–2804
$2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$	–566.0
$C(s) + O_2(g) \longrightarrow CO_2(g)$	–393.5
$4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3(s)$	–3351
$N_2(g) + O_2(g) \longrightarrow 2NO(g)$	+182.6
$N_2(g) + 2O_2(g) \longrightarrow 2NO_2(g)$	+66.4
$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$	–483.6
$2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell)$	–571.6
$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$	–91.8
$2C(s) + 3H_2(g) \longrightarrow C_2H_6(g)$	–84.0
$2C(s) + 2H_2(g) \longrightarrow C_2H_4(g)$	+52.4
$2C(s) + H_2(g) \longrightarrow C_2H_2(g)$	+227.4
$H_2(g) + I_2(g) \longrightarrow 2HI(g)$	+53.0
$KNO_3(s) \xrightarrow{H_2O} K^+(aq) + NO_3^-(aq)$	+34.89
$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$	–44.51
$NH_4Cl(s) \xrightarrow{H_2O} NH_4^+(aq) + Cl^-(aq)$	+14.78
$NH_4NO_3(s) \xrightarrow{H_2O} NH_4^+(aq) + NO_3^-(aq)$	+25.69
$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$	+3.88
$LiBr(s) \xrightarrow{H_2O} Li^+(aq) + Br^-(aq)$	–48.83
$H^+(aq) + OH^-(aq) \longrightarrow H_2O(\ell)$	–55.8

*Minus sign indicates an exothermic reaction.

Table J
Activity Series**

Most	Metals	Nonmetals	Most
	Li	F_2	
	Rb	Cl_2	
	K	Br_2	
	Cs	I_2	
	Ba		
	Sr		
	Ca		
	Na		
	Mg		
	Al		
	Ti		
	Mn		
	Zn		
	Cr		
	Fe		
	Co		
	Ni		
	Sn		
	Pb		
	**H_2		
	Cu		
	Ag		
Least	Au		Least

**Activity Series based on hydrogen standard

Table K
Common Acids

Formula	Name
$HCl(aq)$	hydrochloric acid
$HNO_3(aq)$	nitric acid
$H_2SO_4(aq)$	sulfuric acid
$H_3PO_4(aq)$	phosphoric acid
$H_2CO_3(aq)$ or $CO_2(aq)$	carbonic acid
$CH_3COOH(aq)$ or $HC_2H_3O_2(aq)$	ethanoic acid (acetic acid)

Table L
Common Bases

Formula	Name
$NaOH(aq)$	sodium hydroxide
$KOH(aq)$	potassium hydroxide
$Ca(OH)_2(aq)$	calcium hydroxide
$NH_3(aq)$	aqueous ammonia

Table M
Common Acid–Base Indicators

Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.2–4.4	red to yellow
bromthymol blue	6.0–7.6	yellow to blue
phenolphthalein	8.2–10	colorless to pink
litmus	5.5–8.2	red to blue
bromcresol green	3.8–5.4	yellow to blue
thymol blue	8.0–9.6	yellow to blue

Table N
Selected Radioisotopes

Nuclide	Half-Life	Decay Mode	Nuclide Name
^{198}Au	2.69 d	β^-	gold-198
^{14}C	5730 y	β^-	carbon-14
^{37}Ca	175 ms	β^+	calcium-37
^{60}Co	5.26 y	β^-	cobalt-60
^{137}Cs	30.23 y	β^-	cesium-137
^{53}Fe	8.51 min	β^+	iron-53
^{220}Fr	27.5 s	α	francium-220
^{3}H	12.26 y	β^-	hydrogen-3
^{131}I	8.07 d	β^-	iodine-131
^{37}K	1.23 s	β^+	potassium-37
^{42}K	12.4 h	β^-	potassium-42
^{85}Kr	10.76 y	β^-	krypton-85
^{16}N	7.2 s	β^-	nitrogen-16
^{19}Ne	17.2 s	β^+	neon-19
^{32}P	14.3 d	β^-	phosphorus-32
^{239}Pu	2.44×10^4 y	α	plutonium-239
^{226}Ra	1600 y	α	radium-226
^{222}Rn	3.82 d	α	radon-222
^{90}Sr	28.1 y	β^-	strontium-90
^{99}Tc	2.13×10^5 y	β^-	technetium-99
^{232}Th	1.4×10^{10} y	α	thorium-232
^{233}U	1.62×10^5 y	α	uranium-233
^{235}U	7.1×10^8 y	α	uranium-235
^{238}U	4.51×10^9 y	α	uranium-238

ms = milliseconds; s = seconds; min = minutes;
h = hours; d = days; y = years

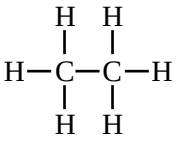
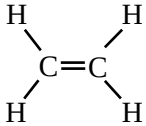
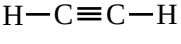
Table O
Symbols Used in Nuclear Chemistry

Name	Notation	Symbol
alpha particle	${}^{4}_{2}\mathrm{He}$ or ${}^{4}_{2}\alpha$	α
beta particle (electron)	${}^{0}_{-1}\mathrm{e}$ or ${}^{0}_{-1}\beta$	β^-
gamma radiation	${}^{0}_{0}\gamma$	γ
neutron	${}^{1}_{0}\mathrm{n}$	n
proton	${}^{1}_{1}\mathrm{H}$ or ${}^{1}_{1}\mathrm{p}$	p
positron	${}^{0}_{+1}\mathrm{e}$ or ${}^{0}_{+1}\beta$	β^+

Table P
Organic Prefixes

Prefix	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10

Table Q
Homologous Series of Hydrocarbons

Name	General Formula	Examples	
		Name	Structural Formula
alkanes	C_nH_{2n+2}	ethane	
alkenes	C_nH_{2n}	ethene	
alkynes	C_nH_{2n-2}	ethyne	

n = number of carbon atoms

Table R
Organic Functional Groups

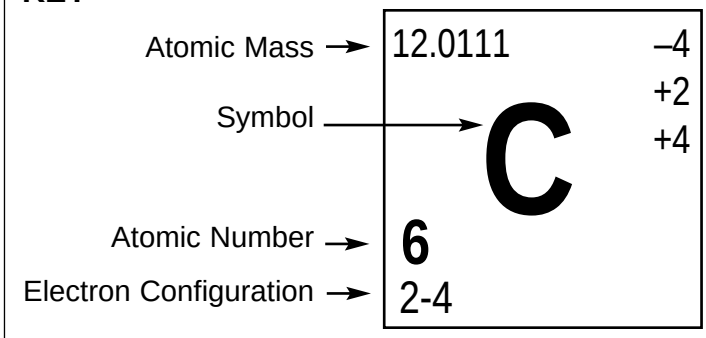
Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	—F (fluoro-) —Cl (chloro-) —Br (bromo-) —I (iodo-)	*R*—*X* (*X* represents any halogen)	$CH_3CHClCH_3$ 2-chloropropane
alcohol	—OH	*R*—OH	$CH_3CH_2CH_2OH$ 1-propanol
ether	—O—	*R*—O—*R*′	$CH_3OCH_2CH_3$ methyl ethyl ether
aldehyde	$-C(=O)-H$	$R-C(=O)-H$	$CH_3CH_2C(=O)-H$ propanal
ketone	$-C(=O)-$	$R-C(=O)-R'$	$CH_3C(=O)CH_2CH_2CH_3$ 2-pentanone
organic acid	$-C(=O)-OH$	$R-C(=O)-OH$	$CH_3CH_2C(=O)-OH$ propanoic acid
ester	$-C(=O)-O-$	$R-C(=O)-O-R'$	$CH_3CH_2C(=O)OCH_3$ methyl propanoate
amine	$-\overset{\vert}{N}-$	$R-\overset{R'}{\overset{\vert}{N}}-R''$	$CH_3CH_2CH_2NH_2$ 1-propanamine
amide	$-C(=O)-NH$	$R-C(=O)-\overset{R'}{N}H$	$CH_3CH_2C(=O)-NH_2$ propanamide

R represents a bonded atom or group of atoms.

Periodic Table o

Period	1
1	1.00794 +1 −1 **H** **1** 1

KEY



	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9
2	6.941 +1 **Li** **3** 2-1	9.01218 +2 **Be** **4** 2-2							
3	22.98977 +1 **Na** **11** 2-8-1	24.305 +2 **Mg** **12** 2-8-2							
4	39.0983 +1 **K** **19** 2-8-8-1	40.08 +2 **Ca** **20** 2-8-8-2	44.9559 +3 **Sc** **21** 2-8-9-2	47.88 +2 +3 +4 **Ti** **22** 2-8-10-2	50.9415 +2 +3 +4 +5 **V** **23** 2-8-11-2	51.996 +2 +3 +6 **Cr** **24** 2-8-13-1	54.9380 +2 +3 +4 +7 **Mn** **25** 2-8-13-2	55.847 +2 +3 **Fe** **26** 2-8-14-2	58.9332 **Co** **27** 2-8-15-2
5	85.4678 +1 **Rb** **37** 2-8-18-8-1	87.62 +2 **Sr** **38** 2-8-18-8-2	88.9059 +3 **Y** **39** 2-8-18-9-2	91.224 +4 **Zr** **40** 2-8-18-10-2	92.9064 +3 +5 **Nb** **41** 2-8-18-12-1	95.94 +3 +6 **Mo** **42** 2-8-18-13-1	(98) +4 +6 +7 **Tc** **43** 2-8-18-14-1	101.07 +3 **Ru** **44** 2-8-18-15-1	102.906 **Rh** **45** 2-8-18-16-1
6	132.905 +1 **Cs** **55** 2-8-18-18-8-1	137.33 +2 **Ba** **56** 2-8-18-18-8-2	138.906 +3 **La** **57** 2-8-18-18-9-2	178.49 +4 **Hf** **72** **18-32-10-2	180.948 +5 **Ta** **73** -18-32-11-2	183.85 +6 **W** **74** -18-32-12-2	186.207 +4 +6 +7 **Re** **75** -18-32-13-2	190.2 +3 +4 **Os** **76** -18-32-14-2	192.22 **Ir** **77** -18-32-15-2
7	(223) +1 **Fr** **87** -18-32-18-8-1	226.025 +2 **Ra** **88** -18-32-18-8-2	227.028 +3 **Ac** **89** -18-32-18-9-2	(261) **Rf** **104**	(262) **Db** **105**	(263) **Sg** **106**	(264) **Bh** **107**	(265) **Hs** **108**	(268) **Mt** **109**

**Denotes the presence of (2-8-) for elements 72 and above

140.12 +3 +4 **Ce** **58**	140.908 +3 **Pr** **59**	144.24 +3 **Nd** **60**	(145) +3 **Pm** **61**	150.36 **Sm** **62**
232.038 +4 **Th** **90**	231.036 +4 +5 **Pa** **91**	238.029 +3 +4 +5 +6 **U** **92**	237.048 +3 +4 +5 +6 **Np** **93**	(244) **Pu** **94**

f the Elements

tion States

masses are based
0

mbers in parentheses
ers of the most
on isotope.

10	11	12	13	14	15	16	17	18
								18
								4.00260 0 **He** 2 2
			Group					
			13	14	15	16	17	18
			10.81 +3 **B** 5 2-3	12.0111 –4 +2 +4 **C** 6 2-4	14.0067 –3 –2 –1 +1 +2 +3 +4 +5 **N** 7 2-5	15.9994 –2 **O** 8 2-6	18.998403 –1 **F** 9 2-7	20.179 0 **Ne** 10 2-8
			26.98154 +3 **Al** 13 2-8-3	28.0855 –4 +2 +4 **Si** 14 2-8-4	30.97376 –3 +3 +5 **P** 15 2-8-5	32.06 –2 +4 +6 **S** 16 2-8-6	35.453 –1 +1 +3 +5 +7 **Cl** 17 2-8-7	39.948 0 **Ar** 18 2-8-8
+2 +3 **Ni** 2	63.546 +1 +2 **Cu** 29 2-8-18-1	65.39 +2 **Zn** 30 2-8-18-2	69.72 +3 **Ga** 31 2-8-18-3	72.59 –4 +2 +4 **Ge** 32 2-8-18-4	74.9216 –3 +3 +5 **As** 33 2-8-18-5	78.96 –2 +4 +6 **Se** 34 2-8-18-6	79.904 –1 +1 +5 **Br** 35 2-8-18-7	83.80 0 +2 **Kr** 36 2-8-18-8
+2 +4 **Pd** 18	107.868 +1 **Ag** 47 2-8-18-18-1	112.41 +2 **Cd** 48 2-8-18-18-2	114.82 +3 **In** 49 2-8-18-18-3	118.71 +2 +4 **Sn** 50 2-8-18-18-4	121.75 –3 +3 +5 **Sb** 51 2-8-18-18-5	127.60 –2 +4 +6 **Te** 52 2-8-18-18-6	126.905 –1 +1 +5 +7 **I** 53 2-8-18-18-7	131.29 0 +2 +4 +6 **Xe** 54 2-8-18-18-8
+2 +4 **Pt** 17-1	196.967 +1 +3 **Au** 79 -18-32-18-1	200.59 +1 +2 **Hg** 80 -18-32-18-2	204.383 +1 +3 **Tl** 81 -18-32-18-3	207.2 +2 +4 **Pb** 82 -18-32-18-4	208.980 +3 +5 **Bi** 83 -18-32-18-5	(209) +2 +4 **Po** 84 -18-32-18-6	(210) **At** 85 -18-32-18-7	(222) 0 **Rn** 86 -18-32-18-8
Uun*	(272) **Uuu** 111	(277) **Uub** 112		(285) **Uuq** 114				

systematic names and symbols for elements of atomic numbers above 109
be used until the approval of trivial names by IUPAC.

+2 +3 **Eu**	157.25 +3 **Gd** 64	158.925 +3 **Tb** 65	162.50 +3 **Dy** 66	164.930 +3 **Ho** 67	167.26 +3 **Er** 68	168.934 +3 **Tm** 69	173.04 +2 +3 **Yb** 70	174.967 +3 **Lu** 71
+3 +4 +5 +6 **Am**	(247) +3 **Cm** 96	(247) +3 +4 **Bk** 97	(251) +3 **Cf** 98	(252) **Es** 99	(257) **Fm** 100	(258) **Md** 101	(259) **No** 102	(260) **Lr** 103

Table S
Properties of Selected Elements

Atomic Number	Symbol	Name	Ionization Energy (kJ/mol)	Electro-negativity	Melting Point (K)	Boiling Point (K)	Density** (g/cm^3)	Atomic Radius (pm)
1	H	hydrogen	1312	2.1	14	20	0.00009	208
2	He	helium	2372	—	1	4	0.000179	50
3	Li	lithium	520	1.0	454	1620	0.534	155
4	Be	beryllium	900	1.6	1551	3243	1.8477	112
5	B	boron	801	2.0	2573	3931	2.340	98
6	C	carbon	1086	2.6	3820	5100	3.513	91
7	N	nitrogen	1402	3.0	63	77	0.00125	92
8	O	oxygen	1314	3.4	55	90	0.001429	65
9	F	fluorine	1681	4.0	54	85	0.001696	57
10	Ne	neon	2081	—	24	27	0.0009	51
11	Na	sodium	496	0.9	371	1156	0.971	190
12	Mg	magnesium	736	1.3	922	1363	1.738	160
13	Al	aluminum	578	1.6	934	2740	2.698	143
14	Si	silicon	787	1.9	1683	2628	2.329	132
15	P	phosphorus	1012	2.2	44	553	1.820	128
16	S	sulfur	1000	2.6	386	718	2.070	127
17	Cl	chlorine	1251	3.2	172	239	0.003214	97
18	Ar	argon	1521	—	84	87	0.001783	88
19	K	potassium	419	0.8	337	1047	0.862	235
20	Ca	calcium	590	1.0	1112	1757	1.550	197
21	Sc	scandium	633	1.4	1814	3104	2.989	162
22	Ti	titanium	659	1.5	1933	3580	4.540	145
23	V	vanadium	651	1.6	2160	3650	6.100	134
24	Cr	chromium	653	1.7	2130	2945	7.190	130
25	Mn	manganese	717	1.6	1517	2235	7.440	135
26	Fe	iron	762	1.8	1808	3023	7.874	126
27	Co	cobalt	760	1.9	1768	3143	8.900	125
28	Ni	nickel	737	1.9	1726	3005	8.902	124
29	Cu	copper	745	1.9	1357	2840	8.960	128
30	Zn	zinc	906	1.7	693	1180	7.133	138
31	Ga	gallium	579	1.8	303	2676	5.907	141
32	Ge	germanium	762	2.0	1211	3103	5.323	137
33	As	arsenic	944	2.2	1090	889	5.780	139
34	Se	selenium	941	2.6	490	958	4.790	140
35	Br	bromine	1140	3.0	266	332	3.122	112
36	Kr	krypton	1351	—	117	121	0.00375	103
37	Rb	rubidium	403	0.8	312	961	1.532	248
38	Sr	strontium	549	1.0	1042	1657	2.540	215
39	Y	yttrium	600	1.2	1795	3611	4.469	178
40	Zr	zirconium	640	1.3	2125	4650	6.506	160

Atomic Number	Symbol	Name	Ionization Energy (kJ/mol)	Electro-negativity	Melting Point (K)	Boiling Point (K)	Density** (g/cm^3)	Atomic Radius (pm)
41	Nb	niobium	652	1.6	2741	5015	8.570	146
42	Mo	molybdenum	684	2.2	2890	4885	10.220	139
43	Tc	technetium	702	1.9	2445	5150	11.500	136
44	Ru	ruthenium	710	2.2	2583	4173	12.370	134
45	Rh	rhodium	720	2.3	2239	4000	12.410	134
46	Pd	palladium	804	2.2	1825	3413	12.020	137
47	Ag	silver	731	1.9	1235	2485	10.500	144
48	Cd	cadmium	868	1.7	594	1038	8.650	171
49	In	indium	558	1.8	429	2353	7.310	166
50	Sn	tin	709	2.0	505	2543	7.310	162
51	Sb	antimony	831	2.1	904	1908	6.691	159
52	Te	tellurium	869	2.1	723	1263	6.240	142
53	I	iodine	1008	2.7	387	458	4.930	132
54	Xe	xenon	1170	2.6	161	166	0.0059	124
55	Cs	cesium	376	0.8	302	952	1.873	267
56	Ba	barium	503	0.9	1002	1910	3.594	222
57	La	lanthanum	538	1.1	1194	3730	6.145	138
Elements 58–71 have been omitted.								
72	Hf	hafnium	659	1.3	2503	5470	13.310	167
73	Ta	tantalum	728	1.5	3269	5698	16.654	149
74	W	tungsten	759	2.4	3680	5930	19.300	141
75	Re	rhenium	756	1.9	3453	5900	21.020	137
76	Os	osmium	814	2.2	3327	5300	22.590	135
77	Ir	iridium	865	2.2	2683	4403	22.560	136
78	Pt	platinum	864	2.3	2045	4100	21.450	139
79	Au	gold	890	2.5	1338	3080	19.320	146
80	Hg	mercury	1007	2.0	234	630	13.546	160
81	Tl	thallium	589	2.0	577	1730	11.850	171
82	Pb	lead	716	2.3	601	2013	11.350	175
83	Bi	bismuth	703	2.0	545	1833	9.747	170
84	Po	polonium	812	2.0	527	1235	9.320	167
85	At	astatine	—	2.2	575	610	—	145
86	Rn	radon	1037	—	202	211	0.00973	134
87	Fr	francium	393	0.7	300	950	—	270
88	Ra	radium	—	0.9	973	1413	5.000	233
89	Ac	actinium	499	1.1	1320	3470	10.060	—
Elements 90 and above have been omitted.								

*Boiling point at standard pressure

**Density at STP

Table T
Important Formulas and Equations

Density	$d = \frac{m}{V}$	d = density m = mass V = volume
Mole Calculations	number of moles = $\frac{\text{given mass (g)}}{\text{gram-formula mass}}$	
Percent Error	% error = $\frac{\text{measured value} - \text{accepted value}}{\text{accepted value}} \times 100$	
Percent Composition	% composition by mass = $\frac{\text{mass of part}}{\text{mass of whole}} \times 100$	
Concentration	parts per million = $\frac{\text{grams of solute}}{\text{grams of solution}} \times 1\,000\,000$	
	molarity = $\frac{\text{moles of solute}}{\text{liters of solution}}$	
Combined Gas Law	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	P = pressure V = volume T = temperature (K)
Titration	$M_AV_A = M_BV_B$	M_A = molarity of H^+ M_B = molarity of OH^- V_A = volume of acid V_B = volume of base
Heat	$q = mC\Delta T$ $q = mH_f$ $q = mH_v$	q = heat H_f = heat of fusion m = mass H_v = heat of vaporization C = specific heat capacity ΔT = change in temperature
Temperature	K = °C + 273	K = kelvin °C = degrees Celsius
Radioactive Decay	fraction remaining = $\left(\frac{1}{2}\right)^{\frac{t}{T}}$ number of half-life periods = $\frac{t}{T}$	t = total time elapsed T = half-life

DET (7–01-450,000)
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Appendix I

Examination Blueprint

Content	Approximate Weight (%)
Standard 1 (Analysis, Inquiry, and Design) Mathematical Analysis Scientific Inquiry Engineering Design	15–20
Standard 2 Information Systems	0–5
Standard 6 (Interconnectedness: Common Themes) Systems Thinking Models Magnitude and Scale Equilibrium and Stability Patterns of Change Optimization	5–10
Standard 7 (Interdisciplinary Problem Solving) Connections Strategies	5–10
Standard 4	
Key Idea 3	40–45
Key Idea 4	5–10
Key Idea 5	5–10

Appendix II

Mapping the Sampler to the Standards in the Core Curriculum

Standards	Test Sampler Draft Question Numbers		
	Part A	**Part B**	**Part C**
Standard 1—Analysis, Inquiry, and Design			
Mathematical Analysis			
Key Idea 1		45	57a
Key Idea 2		39, 43	
Key Idea 3		37, 38, 44, 51b	
Scientific Inquiry			
Key Idea 1		40, 54d, 58b, 58c	
Key Idea 2			59
Key Idea 3		39, 41, 47	
Engineering Design			
Standard 2—Information Systems			
Key Idea 1			
Key Idea 2			
Key Idea 3			
Standard 6—Interconnectedness: Common Themes			
Key Idea 1			
Key Idea 2			
Key Idea 3			
Key Idea 4			57e
Key Idea 5			
Key Idea 6			
Standard 7—Interdisciplinary Problem Solving			
Mathematical Analysis			
Key Idea 1			
Key Idea 2			
Standard 4			
Key Idea 3	1, 2, 3, 4, 5, 6, 8, 7, 8, 9, 10, 11, 13, 16, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35	36, 37, 39, 40, 41, 42, 43, 44, 45, 46, 47, 49, 50, 51, 53, 54	56a, 57, 58, 59, 60
Key Idea 4	19, 34	38, 48, 55	56b
Key Idea 5	12, 13, 14, 15, 17	41, 52	
Chemistry Reference Tables (2002 edition)	2, 3, 6, 8, 11, 12, 13, 18, 23, 25, 27, 28, 29, 31, 32, 33	36, 38, 40, 43, 44, 45, 46, 47, 48, 51, 52	57a, 58a, 60a, 60c, 60d

Appendix III

Mapping the Standards in the Core Curriculum to the Sampler
(Part A—Multiple Choice #1-35)

Sampler Question Number	Content Standard 4 (Appendix A)	Content Major Understanding	Reference Tables/ Periodic Table of the Elements
1	I. 9	3.1j	
2	I. 11	3.1l	PTE
3	II. 8 II. 9	3.1aa 3.1bb	S
4	II. 2	3.1g	
5	II. 2	3.1g	
6	II. 4	3.1w	PTE
7	II. 2	3.1g	
8	II. 3	3.1v	PTE
9	III. 5	3.3c	
10	III. 4	3.3a	
11	III. 1	3.1cc	PTE
12	IV. 2	5.2g	PTE, S
13	II. 2 IV. 6	3.1g 5.2c	PTE
14	IV. 12	5.2k	
15	IV. 5	5.2l	
16	V. 4	3.1u	
17	V. 23 V. 24	5.2m 5.2n	
18	V. 22	3.1jj	H
19	V. 13	4.2b	
20	VI. 5	3.4j	
21	VI. 3	3.4h	
22	VI. 5	3.4j	
23	VII. 2	3.1gg	Q
24	VII. 4	3.1ii	
25	VII. 3	3.1hh	R
26	VIII. 1	3.2d	
27	VIII. 7	3.2i	PTE
28	VIII. 5	3.2h	E
29	IX. 3	3.1vv	K
30	IX. 8 IX. 9	3.1ss 3.1tt	
31	IX. 4	3.1ww	E
32	X. 4	3.1p	O
33	X. 1	3.1o	N
34	X. 5	4.4b	
35	V. 15	3.4b	

Appendix IV

Mapping the Standards in the Core Curriculum to the Sampler
(Part B—Multiple Choice #36-50)

	Key to the Core				
Sampler Question Number	Content Standard 4 (Appendix A)	Content Major Understanding	ReferenceTable/ Periodic Table of the Elements	Skill Standard Number	Skill Key Idea
36	V. 17	3.4c	A,T	4	3.4*ii*
37	III. 5	3.3c		4 1	3.3*iv* M3.1
38	X. 2	4.4a	N	4 1	4.4*i* M3.1
39	V. 17	3.4c		1 1	M2.1 S3.1
40	III. 8	3.2b	F	1	S1.2
41	IV. 9 VII. 6	5.2n 3.2c		4 4 1	3.1*xix* 5.2*ii* S3.1
42	V. 9	3.1pp		4	3.1*xxx*
43	V. 8	3.1oo	G	4 1	3.1*xxv* M2.1
44	IX. 6	3.1zz	T	4 1	3.1*xxxv* M3.1
45	II. 4	3.1w	T	1	M1.1
46	VII. 6	3.2c	R	4	3.2*iii*
47	III. 7	3.3f	T	1	S3.1
48	VI. 6	4.1c	I	4 4	4.1*i* 4.1*ii*
49	VI. 9	3.1ll		4	3.1*xxiii*
50	V. 7	3.1nn		4	3.1*xxiv*

Appendix V

Mapping the Standards in the Core Curriculum to the Sampler
(Part B—Constructed Response #51-55)

	Key to the Core				
Sampler Question Number	Content Standard 4 (Appendix A)	Content Major Understanding	ReferenceTable/ Periodic Table of the Elements	Skill Standard Number	Skill Key Idea
51a	III. 6	3.3e	PTE, T	4	3.3*viii*
51b	III. 6	3.3e	PTE, T	4 1	3.3*ix* M3.1
52a,b	IV. 10	5.2d	PTE	4	3.1*viii*
52c	IV. 10	5.2d	PTE	4	5.2*i*
53	III. 8 VI. 9	3.2b 3.1ll		4 4	3.2*ii* 3.1*xxiii*
54a,b,c	V. 22	3.1jj		4	3.1*xxii*
54d	V. 22	3.1jj		1	S1.1
55a,b,c	V. 19	4.2c		4	4.2*iii*
55c	V. 19	4.2c		4	4.2*ii*

Appendix VI

Mapping the Standards in the Core Curriculum to the Sampler
Part C—Constructed Response #56-60)

	Key to the Core				
Sampler Question Number	Content Standard 4 (Appendix A)	Content Major Understanding	ReferenceTable/ Periodic Table of the Elements	Skill Standard Number	Skill Key Idea
56a	III. 5	3.3c		4	3.2*v*
56b	VI. 7	4.1d		4	4.1*i*
57a	V. 8	3.1oo	G	1	M1.1
57b,c	V. 8	3.1oo		1	M1.1
57d	V. 8	3.1oo		1	M2.1
57e	V. 8	3.1oo		6	KI4.1
58a	I. 5 II. 2	3.1e 3.2g	PTE, S	4 4	3.1*iii* 3.1*iv*
58b,c	Introduction to KI 3 in ST 4			4 1	3.1*i* S1.3
59	VI. 2	3.4f		1	S2.1
60a,c	VII. 3	3.1hh	R	4	3.1*xx*
60b,d	VII. 3	3.1hh	R	4	3.1*xvii*
60e	VII. 3	3.1hh		7	KI1.2
60f	V. 8	3.1oo		4	3.1*xxvi*

New York State Education Department, Room 674 EBA, Albany, NY 12234

Physical Setting/Chemistry Regents Examination Test Sampler Draft Fall 2001 Comment Sheet

Please circle "Yes" or "No" and share your comments for each question below.

1. **Content**—Are the questions generally appropriate in content? YES NO
   Comments:

2. **Difficulty**—Are the questions generally appropriate in difficulty? YES NO
   Comments:

3. **Directions**—Are the directions clear and easy for students to follow? YES NO
   Comments:

4. **Scoring Materials**—Are the scoring materials for Parts B and C clear and easy for teachers to follow? YES NO
   Comments:

5. **Time**—Would most of the students be able to complete this test within the time allotted (3 hours)? YES NO
   Comments:

6. **Additional Comments:**

Please fax this sheet to (518) 473-0858 or mail it to the New York State Education Department at the above address.