BRITISH COLUMBIA
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Chemistry 12

Examination Booklet
2008/09 Released Exam
June 2009

Form A

DO NOT OPEN ANY EXAMINATION MATERIALS UNTIL INSTRUCTED TO DO SO.

FOR FURTHER INSTRUCTIONS REFER TO THE RESPONSE BOOKLET.

Contents: 18 pages
50 multiple-choice questions

Examination: 2 hours
Additional Time Permitted: 60 minutes

PART A: MULTIPLE CHOICE
Value: 62.5% of the examination

Suggested Time: 80 minutes

INSTRUCTIONS: For each question, select the **best** answer and record your choice on the **Answer Sheet** provided. Using an HB pencil, completely fill in the bubble that has the letter corresponding to your answer.

You have **Examination Booklet Form A**. In the box above #1 on your **Answer Sheet**, fill in the bubble as follows.

Exam Booklet Form/ Cahier d'examen	A	B	C	D	E	F	G	H
	●	○	○	○	○	○	○	○

1. Which of the following would have the highest reaction rate at room temperature?

   A. $H_2(g) + I_2(g) \rightarrow 2HI(g)$

   B. $H_2S(g) + Cl_2(aq) \rightarrow 2HCl(aq) + S(s)$

   C. $Ca^{2+}(aq) + C_2O_4^{2-}(aq) \rightarrow CaC_2O_4(s)$

   D. $Mg(s) + 2H_2O(\ell) \rightarrow Mg(OH)_2(aq) + H_2(g)$

2. Consider the following experimental results:

	Experiment 1	Experiment 2
Reactants	powdered Cu and HCl	chunk of Cu and HNO_3
Temperature	20° C	10° C
Concentration of acid	0.6 M HCl	0.4 M HNO_3
Rate	low	high

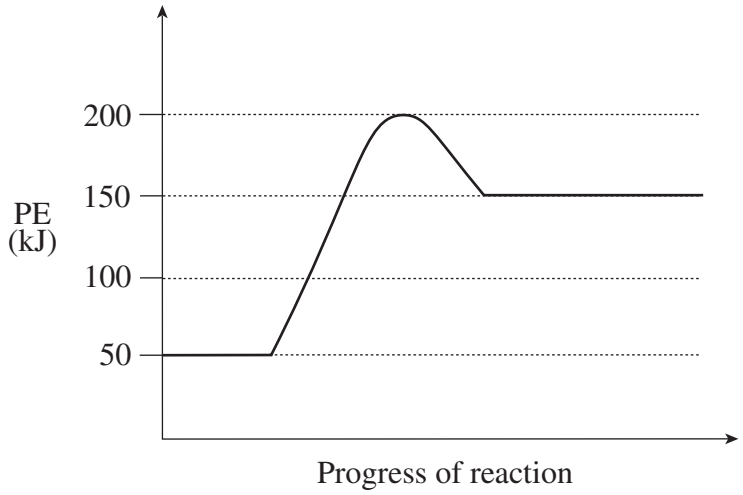
Which of the following factors would account for the lower rate in Experiment 1?

A. temperature
B. nature of reactants
C. surface area of Cu
D. concentration of acid

3 Which of the following describes “activation energy”?

A. the amount of energy that product molecules possess
B. the difference between the products PE and the reactants PE
C. the amount of energy released when reactant molecules collide
D. the minimum amount of energy required to start a chemical reaction

4. Consider the following PE diagram:



Which of the following is correct for the reverse reaction?

	PE (activated complex) (kJ)	ΔH (kJ)
A.	50	−100
B.	50	+100
C.	200	−100
D.	200	+100

5. Consider the following reaction mechanism:

Step 1:	$ClO^- + H_2O \rightarrow HClO + OH^-$
Step 2:	$I^- + HClO \rightarrow HIO + Cl^-$
Step 3:	$HIO + OH^- \rightarrow IO^- + H_2O$

Which of the following is correct?

	Reactant for the Overall Reaction	Reaction Intermediate
A.	I^-	OH^-
B.	ClO^-	H_2O
C.	H_2O	$HClO$
D.	$HClO$	HIO

6. Which of the following is correct for all systems at equilibrium?

I	The temperature is constant.
II	[Reactants] = [Products]
III	Forward and reverse reactions are occurring.
IV	The forward and reverse reaction rates are equal.

A. I and II only
B. I, III and IV only
C. II, III and IV only
D. III and IV only

7. In which of the following does entropy increase?

   A. the electrolysis of $Na_2SO_4(aq)$
   B. the reaction of $NaCl(aq)$ with $AgNO_3(aq)$
   C. the redox reaction of an Fe nail in $CuCl_2(aq)$
   D. the neutralization of $Sr(OH)_2(aq)$ by $H_2SO_4(aq)$

8. Considering enthalpy and entropy factors, in which of the following will equilibrium be established?

I	$Cl_2(g) \overset{?}{\rightleftarrows} Cl_2(aq)$	$\Delta H = -25\,kJ$
II	$CO(g) + 2H_2(g) \overset{?}{\rightleftarrows} CH_3OH(g)$	$\Delta H = -91\,kJ$
III	$Mg(s) + 2HCl(aq) \overset{?}{\rightleftarrows} MgCl_2(aq) + H_2(g)$	$\Delta H = -425\,kJ$
IV	$3CO_2(g) + 4H_2O(g) \overset{?}{\rightleftarrows} C_3H_8(g) + 5O_2(g)$	$\Delta H = +2200\,kJ$

   A. I and II only
   B. II and IV only
   C. III and IV only
   D. I, II and III only

Use the following equilibrium to answer questions 9 and 10.

$$2NO(g) \rightleftarrows N_2(g) + O_2(g) \qquad \Delta H = +181kJ$$

9. Which of the following pairs of stresses cause the same shift to the above equilibrium?

   A. adding a catalyst and decreasing volume
   B. increasing pressure and increasing $[NO]$
   C. decreasing $[N_2]$ and decreasing temperature
   D. decreasing temperature and increasing volume

10. If some O_2 is injected into the above equilibrium system, which of the following is correct?

	Equilibrium Shift	Net Change $[O_2]$
A.	left	increase
B.	left	decrease
C.	right	increase
D.	right	decrease

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11. Consider the following:

$$SO_3(g) + 6HF(g) \rightleftarrows SF_6(g) + 3H_2O(g) \qquad K_{eq} = 6.3 \times 10^{-3}$$

Which of the following is the value of K_{eq} for:

$$2SF_6(g) + 6H_2O(g) \rightleftarrows 12HF(g) + 2SO_3(g)$$

A. 1.3×10^{1}
B. 1.6×10^{2}
C. 3.2×10^{2}
D. 2.5×10^{4}

12. Consider the following:

I	$C_2H_4(g) + H_2(g) \rightleftarrows C_2H_6(g)$	$K_{eq} = 1.2 \times 10^{19}$
II	$2HBr(g) \rightleftarrows H_2(g) + Br_2(g)$	$K_{eq} = 7.0 \times 10^{-20}$
III	$Si(s) + O_2(g) \rightleftarrows SiO_2(s)$	$K_{eq} = 2.0 \times 10^{142}$

Which of the following lists these equilibria from the one that most favours products to the one that least favours products?

A. I, II, III
B. I, III, II
C. II, III, I
D. III, I, II

13. Consider the following equilibrium system:

$$Ni(s) + 4CO(g) \rightleftarrows Ni(CO)_4(g) \qquad \Delta H = -603\,kJ$$

Which of the following statements is correct?

A. Increasing $[CO]$ will increase K_{eq}.
B. Increasing temperature will increase K_{eq}.
C. Increasing temperature will decrease K_{eq}.
D. Decreasing $[Ni(CO)_4]$ will decrease K_{eq}.

14. Consider the equilibrium:

$$N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g) \qquad K_{eq} = 64$$

A 1.0 L container is filled with 0.28 mol N_2, 0.16 mol H_2 and 0.54 mol NH_3.
In which direction will the reaction proceed and what will happen to the pressure of the system?

	Direction	Pressure
A.	left	decreases
B.	left	increases
C.	right	decreases
D.	right	increases

15. Which of the following will form a saturated solution?

A. 0.10 mol $CaSO_4$ added to 1.0 L of water
B. 0.10 mol Cs_2SO_4 added to 1.0 L of water
C. 0.20 mol $MgSO_4$ added to 2.0 L of water
D. 0.50 mol $Pb(NO_3)_2$ added to 2.0 L of water

16. Which of the following would be an appropriate measure of solubility?

A. moles of solute per volume of solute
B. mass of solute per volume of solution
C. volume of solvent per mass of solvent
D. moles of solute at a specific temperature

17. What is the complete ionic equation for the precipitation reaction between $MgS(aq)$ and $Sr(OH)_2(aq)$?

A. $Mg^{2+}(aq) + 2OH^-(aq) \rightarrow Mg(OH)_2(s)$

B. $MgS(aq) + Sr(OH)_2(aq) \rightarrow SrS(aq) + Mg(OH)_2(s)$

C. $Mg^{2+}(aq) + S^{2-}(aq) + Sr^{2+}(aq) + 2OH^-(aq) \rightarrow Mg^{2+}(aq) + 2OH^-(aq) + SrS(s)$

D. $Mg^{2+}(aq) + S^{2-}(aq) + Sr^{2+}(aq) + 2OH^-(aq) \rightarrow Sr^{2+}(aq) + S^{2-}(aq) + Mg(OH)_2(s)$

18. What is the K_{sp} expression for the low solubility salt formed when $K_2SO_3(aq)$ and $AlCl_3(aq)$ are mixed?

A. $K_{sp} = [SO_3^{2-}]$

B. $K_{sp} = [K^+][Cl^-]$

C. $K_{sp} = [Al^{3+}]^2[SO_3^{2-}]^3$

D. $K_{sp} = [Al^{3+}]^3[SO_3^{2-}]^2$

19. Which compound has the lowest solubility?

A. ZnS

B. CuS

C. AgCl

D. $SrSO_4$

20. What is the solubility of the salt $PbCl_2$?

A. 1.4×10^{-2} M

B. 2.4×10^{-3} M

C. 3.5×10^{-3} M

D. 1.2×10^{-5} M

21. A solution is found to contain a $[Pb^{2+}]$ of 0.10M. What is the maximum $[SO_4^{2-}]$ that can exist in this solution before a precipitate forms?

A. $[SO_4^{2-}] = 1.8 \times 10^{-9}$ M

B. $[SO_4^{2-}] = 1.8 \times 10^{-8}$ M

C. $[SO_4^{2-}] = 1.8 \times 10^{-7}$ M

D. $[SO_4^{2-}] = 1.3 \times 10^{-4}$ M

22. Which of the following represents the results of tests using an acidic solution?

	Reaction with Mg(s)	Colour in Phenol Red
A.	yes	yellow
B.	yes	red
C.	no	yellow
D.	no	red

23. Identify the reactant acid and its conjugate base in the equilibrium below.

$$Al(H_2O)_6^{3+} + HS^- \rightleftarrows H_2S + Al(H_2O)_5(OH)^{2+}$$

	Reactant Acid	Conjugate Base
A.	HS^-	H_2S
B.	H_2S	$Al(H_2O)_6^{3+}$
C.	$Al(H_2O)_6^{3+}$	HS^-
D.	$Al(H_2O)_6^{3+}$	$Al(H_2O)_5(OH)^{2+}$

24. Which of the following is the weakest acid?

A. 0.10 M CH_3COOH

B. 0.50 M $HClO_4$

C. 1.0 M HIO_3

D. 1.5 M HCN

25. Which of the following is the correct sequence of relative acid strengths?

A. $HO_2^- > HCO_3^- > H_2O_2 > H_2CO_3$

B. $H_2CO_3 > HCO_3^- > H_2O_2 > HO_2^-$

C. $H_2CO_3 > H_2O_2 > HCO_3^- > HO_2^-$

D. $HCO_3^- > H_2O_2 > H_2CO_3 > HO_2^-$

26. Water reacts most completely as an acid with which of the following?

A. HO_2^-

B. CO_3^{2-}

C. $C_2O_4^{2-}$

D. HPO_4^{2-}

27. Which of the following equations represents the ionization of water?

A. $H_2O(\ell) \rightleftarrows H_2(aq) + \frac{1}{2}O_2(aq)$

B. $2H_2O(\ell) \rightleftarrows H_3O^+(aq) + O^{2-}(aq)$

C. $H_2O(\ell) + H_2O(\ell) \rightleftarrows H^+(aq) + OH^-(aq)$

D. $H_2O(\ell) + H_2O(\ell) \rightleftarrows H_3O^+(aq) + OH^-(aq)$

28. The ionization of water is endothermic. Which of the following is a suitable value of K_w if the temperature of water is lower than $25°C$?

A. 6.8×10^{-15}

B. 2.0×10^{-14}

C. 1.0×10^{-14}

D. 1.6×10^{-13}

29. What is the pOH of $0.30\,\text{M}$ HI ?

A. 3.3×10^{-14}
B. -0.52
C. 0.52
D. 13.48

30. What is the equilibrium constant expression for the predominant equilibrium in $HCO_3^-(aq)$?

A. $\dfrac{\left[H_2CO_3\right]\left[OH^-\right]}{\left[HCO_3^-\right]}$

B. $\dfrac{\left[H_3O^+\right]\left[CO_3^{2-}\right]}{\left[HCO_3^-\right]}$

C. $HCO_3^-(aq) + H_2O(\ell) \rightleftarrows H_2CO_3(aq) + OH^-(aq)$

D. $HCO_3^-(aq) + H_2O(\ell) \rightleftarrows H_3O^+(aq) + CO_3^{2-}(aq)$

31. Which of the following $0.10\,\text{M}$ solutions would have the lowest pH?

A. HF
B. NH_3
C. HNO_3
D. H_2CO_3

32. Which of the following describes the predominant hydrolysis reaction that occurs in $Na_2HPO_4(aq)$?

A. $Na_2HPO_4(aq) \rightleftarrows 2Na^+(aq) + HPO_4^{2-}(aq)$

B. $PO_4^{3-}(aq) + H_2O(\ell) \rightleftarrows HPO_4^{2-}(aq) + OH^-(aq)$

C. $HPO_4^{2-}(aq) + H_2O(\ell) \rightleftarrows H_3O^+(aq) + PO_4^{3-}(aq)$

D. $HPO_4^{2-}(aq) + H_2O(\ell) \rightleftarrows H_2PO_4^-(aq) + OH^-(aq)$

33. Which of the following represents a basic salt solution?

A. $NaI(aq)$

B. $NH_4Cl(aq)$

C. $Na_2CO_3(aq)$

D. $NaHSO_4(aq)$

34. The term "equivalence point" typically applies to

A. buffer solutions.
B. titration reactions.
C. saturated solutions.
D. chemical indicators.

35. A solution is tested with two indicators and the following results are obtained:

Indicator	Colour
chlorophenol red	red
phenolphthalein	colourless

What is the approximate pH of the solution?

A. 4.0
B. 6.0
C. 7.0
D. 10.0

36. What is the net ionic equation for the reaction of hydrochloric acid with $NaOH(aq)$?

A. $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$

B. $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(\ell)$

C. $HCl(aq) + NaOH(aq) + H_2O(\ell) \rightarrow NaCl(aq) + H_3O^+(aq) + OH^-(aq)$

D. $H^+(aq) + Cl^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow Na^+(aq) + Cl^-(aq) + H_2O(\ell)$

37. Consider the following buffer equilibrium system:

$$HCN(aq) + H_2O(\ell) \rightleftarrows H_3O^+(aq) + CN^-(aq)$$

What is the net result of adding a small amount of KOH?

A. The pH increases slightly.
B. The pH decreases slightly.
C. The $[HCN]$ increases slightly.
D. The $[CN^-]$ decreases slightly.

38. An oxide of which of the following elements will form a basic solution?

A. P
B. N
C. K
D. C

39. A reducing agent in a chemical reaction can best be described as a substance that

A. loses electrons and has a decrease in oxidation number.
B. gains electrons and has a decrease in oxidation number.
C. loses electrons and has an increase in oxidation number.
D. gains electrons and has an increase in oxidation number.

40. What happens to the oxidation number of O as MgO_2 undergoes a reaction in which H_2O_2 is formed?

A. It decreases by 1.
B. It increases by 1.
C. It increases by 2.
D. It does not change.

41. Consider the following redox equation:

$$K_2Cr_2O_7 + 7H_2SO_4 + 6KBr \rightarrow 3Br_2 + 4K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O$$

Which chemical species is oxidized?

A. Br in KBr
B. S in H_2SO_4
C. H in H_2SO_4
D. Cr in $K_2Cr_2O_7$

42. Consider the following spontaneous redox reactions:

$$X^- + Y \rightarrow X + Y^-$$

$$Y^- + Z \rightarrow Y + Z^-$$

Which of the following describes the relative strengths of the reducing agents?

A. $X > Y > Z$

B. $Z > Y > X$

C. $X^- > Y^- > Z^-$

D. $Z^- > Y^- > X^-$

43. The following half-reaction can be balanced in acidic solution:

$$N_2O_5 \rightarrow NH_4^+$$

Which of the following appear in the balanced equation?

A. $13e^-$

B. $14e^-$

C. $16e^-$

D. $18e^-$

44. Consider the following redox reaction:

$$2MnO_4^- + 16H^+ + 10\,I^- \rightarrow 2Mn^{2+} + 8H_2O + 5\,I_2$$

A $10.0\,mL$ sample of an iodide solution is titrated with $15.7\,mL$ of acidified $0.0106\,M$ MnO_4^-. What is the $[I^-]$ of the sample?

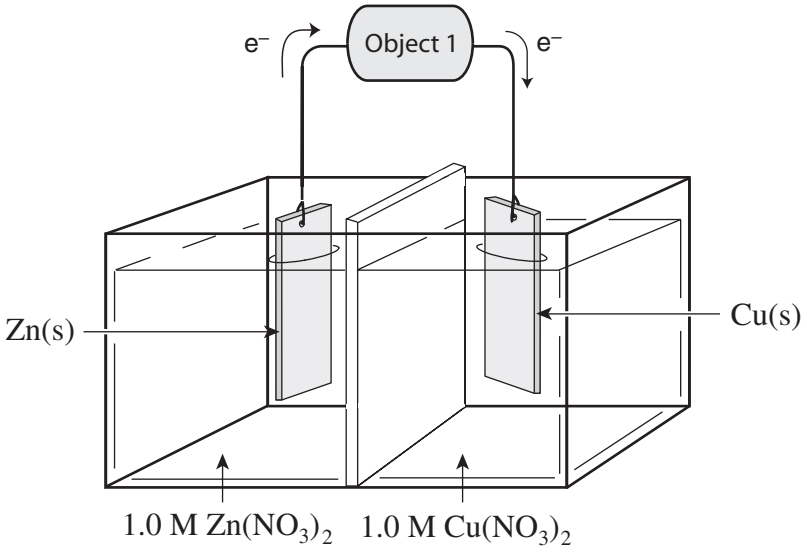
A. $3.33 \times 10^{-3}\,M$

B. $1.66 \times 10^{-2}\,M$

C. $3.24 \times 10^{-2}\,M$

D. $8.32 \times 10^{-2}\,M$

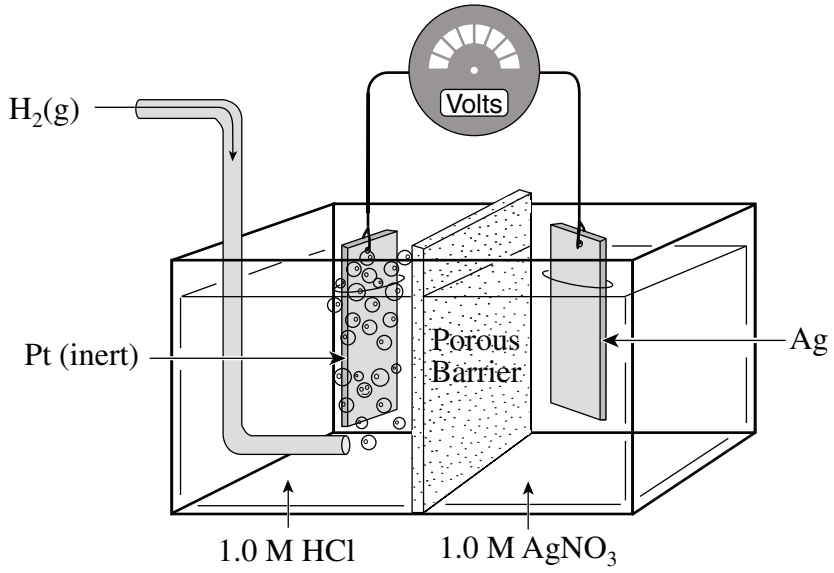
45. Consider the following diagram of a standard electrochemical cell:



Which of the following is correct?

	Object 1	Zn (s)
A.	light bulb	cathode
B.	light bulb	anode
C.	power supply	cathode
D.	power supply	anode

Use the following diagram to answer questions 46, 47 and 48.



46. What is the overall cell reaction?

A. $Ag^+ + H^+ \rightarrow H_2 + Ag$

B. $2Ag + 2H^+ \rightarrow 2Ag^+ + H_2$

C. $2Ag^+ + H_2 \rightarrow 2H^+ + 2Ag$

D. $Ag^+ + H_2 \rightarrow Ag + 2H^+ + e^-$

47. Which of the following is correct as the cell operates?

	Direction of NO_3^- Migration	pH near the Pt Electrode
A.	towards Pt	increases
B.	towards Pt	decreases
C.	towards Ag	increases
D.	towards Ag	decreases

48. Which of the following describes the direction of electron flow and the change in mass of the Ag electrode as the cell operates?

	Direction of Electron Flow	Mass of Ag Electrode
A.	from Pt to Ag	increases
B.	from Pt to Ag	decreases
C.	from Ag to Pt	increases
D.	from Ag to Pt	decreases

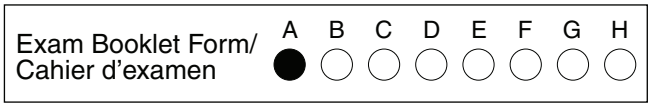
49. An iron pipeline can be protected from rusting by connecting it to a

A. silver electrode buried beside the pipeline.
B. copper electrode buried beside the pipeline.
C. positive terminal of a direct current power supply.
D. negative terminal of a direct current power supply.

50. The electrolysis of molten NaCl is an industrial process. What does the electrolysis produce?

A. Na and Cl_2
B. H_2 and O_2
C. Na^+ and Cl^-
D. NaOH and Cl_2

You have **Examination Booklet Form A**. In the box above #1 on your **Answer Sheet**, ensure you filled in the bubble as follows.



This is the end of the multiple-choice section.
Answer the remaining questions in the Response Booklet.

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** Hydrogen 1.0																	2 **He** Helium 4.0
3 **Li** Lithium 6.9	4 **Be** Beryllium 9.0											5 **B** Boron 10.8	6 **C** Carbon 12.0	7 **N** Nitrogen 14.0	8 **O** Oxygen 16.0	9 **F** Fluorine 19.0	10 **Ne** Neon 20.2
11 **Na** Sodium 23.0	12 **Mg** Magnesium 24.3											13 **Al** Aluminum 27.0	14 **Si** Silicon 28.1	15 **P** Phosphorus 31.0	16 **S** Sulphur 32.1	17 **Cl** Chlorine 35.5	18 **Ar** Argon 39.9
19 **K** Potassium 39.1	20 **Ca** Calcium 40.1	21 **Sc** Scandium 45.0	22 **Ti** Titanium 47.9	23 **V** Vanadium 50.9	24 **Cr** Chromium 52.0	25 **Mn** Manganese 54.9	26 **Fe** Iron 55.8	27 **Co** Cobalt 58.9	28 **Ni** Nickel 58.7	29 **Cu** Copper 63.5	30 **Zn** Zinc 65.4	31 **Ga** Gallium 69.7	32 **Ge** Germanium 72.6	33 **As** Arsenic 74.9	34 **Se** Selenium 79.0	35 **Br** Bromine 79.9	36 **Kr** Krypton 83.8
37 **Rb** Rubidium 85.5	38 **Sr** Strontium 87.6	39 **Y** Yttrium 88.9	40 **Zr** Zirconium 91.2	41 **Nb** Niobium 92.9	42 **Mo** Molybdenum 95.9	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.1	45 **Rh** Rhodium 102.9	46 **Pd** Palladium 106.4	47 **Ag** Silver 107.9	48 **Cd** Cadmium 112.4	49 **In** Indium 114.8	50 **Sn** Tin 118.7	51 **Sb** Antimony 121.8	52 **Te** Tellurium 127.6	53 **I** Iodine 126.9	54 **Xe** Xenon 131.3
55 **Cs** Cesium 132.9	56 **Ba** Barium 137.3	57 **La** Lanthanum 138.9	72 **Hf** Hafnium 178.5	73 **Ta** Tantalum 180.9	74 **W** Tungsten 183.8	75 **Re** Rhenium 186.2	76 **Os** Osmium 190.2	77 **Ir** Iridium 192.2	78 **Pt** Platinum 195.1	79 **Au** Gold 197.0	80 **Hg** Mercury 200.6	81 **Tl** Thallium 204.4	82 **Pb** Lead 207.2	83 **Bi** Bismuth 209.0	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)									

14 — Atomic Number
Si — Symbol
Silicon — Name
28.1 — Atomic Mass

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce Cerium 140.1	**Pr** Praseodymium 140.9	**Nd** Neodymium 144.2	**Pm** Promethium (145)	**Sm** Samarium 150.4	**Eu** Europium 152.0	**Gd** Gadolinium 157.3	**Tb** Terbium 158.9	**Dy** Dysprosium 162.5	**Ho** Holmium 164.9	**Er** Erbium 167.3	**Tm** Thulium 168.9	**Yb** Ytterbium 173.0	**Lu** Lutetium 175.0
90 **Th** Thorium 232.0	91 **Pa** Protactinium 231.0	92 **U** Uranium 238.0	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

Based on mass of C^{12} at 12.00.

Values in parentheses are the masses of the most stable or best known isotopes for elements which do not occur naturally.

ATOMIC MASSES OF THE ELEMENTS

Based on mass of C^{12} at 12.00.
Values in parentheses are the mass number of the most stable or best known isotopes for elements that do not occur naturally.

Element	Symbol	Atomic Number	Atomic Mass
Actinium	Ac	89	(227)
Aluminum	Al	13	27.0
Americium	Am	95	(243)
Antimony	Sb	51	121.8
Argon	Ar	18	39.9
Arsenic	As	33	74.9
Astatine	At	85	(210)
Barium	Ba	56	137.3
Berkelium	Bk	97	(247)
Beryllium	Be	4	9.0
Bismuth	Bi	83	209.0
Boron	B	5	10.8
Bromine	Br	35	79.9
Cadmium	Cd	48	112.4
Calcium	Ca	20	40.1
Californium	Cf	98	(251)
Carbon	C	6	12.0
Cerium	Ce	58	140.1
Cesium	Cs	55	132.9
Chlorine	Cl	17	35.5
Chromium	Cr	24	52.0
Cobalt	Co	27	58.9
Copper	Cu	29	63.5
Curium	Cm	96	(247)
Dubnium	Db	105	(262)
Dysprosium	Dy	66	162.5
Einsteinium	Es	99	(252)
Erbium	Er	68	167.3
Europium	Eu	63	152.0
Fermium	Fm	100	(257)
Fluorine	F	9	19.0
Francium	Fr	87	(223)
Gadolinium	Gd	64	157.3
Gallium	Ga	31	69.7
Germanium	Ge	32	72.6
Gold	Au	79	197.0
Hafnium	Hf	72	178.5
Helium	He	2	4.0
Holmium	Ho	67	164.9
Hydrogen	H	1	1.0
Indium	In	49	114.8
Iodine	I	53	126.9
Iridium	Ir	77	192.2
Iron	Fe	26	55.8
Krypton	Kr	36	83.8
Lanthanum	La	57	138.9
Lawrencium	Lr	103	(262)
Lead	Pb	82	207.2
Lithium	Li	3	6.9
Lutetium	Lu	71	175.0
Magnesium	Mg	12	24.3
Manganese	Mn	25	54.9
Mendelevium	Md	101	(258)
Mercury	Hg	80	200.6
Molybdenum	Mo	42	95.9
Neodymium	Nd	60	144.2
Neon	Ne	10	20.2
Neptunium	Np	93	(237)
Nickel	Ni	28	58.7
Niobium	Nb	41	92.9
Nitrogen	N	7	14.0
Nobelium	No	102	(259)
Osmium	Os	76	190.2
Oxygen	O	8	16.0
Palladium	Pd	46	106.4
Phosphorus	P	15	31.0
Platinum	Pt	78	195.1
Plutonium	Pu	94	(244)
Polonium	Po	84	(209)
Potassium	K	19	39.1
Praseodymium	Pr	59	140.9
Promethium	Pm	61	(145)
Protactinium	Pa	91	231.0
Radium	Ra	88	(226)
Radon	Rn	86	(222)
Rhenium	Re	75	186.2
Rhodium	Rh	45	102.9
Rubidium	Rb	37	85.5
Ruthenium	Ru	44	101.1
Rutherfordium	Rf	104	(261)
Samarium	Sm	62	150.4
Scandium	Sc	21	45.0
Selenium	Se	34	79.0
Silicon	Si	14	28.1
Silver	Ag	47	107.9
Sodium	Na	11	23.0
Strontium	Sr	38	87.6
Sulphur	S	16	32.1
Tantalum	Ta	73	180.9
Technetium	Tc	43	(98)
Tellurium	Te	52	127.6
Terbium	Tb	65	158.9
Thallium	Tl	81	204.4
Thorium	Th	90	232.0
Thulium	Tm	69	168.9
Tin	Sn	50	118.7
Titanium	Ti	22	47.9
Tungsten	W	74	183.8
Uranium	U	92	238.0
Vanadium	V	23	50.9
Xenon	Xe	54	131.3
Ytterbium	Yb	70	173.0
Yttrium	Y	39	88.9
Zinc	Zn	30	65.4
Zirconium	Zr	40	91.2

NAMES, FORMULAE, AND CHARGES OF SOME COMMON IONS

* *Aqueous solutions are readily oxidized by air.*
** *Not stable in aqueous solutions.*

Positive Ions (Cations)

Al^{3+}	Aluminum	Pb^{4+}	Lead(IV), plumbic
NH_4^+	Ammonium	Li^+	Lithium
Ba^{2+}	Barium	Mg^{2+}	Magnesium
Ca^{2+}	Calcium	Mn^{2+}	Manganese(II), manganous
Cr^{2+}	Chromium(II), chromous	Mn^{4+}	Manganese(IV)
Cr^{3+}	Chromium(III), chromic	Hg_2^{2+}	Mercury(I)*, mercurous
Cu^+	Copper(I)*, cuprous	Hg^{2+}	Mercury(II), mercuric
Cu^{2+}	Copper(II), cupric	K^+	Potassium
H^+	Hydrogen	Ag^+	Silver
H_3O^+	Hydronium	Na^+	Sodium
Fe^{2+}	Iron(II)*, ferrous	Sn^{2+}	Tin(II)*, stannous
Fe^{3+}	Iron(III), ferric	Sn^{4+}	Tin(IV), stannic
Pb^{2+}	Lead(II), plumbous	Zn^{2+}	Zinc

Negative Ions (Anions)

Br^-	Bromide	OH^-	Hydroxide
CO_3^{2-}	Carbonate	ClO^-	Hypochlorite
ClO_3^-	Chlorate	I^-	Iodide
Cl^-	Chloride	HPO_4^{2-}	Monohydrogen phosphate
ClO_2^-	Chlorite	NO_3^-	Nitrate
CrO_4^{2-}	Chromate	NO_2^-	Nitrite
CN^-	Cyanide	$C_2O_4^{2-}$	Oxalate
$Cr_2O_7^{2-}$	Dichromate	O^{2-}	Oxide**
$H_2PO_4^-$	Dihydrogen phosphate	ClO_4^-	Perchlorate
CH_3COO^-	Ethanoate, acetate	MnO_4^-	Permanganate
F^-	Fluoride	$PO_4^{?-}$	Phosphate
HCO_3^-	Hydrogen carbonate, bicarbonate	SO_4^{2-}	Sulphate
$HC_2O_4^-$	Hydrogen oxalate, binoxalate	S^{2-}	Sulphide
HSO_4^-	Hydrogen sulphate, bisulphate	SO_3^{2-}	Sulphite
HS^-	Hydrogen sulphide, bisulphide	SCN^-	Thiocyanate
HSO_3^-	Hydrogen sulphite, bisulphite		

SOLUBILITY OF COMMON COMPOUNDS IN WATER

The term soluble here means > 0.1 mol/L at 25°C.

Negative Ions (Anions)	Positive Ions (Cations)	Solubility of Compounds
All	Alkali ions: Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+	Soluble
All	Hydrogen ion: H^+	Soluble
All	Ammonium ion: NH_4^+	Soluble
Nitrate, NO_3^-	All	Soluble
Chloride, Cl^- or Bromide, Br^- or Iodide, I^-	All others	Soluble
	Ag^+, Pb^{2+}, Cu^+	Low Solubility
Sulphate, SO_4^{2-}	All others	Soluble
	Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}	Low Solubility
Sulphide, S^{2-}	Alkali ions, H^+, NH_4^+, Be^{2+}, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}	Soluble
	All others	Low Solubility
Hydroxide, OH^-	Alkali ions, H^+, NH_4^+, Sr^{2+} ?	Soluble
	All others	Low Solubility
Phosphate, PO_4^{3-} or Carbonate, CO_3^{2-} or Sulphite, SO_3^{2-}	Alkali ions, H^+, NH_4^+	Soluble
	All others	Low Solubility

SOLUBILITY PRODUCT CONSTANTS AT 25°C

Name	Formula	K_{sp}
Barium carbonate	$BaCO_3$	2.6×10^{-9}
Barium chromate	$BaCrO_4$	1.2×10^{-10}
Barium sulphate	$BaSO_4$	1.1×10^{-10}
Calcium carbonate	$CaCO_3$	5.0×10^{-9}
Calcium oxalate	CaC_2O_4	2.3×10^{-9}
Calcium sulphate	$CaSO_4$	7.1×10^{-5}
Copper(I) iodide	CuI	1.3×10^{-12}
Copper(II) iodate	$Cu(IO_3)_2$	6.9×10^{-8}
Copper(II) sulphide	CuS	6.0×10^{-37}
Iron(II) hydroxide	$Fe(OH)_2$	4.9×10^{-17}
Iron(II) sulphide	FeS	6.0×10^{-19}
Iron(III) hydroxide	$Fe(OH)_3$	2.6×10^{-39}
Lead(II) bromide	$PbBr_2$	6.6×10^{-6}
Lead(II) chloride	$PbCl_2$	1.2×10^{-5}
Lead(II) iodate	$Pb(IO_3)_2$	3.7×10^{-13}
Lead(II) iodide	PbI_2	8.5×10^{-9}
Lead(II) sulphate	$PbSO_4$	1.8×10^{-8}
Magnesium carbonate	$MgCO_3$	6.8×10^{-6}
Magnesium hydroxide	$Mg(OH)_2$	5.6×10^{-12}
Silver bromate	$AgBrO_3$	5.3×10^{-5}
Silver bromide	$AgBr$	5.4×10^{-13}
Silver carbonate	Ag_2CO_3	8.5×10^{-12}
Silver chloride	$AgCl$	1.8×10^{-10}
Silver chromate	Ag_2CrO_4	1.1×10^{-12}
Silver iodate	$AgIO_3$	3.2×10^{-8}
Silver iodide	AgI	8.5×10^{-17}
Strontium carbonate	$SrCO_3$	5.6×10^{-10}
Strontium fluoride	SrF_2	4.3×10^{-9}
Strontium sulphate	$SrSO_4$	3.4×10^{-7}
Zinc sulphide	ZnS	2.0×10^{-25}

RELATIVE STRENGTHS OF BRØNSTED-LOWRY ACIDS AND BASES

in aqueous solution at room temperature.

Name of Acid	Acid		Base	K_a
Perchloric	$HClO_4$	$\rightarrow$	$H^+ + ClO_4^-$	very large
Hydriodic	HI	$\rightarrow$	$H^+ + I^-$	very large
Hydrobromic	HBr	$\rightarrow$	$H^+ + Br^-$	very large
Hydrochloric	HCl	$\rightarrow$	$H^+ + Cl^-$	very large
Nitric	HNO_3	$\rightarrow$	$H^+ + NO_3^-$	very large
Sulphuric	H_2SO_4	$\rightarrow$	$H^+ + HSO_4^-$	very large
Hydronium Ion	H_3O^+	$\rightleftarrows$	$H^+ + H_2O$	1.0
Iodic	HIO_3	$\rightleftarrows$	$H^+ + IO_3^-$	1.7×10^{-1}
Oxalic	$H_2C_2O_4$	$\rightleftarrows$	$H^+ + HC_2O_4^-$	5.9×10^{-2}
Sulphurous ($SO_2 + H_2O$)	H_2SO_3	$\rightleftarrows$	$H^+ + HSO_3^-$	1.5×10^{-2}
Hydrogen sulphate ion	HSO_4^-	$\rightleftarrows$	$H^+ + SO_4^{2-}$	1.2×10^{-2}
Phosphoric	H_3PO_4	$\rightleftarrows$	$H^+ + H_2PO_4^-$	7.5×10^{-3}
Hexaaquoiron ion, iron(III) ion	$Fe(H_2O)_6^{3+}$	$\rightleftarrows$	$H^+ + Fe(H_2O)_5(OH)^{2+}$	6.0×10^{-3}
Citric	$H_3C_6H_5O_7$	$\rightleftarrows$	$H^+ + H_2C_6H_5O_7^-$	7.1×10^{-4}
Nitrous	HNO_2	$\rightleftarrows$	$H^+ + NO_2^-$	4.6×10^{-4}
Hydrofluoric	HF	$\rightleftarrows$	$H^+ + F^-$	3.5×10^{-4}
Methanoic, formic	$HCOOH$	$\rightleftarrows$	$H^+ + HCOO^-$	1.8×10^{-4}
Hexaaquochromium ion, chromium(III) ion	$Cr(H_2O)_6^{3+}$	$\rightleftarrows$	$H^+ + Cr(H_2O)_5(OH)^{2+}$	1.5×10^{-4}
Benzoic	C_6H_5COOH	$\rightleftarrows$	$H^+ + C_6H_5COO^-$	6.5×10^{-5}
Hydrogen oxalate ion	$HC_2O_4^-$	$\rightleftarrows$	$H^+ + C_2O_4^{2-}$	6.4×10^{-5}
Ethanoic, acetic	CH_3COOH	$\rightleftarrows$	$H^+ + CH_3COO^-$	1.8×10^{-5}
Dihydrogen citrate ion	$H_2C_6H_5O_7^-$	$\rightleftarrows$	$H^+ + HC_6H_5O_7^{2-}$	1.7×10^{-5}
Hexaaquoaluminum ion, aluminum ion	$Al(H_2O)_6^{3+}$	$\rightleftarrows$	$H^+ + Al(H_2O)_5(OH)^{2+}$	1.4×10^{-5}
Carbonic ($CO_2 + H_2O$)	H_2CO_3	$\rightleftarrows$	$H^+ + HCO_3^-$	4.3×10^{-7}
Monohydrogen citrate ion	$HC_6H_5O_7^{2-}$	$\rightleftarrows$	$H^+ + C_6H_5O_7^{3-}$	4.1×10^{-7}
Hydrogen sulphite ion	HSO_3^-	$\rightleftarrows$	$H^+ + SO_3^{2-}$	1.0×10^{-7}
Hydrogen sulphide	H_2S	$\rightleftarrows$	$H^+ + HS^-$	9.1×10^{-8}
Dihydrogen phosphate ion	$H_2PO_4^-$	$\rightleftarrows$	$H^+ + HPO_4^{2-}$	6.2×10^{-8}
Boric	H_3BO_3	$\rightleftarrows$	$H^+ + H_2BO_3^-$	7.3×10^{-10}
Ammonium ion	NH_4^+	$\rightleftarrows$	$H^+ + NH_3$	5.6×10^{-10}
Hydrocyanic	HCN	$\rightleftarrows$	$H^+ + CN^-$	4.9×10^{-10}
Phenol	C_6H_5OH	$\rightleftarrows$	$H^+ + C_6H_5O^-$	1.3×10^{-10}
Hydrogen carbonate ion	HCO_3^-	$\rightleftarrows$	$H^+ + CO_3^{2-}$	5.6×10^{-11}
Hydrogen peroxide	H_2O_2	$\rightleftarrows$	$H^+ + HO_2^-$	2.4×10^{-12}
Monohydrogen phosphate ion	HPO_4^{2-}	$\rightleftarrows$	$H^+ + PO_4^{3-}$	2.2×10^{-13}
Water	H_2O	$\rightleftarrows$	$H^+ + OH^-$	1.0×10^{-14}
Hydroxide ion	OH^-	$\leftarrow$	$H^+ + O^{2-}$	very small
Ammonia	NH_3	$\leftarrow$	$H^+ + NH_2^-$	very small

STRONG — STRENGTH OF ACID — WEAK

WEAK — STRENGTH OF BASE — STRONG

ACID-BASE INDICATORS

Indicator	pH Range in Which Colour Change Occurs	Colour Change as pH Increases
Methyl violet	0.0 – 1.6	yellow to blue
Thymol blue	1.2 – 2.8	red to yellow
Orange IV	1.4 – 2.8	red to yellow
Methyl orange	3.2 – 4.4	red to yellow
Bromcresol green	3.8 – 5.4	yellow to blue
Methyl red	4.8 – 6.0	red to yellow
Chlorophenol red	5.2 – 6.8	yellow to red
Bromthymol blue	6.0 – 7.6	yellow to blue
Phenol red	6.6 – 8.0	yellow to red
Neutral red	6.8 – 8.0	red to amber
Thymol blue	8.0 – 9.6	yellow to blue
Phenolphthalein	8.2 – 10.0	colourless to pink
Thymolphthalein	9.4 – 10.6	colourless to blue
Alizarin yellow	10.1 – 12.0	yellow to red
Indigo carmine	11.4 – 13.0	blue to yellow

STANDARD REDUCTION POTENTIALS OF HALF-CELLS

Ionic concentrations are at 1M in water at 25°C.

Oxidizing Agents		Reducing Agents	E° (Volts)
$F_2(g) + 2e^-$	$\rightleftarrows$	$2F^-$	+2.87
$S_2O_8^{2-} + 2e^-$	$\rightleftarrows$	$2SO_4^{2-}$	+2.01
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftarrows$	$2H_2O$	+1.78
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftarrows$	$Mn^{2+} + 4H_2O$	+1.51
$Au^{3+} + 3e^-$	$\rightleftarrows$	$Au(s)$	+1.50
$BrO_3^- + 6H^+ + 5e^-$	$\rightleftarrows$	$\frac{1}{2}Br_2(\ell) + 3H_2O$	+1.48
$ClO_4^- + 8H^+ + 8e^-$	$\rightleftarrows$	$Cl^- + 4H_2O$	+1.39
$Cl_2(g) + 2e^-$	$\rightleftarrows$	$2Cl^-$	+1.36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftarrows$	$2Cr^{3+} + 7H_2O$	+1.23
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftarrows$	H_2O	+1.23
$MnO_2(s) + 4H^+ + 2e^-$	$\rightleftarrows$	$Mn^{2+} + 2H_2O$	+1.22
$IO_3^- + 6H^+ + 5e^-$	$\rightleftarrows$	$\frac{1}{2}I_2(s) + 3H_2O$	+1.20
$Br_2(\ell) + 2e^-$	$\rightleftarrows$	$2Br^-$	+1.09
$AuCl_4^- + 3e^-$	$\rightleftarrows$	$Au(s) + 4Cl^-$	+1.00
$NO_3^- + 4H^+ + 3e^-$	$\rightleftarrows$	$NO(g) + 2H_2O$	+0.96
$Hg^{2+} + 2e^-$	$\rightleftarrows$	$Hg(\ell)$	+0.85
$\frac{1}{2}O_2(g) + 2H^+(10^{-7}\,M) + 2e^-$	$\rightleftarrows$	H_2O	+0.82
$2NO_3^- + 4H^+ + 2e^-$	$\rightleftarrows$	$N_2O_4 + 2H_2O$	+0.80
$Ag^+ + e^-$	$\rightleftarrows$	$Ag(s)$	+0.80
$\frac{1}{2}Hg_2^{2+} + e^-$	$\rightleftarrows$	$Hg(\ell)$	+0.80
$Fe^{3+} + e^-$	$\rightleftarrows$	Fe^{2+}	+0.77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftarrows$	H_2O_2	+0.70
$MnO_4^- + 2H_2O + 3e^-$	$\rightleftarrows$	$MnO_2(s) + 4OH^-$	+0.60
$I_2(s) + 2e^-$	$\rightleftarrows$	$2I^-$	+0.54
$Cu^+ + e^-$	$\rightleftarrows$	$Cu(s)$	+0.52
$H_2SO_3 + 4H^+ + 4e^-$	$\rightleftarrows$	$S(s) + 3H_2O$	+0.45
$Cu^{2+} + 2e^-$	$\rightleftarrows$	$Cu(s)$	+0.34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftarrows$	$H_2SO_3 + H_2O$	+0.17
$Cu^{2+} + e^-$	$\rightleftarrows$	Cu^+	+0.15
$Sn^{4+} + 2e^-$	$\rightleftarrows$	Sn^{2+}	+0.15
$S(s) + 2H^+ + 2e^-$	$\rightleftarrows$	$H_2S(g)$	+0.14
$2H^+ + 2e^-$	$\rightleftarrows$	$H_2(g)$	+0.00
$Pb^{2+} + 2e^-$	$\rightleftarrows$	$Pb(s)$	−0.13
$Sn^{2+} + 2e^-$	$\rightleftarrows$	$Sn(s)$	−0.14
$Ni^{2+} + 2e^-$	$\rightleftarrows$	$Ni(s)$	−0.26
$H_3PO_4 + 2H^+ + 2e^-$	$\rightleftarrows$	$H_3PO_3 + H_2O$	−0.28
$Co^{2+} + 2e^-$	$\rightleftarrows$	$Co(s)$	−0.28
$Se(s) + 2H^+ + 2e^-$	$\rightleftarrows$	H_2Se	−0.40
$Cr^{3+} + e^-$	$\rightleftarrows$	Cr^{2+}	−0.41
$2H_2O + 2e^-$	$\rightleftarrows$	$H_2 + 2OH^-(10^{-7}\,M)$	−0.41
$Fe^{2+} + 2e^-$	$\rightleftarrows$	$Fe(s)$	−0.45
$Ag_2S(s) + 2e^-$	$\rightleftarrows$	$2Ag(s) + S^{2-}$	−0.69
$Cr^{3+} + 3e^-$	$\rightleftarrows$	$Cr(s)$	−0.74
$Zn^{2+} + 2e^-$	$\rightleftarrows$	$Zn(s)$	−0.76
$Te(s) + 2H^+ + 2e^-$	$\rightleftarrows$	H_2Te	−0.79
$2H_2O + 2e^-$	$\rightleftarrows$	$H_2(g) + 2OH^-$	−0.83
$Mn^{2+} + 2e^-$	$\rightleftarrows$	$Mn(s)$	−1.19
$Al^{3+} + 3e^-$	$\rightleftarrows$	$Al(s)$	−1.66
$Mg^{2+} + 2e^-$	$\rightleftarrows$	$Mg(s)$	−2.37
$Na^+ + e^-$	$\rightleftarrows$	$Na(s)$	−2.71
$Ca^{2+} + 2e^-$	$\rightleftarrows$	$Ca(s)$	−2.87
$Sr^{2+} + 2e^-$	$\rightleftarrows$	$Sr(s)$	−2.89
$Ba^{2+} + 2e^-$	$\rightleftarrows$	$Ba(s)$	−2.91
$K^+ + e^-$	$\rightleftarrows$	$K(s)$	−2.93
$Rb^+ + e^-$	$\rightleftarrows$	$Rb(s)$	−2.98
$Cs^+ + e^-$	$\rightleftarrows$	$Cs(s)$	−3.03
$Li^+ + e^-$	$\rightleftarrows$	$Li(s)$	−3.04

Overpotential Effect

Overpotential Effect

STRONG ↑ STRENGTH OF OXIDIZING AGENT ↓ WEAK

WEAK ↑ STRENGTH OF REDUCING AGENT ↓ STRONG

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Course Code = CH 12
2008/09 Released Exam
JUNE 2009

Exam Booklet Form/ Cahier d'examen A B C D E F G H

Student Instructions

1. Place your Personal Education Number (PEN) label at the top of this Booklet AND fill in the bubble (Form A, B, C, D, E, F, G or H) that corresponds to the letter on your Examination Booklet.
2. Use a pencil to fill in bubbles when answering questions on your Answer Sheet.
3. Use a pencil or blue- or black-ink pen when answering written-response questions in this Booklet.
4. When the examination begins, remove the Data Pages located in the centre of the Examination Booklet.
5. Read the Examination Rules on the back of this Booklet.

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Question 1	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	(.5) ☐	NR ☐
Question 2	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	(.5) ☐	NR ☐
Question 3	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	(.5) ☐	NR ☐
Question 4	0 ☐	1 ☐	2 ☐	3 ☐		(.5) ☐	NR ☐
Question 5	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	(.5) ☐ NR ☐
Question 6	0 ☐	1 ☐	2 ☐	3 ☐		(.5) ☐	NR ☐
Question 7	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	(.5) ☐	NR ☐
Question 8	0 ☐	1 ☐	2 ☐	3 ☐		(.5) ☐	NR ☐

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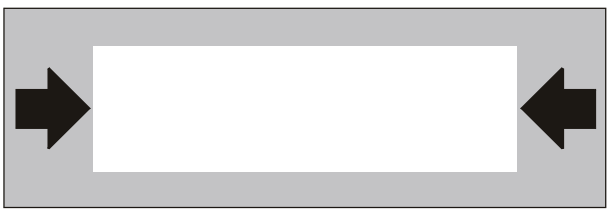

Course Code = CH 12

Chemistry 12

2008/09 Released Exam

JUNE 2009

Response Booklet

Instructions:

Answer the following questions in the space provided in this **Response Booklet**. You are expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner. Your steps and assumptions leading to a solution must be written in this **Response Booklet**. Answers must include units where appropriate and be given to the correct number of significant figures. **For questions involving calculations, full marks will NOT be given for providing only an answer.**

BRITISH COLUMBIA
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PART B: WRITTEN RESPONSE
Value: 37.5% of the examination

Suggested Time: 40 minutes

1. **(4 marks)**

A student burned a paraffin candle ($C_{25}H_{52}$) in an open beaker according to the following equation:

$$C_{25}H_{52}(s) + 38\,O_2(g) \rightarrow 25CO_2(g) + 26H_2O(g)$$

The following data was recorded:

Time (min)	Mass of candle and beaker (g)
0.0	175.00
2.0	173.20

Calculate the rate of paraffin consumption in moles of $C_{25}H_{52}$ per minute (mol $C_{25}H_{52}$/min); then, calculate how long it would take to produce 0.70 g CO_2.

2. **(4 marks)**

Consider the following equilibrium:

$$CO(g) + 3H_2(g) \rightleftarrows CH_4(g) + H_2O(g)$$

Initially, $0.200\,\text{mol}$ CO and $0.600\,\text{mol}$ H_2 are placed in a $2.00\,\text{L}$ container. At equilibrium, $[H_2O] = 0.039\,\text{M}$. Calculate the value of K_{eq}.

3. **(4 marks)**

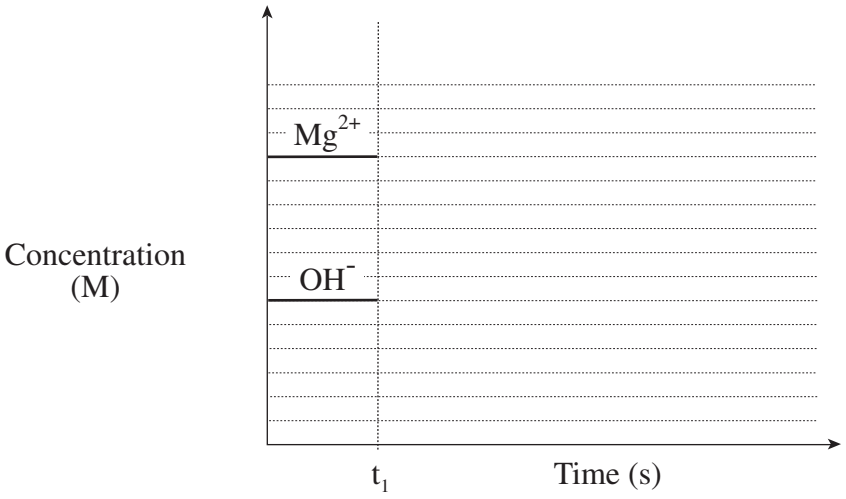
Consider the following equilibrium:

$$Mg(OH)_2(s) \rightleftarrows Mg^{2+}(aq) + 2OH^-(aq)$$

What happens to the amount of solid $Mg(OH)_2$ when some HCl is added? _____

_____

On the graph below, sketch the effect of adding HCl at time t_1.



4. **(3 marks)**

A solution of $Sr(OH)_2(aq)$ is titrated with H_2SO_4.
Explain what will happen to the electrical conductivity during the titration.
Begin by writing the balanced formula equation, including states, to support your answer.

5. **(5 marks)**

Aniline $(C_6H_5NH_2)$ is a weak base with a $K_b = 4.3 \times 10^{-10}$.
Calculate the concentration of an aniline solution that has a $pH = 8.80$.
Begin by writing the equation for the predominant equilibrium.

6. **(3 marks)**

Calculate the $[OH^-]$ that results when $800.0\,mL$ of $0.010\,M$ HCl is mixed with $1.216\,g$ $Sr(OH)_2$. (Assume no volume change on mixing.)

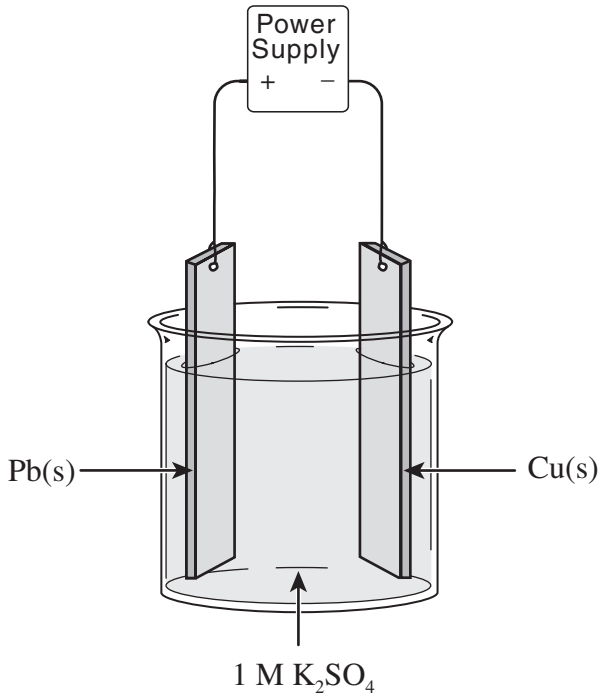
7. **(4 marks)**

Balance the following redox equation in acidic solution:

$$TeO_4^- + In \rightarrow In_2O_3 + Te \qquad \text{(acidic)}$$

8. **(3 marks)**

Consider the following cell diagram:



Write the overall cell reaction.

Write the formula for a precipitate that forms as the cell operates.

Examination Rules

1. The time allotted for this examination is two hours.
   You may, however, take up to 60 minutes of additional time to finish.
2. Answers entered in the Examination Booklet will not be marked.
3. Cheating on an examination will result in a mark of zero. The Ministry of Education considers cheating to have occurred if students break any of the following rules:

   - Students must not be in possession of or have used any secure examination materials prior to the examination session.
   - Students must not communicate with other students during the examination.
   - Students must not give or receive assistance of any kind in answering an examination question during an examination, including allowing one's paper to be viewed by others or copying answers from another student's paper.
   - Students must not possess any book, paper or item that might assist in writing an examination, including a dictionary or piece of electronic equipment, that is not specifically authorized for the examination by ministry policy.
   - Students must not copy, plagiarize or present as one's own, work done by any other person.
   - Students must immediately follow the invigilator's order to stop writing at the end of the examination time and must not alter an Examination Booklet, Response Booklet or Answer Sheet after the invigilator has asked students to hand in examination papers.
   - Students must not remove any piece of the examination materials from the examination room, including work pages.

4. The use of inappropriate language or content may result in a mark of zero being awarded.
5. Upon completion of the examination, return all examination materials to the supervising invigilator.