Student Name: ______________________ Student No: ________________________

Chemistry 1AA3 **Test 1** **January 27, 2012**

McMaster University VERSION **1**

Instructors: P. Berti, J. Landry, P. Lock, H. Stöver

Duration: 100 min.

This test contains 18 numbered pages printed on both sides. There are 24 multiple-choice questions appearing on pages numbered 3 to 15. Page 16 is extra space for rough work. Page 17 includes some useful data and equations. There is a periodic table on page 18. You may tear off the last page to view the periodic table and to do your rough work.

You must enter your name and student number on the question sheets, as well as on the answer sheet. Your invigilator will be checking your student card for identification.

You are responsible for ensuring that your copy of the question paper is complete. Bring any discrepancy to the attention of your invigilator.

All questions are worth 2 marks each; the total marks available are 48. There is no additional penalty for incorrect answers.

BE SURE TO ENTER THE CORRECT VERSION OF YOUR TEST (shown near the top of page 1), IN THE SPACE PROVIDED ON THE ANSWER SHEET.

<u>ANSWER ALL QUESTIONS</u> ON THE ANSWER SHEET, IN PENCIL.
Instructions for entering multiple-choice answers are given on page 2.

SELECT <u>ONE AND ONLY ONE</u> ANSWER FOR EACH QUESTION from the answers (A) through (E). No work written on the question sheets will be marked. The question sheets may be collected and reviewed in cases of suspected academic dishonesty.

Academic dishonesty may include, among other actions, communication of any kind (verbal, visual, etc.) between students, sharing of materials between students, copying or looking at other students' work. If you have a problem, please ask the invigilator to deal with it for you. Do not make contact with other students directly. Keep your eyes on your own paper – looking around the room may be interpreted as an attempt to copy.

Only Casio FX 991 MS electronic calculators may be used; but they must NOT be transferred between students. Use of periodic tables or any aids, other than those provided, is not allowed.

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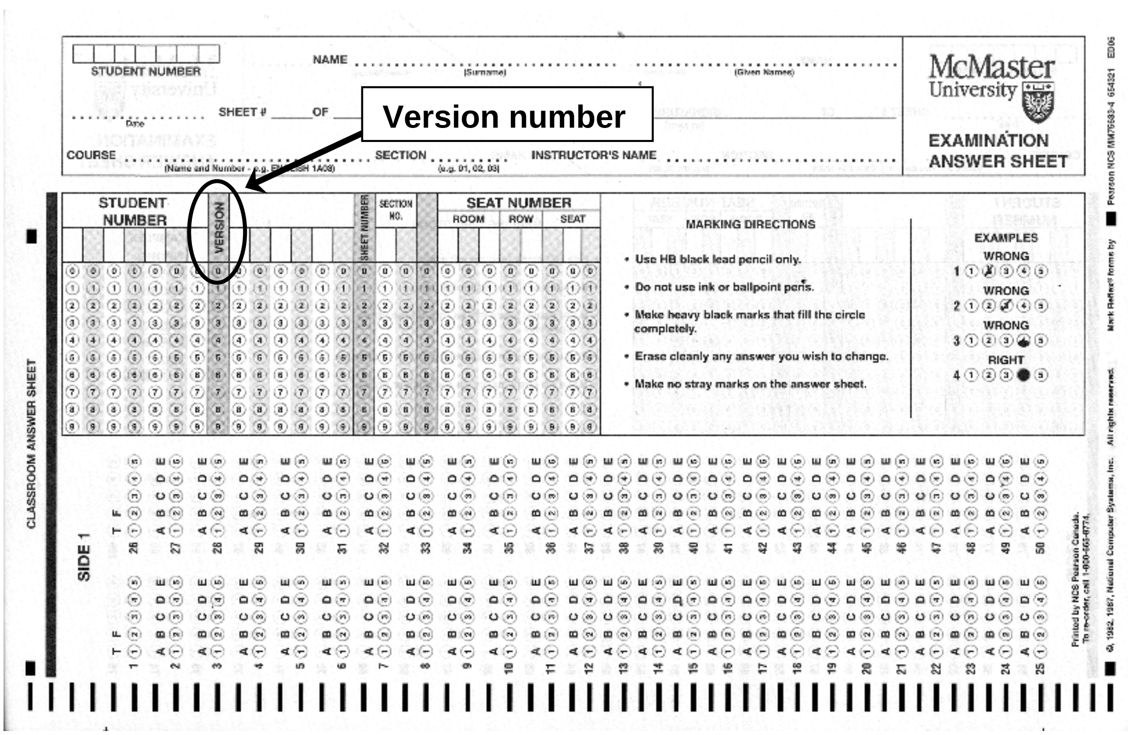
Student Name: ______________________ Student No: ________________________

OMR EXAMINATION – STUDENT INSTRUCTIONS

NOTE: IT IS YOUR RESPONSIBILITY TO ENSURE THAT THE ANSWER SHEET IS PROPERLY COMPLETED: YOUT EXAMINIATION RESULT DEPENDS UPON PROPER ATTENTION TO THESE INSTRUCTIONS.

The scanner, which reads the sheets, senses the bubble shaded areas by their non-reflection of light. A heavy mark must be made, completely filling the circular bubble, with an HB pencil. Marks made with a pen will NOT be sensed. Erasures must be thorough or the scanner will still sense a mark. Do NOT use correction fluid on the sheets. Do NOT put any unnecessary marks or writing on the sheet.

1. On SIDE 1 (red side) of the form, in the top box, in pen, print your student number, name, course name, and the date in the spaces provided. Then you MUST write your signature, in the space marked SIGNATURE.
2. In the second box, with a pencil, mark your student number, exam version number in the space provided and fill in the corresponding bubble numbers underneath.
3. Answers: mark only ONE choice from the alternatives (A,B,C,D,E) provided for each question. The question number is to the left of the bubbles. Make sure that the number of the question on the scan sheet is the same as the number on the test paper.
4. Pay particular attention to the Marking+ Directions on the form.
5. Begin answering the question using the first set of bubbles, marked “1”.



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VERSION **1.**
Enter your version number in the correct column on your scan sheet (see p. 2 for details).

1. The **pH** of a 0.01 M aqueous solution of a strong base is:

   A) 3
   B) 13
   C) 12
   D) 1
   E) 7

2. **Which** of the following combinations of aqueous solutions would give a **buffer**? (All solutions are 1.0 M).

   A) 10 mL $HClO_4$ + 20 mL $KClO_2$
   B) 15 mL $HClO_4$ + 15 mL $KClO_4$
   C) 20 mL $HClO_4$ + 10 mL KOH
   D) 20 mL $HClO_2$ + 10 mL $KClO_4$
   E) 10 mL $HClO_2$ + 20 mL KOH

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3. Which of the following compounds will produce a **basic solution** when placed into water?

   (i) Na_2O (ii) NH_4Cl (iii) LiBr (iv) CH_3COOK (v) CH_3NH_2

   A) iii, v
   B) i, ii
   C) ii, iii, iv
   D) ii, iv
   E) i, iv, v

4. MES is a common buffer in chemical biology. At pH 6.5, the ratio of MES, a weak base, to its conjugate acid, $MESH^+$, is $[MES]/[MESH^+] = 2.19$. What is the **p$\boldsymbol{K_a}$** of $MESH^+$?

   A) 7.17
   B) 7.47
   C) 6.76
   D) 5.65
   E) 6.16

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5. Which of the following statements about buffers is **false**?

A) The percent ionization of the weak acid or weak base in a buffer is negligible (close to zero).
B) Weak acid-strong base titration curves show a buffer region right up until the equivalence point.
C) Buffers resist changes in pH by converting strong base into weak base, or strong acid into weak acid.
D) The buffer capacity for a weak acid (HA) / weak base (A^-) system is at a maximum when [HA] and [A^-] are equal.
E) A buffer's capacity can be exceeded by adding excess amounts of strong acid.

6. What is **[H_3O^+] (in M)** in 1.0 M $CH_3COOH(aq)$?

Data:
$K_a(CH_3COOH) = 1.8 \times 10^{-5}$

A) 1.66×10^{-3}
B) 1.34×10^{-3}
C) 3.22×10^{-3}
D) 4.24×10^{-3}
E) 7.18×10^{-3}

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7. A buffer is made using only Tris (weak base) and TrisHCl (weak acid). **What mass (in g)** of solid TrisHCl would be used to make 0.20 L of a buffer solution with a total buffer concentration ([Tris] + [$TrisH^+$]) of 0.050 M, and pH 7.80?

$$TrisH^+ + H_2O \rightleftharpoons Tris + H_3O^+$$

Data:
$pK_a(TrisH^+) = 8.30$
mol wt(TrisHCl) = 157.6 g/mol
mol wt(Tris) = 121.1 g/mol

A) 10.5
B) 2.80
C) 1.20
D) 1.50
E) 0.80

8. What is the **pH** of the solution that results when the following substances are added to water to create 1.00 L of solution?

0.100 mol HNO_3
0.100 mol HNO_2
0.300 mol $NaNO_2$

Data:
$K_a(HNO_2) = 7.2 \times 10^{-4}$

A) 3.53
B) 4.65
C) 6.04
D) 2.30
E) 3.14

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9. Bromophenol blue is an acid-base indicator with a pK_a of 4.0. The acidic form is yellow and the basic form is blue-violet. A few drops of this indicator are added to the titration of benzoic acid (beaker, $pK_a = 4.20$) with NaOH(aq) (buret). Find the **false** statement(s) about this titration experiment.

(i) The indicator starts to change from yellow to blue-violet at about pH 3 and completes the change from to blue-violet at about pH 5.
(ii) The indicator will be yellow over the entire buffer region of the titration curve.
(iii) The bromophenol blue indicator is not an appropriate choice for locating the equivalence point of this titration.

A) No statements are false
B) i
C) ii
D) iii
E) i, iii

10. Which would be the **best pH indicator** to find the endpoint in a titration of 0.050 M cacodylic acid with 0.100 M LiOH? (Cacodylic acid is a monoprotic acid.)

Data:
K_a(cacodylic acid) = 5.7×10^{-7}

	Indicator	Colour change range (pH)
A)	Methyl orange	3.1 - 4.4
B)	Thymolphthalein	9.3 - 10.5
C)	Cresol red	7.2 - 8.8
D)	Bromophenol blue	3.0 - 4.6
E)	Bromothymol blue	6.0 - 7.6

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11. Some parts of human cells, like the endosomes, are acidic, with pH ≈ 5.5. **Which** of the following **weak acids** would be the most effective acid component of a buffer to maintain pH 5.5 (assuming equal concentrations of all buffers)?

	Weak acid	K_a
A)	glycine	4.6×10^{-3}
B)	lactic acid	1.4×10^{-4}
C)	$H_2PO_4^-$	6.3×10^{-8}
D)	H_2CO_3	4.5×10^{-7}
E)	NH_4^+	5.5×10^{-10}

12. If the pH indicator cresol red (yellow at low pH, purple at high pH) is placed in a buffer solution with pH 7.40, **what percentage** of the indicator would be in the protonated (HIn) form?

Data:
pK_{HIn}(cresol red) = 8.32

A) 19%
B) 79%
C) 9%
D) 39%
E) 89%

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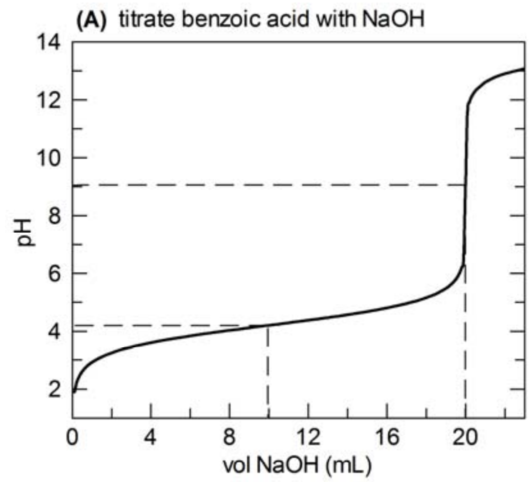
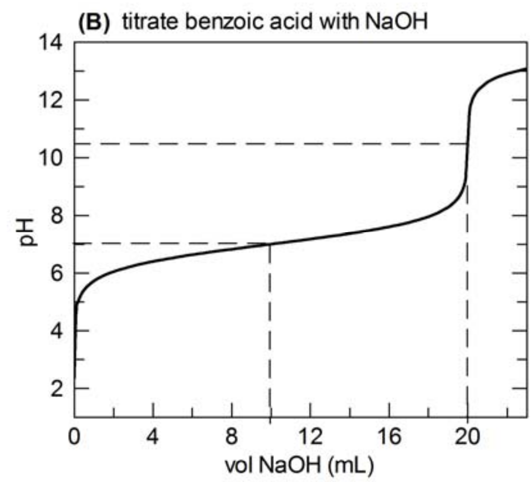
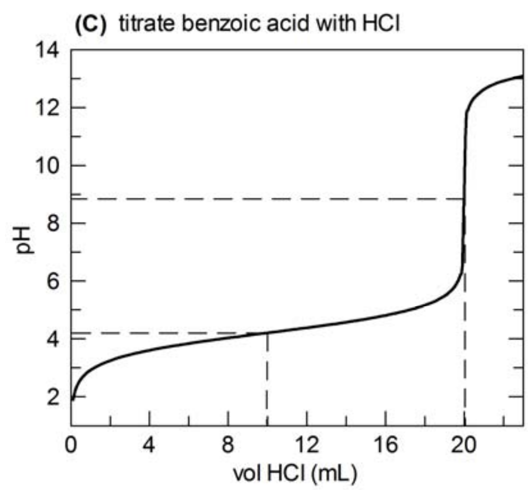
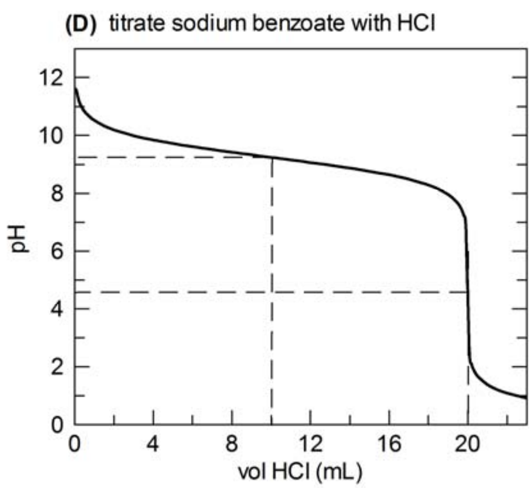
13. Which of the following titration graphs is **completely accurate**?

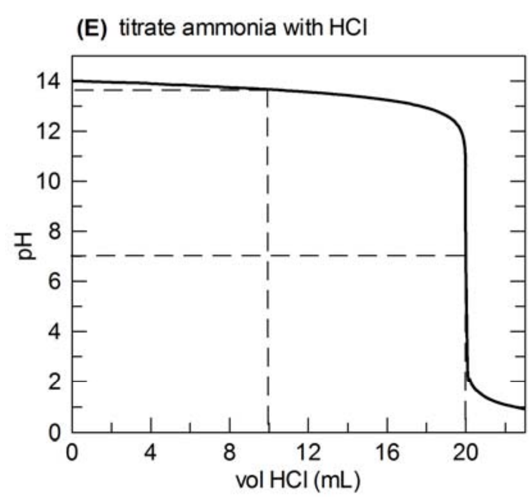
Data:
K_a(benzoic acid) = 6.3×10^{-5}
K_b(ammonia) = 1.8×10^{-5}











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14. The titration of 10.00 mL of a weak base with a 0.180 M HCl(aq) solution reaches the half-equivalence point after adding 4.75 mL of acid. The pH at the half-equivalence point is 9.42. Calculate the **initial concentration of the base** and its $\boldsymbol{K_b}$ value.

A) 0.187 M $K_b = 2.6 \times 10^{-10}$
B) 0.171 M $K_b = 2.6 \times 10^{-5}$
C) 0.187 M $K_b = 2.6 \times 10^{-5}$
D) 0.171 M $K_b = 3.8 \times 10^{-10}$
E) 0.200 M $K_b = 3.8 \times 10^{-10}$

15. In a titration of 0.050 M NaOH (beaker) with 0.20 M HCl (buret), what is the **pH** at the half-equivalence point?

A) 2.53
B) 3.33
C) 7.00
D) 11.55
E) 12.35

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16. A 1.00 L solution of a HCOOH/HCOONa buffer has pH 3.60, and [HCOONa] = 0.68 M. After 50.0 mL of 1.00 M HCl are added, what is the **new pH**?

Data:
$K_a(HCOOH) = 1.8 \times 10^{-4}$

A) 3.49
B) 3.39
C) 3.44
D) 3.54
E) 3.61

17. A student titrates a weak acid (beaker, 20. mL, 0.22 M, $K_a = 1.0 \times 10^{-4}$) with NaOH (buret, 0.12 M). Which of the following statements would be **incorrect** regarding this titration?

A) The initial pH of the solution in the beaker would be below 4.
B) The equivalence point should occur at 37 mL of added NaOH.
C) The buffer region would occur at a pH above 7.
D) The half equivalence point would occur at pH 4.
E) At the equivalence point, the pH of the solution would be basic.

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18. Which statement is **incorrect** regarding the pseudo-zero order reaction A → G?

A) A graph of v_0 vs. [A] is a horizontal line.
B) $v = k[A]$
C) average rate = $-\Delta[A]/\Delta t$
D) A graph of [A] vs. time is linear.
E) The plot of v vs. time is a horizontal line.

19. The table below shows the rate of formation of G during the reaction A → 2G. What is the **rate constant** for this reaction?

time (h)	[G] (M)
1.0	0.12
2.0	0.24
4.0	0.48

A) $3.0 \times 10^{-2}\ h^{-1}$
B) $6.0 \times 10^{-2}\ M\ h^{-1}$
C) $3.0\ M\ h^{-1}$
D) $0.030\ M\ h^{-1}$
E) $0.060\ h^{-1}$

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20. Which statement regarding the rate of the reaction $2A + B \rightarrow G + H$ is **incorrect**?

A) The reaction rate can be described as: average rate = $\Delta[H]/\Delta t$.
B) The reaction rate can be described as: average rate = $-(1/2 \times \Delta[A])/\Delta t$.
C) The instantaneous reaction rate can be described as: $v = -d[B]/dt$.
D) If the reaction rate doubles with a doubling of either [A] or [B], then the rate law may written as $v = k[A][B]$.
E) The reaction order can be determined from the reaction stoichiometry shown above.

21. Based on the observed rates, what is the **rate law** for the reaction $A + B \rightarrow G$?

[A] (M)	[B] (M)	v_0 (M/s)
0.1	0.1	0.4
0.1	0.3	1.2
0.2	0.2	3.2

A) $v_0 = k[A][B]$
B) $v_0 = k[A]^2[B]$
C) $v_0 = k[A][B]^2$
D) $v_0 = k[A]^0[B]$
E) $v_0 = k[A]^0[B]^2$

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22. Which statement regarding reaction rates is **incorrect**?

A) Initial rates can be approximated by measuring average rates at closely spaced time points, and as close to time t = 0 as possible.
B) Instantaneous rates at time t can be approximated by measuring average rates over a very small time interval about t.
C) Experimentally determined rates are always average rates.
D) Two reactions that have identical average rates over one time period must have identical average rates over all subsequent time periods.
E) An instantaneous rate describes the rate of a reaction at a specific time, t.

23. The rate law for the reaction $A + 2B \rightarrow 2C$ was determined to be $v = k[A][B]^2$, with a rate constant $k = 1.2 \times 10^{-2}\ M^{-2}s^{-1}$ at 20°C. What is the **reaction rate (in Ms^{-1})** when [A] = 0.1 M and [B] = 0.2 M?

A) 2.6×10^{-4}
B) 4.4×10^{-4}
C) 4.8×10^{-5}
D) 1.2×10^{-5}
E) 2.2×10^{-5}

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24. Which of the following reactions is **not third order** overall?

A) $v_0 = k[B]^2[C]^0[D]$

B) $v_0 = k[B][C][D]$

C) $v_0 = k[B]^3[C]^0[D]^0$

D) $v_0 = k[A]^2[C][D]$

E) $v_0 = k[A][C]^2[D]^0$

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Extra space for rough work.

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General data and equations. Other data appear with the questions.

There is a periodic table on the next page.

STP = 273.15 K, 1 atm

$R = 8.3145$ J/K·mol = 0.08206 L·atm/K·mol

1 atm = 760 mm Hg = 101.325 kPa

1 J = 1 kg m^2 s^{-2} = 1 kPa·L = 1 Pa·m^3

1 cm^3 = 1 mL

F = 96485 C/mol

$N_A = 6.022 \times 10^{23}$ mol^{-1}

0°C = 273.15 K

1 m = 10^9 nm = 10^{10} Å

1 g = 10^3 mg

$K_w = 1.0 \times 10^{-14}$

$\text{average rate} = -\frac{1}{a}\frac{\Delta[A]}{\Delta t} = \ldots = \frac{1}{g}\frac{\Delta[G]}{\Delta t}\ldots$	$v = \lim_{t \to 0} \frac{1}{g}\frac{\Delta[G]}{\Delta t} = \frac{1}{g}\frac{d[G]}{dt}$
$v_0 = k[A]^m[B]^n$	

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Student Name: ________________________ Student No: __________________________

PERIODIC TABLE OF THE ELEMENTS

ALDRICH®

Transition Metals (groups 3–12)

I 1	II 2	3	4	5	6	7	8	9	10	11	12	III 13	IV 14	V 15	VI 16	VII 17	VIII 18
1 H 1.0079																	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc [98]	44 Ru 101.07	45 Rh 102.91	46 Pd 105.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 *La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra 226.03	89 **Ac 227.03	104 Unq [261]	105 Unp [262]	106 Unh [263]												

Atomic weights are based on $^{12}C = 12$ and conform to the 1987 IUPAC report values rounded to 5 significant digits.
Numbers in [ ] indicate the most stable isotope.

* Lanthanides	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
** Actinides	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [262]