

CHEMISTRY 1B - CHEM1102SECOND SEMESTER EXAMINATION**CONFIDENTIAL****NOVEMBER 2003****TIME ALLOWED: THREE HOURS**

GIVE THE FOLLOWING INFORMATION IN BLOCK LETTERS

FAMILY NAME		SID NUMBER	
OTHER NAMES		TABLE NUMBER	

INSTRUCTIONS TO CANDIDATES

- All questions are to be attempted. There are 16 pages of examinable material.
- Complete the written section of the examination paper in **INK**.
- Read each question carefully. Report the appropriate answer and show all relevant working in the space provided.
- The total score for this paper is 100. The possible score per page is shown in the adjacent tables.
- Each new question of the short answer section begins with a •.
- Electronic calculators, including programmable calculators, may be used. Students are warned, however, that credit may not be given, even for a correct answer, where there is insufficient evidence of the working required to obtain the solution.
- Numerical values required for any question and a Periodic Table may be found on a separate data sheet.
- Pages 15, 18 & 20 are for rough working only.

OFFICIAL USE ONLY**Multiple choice section**

Pages	Marks	
	Max	Gained
2-10	50	

Short answer section

Page	Marks		Marker
	Max	Gained	
11	7		
12	7		
13	7		
14	12		
16	8		
17	2		
19	7		
Total	50		
Check Total			

Marks
3

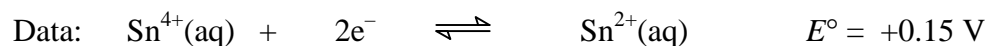
- Consider the compound with formula $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2$.

Name the compound.

What is the oxidation state of the metal?

What is the co-ordination number of the metal?

- Write balanced equations for each of the following reactions. If there is no reaction then write "no reaction".

**4**

Excess ammonia is added to an aqueous solution of magnesium sulfate.

Excess ammonia is added to an aqueous solution of cobalt(II) chloride.

A solution of Fe^{2+} ions is added to bromine water.An acidified solution of $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$ is added to SnCl_2 solution.

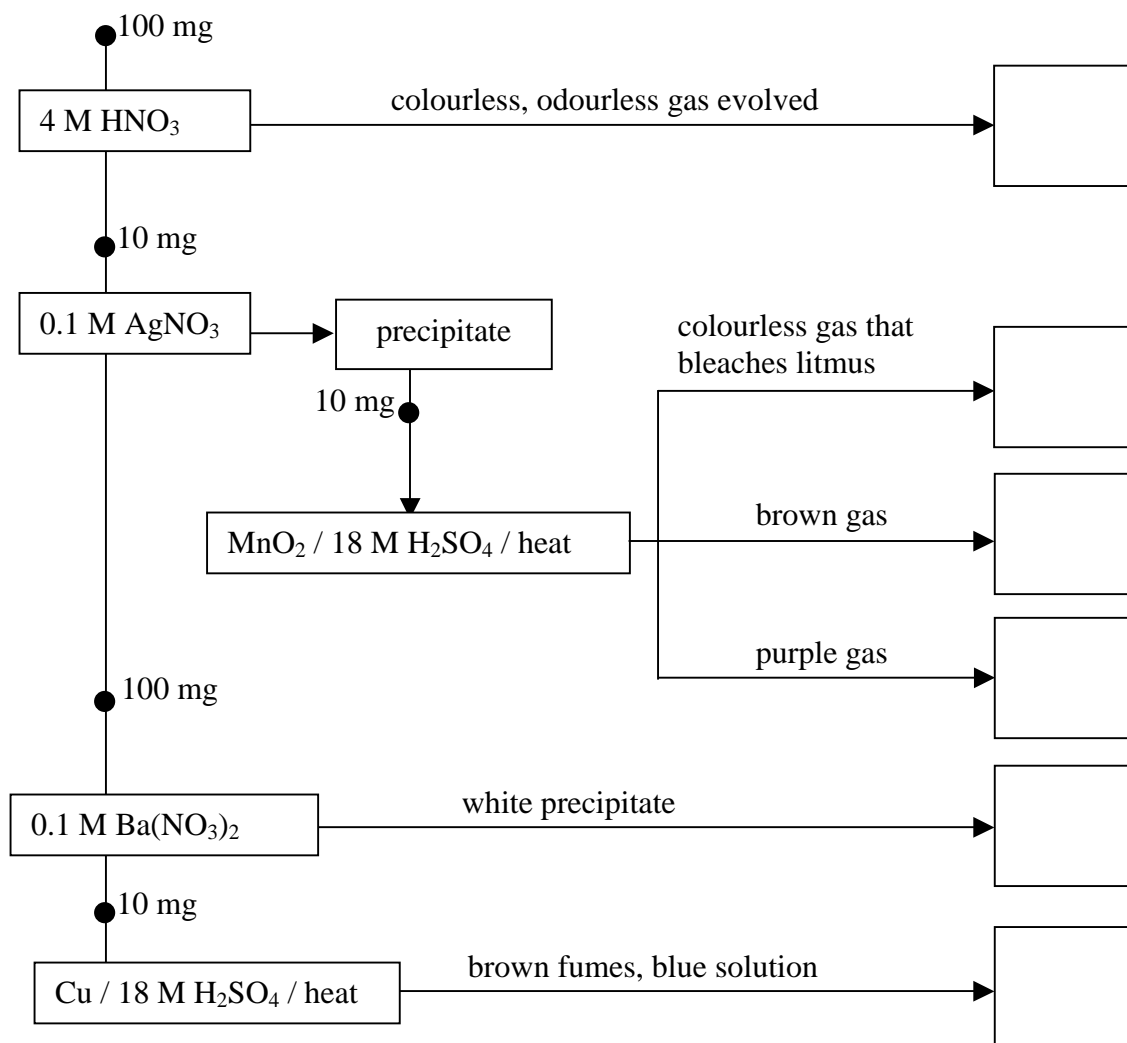
- The solubility of AgCl in pure water is $1.3 \times 10^{-5} \text{ mol L}^{-1}$. What is the maximum amount of AgCl (in mol) that will dissolve in 1.0 L of a 0.55 M NaCl solution?

Marks
4

ANSWER:

- The following flowchart is for the identification of anions in an unknown inorganic salt, similar to that in E5. Complete the blanks on the right with the formula of the anion identified by the test described.

3



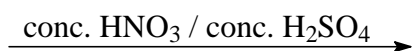
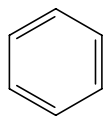
Marks**7**

- A hydrogen/oxygen fuel cell uses the reaction $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$. For how many hours can the cell operate at 1.50 A, if it is supplied by a 1.00 L tank of $\text{H}_2(\text{g})$ at 200 atm and 298 K in the presence of an excess of $\text{O}_2(\text{g})$? Assume that H_2 functions as an ideal gas under these conditions.

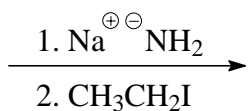
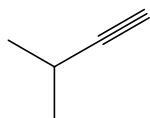
ANSWER:

Marks
12

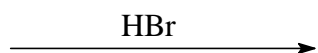
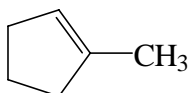
- Give the constitutional formula and the name of the major organic product of each of the following reactions.



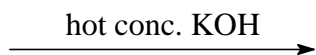
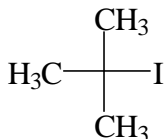
Name:



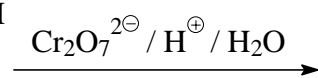
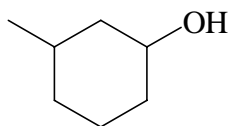
Name:



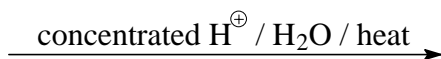
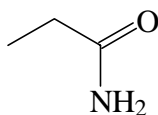
Name:



Name:



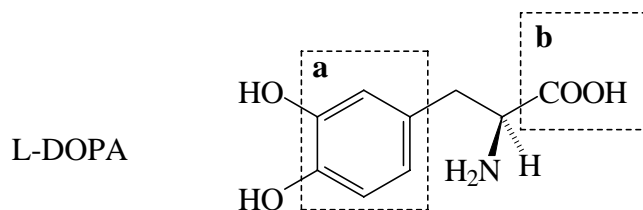
Name:



Name:

Marks
8

- L-DOPA is used extensively in the treatment of Parkinson's disease, while the enantiomer is actually toxic to nerve cells.



(i) What is the molecular formula of L-DOPA?

--

(ii) On the above diagram mark the stereogenic centre in L-DOPA with an asterisk (*).

(iii) List the substituents attached to the stereogenic centre in descending order of priority according to the sequence rules.

highest priority

lowest priority

--	--	--	--

(iv) What is the absolute stereochemistry of L-DOPA? Write (*R*) or (*S*).

--

(v) Name the functional groups, highlighted by the boxes **a** and **b**, present in L-DOPA.

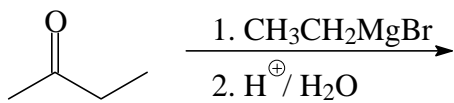
a =	b =
------------	------------

(vi) What is the product of the reaction when L-DOPA is treated with HCl?

--

- Give the stick representation of the product formed when butanone is reacted with ethylmagnesium bromide ($\text{CH}_3\text{CH}_2\text{MgBr}$), followed by aqueous acid.

Marks
2

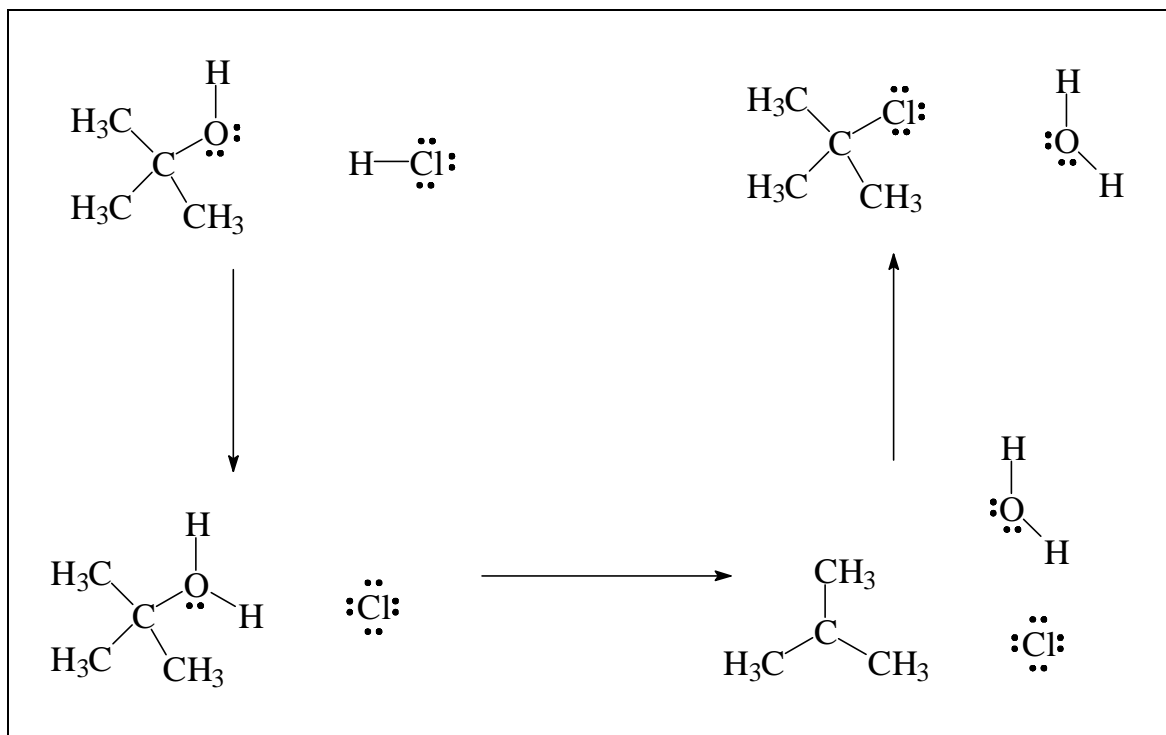


State whether the product formed by this reaction is *achiral*, the *(S)-enantiomer*, the *(R)-enantiomer*, a *meso-compound* or a *racemic mixture*.

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

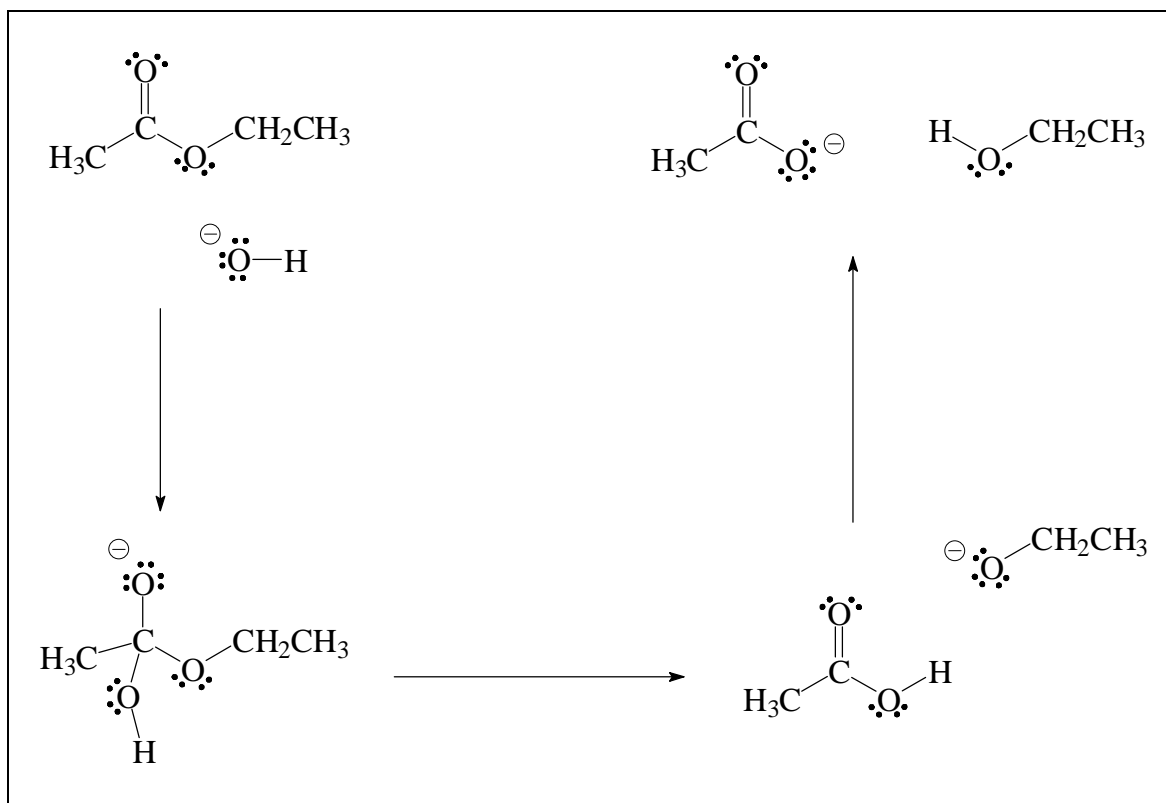
- The incomplete proposed mechanism for the reaction of 2-methyl-2-propanol with HCl is shown below. Complete the mechanism by showing formal charges on all appropriate atoms and by adding curly arrows to illustrate the bonding changes that take place. Hint: Four (4) curly arrows and four (4) charges are required.

Marks
4



3

- The incomplete proposed mechanism for the hydrolysis of ethyl acetate is shown below. Complete the mechanism by adding curly arrows to illustrate the bonding changes that take place. Hint: Six (6) curly arrows (but no charges) are required.



CHEM1102 - CHEMISTRY 1B**DATA SHEET***Physical constants*Avogadro constant, $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$ Faraday constant, $F = 96485 \text{ C mol}^{-1}$ Planck constant, $h = 6.626 \times 10^{-34} \text{ J s}$ Speed of light in vacuum, $c = 2.998 \times 10^8 \text{ m s}^{-1}$ Gas constant, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
 $= 0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$

Volume of 1 mole of ideal gas at 1 atm and 25 °C = 24.5 L

Volume of 1 mole of ideal gas at 1 atm and 0 °C = 22.4 L

Conversion factors

1 atm = 760 mmHg = 101.3 kPa

0 °C = 273 K

1 L = 10^{-3} m^3 1 Å = 10^{-10} m 1 eV = $1.602 \times 10^{-19} \text{ J}$ 1 Ci = $3.70 \times 10^{10} \text{ Bq}$ *Useful formulas***Acids and Bases**

$$\text{p}K_w = \text{pH} + \text{pOH} = 14$$

$$\text{p}K_w = \text{p}K_a + \text{p}K_b = 14$$

$$\text{pH} = \text{p}K_a + \log\{[A^-] / [HA]\}$$

Electrochemistry

$$\Delta G^\circ = -nFE^\circ$$

$$E = E^\circ - (RT/nF) \ln Q$$

$$E^\circ = (RT/nF) \ln K$$

$$\text{Moles of } e^- = It/F$$

Quantum Chemistry

$$E = h\nu = hc/\lambda$$

$$\lambda = h/mu$$

Kinetics

$$k = Ae^{-E_a/RT}$$

$$t_{1/2} = \ln 2/k$$

$$\ln[A] = \ln[A]_0 - kt$$

Colligative properties

$$\pi = cRT$$

$$p = kc$$

$$\Delta T_f = K_f m$$

$$\Delta T_b = K_b m$$

Gas Laws

$$PV = nRT$$

$$(P + n^2a/V^2)(V - nb) = nRT$$

Radioactivity

$$A = kN$$

$$\ln(N_0/N_t) = kt$$

$$t = 8033 \ln(A_0/A_t)$$

Thermodynamics & Equilibrium

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta G = \Delta G^\circ + RT \ln Q$$

$$\Delta G^\circ = -RT \ln K$$

$$K_p = K_c (RT)^{\Delta n}$$

Decimal fractions

Fraction	Prefix	Symbol
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

Decimal multiples

Multiple	Prefix	Symbol
10^3	kilo	k
10^6	mega	M
10^9	giga	G

A periodic table is printed on the other side of this data sheet.
Atomic weights are included in the periodic table.

PERIODIC TABLE OF THE ELEMENTS

November 2003

CHEM1102 - CHEMISTRY 1B

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
	1 <small>HYDROGEN</small> H 1.008											2 <small>HELIUM</small> He 4.003									
	3 <small>LITHIUM</small> Li 6.941	4 <small>BERYLLIUM</small> Be 9.012											5 <small>BORON</small> B 10.81	6 <small>CARBON</small> C 12.01	7 <small>NITROGEN</small> N 14.01	8 <small>OXYGEN</small> O 16.00	9 <small>FLUORINE</small> F 19.00	10 <small>NEON</small> Ne 20.18			
	11 <small>SODIUM</small> Na 22.99	12 <small>MAGNESIUM</small> Mg 24.31											13 <small>ALUMINIUM</small> Al 26.98	14 <small>SILICON</small> Si 28.09	15 <small>PHOSPHORUS</small> P 30.97	16 <small>SULFUR</small> S 32.07	17 <small>CHLORINE</small> Cl 35.45	18 <small>ARGON</small> Ar 39.95			
	19 <small>POTASSIUM</small> K 39.10	20 <small>CALCIUM</small> Ca 40.08	21 <small>SCANDIUM</small> Sc 44.96	22 <small>TITANIUM</small> Ti 47.88	23 <small>VANADIUM</small> V 50.94	24 <small>CHROMIUM</small> Cr 52.00	25 <small>MANGANESE</small> Mn 54.94	26 <small>IRON</small> Fe 55.85	27 <small>COBALT</small> Co 58.93	28 <small>NICKEL</small> Ni 58.69	29 <small>COPPER</small> Cu 63.55	30 <small>ZINC</small> Zn 65.39	31 <small>GALLIUM</small> Ga 69.72	32 <small>GERMANIUM</small> Ge 72.59	33 <small>ARSENIC</small> As 74.92	34 <small>SELENIUM</small> Se 78.96	35 <small>BROMINE</small> Br 79.90	36 <small>KRYPTON</small> Kr 83.80			
	37 <small>RUBIDIUM</small> Rb 85.47	38 <small>STRONTIUM</small> Sr 87.62	39 <small>YTRIUM</small> Y 88.91	40 <small>ZIRCONIUM</small> Zr 91.22	41 <small>NIوبيUM</small> Nb 92.91	42 <small>MOLYBDENUM</small> Mo 95.94	43 <small>TECHNETIUM</small> Tc [98.91]	44 <small>RUTHENIUM</small> Ru 101.07	45 <small>RHODIUM</small> Rh 102.91	46 <small>PALLADIUM</small> Pd 106.4	47 <small>SILVER</small> Ag 107.87	48 <small>CADMIUM</small> Cd 112.40	49 <small>INDIUM</small> In 114.82	50 <small>TIN</small> Sn 118.69	51 <small>ANTIMONY</small> Sb 121.75	52 <small>TELLURIUM</small> Te 127.60	53 <small>IODINE</small> I 126.90	54 <small>XENON</small> Xe 131.30			
	55 <small>CAESIUM</small> Cs 132.91	56 <small>BARIUM</small> Ba 137.34	57-71		72 <small>HAFNIUM</small> Hf 178.49	73 <small>TANTALUM</small> Ta 180.95	74 <small>TUNGSTEN</small> W 183.85	75 <small>RHENIUM</small> Re 186.2	76 <small>OSMIUM</small> Os 190.2	77 <small>IRIDIUM</small> Ir 192.22	78 <small>PLATINUM</small> Pt 195.09	79 <small>GOLD</small> Au 196.97	80 <small>MERCURY</small> Hg 200.59	81 <small>THALLIUM</small> Tl 204.37	82 <small>LEAD</small> Pb 207.2	83 <small>BISMUTH</small> Bi 208.98	84 <small>POLONIUM</small> Po [210.0]	85 <small>ASTATINE</small> At [210.0]	86 <small>RADON</small> Rn [222.0]		
	87 <small>FRANCIUM</small> Fr [223.0]	88 <small>RADIUM</small> Ra [226.0]	89-103		104 <small>RUTHERFORDIUM</small> Rf [261]	105 <small>DUBNIUM</small> Db [262]	106 <small>SEABORGIUM</small> Sg [266]	107 <small>BOHRIUM</small> Bh [262]	108 <small>HASSIUM</small> Hs [265]	109 <small>MEITNERIUM</small> Mt [266]											

LANTHANIDES

	57 <small>LANTHANUM</small> La 138.91	58 <small>CERIUM</small> Ce 140.12	59 <small>PRASEODYMIUM</small> Pr 140.91	60 <small>NEODYMIUM</small> Nd 144.24	61 <small>PROMETHIUM</small> Pm [144.9]	62 <small>SAMARIUM</small> Sm 150.4	63 <small>EUROPIUM</small> Eu 151.96	64 <small>GADOLINIUM</small> Gd 157.25	65 <small>TERBIUM</small> Tb 158.93	66 <small>DYSPROSIUM</small> Dy 162.50	67 <small>HOLMIUM</small> Ho 164.93	68 <small>ERBIUM</small> Er 167.26	69 <small>THULIUM</small> Tm 168.93	70 <small>YTTERBIUM</small> Yb 173.04	71 <small>LUTETIUM</small> Lu 174.97
	89 <small>ACTINIUM</small> Ac [227.0]	90 <small>THORIUM</small> Th 232.04	91 <small>PROTACTINIUM</small> Pa [231.0]	92 <small>URANIUM</small> U 238.03	93 <small>NEPTUNIUM</small> Np [237.0]	94 <small>PLUTONIUM</small> Pu [239.1]	95 <small>AMERICIUM</small> Am [243.1]	96 <small>CURIUM</small> Cm [247.1]	97 <small>BERKELIUM</small> Bk [247.1]	98 <small>CALIFORNIUM</small> Cf [252.1]	99 <small>EINSTEINIUM</small> Es [252.1]	100 <small>FERMIUM</small> Fm [257.1]	101 <small>MENDELEVIUM</small> Md [256.1]	102 <small>NOBELIUM</small> No [259.1]	103 <small>LAWRENCIUM</small> Lr [260.1]

ACTINIDES

22/05(b)