22/10(a)

The University of Sydney

CHEM1902 - CHEMISTRY 1B (ADVANCED)

and

CHEM1904 - CHEMISTRY 1B (SPECIAL STUDIES PROGRAM)

SECOND 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.
- A Periodic Table and numerical values required for any question may be found on a separate data sheet.
- Pages 12, 16 & 20 are for rough working only.

OFFICIAL USE ONLY

Multiple choice section

	Marks	
Page	Max	Gained
2-10	50	

Short answer section

	Marks			
Page	Max	Gained		Marker
11	8			
13	6			
14	6			
15	11			
17	5			
18	8			
19	6			
Total	50			

	Marks
• Consider the compound with formula $Na_3[FeCl(CN)_5]\cdot H_2O$.	3
Name the compound.	
Write the formula of the complex ion.	
Write the atomic symbols of the ligand donor atoms.	
• Write balanced equations for each of the following reactions. If there is no reaction then write "no reaction".	5
Excess nitric acid (2 M) is added to a solution of $Na_2[Zn(OH)_4]$.	
Excess water is added to solid potassium oxide.	
Excess hydrochloric acid (4 M) is added to solid silver(I) sulfide.	
50 mL of magnesium nitrate solution (1 M) is added to 1 L of ammonia solution (2 M).	
Chlorine gas is bubbled through a solution of sodium iodide.	

Marks
6

- Lead(II) chromate was used as a paint pigment for many years. Both lead and chromate cause irreversible damage to human health and are of serious environmental concern. Calculate the concentration of Pb^{2+} (in mol L^{-1}) in a solution that is in equilibrium with excess $PbCrO_4(s)$.
  The solubility product constant, K_{so}, of $PbCrO_4$ is 2.3×10^{-13} M^2.

ANSWER:

Lead(II) chloride is substantially more soluble than lead(II) chromate. What is the molar solubility of lead(II) chromate in a saturated solution of lead(II) chloride?
The K_{so} of $PbCl_2$ is 1.7×10^{-5} M^3.

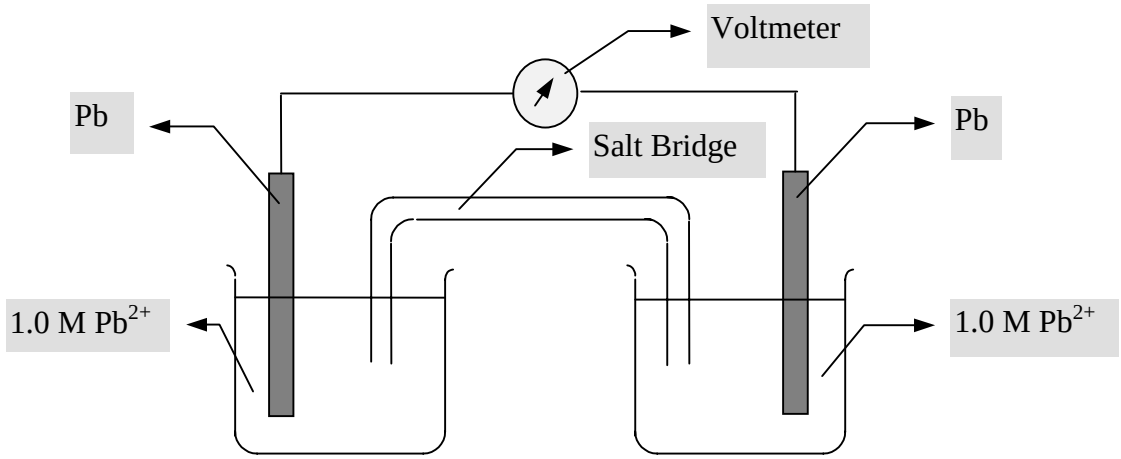
ANSWER:

Marks

- A solution contains platinum ions in an unknown oxidation state. When a current of 2.0 A was applied for 2.0 hours, 7.3 g of platinum metal was deposited. What was the oxidation state of the platinum ions? Show all working. **3**

ANSWER:

- Consider the electrolytic cell and electrode reduction potential shown below. Both half-cells consist of Pb electrodes immersed in 1.0 M $Pb(NO_3)_2$ solution. **3**



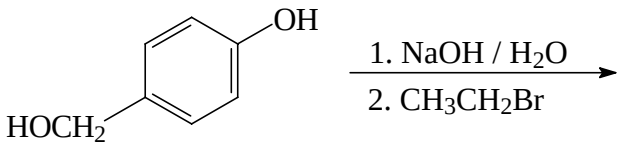
$$Pb^{2+} + 2e^- \rightleftharpoons Pb(s) \qquad E° = -0.13\ V$$

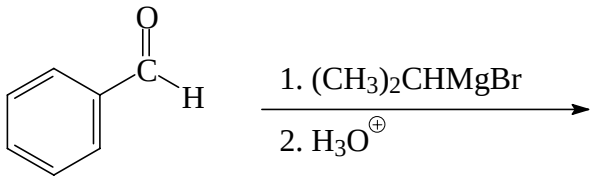
What is the initial voltage of the cell?

A solution of Na_2S is added to the half-cell on the left. Which half-cell is the cathode? Describe and explain all changes to the cell. The K_{so} of PbS = 3×10^{-28} M^2.

- Give the constitutional formulas of the major organic product(s) formed in the following reactions. Give the names of the organic compounds where requested.

Marks 11





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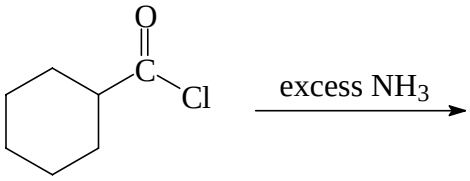

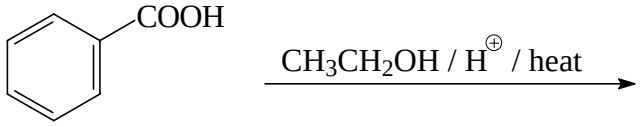

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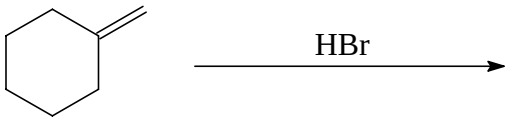

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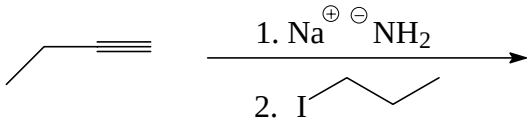


Name:

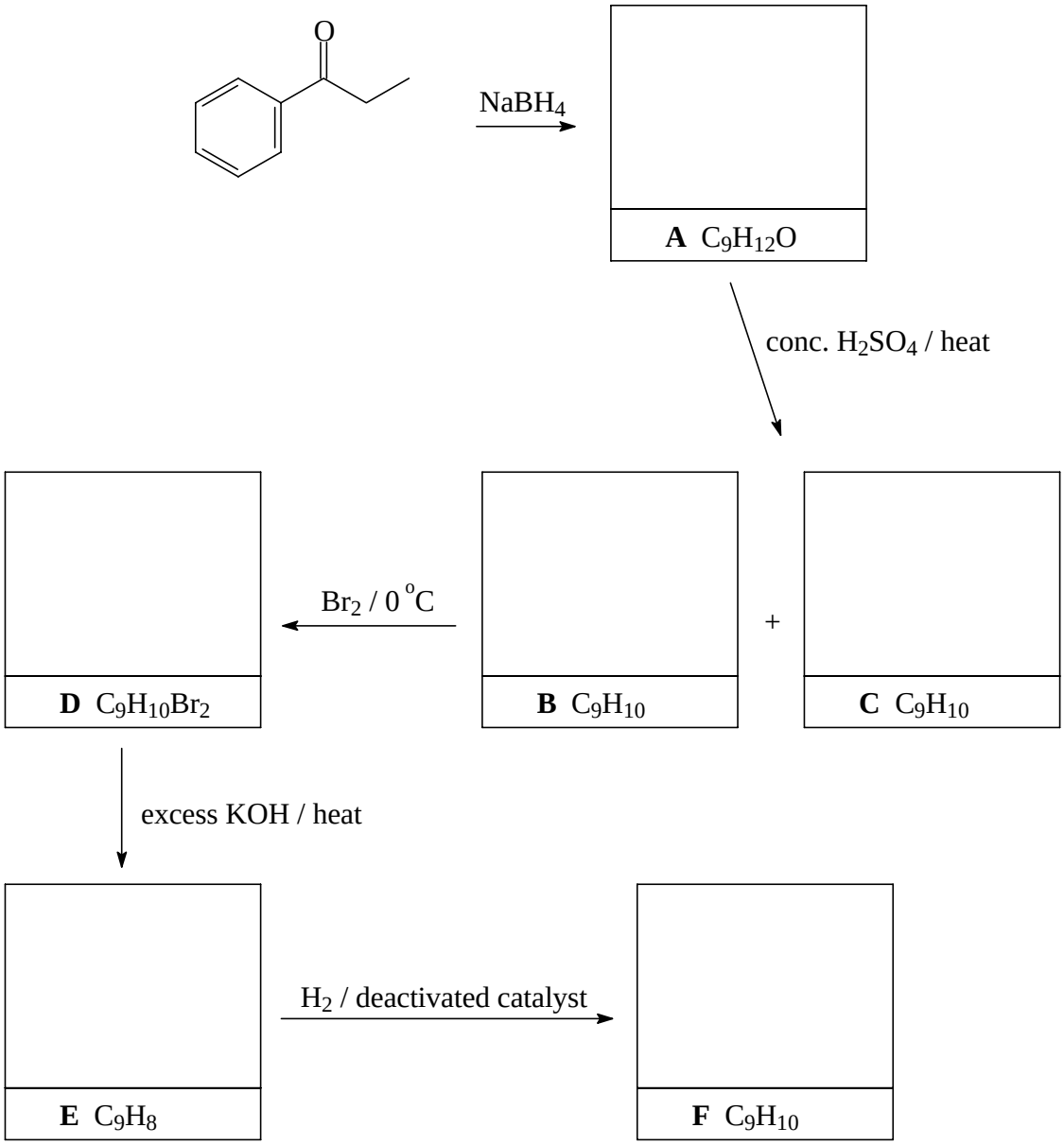
- With the aid of structure diagrams, show how you would effect the following conversions. Clearly indicate the reagents you would use and any intermediate compounds.

Marks
5

Marks 8

- Draw the constitutional structures of the compounds **A**, **B**, **C**, **D**, **E** and **F** produced in the following reaction sequence. Use the following clues to help you.

  The molecular formula of each compound is given. Compound **B** is the major product of the second step. Compounds **B** and **C** are diastereoisomers. Compound **D** is a mixture of stereoisomers. Compound **E** has a ^{1}H nmr spectrum that consists of an absorption due to the phenyl ring and one other signal that appears as a singlet. Compound **F** is identical to compound **C**.

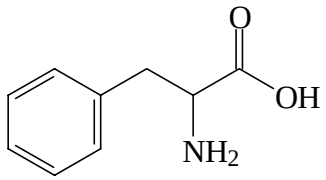


Which of the following is the best stereochemical description of compound **A**?
achiral, a racemic mixture, a mixture of diastereoisomers, an (*R*)-enantiomer, an (*S*)-enantiomer

How many different stereoisomers comprise compound **D**?

Marks
6

- Phenylalanine is an amino acid essential for human development. Draw the (*S*)-enantiomer.



phenylalanine

What is the molecular formula of phenylalanine?

Name the functional groups present in phenylalanine.

Draw the structure of the product formed when phenylalanine is dissolved in water at the following pH values.

pH = 10	pH = 4

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

CHEM1902 - CHEMISTRY 1B (ADVANCED)

CHEM1904 - CHEMISTRY 1B (SPECIAL STUDIES PROGRAM)

DATA SHEET

Physical constants

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

Faraday constant, $F = 96485$ C mol^{-1}

Planck constant, $h = 6.626 \times 10^{-34}$ J s

Speed of light in vacuum, $c = 2.998 \times 10^{8}$ m s^{-1}

Gas constant, $R = 8.314$ J K^{-1} mol^{-1}

$= 0.08206$ L atm K^{-1} 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 = 1.602×10^{-19} J

1 Ci = 3.70×10^{10} Bq

Useful formulas

Acids and Bases

$pK_w = pH + pOH = 14$

$pK_w = pK_a + pK_b = 14$

$pH = pK_a + \log\{[A^-] / [HA]\}$

Kinetics

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

$t_{½} = \ln 2/k$

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

Radioactivity

$A = kN$

$\ln(N_0/N_t) = kt$

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

Electrochemistry

$\Delta G° = -nFE°$

$E = E° - (RT/nF) \ln Q$

$E° = (RT/nF) \ln K$

Moles of $e^- = It/F$

Colligative properties

$\pi = cRT$

$p = kc$

$\Delta T_f = K_f m$

$\Delta T_b = K_b m$

Thermodynamics & Equilibrium

$\Delta G° = \Delta H° - T\Delta S°$

$\Delta G = \Delta G° + RT \ln Q$

$\Delta G° = -RT \ln K$

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

Quantum Chemistry

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

$\lambda = h/mu$

Gas Laws

$PV = nRT$

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

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.

November 2003

CHEM1902/1904

22/10(b)

PERIODIC TABLE OF THE ELEMENTS

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

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