22/10(a) # The University of Sydney

CHEM1902 - CHEMISTRY 1B (ADVANCED)

and

CHEM1904 - CHEMISTRY 1B (SPECIAL STUDIES PROGRAM)

SECOND SEMESTER EXAMINATION

CONFIDENTIAL

NOVEMBER 2002 **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, 19 & 20 are for rough working only.

OFFICIAL USE ONLY

Multiple choice section

	Marks	
Page	Max	Gained
2-10	50	

Short answer section

Page	Marks Max	Gained		Marker
11	8			
13	6			
14	6			
15	11			
16	4			
17	6			
18	9			
Total	50			

	Marks
• Consider the compound with formula $[CrCl_2(NH_3)_4]Cl \cdot 2H_2O$.	**3**
Name the compound.	
Write the formula of the complex ion.	
Write the atomic symbols of the ligand donor atoms.	
What is the 3*d* electron configuration of the metal ion in this complex?	
• Write balanced equations for each of the following reactions. If there is no reaction then write "no reaction".	**5**
Excess nitric acid (1 M) is added to a solution of $[Cu(NH_3)_4](NO_3)_2$.	
Water is added to solid potassium superoxide.	
Hydrogen sulfide gas is bubbled through a solution containing hydrochloric acid (4 M) and cadmium(II) sulfate.	
Chlorine gas is bubbled through a dilute solution of sodium fluoride.	
Excess sodium hydroxide solution (1 M) is added to a dilute solution of zinc(II) sulfate.	

Marks 6

- What is the concentration of $Fe^{2+}(aq)$ in equilibrium with $Fe(OH)_2$ in a solution buffered to pH 9.0? The solubility product constant, K_{so}, of $Fe(OH)_2$ is 1.0×10^{-15} M^3.

ANSWER:

Solutions of $Fe^{2+}(aq)$ are often contaminated with traces of $Fe^{3+}(aq)$ formed by air oxidation. What is the maximum concentration of $Fe^{3+}(aq)$ remaining in a solution of 0.2 M Fe^{2+} just before $Fe(OH)_2$ is precipitated by raising the pH of an acidic aqueous solution? The K_{so} of $Fe(OH)_3$ is 1.0×10^{-38} M^4.

ANSWER:

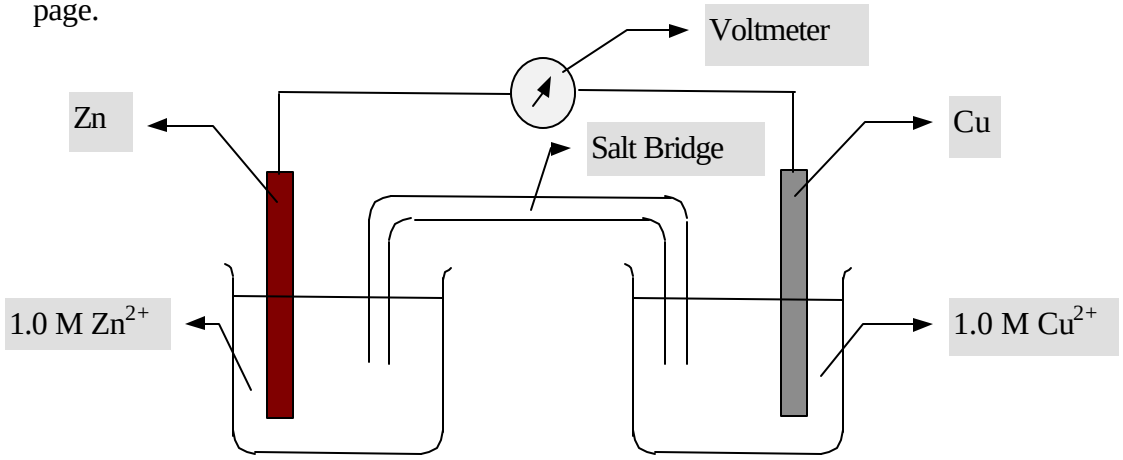
- Two electrolytic cells are connected in series so that the same quantity of charge flows through each cell. Silver metal (2.67 g) is deposited from the first cell, which contains Ag^+, and iron metal (0.46 g) is deposited from the second cell. What is the oxidation state of the iron in the second cell? Show all working.

Marks **3**

ANSWER:

- Consider the electrolytic cell shown below. Relevant reduction potentials are on the data page.

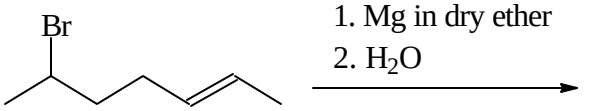
3



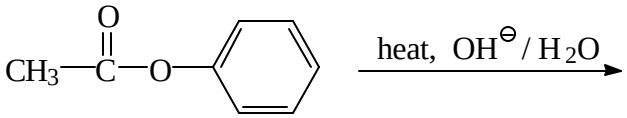
A potential of 1.10 V is observed when the cell is first connected. If H_2S gas is bubbled through the Cu^{2+} solution, will this potential increase or decrease? Give reasons for your answer.

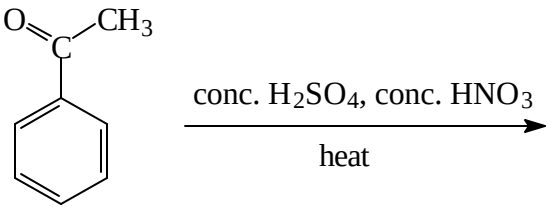
- Give the constitutional formulas and names, where required, of the major organic product(s) formed in the following reactions.

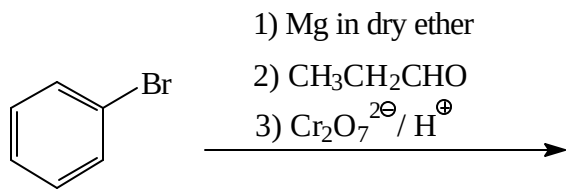
Marks 11



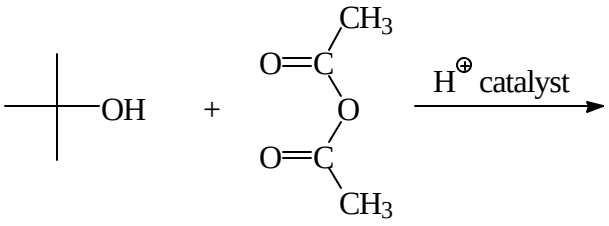
Name:

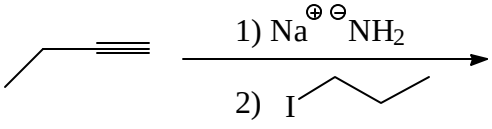






Name:

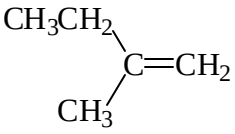




Name:

- Draw a scheme that represents the reaction between 2-methyl-1-butene and HBr. Clearly show any intermediates in the reaction and include curly arrows to indicate electron movements.

Marks **4**



Comment on the stability of any intermediate(s).

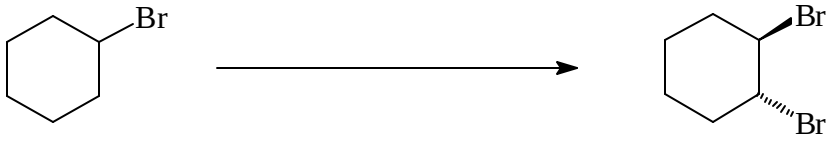
Which one of the following terms best describes the product of this reaction?

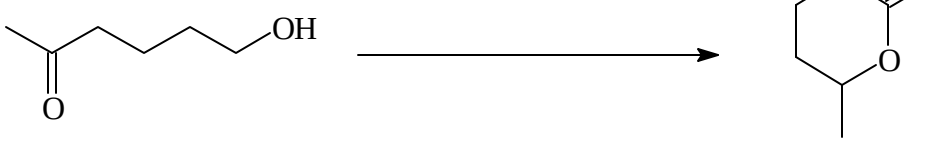
achiral compound, the (*R*)-enantiomer, the (*S*)-enantiomer, or a racemic mixture

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

- 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 6

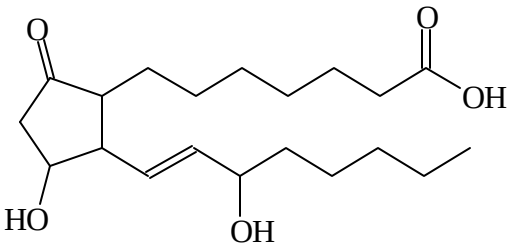




Marks **9**

- The substance prostaglandin E1 (**A**) is one of a broad class of substances called prostaglandins. They have a variety of functions in humans including blood platelet aggregation, bronchial dilation, and inhibition of gastric secretions.

(**A**)



What is the molecular formula of (**A**)?

Name the functional groups in (**A**).

How many stereogenic carbon atoms are there in (**A**)?

What is the total number stereoisomers possible for structure (**A**)?

Write the structure of the major organic products formed in the following reactions.

(**A**) is treated with dilute sodium hydrogencarbonate.	(**A**) is warmed with chromic acid.
(**A**) is treated with hydrogen gas in the presence of platinum metal.	(**A**) is warmed with thionyl chloride.

22/10(b)

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Numerical Data

Physical constants Faraday constant = F = 96485 C mol^{-1}

Electrode potentials

$Cu^{2+}(aq)$	+	$2e^-$	⇌	Cu(s)	$E°$ = +0.34 V
$2H^+(aq)$	+	$2e^-$	⇌	$H_2(g)$	$E°$ = 0.00 V
$Co^{2+}(aq)$	+	$2e^-$	⇌	Co(s)	$E°$ = –0.28 V
$Zn^{2+}(aq)$	+	$2e^-$	⇌	Zn(s)	$E°$ = –0.76 V

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

November 2002

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]