3. (a) Define Corrosion? Explain the electrochemical theory of corrosion by taking Iron as an example. (10)

   (b) Explain the galvanization process. (8)

   (c) What are the technological importances of Metal Finishing? (4 Marks)

   (d) Can we use a Cu vessel to store 1M AgNO3 solution? Explain your answer with help of equation. (3)

4. Choose a suitable material of construction for the following duties and explain your reasoning?

I. A 10,000m3 storage tank for toluene;

II. A 5:0m3 tank for storing a 30% w/w aqueous solution of sodium chloride;

III. A 2m diameter, 20m high distillation column, distilling acrylonitrile;

IV. A 100m3 storage tank for strong nitric acid;

V. A 500m3 aqueous waste hold-up tank. The wastewater pH can vary from 1 to 12. The wastewater will also contain traces of organic material;

VI. A packed absorption column 0.5m diameter, 3m high, absorbing gaseous hydrochloric acid into water. The column will operate at essentially atmospheric pressure. (25)

5. A mining engineer is analyzing a rock sample suspected to contain multiple mineral phases.

   i. Which technique (XRF or XRD) would be more appropriate for identifying the mineral phases present? Explain why. (5 Marks)

   ii. Which technique would be better for determining the elemental composition of the sample? Justify your choice. (5)

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT: ENGINEERING AND PHYSICS

PROGRAMME: <u>BACHELOR OF SCIENCE HONOURS DEGREE IN MINING ENGINEERING</u>

COURSE CODE: MEG1104 (2): CHEMISTRY FOR ENGINEERS

DURATION: 3HRS TOTAL MARKS: 100

JUN 2025

INSTRUCTIONS TO CANDIDATES

I. The exam paper contains six (6) questions.

II. Answer any four (4) questions each question contains 25 Marks.

III. Use Data booklet attached-Appendix 1

IV. Read each question thoroughly before attempting to answer. Make sure you understand what is being asked.

1. Compare and contrast the organic and inorganic theories of petroleum formation? (25)

2. Provide group names for the following minerals below? (25)

Name	**Formula**	**Group**
sphalerite	ZnS	
magnetite	Fe_3O_4	
pyroxene	$MgSiO_3$	
anglesite	$PbSO_4$	
sylvite	KCl	
silver	Ag	
fluorite	CaF_2	
ilmenite	$FeTiO_3$	
siderite	$FeCO_3$	
feldspar	$KAlSi_3O_8$	
sulphur	S	
xenotime	YPO_4	

6. Treating Acid Mine Drainage (AMD) after it has formed often involves resource-intensive and sometimes environmentally questionable methods.

a). Describe two traditional methods used for the treatment of AMD, highlighting their limitations and potential environmental drawbacks? (15 Marks)

b). Discuss how green chemistry principles can guide the development of more sustainable and environmentally friendly technologies for AMD treatment. Provide at least two examples of such innovative or emerging treatment approaches? (10 Marks)

END OF PAPER

Basic information

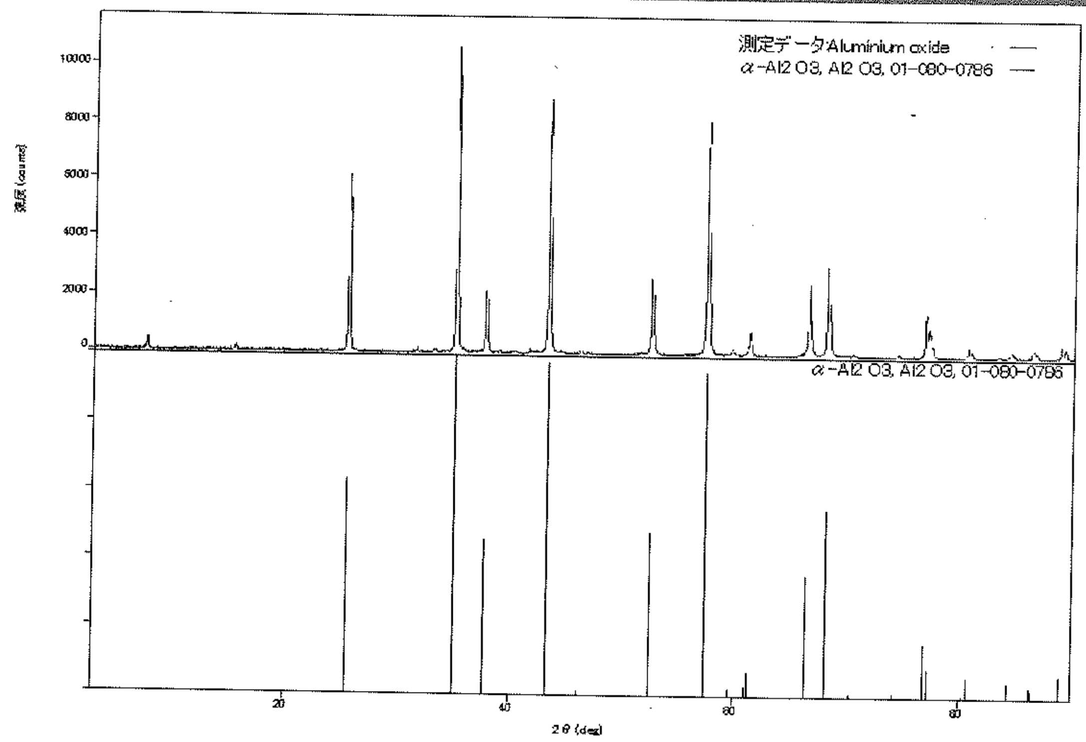
Date of analysis	2024/11/13 15:24:24		
Sample name	Aluminium oxide	Date of Measurement	2024/11/13 14:45:14
File name	Aluminium oxide.raw	Measurer	User1
comment	Normal		

Qualitative analysis results

Aluminium oxide

Phase name	Formula	Figure of merit	Phase reg. detail	DB card number
α-Al2 O3	Al2 O3	0.190	ICDD (PDF-2 2023)	01-080-0786

Phase data pattern



The image presents the results of a quantitative elemental analysis of a sample labeled "Aluminum oxide." Considering the principles of X-ray-based analytical methods, which X-ray technique is the data most likely derived from? Justify your answer by referencing specific aspects of the result table (7 Marks).

c). State at least two potential limitations of the X-ray-based method used to obtain this elemental analysis data? (3 Marks)

Appendix 1-Standard Reduction Potentials at 298.15K

Oxidized species	Reduced species	$E^{\ominus}$ / V
$Li^+(aq) + e^-$ ⇌	$Li(s)$	−3.04
$K^+(aq) + e^-$ ⇌	$K(s)$	−2.93
$Ca^{2+}(aq) + 2e^-$ ⇌	$Ca(s)$	−2.87
$Na^+(aq) + e^-$ ⇌	$Na(s)$	−2.71
$Mg^{2+}(aq) + 2e^-$ ⇌	$Mg(s)$	−2.37
$Al^{3+}(aq) + 3e^-$ ⇌	$Al(s)$	−1.66
$Mn^{2+}(aq) + 2e^-$ ⇌	$Mn(s)$	−1.18
$H_2O(l) + e^-$ ⇌	$\frac{1}{2}H_2(g) + OH^-(aq)$	−0.83
$Zn^{2+}(aq) + 2e^-$ ⇌	$Zn(s)$	−0.76
$Fe^{2+}(aq) + 2e^-$ ⇌	$Fe(s)$	−0.45
$Ni^{2+}(aq) + 2e^-$ ⇌	$Ni(s)$	−0.26
$Sn^{2+}(aq) + 2e^-$ ⇌	$Sn(s)$	−0.14
$Pb^{2+}(aq) + 2e^-$ ⇌	$Pb(s)$	−0.13
$H^+(aq) + e^-$ ⇌	$\frac{1}{2}H_2(g)$	0.00
$Cu^{2+}(aq) + e^-$ ⇌	$Cu^+(aq)$	+0.15
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^-$ ⇌	$H_2SO_3(aq) + H_2O(l)$	+0.17
$Cu^{2+}(aq) + 2e^-$ ⇌	$Cu(s)$	+0.34
$\frac{1}{2}O_2(g) + H_2O(l) + 2e^-$ ⇌	$2OH^-(aq)$	+0.40
$Cu^+(aq) + e^-$ ⇌	$Cu(s)$	+0.52
$\frac{1}{2}I_2(s) + e^-$ ⇌	$I^-(aq)$	+0.54
$Fe^{3+}(aq) + e^-$ ⇌	$Fe^{2+}(aq)$	+0.77
$Ag^+(aq) + e^-$ ⇌	$Ag(s)$	+0.80
$\frac{1}{2}Br_2(l) + e^-$ ⇌	$Br^-(aq)$	+1.09
$\frac{1}{2}O_2(g) + 2H^+(aq) + 2e^-$ ⇌	$H_2O(l)$	+1.23
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^-$ ⇌	$2Cr^{3+}(aq) + 7H_2O(l)$	+1.36
$\frac{1}{2}Cl_2(g) + e^-$ ⇌	$Cl^-(aq)$	+1.36
$MnO_4^-(aq) + 8H^+(aq) + 5e^-$ ⇌	$Mn^{2+}(aq) + 4H_2O(l)$	+1.51
$\frac{1}{2}F_2(g) + e^-$ ⇌	$F^-(aq)$	+2.87