

請留意以下說明：

- 一、本試卷共 30 題，任選 10 題作答。
- 二、每題 10 分。
- 三、作答超過 10 題，每題扣 10 分。

1. Three major bondings in solids are ionic, covalent, and metallic bonds.

- (a) Describe ionic, covalent, and metallic bonds.
- (b) Alumina ( $\text{Al}_2\text{O}_3$ ) is a major ceramic material. Describe the bonding in alumina.
- (c) Silicon (Si) is the major semiconductor material. Describe the bonding in silicon.

2. Answer the following questions about the cubic rock salt (NaCl) crystal structure.

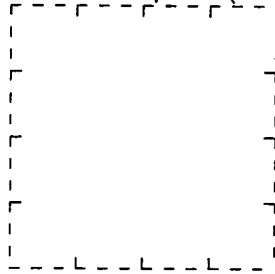
The rock salt crystal is cubic with  $a = 5.6 \text{ \AA}$ .

Sodium (Na) atoms in the unit cell are located at (0, 0, 0) F.C.

Chlorine (Cl) atoms are located at (1/2, 1/2, 1/2) F.C.

(a) Write out the coordinates of all four (4) Na atoms and all four (4) Cl atoms in a unit cell (in unit cell fraction).

(b) Draw a unit cell in a-b plane (as below) and plot all atoms of the rock salt crystal structure.



(c) The cell parameter of NaCl,  $a = 5.6 \text{ \AA}$ . What is the Na-Cl bond length? Show your calculation.

(d) What are the coordination numbers of Na and Cl in the crystal structure?

(f) How many molecules (NaCl) are there in a unit cell (Z)? Show calculation and explain.

3. Neumann's law is the most fundamental law in Mineral Physics or Crystal Physics.

What is Neumann's law? Explain with an example.

4. Describe and explain the trends and regularities of ionic radii with periodic table.

5. There are Pauling's five rules guiding the relation of composition and structure of ionic-bonding materials.

The first rule states "A coordination polyhedron of anions is formed about each cation, the cation-anion distance being determined by the radius sum and the coordination number of the cation being determined by the radius ratio.

**State the 2nd, 3rd, 4th, and 5th rules of Pauling's.**

6. There are three types of crystalline solid solutions: substitutional, interstitial, and vacancy (omission).

(a) Explain that the crystalline solution formed in MgO and NiO is of substitutional type.

(b) Explain that the crystalline solution formed in calcium stabilized zirconia is of vacancy (omission) type.

7. Phase transformation in solids can be categorized into displacive and reconstructive types.

(a) Explain the displacive and the reconstructive phase transformations.

(b) Explain that the phase transformation between high-low quartz is displacive, and the transformation between graphite and diamond is reconstructive.

(c) How does pressure influence crystal structure in terms of density, cation coordination, and symmetry?

(背面仍有題目,請繼續作答)

8. There are four possible mechanisms of electrical polarization when a dielectric ceramic material is under an electric field: electronic, ionic, dipolar (orientational), and space charge polarizations.  
(a) Explain the four electrical polarizations.  
(b) Explain why barium titanate ( $\text{BaTiO}_3$ ) is a material with high dielectric constant.
9. Explain the followings.  
(a) piezoelectricity, (b) pyroelectricity, (c) ferroelectricity, (d) ferromagnetism, (e) ferrimagnetism.
10. The **characteristics** and the **properties** of a material are different. Explain with examples.
11. 何謂資源、材料？二者有何異同？二者關係密切？試舉二例說明。
12. 常稱岩石由礦物組成。難道岩石一定要由礦物組成？而礦物組成的物質就可以稱為岩石？是舉例討論其間的關係。
13. 斜長石(Plagioclase)的兩終端礦物(End members)為鈣長石 (Anorthite,  $\text{CaAl}_2\text{Si}_2\text{O}_8$ ，簡稱 **An**)及納長石(Albite,  $\text{NaAlSi}_3\text{O}_8$ ，簡稱 **Ab**)。其化學通式為  $\text{An}_x\text{Ab}_y$ ,  $x+y=1$ 。請計算  $\text{An}_{0.4}\text{Ab}_{0.6}$  的化學成分(重量%)。
14. 作圖說明 14 types of Bravais lattices。
15. 舉三例說明自然界存在的資源再生現象，並說明其原動力(能源)機制。
16. 何謂綠色產品？有何意義或實質功能？試舉三例說明之。
17. 怎麼評估分選成果的優劣？
18. 微細顆粒的分粒(Classification)作業、一般採用那些方法？如採用顆粒在液體中的運動狀態差異加以分粒。你會注意哪些因素？試討論。
19. 重液選礦為富集有價礦物之重要方法，通常需製作適當『重液』以利作業進行。試舉例說明製作真重液與似重液的方法及應注意事項。
20. 作圖說明重液選礦使用的波震機使用原理。
21. 目前大家重視的奈米科技(Nanotechnology)所指的“奈米”何意？
22. 由發生源、成份、處理方式、再生利用之觀點，比較重金屬淤泥與水庫淤泥之特性。
23. 何謂工業礦物？列出台灣重要工業礦物五種及其地理分佈。
24. 定義耗竭性(Exhaustive)資源與非耗竭性資源。試各舉三例。
25. 界面電動能(Zeta potential)為何？在資源處理作業上具何種功能？
26. 怎麼評估資源分選的優劣？
27. 工業上常利用水之由固(solid)相直接進入汽(gas)相的相變過程製作即溶咖啡粉。此一脫水過程稱為冷凍乾燥。試以水的 P vs T 相圖說明其操作原理。
28. 一般所稱深色(deep-colored)礦物與淺色(light-colored)礦物為何？對岩石命名的重要性如何？
29. 一結晶體的內部構造(Crystal structure)由完整而破壞的過程。可以利用 XRD 及 Electron diffraction pattern 觀察之，二者之 pattern 會有何變化？為什麼？
30. 何謂 a. Isomorphism、b. Polymorphism、c. Isostructuralism、及 d. Pseudomorphism？舉礦物為例加以說明