

※ 注意：請於試卷內之「非選擇題作答區」依序作答，並應註明作答之大題及小題題號。

一、以下是摘自美國礦物學會礦物手冊對 Pyrite 的描述。請詳細閱讀後，回答本題的十小題。除第 2、第 3 小題之外，請以中文答題，照抄英文以零分計。(每小題 2 分，共 20 分)

Pyrite

FeS₂

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Crystal Data: Cubic. *Point Group:* $2/m\bar{3}$. Typically cubic, pyritohedral, octahedral, and combinations of these and other forms, to 25 cm or more. Striated conforming to pyritohedral symmetry; may be elongated to acicular. Commonly granular, globular, framboidal, stalactitic. *Twinning:* Twin axis [001] and twin plane {011}, penetration and contact twins.

Physical Properties: *Cleavage:* Indistinct on {001}; partings on {011} and {111}, indistinct. *Fracture:* Conchoidal to uneven. *Tenacity:* Brittle. *Hardness:* 6-6.5 VHN = 1505-1520 (100 g load). *D(meas.)* = 5.018 *D(calc.)* = 5.013 Paramagnetic; a semiconductor.

Optical Properties: Opaque. *Color:* Pale brass-yellow, tarnishes darker and iridescent; in polished section creamy white. *Streak:* Greenish black to brownish black. *Luster:* Metallic, splendid. *Anisotropism:* Rarely.
R: (400) 38.2, (420) 40.5, (440) 42.8, (460) 45.5, (480) 48.5, (500) 51.0, (520) 52.6, (540) 53.8, (560) 54.6, (580) 55.0, (600) 55.2, (620) 55.5, (640) 56.0, (660) 56.4, (680) 56.8, (700) 57.0

Cell Data: *Space Group:* Pa3. *a* = 5.4179(11) *Z* = 4

X-ray Powder Pattern: Synthetic.
 1.6332 (100), 2.7088 (85), 2.4281 (65), 2.2118 (50), 1.9155 (40), 3.128 (35), 1.4479 (25)

Chemistry:	(1)	(2)	(3)	(4)
Fe	46.49	29.30	33.32	46.55
Ni		16.69	0.19	
Co		trace	13.90	
S	53.49	53.40	52.45	53.45
Total	99.98	99.39	99.86	100.00

(1) Elba, Italy; remainder 0.04% SiO₂. (2) Mill Close mine, Derbyshire, England.
 (3) Gladhammar, Sweden. (4) FeS₂.

Polymorphism & Series: Dimorphous with marcasite; forms a series with catterite.

Mineral Group: Pyrite group.

Occurrence: Formed under a wide variety of conditions. In hydrothermal veins as very large bodies, as magmatic segregations, as an accessory mineral in igneous rocks, in pegmatites; in contact metamorphic deposits, also in metamorphic rocks; as diagenetic replacements in sedimentary rocks.

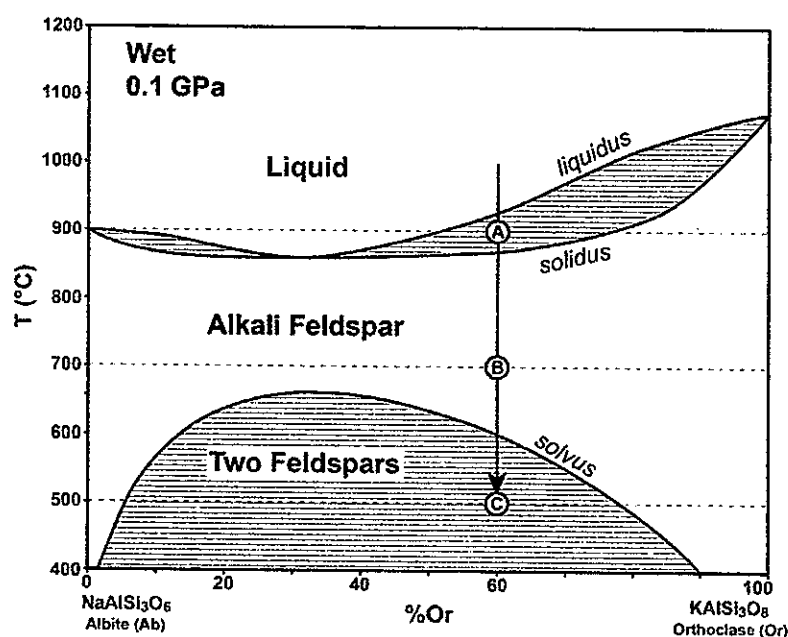
Association: Pyrrhotite, marcasite, galena, sphalerite, arsenopyrite, chalcopyrite, many other sulfides and sulfosalts, hematite, fluorite, quartz, barite, calcite.

Distribution: The most abundant and widespread sulfide. Only a few localities for large or fine crystals can be mentioned. From Rio Marina, on Elba, and at Traversella, Piedmont, Italy. From Ambasaguas and Navajun, Logroño Province, Spain, sculptural groups of crystals. At Aktchitao, Kazakhstan. In the USA, in the Ibex mine, Leadville, Lake Co., Colorado; in Illinois, as "suns" at Sparta, Randolph Co.; very large crystals from the Santo Niño mine, near Duquesne, Santa Cruz Co., Arizona. In Pennsylvania, at the French Creek mines, Chester Co., and in the Carleton talc mine, Chester, Windsor Co., Vermont. From Butte, Silver Bow Co., Montana; at the Spruce claim, King Co., Washington; as "bars" from the Buick mine, Bixby, Iron Co., Missouri. In Peru, from many districts, with exceptional crystals from the Quiruvilca mine, La Libertad, and Huanzala, Huanaco.

Name: From the Greek for fire, as sparks may be struck from it.

1. Pyrite 的中文名稱是什麼？屬於哪一個晶系？
2. Pyrite 屬於哪個點群？哪個空間群？
3. Pyrite 的比重是多少？硬度是多少？
4. Pyrite 有什麼樣的雙晶型態？
5. Pyrite 的化學式為何？除了主要元素以外還可能含有哪些其他元素？
6. Pyrite 屬於何種礦物化學分類？有哪些良好或是大型晶體的產地？請列兩處。
7. Pyrite 在肉眼下的光學特性為何？
8. Pyrite 的斷口形狀為何？磁性特徵為何？
9. Pyrite 的成礦環境與方式有哪些？請列出兩種，只寫岩性以零分計。
10. Pyrite 的名稱是起源自哪種文字？原來的意思為何？

二、以下為 Albite (Ab) 與 Orthoclase (Or) 的二元相圖。圖中有一降溫路徑，顯示成份為 60 wt.% Or 的液態熔岩由攝氏 1,000 度往下降溫，途經 A 點 (攝氏 900 度)、B 點 (攝氏 700 度) 以及 C 點 (攝氏 500 度)。請回答與該相圖有關的五小題 (每小題 3 分，共 15 分)：



1. 以 Albite 與 Orthoclase 為例，說明什麼是「不完全固溶體」(incomplete solid solution)，以及其形成不完全固溶體的原因。
2. 以上方相圖為例，說明什麼是「溶離線」(solvus)，以及「離溶作用」(exsolution)。
3. 當成份為 60 wt.% Or 的液態熔岩降至攝氏 900 度 (A 點) 時，有多少相並存？分別是哪些相 (如果該相為固溶體，請以 %Or 為單位寫出成分)？如果多相並存，每個相各佔多少重量百分比 (wt.%)？
4. 當成份為 60 wt.% Or 的液態熔岩降至攝氏 700 度 (B 點) 時，有多少相並存？分別是哪些相 (如果該相為固溶體，請以 %Or 為單位寫出成分)？如果多相並存，每個相分別佔多少重量百分比 (wt.%)？
5. 當成份為 60 wt.% Or 的液態熔岩降至攝氏 500 度 (C 點) 時，有多少相並存？分別是哪些相 (如果該相為固溶體，請以 %Or 為單位寫出成分)？如果多相並存，每個相分別佔多少重量百分比 (wt.%)？

三、名詞解釋 (每小題 5 分，共 35 分)：

1. Silica tetrahedron
2. Polymorphism
3. Anisotropic mineral
4. Diatreme
5. Serpentinite
6. Regional metamorphism
7. Roundness

四、問答題：(共 30 分)

1. 當軟流圈地函的岩石「Lherzolite」在中洋脊地區發生部分熔融時，則隨著部分熔融程度的提高，其鐵鎂質礦物的組成比例會逐漸有哪些變化？(4 分)
2. 寫出並說明 (1) 火成岩、(2) 沉積岩中可用來判斷古地理空間上、下的構造各一。(各 4 分，共 8 分)
3. 簡要地繪圖與說明「砂岩」分類的依據。(8 分)
4. 說明影響變質岩中各礦物顆粒大小的可能因子。(10 分)