

**Prince of Songkla University**  
**Faculty of Engineering**

**Final Examination: Semester I**

**Academic Year: 2009**

**Date: September 28, 2009**

**Time: 9:00-12:00**

**Subject: 226-304 Heat Treatment Technology**

**Room: A400**

ทฤษฎีในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้นและพักการเรียน 1 ภาคการศึกษา

ชื่อ..... ชื่อสกุล ..... รหัส .....

**Instruction:**

1. *There are 2 parts, 40 questions and 120 points for Part I and 20 questions and 30 points for Part II*
2. *Attempt all questions.*
3. *Only a hand-written note on two-sided A4 and a dictionary are allowed.*
4. *Borrowing things form other students is prohibited.*

**Napisorn Memongkol**  
**Instructor**

**Part I: Answer all the questions (120 points)**

1. (2 points) What are the two different methods of surface hardening?

First method is.....

Second method is .....

2. (3 points) Carburizing can be divided into three categories, what are they?

.....

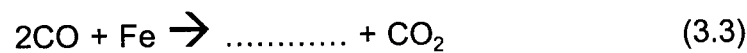
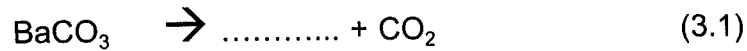
.....

.....

3. (4 points) What is the purpose of BaCO<sub>3</sub> in Carburizing process?

Complete the equations below and give an answer what is the source of carbon in equation 3.2?

BaCO<sub>3</sub> is used for .....



The carbon in equation (3.2) came from .....

4. (2 points) What are the two stages of Vacuum Carburizing?

First stage is .....

Second stage is .....

5. (2 points) As compared to conventional atmosphere carburizing, how many percent of volume of gaseous hydrocarbon is required for identical carburizing? .....%

6. (2 points) What are the limitations of vacuum carburizing?

..... and  
.....

7. (2 points) Why post-carburizing heat treatment is necessary for case carburized parts?

..... and  
.....

8. (2 points) Why the use of a closed pot and ventilating hood are required for cyaniding?

.....

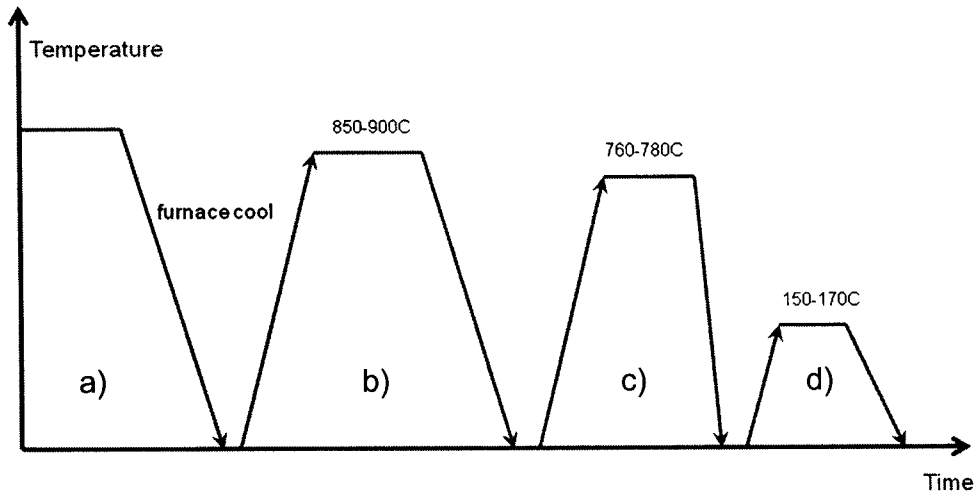
9. (2 points) Why cyaniding process is **less time consuming**?

Because of ..... and  
.....

10. (2 points) Compare **cyaniding** and **carbonitriding** case hardening processes

**Cyaniding** is .....  
while **Carbonitriding** is .....

11. (4 points) Complete the graph of post carburizing heat treatment below.



a is .....  
b is .....  
c is .....  
d is .....

12. (2 points) What kinds of steel using carbonitriding process for improving wear **resistance**?

.....

13. (3 points) Compare to carburizing process, the carbonitriding process are better than carburizing process in .....,  
 ....., and  
 .....

14. (2 points) What kind of steel using nitriding processes the most effective?  
 .....

15. (2 points) What is the material used to cover the portion not to be nitrided in Nitriding process?  
 .....

16. (3 points) What are the advantages of the Nitrocarburizing process?  
 1) .....  
 2) .....  
 3) .....

17. (2 points) Give two examples of the applications of boronizing process?  
 .....

18. (4 points) Complete the table below

Process	Material	Typical surface hardness, VHN
Carburizing	.....	850
Boronizing	.....	1500
Chromizing	Carbon steel, tool steel	.....
Toyota diffusion process	Tool steel	.....

19. (2 points) Toyota diffusion process (TDP) is also known as

..... (TD) and  
..... (TRD)

20. (4 points) What are the benefits of flame hardening?

- 1) .....
- 2) .....
- 3) .....
- 4) .....

21. (4 points) List the disadvantages of flame hardening.

- 1) .....
- 2) .....
- 3) .....
- 4) .....

22. (6 points) Explain the three methods of flame hardening?

- 1) .....  
.....  
.....
- 2) .....  
.....  
.....
- 3) .....  
.....  
.....

23. (3 points) In induction hardening, the degree of current flow on the outer surface of the component depends on 1) ..... ,  
2) ....., and 3) .....  
of the component (last two factors depend on temperature)

24. (3 points) Explain the three procedural principle of the Laser Hardening.

a) .....

.....

b) .....

.....

c) .....

.....

25. (3 คะแนน) ในการควบคุมบรรยากาศภายในเตามีจุดมุ่งหมายสำคัญ 3 ประการ อะไรบ้าง

1.....

2.....

3.....

26. (2 คะแนน) การใช้แก๊สไฮโดรเจนควบคุมบรรยากาศในเตา กระทำได้ 2 ลักษณะ คือ

.....

.....

27. (2 คะแนน) ให้ออกชนิดของโลหะ ที่นิยมใช้บรรยากาศไฮโดรเจนสำหรับการอบชุบ มา 2 ชนิด

..... และ .....

28. (2 คะแนน) ให้ออกข้อดี และข้อเสียของการควบคุมบรรยากาศภายในเตาอบชุบเป็นแบบ  
สุญญากาศ

ข้อดีคือ.....

ข้อเสีย คือ.....

29. (4 คะแนน) ให้ออกความแตกต่างระหว่างบรรยากาศแก๊สเอกซโซเทอร์มิก (exothermic gas) และบรรยากาศแก๊สเอนโดเทอร์มิก (endothermic gas)

.....

.....

.....

.....

.....

.....

30. (2 คะแนน) การอบชุบเหล็กในอ่างเกลือหลอมละลายช่วยลดปัญหาการเกิดปฏิกิริยาที่ผิวเหล็กได้อย่างไร

.....

.....

31. (2 points) What is the basic aim of heat treatment aluminium alloys?

.....

32. (4 points) What is the meaning of specific letter of condition or temper of Al alloy?

Letter	Condition of alloy
F	.....
O	.....
T	.....
H	.....

33. (2 points) what is (aluminium alloy) 5052 H18?

.....

34. (2 points) What are the two annealed tempers of copper alloys?

.....

.....

35. (4 points) Fill in the alloying element in the table below

Alloy No.	Aluminium wrought alloys (major alloying element)
1xxx	Commercially pure aluminium (99% pure)
2xxx	.....
3xxx	Manganese
4xxx	.....
5xxx	Magnesium
6xxx	.....
7xxx	.....

36. (3 points) What are the applications of Al alloy series 6xxx?

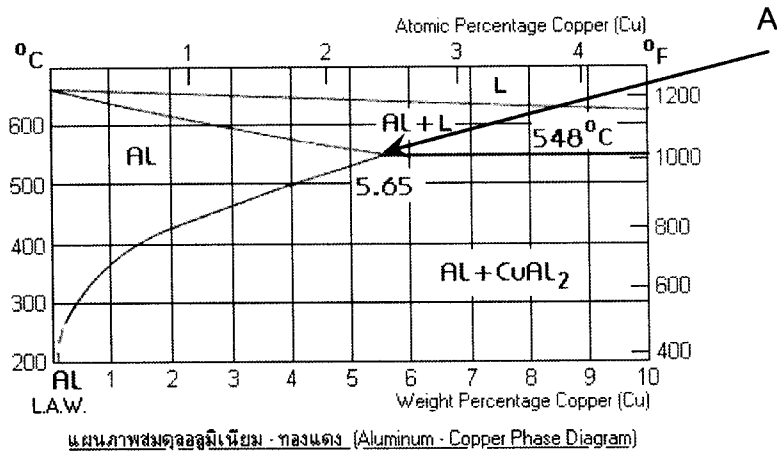
.....  
 .....  
 .....

37. (6 points) Explain the natural aging and artificial aging of aluminium alloys?

Natural aging .....  
 .....  
 .....  
 Artificial aging .....  
 .....  
 .....

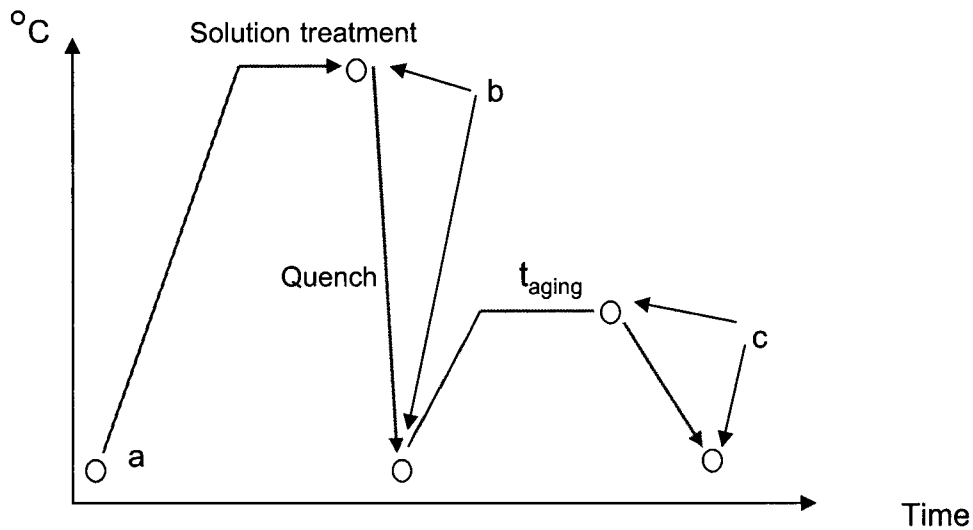


38. (4 points) From the Al-Cu phase diagram below, answer the following questions.



- a) The meaning of point A .....
- .....
- b) Copper increases the strength of aluminium by .....
- .....

39. (6 points) From the precipitation hardening of aluminium graph below, draw the microstructures of aluminium at each point.



a

b

c

.....

10. In Nitriding process, ..... gas is passed into the furnace at about 550°C, it dissociates into nitrogen and hydrogen

40. (5 points) What are the five principal types of heat treatment of nickel and nickel alloys?

.....  
.....  
.....  
.....  
.....

**PART II: Fill in the blank (1 point each ) 30 points**

1. Liquid carburizing is also known as.....
2. The most widely used method of carburizing is .....
3. The advantages of liquid carburizing are .....  
and .....
4. In Pack Carburizing the depth of penetration depend on .....
5. Recent development of gas carburizing technique is the use of .....  
..... as a carrier gas
6. Main advantage of Vacuum Carburizing is .....
7. In vacuum carburizing the gaseous hydrocarbon is introduced into the furnace, give two examples of gaseous hydrocarbon .....  
and .....
8. The quantity of gaseous hydrocarbon using in vacuum carburizing depend on a).....  
b).....  
c).....
9. Sub zero treatment is also called “.....” processes,  
which involve cooling materials or components to temperatures as low as .....
10. In Nitriding process, ..... gas is passed into the furnace at about 550°C, it dissociates into nitrogen and hydrogen

*me e*

- a) .....
  - b) .....
  - c) .....
20. When annealing copper that contains oxygen, the hydrogen in the atmosphere must be kept to a minimum to avoid .....

11. The Boronizing process can apply to any ferrous material but adopted for ..... **steels** and ..... **steels**
12. In Boronizing process, boron diffuses inwards and .....layers are formed
13. In ..... process, the components are packed with chromium powder and additive and put in the furnace.
14. Aluminum alloys and be divided into two forms ..... and .....
15. The objective of solution heat treating aluminium is to .....
16. Age hardening of aluminium is also called as .....
17. The objective of quenching aluminium is to .....  
....., by .....
18. Most frequently, aluminium parts are quenched by immersion in .....
19. Titanium and titanium alloys are heat treated in order to
  - a) .....
  - b) .....
  - c) .....
20. When annealing copper that contains oxygen, the hydrogen in the atmosphere must be kept to a minimum to avoid .....