



UNIVERSITY OF GHANA

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SCHOOL OF ENGINEERING SCIENCES

BSc. (ENG) MATERIALS SCIENCE AND ENGINEERING

END OF FIRST SEMESTER EXAMINATIONS: 2014/2015

MTEN 403: REFRACTORIES

(2 CREDITS)

TIME ALLOWED: 2 HOURS

ANSWER ALL QUESTIONS

1. a) What is a refractory material?
b) Principal raw materials used in the production of refractories are either oxides or non-oxides. List five (5) oxides and five (5) non-oxides raw materials used in the production of refractories.
c) Refractories can be used in boilers, furnaces and ovens. What is a:
i) Boiler?
ii) Furnace?
iii) Oven?
2. a) What are monolithic refractories?
b) Monolithic refractories are rapidly replacing the conventional type fired refractories in many applications including industrial furnaces. What are the main advantages of monolithic refractories?
c) Monolithics are put in place using various methods. What are these methods?
d) What is a mortar and what is it used for in the construction of a furnace?

(20 points)

(20 points)

3. a) Define the following terms:

- i) Bulk density
- ii) Apparent porosity
- iii) True porosity

b) List the advantages and disadvantages of high porosity refractory materials.

c) What is the difference between the modulus of rupture (MOR) and hot modulus of rupture (HMOR)?

d) The flexural strength of a refractory material is 315 MN.m^{-2} . A sample, which is 12 mm wide, 9.5 mm high, and 200 mm long is supported between two rods 125 mm apart. Determine the force required to fracture the material and the cold crushing strength if the load is applied vertically to the 12 mm X 9.5 mm face.

(20 points)

4. a) Define the following terms:

- i) Refractoriness
- ii) Pyrometric cone equivalent (PCE)
- iii) Refractoriness under load (RUL)
- iv) Dimensional stability
- v) Spalling

b) State eight (8) requirements of a refractory material.

(20 points)

5. a) One of the most widely used insulating material is diatomite, also known as kiesel guhr. What is kiesel guhr made of?

b) Describe the experimental procedure for determining dry weight, D, saturated weight, W and suspended weight, S of refractories.

c) A physical analysis of a refractory brick gave the following results:

Dry weight, D = 1804.35 g

Suspended weight, S = 1073.36 g

Saturated weight, W = 1873.55 g

Assuming that the density ρ of water = 1 at normal temperature, determine the following:

- i) Water absorption
- ii) Apparent specific gravity.

(20 points)

All required formulae are provided below.

$$S = F/A$$

$$MOR = 3FL/2wh^2$$

$$V_{ex} = W - S \quad V_{op} = W - D$$

$$P, \% = \frac{W - D}{V_{ex}} \times 100$$

$$B = D/V$$

$$A, \% = [(W - D)/D] \times 100 \quad T = D/(D - S)$$