Unit 19 · Cement

WORKSHEET

Full marks 36

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 36

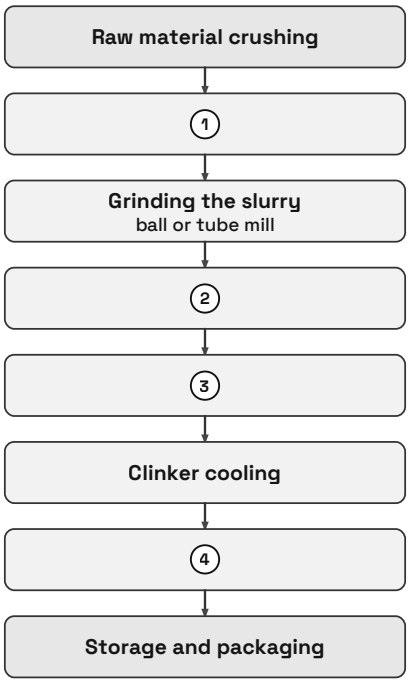
1 Key words [3]

Match each term in Column A with its meaning in Column B. One meaning in Column B is not needed. Each carries 0.5 mark.

Column A		Column B
1. calcareous material	☐	**a.** a cement that hardens only in dry air, by taking up carbon dioxide
2. argillaceous material	☐	**b.** the small, hard, dark gray lumps that come out of the kiln
3. clinker	☐	**c.** a material rich in reactive silica, such as fly ash
4. pozzolana	☐	**d.** a paste of cement, sand and water used to join bricks
5. non-hydraulic cement	☐	**e.** a raw material rich in clay, supplying silica and alumina
6. efflorescence	☐	**f.** a raw material rich in lime, such as limestone
		g. white salty patches on walls, from too much alkali oxide

2 Label the diagram [2]

The flow sheet shows the wet process for making Portland cement. Write the step that belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ **2.** _____

3. _____ **4.** _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. Lime, CaO, makes up about what share of ordinary Portland cement? [1]

a. 3–5% **b.** 20–30%
c. 60–67% **d.** 90–95%

ii. Which compound of the clinker gives concrete its early strength, in hours and days? [1]

a. tricalcium silicate, C_3S **b.** dicalcium silicate, C_2S
c. tricalcium aluminate, C_3A **d.** tetracalcium aluminoferrite, C_4AF

iii. In a rotary kiln, the raw meal and the hot gas: [1]

a. move in the same direction **b.** move in opposite directions
c. stay still while the kiln turns **d.** never meet

iv. The magnesium oxide in cement is kept low because too much of it: [1]

a. stops the clinker forming
b. makes the cement white
c. reacts with water after the concrete has set, swells and cracks it
d. causes flash setting

v. The number in "OPC 53" is: [1]

a. the percentage of clinker in it
b. its compressive strength in N/mm^2 at 28 days
c. the year the grade was set
d. the days it takes to set

4 Short answers [11]

Write short answers to the following questions.

a. Write balanced equations for i. the calcination of limestone in the kiln, and ii. the formation of tricalcium silicate. [2]

b. How do cement, mortar and concrete differ? [2]

c. Why is gypsum ground in with the clinker? What would happen without it? [2]

d. How does the pozzolana in PPC make concrete more durable? **[2]**

e. Write the equation for the hydration of tricalcium silicate. Why does concrete keep getting stronger for months after it is laid? **[3]**

5 Long answer **[4]**

Write a long answer to the following question.

Compare OPC and PPC under three headings: what is in each, heat of hydration and strength, and their effect on the environment. Which would you choose for a dam, and which for the columns of a building that must take load early? Give reasons.

6 Numerical problems **[8]**

Solve the following problems. Show your working. Take Ca = 40, C = 12, O = 16, the molar volume of a gas at STP as 22.4 L, and the heat needed to evaporate water as 2.3 MJ per kg.

a. One tonne of clinker contains 650 kg of calcium oxide, all from limestone. i. Write the equation for calcination. ii. Find the mass of calcium carbonate that must be broken down. iii. Find the mass of carbon dioxide given off by the limestone itself, and its volume at STP. iv. Each 50 kg bag of cement is 4% gypsum. What mass of gypsum is in a bag? **[4]**

Answer:

b. A wet-process plant feeds its kiln a slurry that is 35% water by mass. i. What mass of water goes into the kiln with each tonne of dry raw materials? ii. How much heat is needed just to evaporate it? iii. If the coal burned gives 24 MJ per kg, what mass of coal does that take? iv. Why does the dry process need no such fuel? **[4]**

Answer: _____

7 Think [3]

About half the carbon dioxide from making cement comes from the limestone itself, not from the fuel. Why would running the kiln on clean electricity not remove this half? How does making PPC instead of OPC reduce it?

8 Activity: Lime mortar and cement mortar (not marked)

Carry out this activity under your teacher's eye; wear gloves and goggles, since wet cement and slaked lime are caustic and burn the skin and eyes. Make two small patties in old plastic lids: one of cement, sand and water (1 : 3, with just enough water to make a paste), the other of slaked lime, sand and water. After a day, put half of each under water in a jar and leave the other half in the air for a week.

Patty	After 1 day in air	After a week in air	After a week under water
cement mortar			
lime mortar			

Which is a hydraulic cement? How can you tell?