A20072
Calculators may be used in this examination but must not be used to store text.
Calculators with the ability to store text should have their memories deleted prior to the start of the examination.

THE UNIVERSITY OF BIRMINGHAM

Degree of BEng/MEng with Honours

Chemical Engineering with Foundation Year
Civil Engineering with Foundation Year
Electronic and Electrical Engineering with Foundation Year
Mechanical Engineering with Foundation Year
Manufacturing Engineering with Foundation Year
Metallurgy and Materials Engineering with Foundation Year

METALLURGY AND MATERIALS COURSE 04 01874
(094 Properties of Matter)

May 2004 2 hours

Candidates should attempt <u>four</u> questions only. All questions carry equal marks

There are 80 marks available on this paper.

1. What is a ceramic? (2 marks) Why are ceramics generally less dense than metals? (8 marks)

   (a) What would be the edge length of a cube of granite whose mass is one tonne? (5 marks)

   (b) What mass of copper ingot would be required to make 1 km of wire whose circular cross-section has a diameter of 1 mm? (5 marks)

   [The densities of granite and copper are 2400 and 8900 kg m^{-3}, respectively.]

2. Provide a brief description of:

    (a) the tensile test   (5 marks)

    (b) the hardness test   (5 marks)

    (c) the impact test   (5 marks)

A building is supported on four equally sized cylindrical pillars. The material from which the pillars are made has a yield strength of 400 MPa. If the mass of the building is 10,000 tonnes, what must be the compressive minimum diameter of the pillars if they are not to deform plastically? (5 marks)

[The acceleration due to gravity is 9.81 ms^{-2}.]

3. How are polymers manufactured? (8 marks) What causes them to degrade? (8 marks) How can the process of degradation in polymers be prevented or inhibited? (4 marks)

4. Describe the following and explain when they might be used:

    (a) casting   (5 marks)

    (b) rolling   (4 marks)

    (c) joining.   (4 marks)

Indicate briefly how, and from what, the following might be made:

    (d) a glass tumbler   (2 marks)

    (e) a garden spade   (3 marks)

    (f) a plastic bucket.   (2 marks)

5. Why are metallic materials used as alloys rather than as pure metals? Describe the common strengthening mechanisms that occur when an alloying element is added to a pure metal, and discuss any other reasons why alloys may be used for practical applications. (7 marks)

Write short notes on the following alloys:

(a) steel   (7 marks)

(b) brass and bronze   (2 marks)

Why is copper wire used for electrical purposes *not* alloyed? (2 marks)

Are ceramics ever alloyed? (2 marks)

6. (a) A mercury in glass thermometer is calibrated by reference to the freezing and boiling points of water. When placed in water containing ice the level of the mercury is 15 mm above the reservoir at the base of the thermometer. When placed in boiling water the level of the mercury is 85 mm above the reservoir at the base of the thermometer. If the thermometer is placed in water heated to 75°C what would be the height of the mercury in the thermometer? (4 marks)

(b) A Cu calorimeter of mass 800 g, contains 0.5 litre of water, (= 500 g in mass), at a temperature of 293 K. Into this is dropped 400 g of an unknown material, at a temperature of 500 K. The temperature of the water at the end of the experiment is 340 K. What is the specific heat capacity of the material? (8 marks)

(c) If steel is heated from room temperature, (20°C), to 500°C, what would be the change in density? (8 marks)

[Specific heat capacity of Cu = 380 J $kg^{-1} K^{-1}$

Specific heat capacity of water = 4190 J $kg^{-1} K^{-1}$

Coefficient of linear expansion for steel = 12 x $10^{-6} K^{-1}$

Density of steel = 7800 kg m^{-3}.]

End of question paper

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