THE OPEN UNIVERSITY OF SRI LANKA

DIPLOMA IN TECHNOLOGY - LEVEL 01

068

FINAL EXAMINATION 2007

CEX1330/CEF1301 - ENGINEERING PROPERTIES OF MATERIALS

Time allowed: 3 Hours Registration No.:

Date: 21st March, 2007 Time: 13:30-16:30

Note: The Periodic table is given on the last page for reference.

PART A:

Answer all questions. Each question carries 2.5 marks and the mark for Part A makes up 30% of the total mark.

1. A dolphin can leap several meters above the ocean's surface. Explain how the dolphin overcomes the force due to gravity.
2. People frequently experience a peculiar inner sensation (example: usually a disturbing feeling in the pit of the stomach) in a moving elevator. Discuss the cause of this effect.
3. It is much easier to stop a bicycle traveling toward you at 5 kilometers -per-hour than an automobile traveling toward you at the same velocity. Describe what accounts for this difference?
4. There are six calcium isotopes of atomic weight 40, 42, 43, 44, 46 and 48. Find the number of protons and neutrons in the nuclei of each isotope.
5. State the different types of bonding between atoms and molecules. Give an example each. You may use sketches to explain your answer.
6. A person would feel the reaction acting on his body as its `weight'. Explain why one feels a loss of weight when in a water pool.
7. Describe the process of writing with chalk on a black board in terms of friction and wear.
8. Solid iodine consists of shiny black crystals. Iodine vapour is purple. Explain the difference in chemical bonding between solid and gaseous iodine?
9. Explain why an iron wire when heated to a very high temperature and when quenched in water, becomes very brittle.

10. After you push a suction cup against a smooth wall, the elastic cup bends back and a small, empty space is created between the cup and the wall. Explain what keeps the suction cup against the wall (explain your answer with a diagram)?

11. Grease, coconut oil, engine oil, brake oil, (sewing) machine oil and water have varying viscosities. List these in the ascending order of the said property. List one application each where these are used as lubricants.

12. Explain how you would identify a transition element based on its electron configuration. List 3 (three) characteristic properties shown by transition elements.

PART B:
Answer 4 questions. Each question carries 17.5 marks and the mark for part B makes up 70% of the total mark.

1.

a) The micrometer screw gauge is an instrument designed for accurate measurement of small distances. Figure Q1 shows a part of a micrometer screw gauge. The circular scale is divided into 50 divisions. When the screw rotates by one complete cycle the main scale moves 0.5 mm.

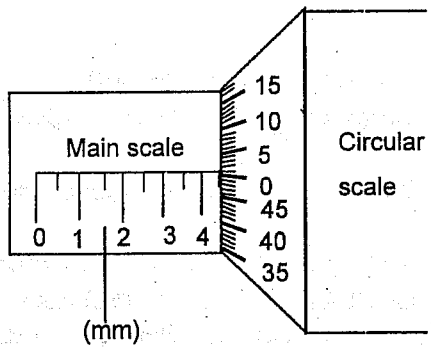

Figure Q1

i) Determine the least count of the screw gauge. (2 marks)

ii) Explain how you determine 'zero error' in a micrometer screw gauge. (1 mark)

iii) Explain the main purpose of a 'thimble head' of a micrometer screw gauge. (1.5 marks)

iv) A micrometer screw gauge was used to measure the diameter of a wire. The observed reading is shown in Figure Q1. Assuming that there is no zero error in the instrument, find the diameter of the wire. (2.5 marks)

v) Usually three trials are made in measuring the diameter of the wire at different places along its length. State the assumptions that you make in assuming that these three trials give an accurate value for the diameter. (2 marks)

b) A small bob of mass m is hung at the end of a thin thread of length l to make a simple pendulum.

i) Verify that the equation used to compute the time period of a simple pendulum can be given by $T = 2\pi\sqrt{l/g}$ is dimensionally correct. (1.5 marks)

ii) Determine the length of the pendulum which passes through its lowest point every second. (1.5 marks)

iii) Explain how you can determine the value of g (gravitational acceleration) in the laboratory using the above equation. (2 marks)

iv) Suggest an experiment that could determine if the period of the pendulum dependends on the mass of the bob. (1 mark)

v) Suppose a pendulum consists of a hollow sphere. Would the behaviour of the pendulum change if the sphere were filled with water? (1 mark)

vi) A large clock is controlled by a pendulum. If the clock is taken to the moon, where objects weigh only about 1/6th their weight on earth, would it run fast, slow or on time. Explain your answer. (1.5 marks)

2.

a) A kite weighing 2.0 N is held stationary by the push of the wind and the pull of the string on it (see Figure Q2). The tension in the string, which makes an angle of 35^0 to the vertical at the place where it meets the kite, is 9.0 N.

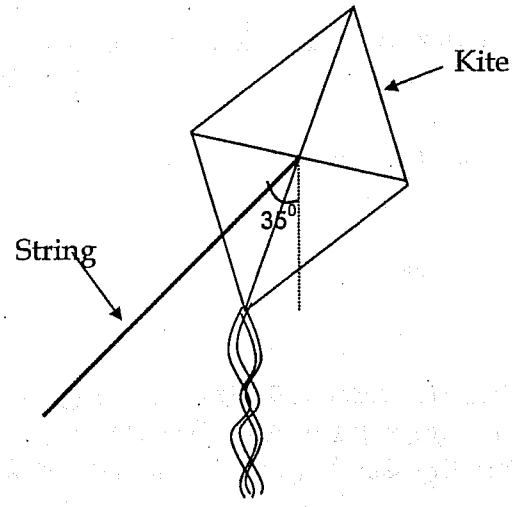

Figure Q2

i) Draw a free body diagram of the kite and mark all the forces.
(2.5 marks)

ii) Determine size and direction of the push of the air on the kite.
(4 marks)

b) An aluminium wire of length 1m has a cross sectional area of 0.10 mm^2; a chromium wire of length 2.0m has a cross sectional area of 0.050 mm^2. The Young modulus of chromium is four times larger than that of aluminium.

i) State Hooks law and define the terms used in the expression.
(2 marks)

ii) When the same mass is hung from each wire, which has the larger extension? (3.5marks)

iii) Find which wire is stiffer. (1 mark)

c) If you are given a glass rod, a copper wire, a length of rubber and a strip of polythene, Sketch the stress-strain behaviour for each specimen. Name the axes. Indicate the point where the specimen breaks with a x mark. (4.5 marks)

3.

a)

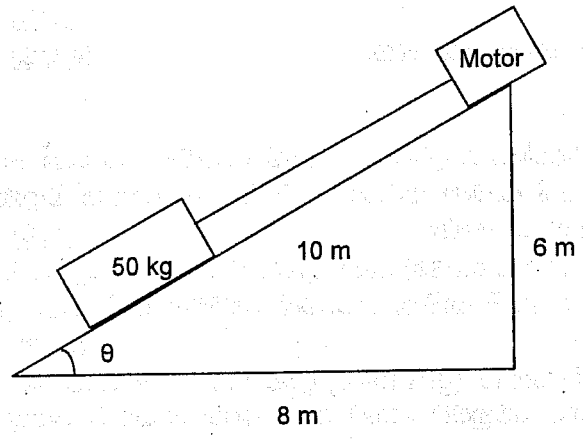

Figure Q3

A motor is to pull a 50 kg block up the incline shown in Figure Q3. The coefficient of friction between the block and the incline is 0.7.

i) State the law of dry friction. Define the terms in the expression. Explain the difference between static and dynamic friction. (1.5 marks)

ii) Draw a free body diagram for the block indicating all the forces. (3 marks)

iii) Determine the tension in the rope if the block is moving at a constant speed? (2 marks)

b) The Flow rate through a pipe of length L and radius R for laminar flow can be given by

$$Q = \frac{\pi R^4 (P_1 - P_2)}{8\eta L}$$

where

Q - Flow rate, η - Viscosity, $(P_1 \_ P_2)$ - Pressure differential

i) List the SI units and dimensions for Q, P, R and L (2 marks)

ii) Determine the units and dimensions of η. (3 marks)

c) Explain the following;

i) Socks are usually made of two materials – a textile such as cotton and an elastic material. Explain why a mixture of fibers is used. (2 marks)

ii) Fiberglass is made of glass fibers dipped in a resin. Explain the advantages of using glass fibers. (2 marks)

iii) Explain why a granular material forms a heap when poured on to a horizontal surface. (2 marks)

4.

a) Concrete is an artificial composite. Figure shows an unreinforced concrete beam, which has failed due to the formation of micro cracks.

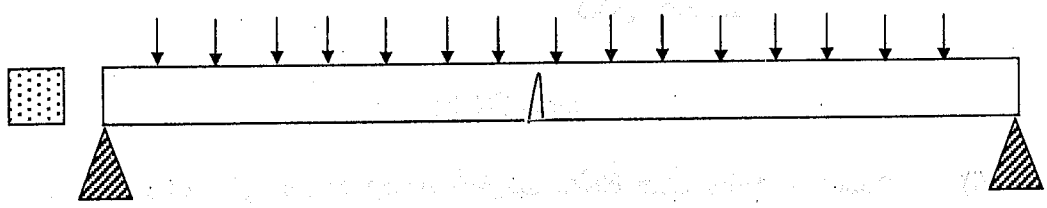

Figure Q4(a)

i) Sketch and explain how the above-mentioned beam can fail marking the forces at the crack. (3 marks)

ii) Suggest two methods from which you can make the above beam strong. Sketch the sections of the beam you have suggested. (3 marks)

iii) Identify the most economical section of the two you have suggested in (ii)? (1.5 marks)

iv) Identify the ingredients used in producing concrete. Discuss the resulting properties and characteristics of concrete against the properties of individual ingredients used to produce concrete. (2.5 marks)

b)

Figure Q4(b) illustrates a table knife with some of its parts.

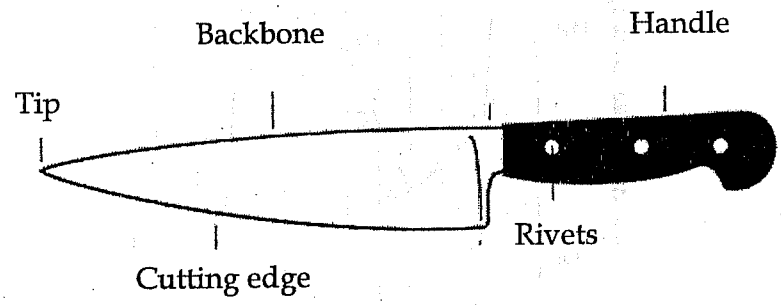

Figure Q4(b)

i) Identify different materials used to manufacture the knife shown in Figure Q4(b). (2.5 marks)

ii) Explain how a good knife is identified. State the purpose for which it is used. (1 mark)

iii) Identify the properties that you would require of the material used to make the cutting edge of your knife. (2 marks)

iv) A knife is made by a single piece of metal. How does it achieve different properties in different places of the knife? (2 marks)

5.

a) Figure Q5 shows a plot of first ionisation energy against atomic number for the first thirteen elements of the periodic table.

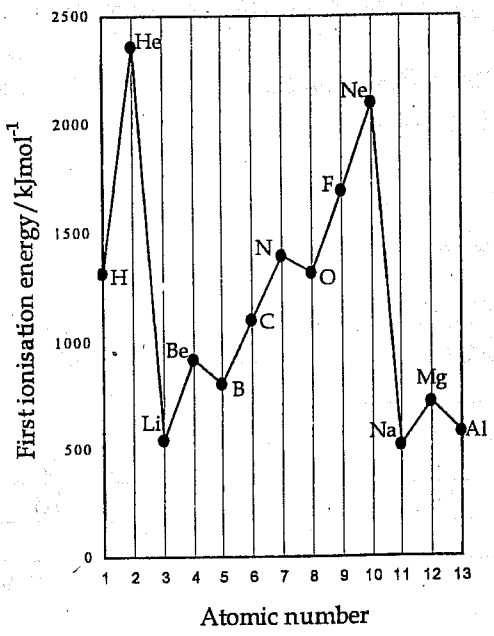

Figure Q5

With reference to the electronic configuration of the elements explain why;

i) The first ionisation energy for neon (Ne) is lower than that of helium (He). (2 marks)

ii) The first ionization energy for Beryllium (Be) is greater than those for lithium and boron. (2 marks)

iii) the first ionization energy for nitrogen (N) is greater than that for oxygen (O) (2 marks)

b) Explain the following considering the structure and bonding of the material.

i) Why is it easy to rub away carbon atoms from graphite? (1.5 marks)

ii) Why is graphite used as a lubricant? (1.5 marks)

iii) Why is it impossible to rub away carbon atoms from a diamond?
(1.5 marks)

iv) What characteristics of diamond and graphite are useful in industry?
(1.5 marks)

v) Why is diamond used in sharp cutting tools but not graphite.
(1.5 marks)

c) Complete the following table;

Isotope	Atomic number	Mass number	Number of electrons
^{31}P	15		
^{18}O	8		8
	19	39	18
$^{58}Ni^{2+}$		58	

(4 marks)

6.

a) A 0.7755g portion of a solid mixture containing sodium hydroxide and unreactive impurities is dissolved in water and titrated with standard 0.1000M H_2SO_4. 34.44 ml of the acid is required to neutralize the sample.

i) The concentration of the acid is given as '0.1000M'. Explain what is meant by 0.1000M. (2 marks)

ii) Explain the steps, which you will carry out in performing the above titration experiment in the laboratory. (2.5 marks)

iii) Write down the equilibrium equation for the above case. (2.5marks)

iv) Determine the percent by mass of the sodium hydroxide in the sample.
(3 marks)

v) State two errors that can occur during titration and the precautions that can be taken to reduce the errors. (1 mark)

b) Magnesium metal burns rapidly in air to form magnesium oxide. This reaction gives off an enormous amount of energy in the form of light and is used in both flares and fireworks. If 10.0g of magnesium reacts with 10.0g of oxygen;

i) Determine the number of moles of magnesium oxide that is formed.
(3.5 marks)

ii) Determine the mass of magnesium oxide. (3 marks)

The Periodic Table of the Elements

1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.933200	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.61	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90545	56 Ba Barium 137.327	57 La Lanthanum 138.9055	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.078	79 Au Gold 196.96655	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98038	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr