

Assignment 5

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- 1) Match the techniques listed in Column I with the characteristics of the materials measured in Column II.

Column I	Column II
P. DSC	1. Density of states
Q. XRD	2. Glass transition temperature
R. STM	3. Cathodoluminescence
S. SEM	4. Crystal structure
	5. Thermal expansion coefficient

(XE 2015)

- a) P-2, Q-3, R-4, S-1 c) P-2, Q-4, R-1, S-3
b) P-5, Q-4, R-5, S-1 d) P-3, Q-5, R-4, S-2

- 2) The mass of an electron would increase _____ times its original mass if it travels at 96% of the speed of light.

(XE 2015)

- 3) With increasing temperature from 15°C in winter to 40°C in summer, the length of an iron rail track increases by 0.05 cm. Calculate the original length of the iron rail track in cm.
(linear thermal expansion coefficient of iron is $11.0 \times 10^{-6} \text{K}^{-1}$)

(XE 2015)

- 4) What is the thickness (in μm) of a germanium crystal layer that would be required for absorbing 80% of the incident radiation whose wavelength is $1.3\mu\text{m}$? The absorption coefficient (α) of germanium at $1.3\mu\text{m}$ is $3.3 \times 10^5 \text{m}^{-1}$

(XE 2015)

- 5) A 1 kg sacrificial anode of Mg (atomic weight: 24.31 amu) is attached to the base of a ship. If the anode lasts for 60 days, what is the average corrosion current (in Amperes) during that period?

(XE 2015)

- 6) A capacitor has a 0.075 cm thick BaTiO_3 dielectric with a dielectric constant of 2000 and an electrode area of 0.2 cm^2 . What is the capacitance of this capacitor in nF?

(XE 2015)

- 7) A hot pressed ceramic composite material consists of 30 volume % SiC whiskers in an Al_2O_3 matrix. The measured bulk density of this composite is 3.65 g cm^{-3} , estimate the porosity (%) of the composite, assuming that the linear rule of mixtures is valid in this case.

(XE 2015)

- 8) Match the technical ceramics listed in Column I with their common applications listed in Column II

(XE 2015)

Column I	Column II
P. Y-doped ZrO_2	1. Lasers
Q. UO_2	2. Turbine Engine
R. Si_3N_4	3. Integrated circuit substrate
S. AlN	4. Oxygen sensor
T. Cr doped Al_2O_3	5. Nuclear fuel
	6. Thermistor

- a) P-6, Q-4, R-5, S-1, T-3
b) P-4, Q-5, R-2, S-3, T-1

- c) P-3, Q-1, R-2, S-6, T-5
d) P-1, Q-4, R-5, S-2, T-1

9) Creep in metals is defined as

(XE 2015)

- a) the maximum energy a solid can absorb elastically
b) the maximum energy a solid can absorb by plastic deformation
c) the stress at which plastic deformation starts
d) slow plastic deformation due to diffusion of atoms usually at high temperatures ($T >$ half the melting point)

10) Calculate the planar density of the (100) plane in an fcc crystal given that R is the atomic radius of the element.

(XE 2015)

- a) $0.25R^2$ b) $\frac{0.25}{R^2}$ c) $\frac{1}{R^2}$ d) $\frac{4}{R^2}$

11) The diffusion coefficient of copper atoms in aluminium is found to be $1.28 \times 10^{-22} \text{ m}^2 \text{ s}^{-1}$ at $T = 400 \text{ K}$ and $5.75 \times 10^{-19} \text{ m}^2 \text{ s}^{-1}$ at $T = 500 \text{ K}$. Find the temperature (in Kelvin) at which the value of the diffusion coefficient is $10^{-16} \text{ m}^2 \text{ s}^{-1}$

(XE 2015)

12) Calculate the density of copper in kgm^{-3} given that copper has an fcc lattice with a lattice parameter of 0.365 nm . Copper has an atomic weight of 63.54 amu .

(XE 2015)

13) What would be the maximum number of electron-hole pairs that can be generated using a silicon detector irradiated by X-ray of energy 1.54 keV . The band gap of silicon is 1.1 eV .

(XE 2015)