## Question 1

On the basis of ionic charge and ionic radii, predict crystal structures for the following materials:

a) CsI
b) NiO
c) KI
d) NiS

## Question 2:

The unit cell for $Al_2O_3$ has hexagonal symmetry with lattice parameters a = 0.4759 nm and c = 1.2989 nm. If the density of this material is 3.99 g/cm$^3$, calculate its atomic packing factor. Ionic radius for $Al^{+3}$ is 0.053 nm and for $O^{-2}$ is 0.140 nm.

## Question 3:

A ceramic material, in the form of a circular bar with radius 5mm, is tested in 3-point bending. The length between the support points is 50 mm. If the load required to cause fracture is 2380 N, determine the flexure strength of this ceramic.

a) If this material has a fracture toughness of 4.5 MPa.m$^{1/2}$ what is the size of the longest internal crack? Assume the geometric parameter Y is equal to 1.

b) Knowing that the modulus of elasticity for the nonporous material is 400 GPa, what is the elastic modulus of the porous ceramic if it has 10 vol% porosity?

## Question 4:

The tensile strength and number-average molecular weight for two polyethylene materials are as follows:

| Tensile Strength (MPa) | Number-Average Molecular Weight (g/mol) |
|---|---|
| 85 | 12,700 |
| 150 | 28,500 |

Estimate the number-average molecular weight that is required to give a tensile strength of 195 MPa.

## Question 5:

Briefly explain how each of the following influences the tensile or yield strength of a semicrystalline polymer and why:

(a) Molecular weight

(b) Degree of crystallinity

(c) Deformation by drawing

(d) Annealing of an undeformed material