

VERSION: 1-1

UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

Multiple Choice Assessment

July 22, 23, 2021

First Year

**APS164 - INTRODUCTORY CHEMISTRY FROM A MATERIALS
PERSPECTIVE**

Exam Type: X (Duration 1.5 hours, plus 30 minutes for submission, no extensions. Open Book; Internet okay, if not communicated/posted during test; no communication with others, including sites such as, but not limited to Chegg)

Examiner(s): SD Ramsay

*Note: as this is a formal assessment, late submissions will not be accepted.
This means that if you do not submit your responses successfully by the
deadline your responses will not be graded.*

Instructions:

- Answer all questions.
- Submit your answers to the Microsoft Form.

1. A rectangular cross-section tensile specimen is loaded by a tensile load of 14550 N. The unloaded gauge length is 220 mm, and the width and thickness of the reduced section are 10 mm and 5 mm, respectively, and the length of the reduced section is 256 mm. Under this load the gauge length elongates elastically by 8 mm. Which of the following is the correct Young's modulus for this material?
 - (a) 0.0 GPa
 - (b) 16005.0 GPa
 - (c) 8.0 GPa
 - (d) 9.3 GPa

2. Which of the following is the correct coordination number for the octahedral interstitial sites within the HCP crystal structure?
 - (a) 12
 - (b) 4
 - (c) 6
 - (d) 8

3. Which of the following is the correct coordination number for atoms within the BCC crystal structure?
 - (a) 12
 - (b) 8
 - (c) 4
 - (d) 6

4. An hypothetical metal having the BCC crystal structure is being studied. What is the coordination number of an atom at the surface of an exposed close-packed plane?
 - (a) There are no close-packed planes within BCC
 - (b) 8
 - (c) 7
 - (d) 6

5. A rectangular cross-section ceramic beam is loaded in 3-point bending by a force of 18.316 kN, resulting in a peak stress on the lower surface of the beam of 190 MPa. The beam has a width of 118 mm and a thickness of 48 mm. Which of the following is the span of this beam?
- (a) 1880.166 m
 - (b) 4230.373 m
 - (c) 4622.075 m
 - (d) 2820.249 m
6. An hypothetical ceramic having the rock salt crystal structure is being studied. A close-packed plane of anions is exposed along a surface. What is the ratio of cations having centres residing on this plane to cations having centres residing on this plane?
- (a) 0.5
 - (b) 0
 - (c) 2
 - (d) 1
7. An hypothetical ceramic has the sodium chloride crystal structure. The anion and cation radii are 0.186 nm and 0.087 nm, respectively. The anion and cation molar masses are $21.5 \frac{g}{mol}$ and $36.36 \frac{g}{mol}$, respectively. Which of the following is the theoretical density of this ceramic?
- (a) $4.72 \frac{g}{cm^3}$
 - (b) $0.59 \frac{g}{cm^3}$
 - (c) $2.36 \frac{g}{cm^3}$
 - (d) $1.18 \frac{g}{cm^3}$
8. Which general class of material has a Young's modulus that is roughly one hundred times less than that of the metals?
- (a) Polymers
 - (b) None of these
 - (c) Ceramics
 - (d) Composites

9. A rectangular cross-section tensile specimen is loaded by a tensile load of 14550 N. The unloaded gauge length is 220 mm, and the width and thickness of the reduced section are 10 mm and 5 mm, respectively, and the length of the reduced section is 256 mm. Under this load the gauge length elongates elastically by 8 mm. This sample is then plastically deformed by 20%. Which of the following is the correct Young's modulus for this material?
- (a) 8.0 GPa
 - (b) 9.3 GPa
 - (c) 16005.0 GPa
 - (d) 0.0 GPa
10. An hypothetical ceramic has the sodium chloride crystal structure. The anion and cation radii are 0.183 nm and 0.158 nm, respectively. The anion and cation molar masses are $20.65 \frac{g}{mol}$ and $44.31 \frac{g}{mol}$, respectively. Which of the following is the theoretical density of this ceramic?
- (a) $3.9 \frac{g}{cm^3}$.
 - (b) $1.36 \frac{g}{cm^3}$.
 - (c) $56.54 \frac{g}{cm^3}$.
 - (d) $7.07 \frac{g}{cm^3}$.
11. An hypothetical metal having the HCP crystal structure is being studied. What is the coordination number of an atom at the surface of an exposed close-packed plane?
- (a) Eleven
 - (b) Nine
 - (c) Five
 - (d) Twelve
12. The temperature of a sample of an HCP metal is changed, resulting in a transformation of the crystal structure to FCC. Which of the following is the volume change that accompanies this phase change?
- (a) 9% increase in volume
 - (b) No change
 - (c) 6% increase in volume
 - (d) 6% decrease in volume

13. A cylindrical cross-section rod is loaded along its long axis with a tensile load of 10068.73 N. The rod has an initial length of 314 cm, a radius of 17 cm and is made from a hypothetical metal having a Young's modulus of 167 GPa. Which of the following is the correct elongation for these conditions, assuming only elastic deformation?
- (a) 2.086 mm
 - (b) 0.0 m
 - (c) 0.002 mm
 - (d) 20.862 mm
14. An hypothetical metal having the FCC crystal structure is being studied. What is the coordination number of an atom at the surface of an exposed close-packed plane?
- (a) Twelve
 - (b) Five
 - (c) Eleven
 - (d) Nine
15. Two identically sized panels of glass are produced, one thermally tempered and one chemically tempered. The ion replacement process in the chemically tempered glass results in three times the residual compressive stresses on the outer surfaces compared with the thermally tempered glass. If the thermally tempered glass has a bending strength of 100 MPa, which of the following is most likely to be close to the bending strength of the chemically tempered glass?
- (a) 300 MPa
 - (b) 30 MPa
 - (c) 10 MPa
 - (d) 100 MPa

16. A rectangular cross-section tensile specimen is loaded by a tensile load of 27700 N. The unloaded gauge length is 473 mm, and the width and thickness of the reduced section are 15 mm and 1 mm, respectively, and the length of the reduced section is 499 mm. Under this load the gauge length elongates elastically by 34 mm. Which of the following is the correct Young's modulus for this material?
- (a) 25.7 GPa
 - (b) 27.1 GPa
 - (c) 0.0 GPa
 - (d) 385355.9 GPa
17. An hypothetical ceramic has an anion radius of 0.177 pm and a cation radius of 0.167 pm. If the stoichiometric ratio of anions to cations is 1 to 1, what is the most likely interstitial site for cations to occupy within the anions?
- (a) None of these options
 - (b) Octahedral
 - (c) Simple cubic
 - (d) Tetrahedral
18. An hypothetical ceramic has an anion radius of 0.188 pm and a cation radius of 0.081 pm. If the stoichiometric ratio of anions to cations is 1 to 1, what is the most likely interstitial site for cations to occupy within the anions?
- (a) Octahedral
 - (b) Tetrahedral
 - (c) None of these options
 - (d) Simple cubic
19. Which general class of material has a density that is roughly the same as water?
- (a) Polymers
 - (b) Composites
 - (c) None of these
 - (d) Ceramics

20. An hypothetical FCC metal has a density of $7.9 \frac{g}{cm^3}$ and a molar mass of $68.1 \frac{g}{mol}$. Which of the following is the correct number of atom sites (that is, without any vacancies)?

- (a) $1.16e-01 \frac{atoms}{cm^3}$
- (b) $8.84e+21 \frac{atoms}{cm^3}$
- (c) $8.93e-22 \frac{atoms}{cm^3}$
- (d) $6.99e+22 \frac{atoms}{cm^3}$

Instructions:

- Congratulations, you've reached the end of the assessment!
- Remember to submit your answers to Microsoft Forms.