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.*

1. A rectangular cross-section tensile specimen is loaded by a tensile load of 143680 N. The unloaded gauge length is 573 mm, and the width and thickness of the reduced section are 12 mm and 6 mm, respectively, and the length of the reduced section is 600 mm. Under this load the guage length elongates elastically by 24 mm. Which of the following is the correct Young's modulus for this material?

   (a) 0.0 GPa
   (b) 95287.8 GPa
   (c) 47.6 GPa
   (d) 49.9 GPa

   Correct answers: (c)

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

   Correct answers: (c)

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

   Correct answers: (b)

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

   Correct answers: (a)

5. A rectangular cross-section ceramic beam is loaded in 3-point bending by a force of 19.203 kN, resulting in a peak stress on the lower surface of the beam of 145 MPa. The beam has a width of 118 mm and a thickness of 35 mm. Which of the following is the span of this beam?

   (a) 727.655 m
   (b) 1637.225 m
   (c) 2453.238 m
   (d) 1091.483 m

   Correct answers: (a)

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 anions having centres residing on this plane?

   (a) 0.5
   (b) 0
   (c) 2
   (d) 1

   Correct answers: (b)

7. An hypothetical ceramic has the sodium chloride crystal structure. The anion and cation radii are 0.186 nm and 0.077 nm, respectively. The anion and cation molar masses are $29.02 \frac{g}{mol}$ and $40.27 \frac{g}{mol}$, respectively. Which of the following is the theoretical density of this ceramic?

   (a) $6.33 \frac{g}{cm^3}$
   (b) $0.79 \frac{g}{cm^3}$
   (c) $3.16 \frac{g}{cm^3}$
   (d) $1.58 \frac{g}{cm^3}$

   Correct answers: (c)

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

   Correct answers: (a)

9. A rectangular cross-section tensile specimen is loaded by a tensile load of 143680 N. The unloaded gauge length is 573 mm, and the width and thickness of the reduced section are 12 mm and 6 mm, respectively, and the length of the reduced section is 600 mm. Under this load the guage length elongates elastically by 24 mm. This sample is then plastically deformed by 20%. Which of the following is the correct Young's modulus for this material?

   (a) 47.6 GPa
   (b) 49.9 GPa
   (c) 95287.8 GPa
   (d) 0.0 GPa

   Correct answers: (a)

10. An hypothetical ceramic has the sodium chloride crystal structure. The anion and cation radii are 0.168 nm and 0.161 nm, respectively. The anion and cation molar masses are $21.19\frac{g}{mol}$ and $42.44\frac{g}{mol}$, respectively. Which of the following is the theoretical density of this ceramic?

    (a) $4.47\frac{g}{cm^3}$.
    (b) $1.48\frac{g}{cm^3}$.
    (c) $61.67\frac{g}{cm^3}$.
    (d) $7.71\frac{g}{cm^3}$.

    Correct answers: (b)

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

Correct answers: (b)

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

Correct answers: (b)

13. A cylindrical cross-section rod is loaded along its long axis with a tensile load of 7276.617 N. The rod has an initial length of 389 cm, a radius of 21 cm and is made from a hypothetical metal having a Young's modulus of 178 GPa. Which of the following is the correct elongation for these conditions, assuming only elastic deformation?

    (a) 1.148 mm
    (b) 0.0 m
    (c) 0.001 mm
    (d) 11.484 mm

Correct answers: (c)

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

Correct answers: (d)

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

Correct answers: (a)

16. A rectangular cross-section tensile specimen is loaded by a tensile load of 91290 N. The unloaded gauge length is 560 mm, and the width and thickness of the reduced section are 9 mm and 1 mm, respectively, and the length of the reduced section is 583 mm. Under this load the guage length elongates elastically by 46 mm. Which of the following is the correct Young's modulus for this material?

    (a) 123.5 GPa
    (b) 128.6 GPa
    (c) 0.0 GPa
    (d) 1111356.5 GPa

Correct answers: (a)

17. An hypothetical ceramic has an anion radius of 0.191 pm and a cation radius of 0.17 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

Correct answers: (c)

18. An hypothetical ceramic has an anion radius of 0.19 pm and a cation radius of 0.114 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

   Correct answers: (a)

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

   Correct answers: (a)

20. An hypothetical FCC metal has a density of $5.8 \frac{g}{cm^3}$ and a molar mass of $56.1 \frac{g}{mol}$. Which of the following is the correct number of atom sites (that is, without any vacancies)?

   (a) 1.03e-01 $\frac{atoms}{cm^3}$
   (b) 1.07e+22 $\frac{atoms}{cm^3}$
   (c) 5.40e-22 $\frac{atoms}{cm^3}$
   (d) 6.23e+22 $\frac{atoms}{cm^3}$

   Correct answers: (d)