Material Science Exam

Do not open the test booklet until you are instructed to do so.

Each team will be allotted a total time of fifty minutes to complete the exam.
1. The internal deformation most likely to propagate its way through a material is known as a ________ dislocation.

2. The viscosity of an object is closely related to its ____________ and can be measured by contrasting ____________ to ____________.

3. Calculate the volume of an FCC unit cell in terms of the atomic radius R.

4. Calculate the equilibrium number of vacancies per cubic meter for copper at 1000°C. The activation energy for vacancy formation is 0.9 eV/atom; the atomic weight and density for copper are 63.5 g/mol and 8.4 g/cm³, respectively.

5. An alloy, also known as a ________ solution, is defined simply as a metal that has been combined with ________________.
6. The following tensile strengths were measured for four specimens of the same steel alloy:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Tensile Strength (N/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.2x10⁸</td>
</tr>
<tr>
<td>B</td>
<td>5.12x10⁸</td>
</tr>
<tr>
<td>C</td>
<td>5.15x10⁸</td>
</tr>
<tr>
<td>D</td>
<td>5.22x10⁸</td>
</tr>
</tbody>
</table>

Calculate the average tensile strength in MPa.

7. The phenomenon whereby a ductile metal becomes harder and stronger as it is plastically deformed is known as ________________.

Questions 8-10
A 1025N is applied to a cylindrical tensile specimen measuring 12 cm in length and 4 cm in diameter.

8. Calculate the stress undergone by the specimen.

9. If an identical specimen is found to increase by 3 mm when stretched, calculate the strain undergone by the specimen.

10. Calculate the Young’s modulus of the specimen.
11. Polymeric materials are often synthesized with a close eye on the point at which the individual chains will begin to knot together.

12. Ionic bonding exists in compounds that contain _______ and _______ elements.

13. Using the following diagram, determine the vector notation necessary to access points A, B, and C from the origin.

![Diagram of a 3D coordinate system with points A, B, and C]

14. Polymers of the same monomer type are often distinguishable by examining their _______.
15. Diffusivity of a given metal through another can be calculated using the following equation.

\[ D = D_0 e^{-\frac{Q}{RT}} \]

For magnesium diffusing through aluminum at 400°C, the diffusivity and preexponential, D and D₀, respectively, are found to be \(8.1 \times 10^{-15}\) m²/s and \(1.2 \times 10^{-4}\) m²/s, respectively. What is the activation energy of magnesium diffusing through aluminum in J/mol?.

16. The measure of materials resistance to localized plastic deformation is known as ____________.

17. The measure of a materials ability to absorb energy up to fracture is known as ____________.

18. Plexiglas is one of the many trade names given to which plastic/polymer?

19. A substance used to join together the surfaces of two solid materials to produce a joint with a high shear strength is known as an ________________.

20. ________________ are materials consisting of multiple materials existing within the same matrix in order to take advantage of the benefits offered by each while limiting the disadvantages provided by each material.