Q1: Which crystallographic plane is shown in the figure?

Et billede, der indeholder cirkel, blå/nedtrykt, Farverigt, Elektrisk blå

Automatisk genereret beskrivelse

* A {100} plane in BCC lattice
* A {110] plane in BCC lattice
* A {100} plane in FCC lattice
* **A {110} plane in FCC lattice**
* A {100} plane in SC lattice
* A {110} plane in SC lattice

Q2: What is the proper notation of the particular crystallographic direction shown in the unit cell in the figure?’

Et billede, der indeholder linje/række, diagram, Kurve, Parallel

Automatisk genereret beskrivelse

in direction, in direction, in direction

* **[]**
* []
* []
* []

Q3: What is the proper notation of the particular crystallographic plane shown in the unit cell in the figure?

Et billede, der indeholder linje/række, diagram, design, origami

Automatisk genereret beskrivelse

Infinite on axis, on axis, starts at origon, therefore

Parentheses , NOT brackets , as not all equivalent/orthogonal planes are meant!

Q4: Atoms of the element antimony crystallize under high pressure into a cubic phase with a mass density of . The molar mass of antimony is , its atomic radius is . Which crystal structure has that cubic solid phase?

* A FCC structure
* A BCC structure
* **A SC structure**
* A diamond structure

Q5: The fictive element Melinium (MI) forms an oxide and a sulfide, both with cubic crystal structure. The table provides some properties of the elements

Et billede, der indeholder tekst, nummer/tal, Font/skrifttype, linje/række

Automatisk genereret beskrivelse

Which statement concerning the compounds MIO and MIS are correct?

Et billede, der indeholder tekst, skærmbillede, Font/skrifttype, diagram

Automatisk genereret beskrivelse

:

:

* Both compounds have same crystal structure, and their fraction of ionic bonding is at least 50%
* **Both compounds have the same crystal structure, and at least one of the compounds has a fraction of ionic bonding of less than 50%.**
* Both compounds have different crystal structures, and their fraction of ionic bonding is at least 50%.
* Both compounds have different crystal structures, and at least one of the compounds has a fraction of ionic bonding of less than 50%.

Q6: Complete miscibility between two metallic elements requires similarity of several material properties. Which of the mentioned material properties will impede complete miscibility in case of a too large difference?

Too large difference in electronegativity creates ionic bonds. The electrons are thus not shared anymore. And the miscibility will be impeded.

* Young’s modulus
* Poisson ratio
* **Electronegativity**
* Electrical resistivity
* Mass density
* Molar mass

Q7: Where are foreign atoms NOT to be expected, when a pure metal is alloyed with a second element of ***slightly*** smaller atomic size?

Too big to be on the small interstitial sites.

* On regular lattice sites
* **On interstitial sites.**
* At dislocations.
* At grain boundaries.
* At vacancies.

Q8: Which point defects have the least effect on strengthening of a metal?

Vacancies do NOT make a material stronger. If anything, they make it weaker (less tough) at large enough amounts.

* Vacancies
* Self-interstitial atoms
* Large substitutional atoms
* Small interstitial atoms

Q9: By increasing the dislocation density in an aluminum specimen from to , its yield stress increases by . Which additional strengthening is achieved by increasing the dislocation density even further from to ?

*Ligningen løses for k vha. WordMat.*

* **About 100 MPa**
* About 230 MPa
* About 330 MPa
* About 460 MPa

Q10: A specimen of pure gold is cooled slowly from room temperature to the temperature of liquid nitrogen . How does this affect the defect content?

Equilibrium Density of Vacancies:

The higher the temperature, the higher the vacancy density!

* **The vacancy concentration decreases**
* The dislocation density decreases.
* The grain size decreases.
* The density of grain boundaries decreases.
* Not at all.

Q11: Copper is tested in tension. Initially the specimen is loaded to the 0.2% proof stress. What happens when the specimen is tested further and the stress increases by a factor of 10% (which still remains below the fracture strength)?

The 0.2% proof stress is equivalent to the point of yield stress. From here on, a significant fraction of the deformation will be permanent (plastic). Thus, the elastic strain increases by an amount while the plastic increases even more!…

* The plastic strain increases by 10%, while the elastic strain remains unchanged.
* Both strains, the plastic and the elastic strain, increase by 10%
* The plastic strain increases by more than 10%, while the elastic strain remains unchanged.
* **The elastic strain increases by 10%, while the plastic strain increases even more.**

Q12: A copper smith hammers a piece of -brass (a single phase alloy with less than 38 wt. % Zn) into a new shape at room temperature. Why does the material become stronger?

Work-hardening happens by the use of dislocations, which makes it stronger.

* The atoms are squeezed together.
* Cu and Zn atoms are mixed in a better way.
* The grain size becomes reduced.
* **More dislocations are formed.**

Q13: Stiffness and toughness of a metal depend on temperature. When a body-centered-cubic metal is cooled to extremely low temperatures...

When a metal generally is cooled, it becomes stiffer, but not more tough (more prone to fracture if anything).

* …both its stiffness and its toughness increase.
* **… its stiffness increases, but not its toughness.**
* … its toughness increases, but not its stiffness.
* … neither its stiffness, nor its toughness increases.

Q14: How is crack growth in metals under tension affected by their ability to deform plastically?

Regions prone to plastic deformation can by plastically deforming absorb some of the energy that otherwise could result in the propagation of a crack. Therefore, cracks grow slower when the metal can deform plastically.

* Cracks cannot grow at all when the metal can deform plastically.
* **Cracks grow slower when the metal can deform plastically.**
* Cracks grow faster when the metal can deform plastically.
* The ability to deform plastically has no effect on crack growth.

Q15: The stress strain diagram shows two flow curves obtained for two different metallic specimens (1 and 2) at room temperature under the same conditions.

Et billede, der indeholder linje/række, diagram, tekst, Kurve

Automatisk genereret beskrivelse

Compare tensile strength and toughness of the two metallic specimens. Which statement is correct?

The specimen 2 clearly has higher UTS (maximum on curve) and Toughness (area under curve).

* Specimen 1 has both a higher tensile strength and a higher toughness than specimen 2.
* Specimen 1 has a higher tensile strength, but a lower toughness than specimen 2.
* Specimen 1 has not a higher tensile strength, but a higher toughness than specimen 2.
* **Specimen 1 has neither a higher tensile strength, nor a higher toughness than specimen 2.**

Q16: What could be the difference between the two metallic specimens?

Grain refinement DOES NOT impede toughness, only INCREASES strength.

Work hardening, IMPEDES toughness, but INCREASES strength…

2 is STRONGER AND TOUGHER than 1, so the difference must be grain refinement.

* Both specimens may have the same composition, but they have been work-hardened to a different extend.
* **Both specimens may have the same composition, but a different grain size.**
* Both specimens may have the same composition, but one must have larger grains and must also have been work-hardened to a larger extend than the one with smaller grain size.
* The two specimens must obviously have a different chemical composition.

Q17: Which of the two metallic specimens should be selected for a light and stiff pillar of a given length?

For a light material, a low mass density is required. Stiffness is the resistance to elastic deformation. The elastic modulus is a measure of that. Both materials have the same Young’s modulus, therefore:

* Specimen 1, if both specimens have the same mass density.
* Specimen 2, if both specimens have the same mass density.
* **Both specimens are equally suited, if both specimen have the same mass density.**
* The specimen with lower mass density, independent of the flow curve.

Q18: A laminate composite is manufactured from several plates made of three different metals (aluminium, copper and lead) such that their volume fraction is the same. The table summarized mechanical properties of the three metals.

Et billede, der indeholder tekst, nummer/tal, Font/skrifttype, skærmbillede

Automatisk genereret beskrivelse

Which metal is the first to deform plastically when the laminate is loaded in tension along the plates?

Et billede, der indeholder tekst, Font/skrifttype, skærmbillede, linje/række

Automatisk genereret beskrivelse

Thus, Copper will be the first to yield, since it has the lowest yield strain, (although the highest yield strength)… The components will experience the same strain (and different stresses), since tension is along the plates (iso-strain).

* Al yields first.
* **Cu yields first.**
* Pb yields first.
* Due to the mechanical restrictions, all metals in the composite must yield simultaneously.

Q19: A piece of jewelry is manufactured as layered composite from several thin foils made of two different metals (copper and gold). For economic reasons, the volume fraction of gold is only 15%. The table summarizes mechanical properties of both metals.

Et billede, der indeholder tekst, Font/skrifttype, nummer/tal, skærmbillede

Automatisk genereret beskrivelse

What is the Young’s modulus of the layered compsite under compression perpendicular to the foils?

* At least 125 GPa.
* **At least 120 GPa, but less than 125 GPa.**
* At least 105 GPa, but less than 120 GPa.
* At least 90 GPa, but less than 105 GPa.
* At least 85 GPa, but less than 90 GPa.
* Less than 85 GPa.

Q20: High density polyethylene (HDPE) and low-density polyethylene (LDPE) do not only differ in their density. Which statement is correct when comparing two baches of HDPE and LDPE with same molar mass?

Et billede, der indeholder tekst, skærmbillede, nummer/tal, Font/skrifttype

Automatisk genereret beskrivelse

* **HDPE has both a higher melting temperature and a higher glass transition temperature than LDPE.**
* HDPE has a higher melting temperature, but a lower glass transition temperature than LDPE.
* HDPE has a lower melting temperature, but a higher glass transition temperature than LDPE.
* HDPE has both a lower melting temperature and a lower glass transition temperature than LDPE.

Q21: The picture shows plastic beverage cans at room temperature

Et billede, der indeholder sodavand, Gennemsigtigt materiale, glas, container

Automatisk genereret beskrivelse

What can be concluded about the polymer the cans are made of?

The glass transition temperature marks the temp at which the amorphous material “melts” and becomes opaque (non-transparent,non-glassy).

* The polymer must be semi-crystalline, and its glass transition temperature must be above room temperature
* The polymer must be semi-crystalline, and its glass temperature must be below room temperature.
* **The polymer cannot be semi-crystalline, and its glass transition temperature must be above room temperature**
* The polymer cannot be semi-crystalline, and its glass transition temperature must be below room temperature.

Q22: The figure shows the monomer of the polymer polyvinylidene difluoride (PVDF).

Et billede, der indeholder ur, design

Automatisk genereret beskrivelse

In which condition can PVDF be found?

Wikipedia (Polyvinylidene fluoride): ”is typically 50–60% crystalline”

* Syndiotactic
* Atactic
* Crystalline
* **Semi-crystalline**

Q23: Flouorinated ethylene propylene (FEP) is a copoylmer of tetrafluoroethylene and hexafuoropropylene, while polytetrafluoroethylene (PFTE) is solely build from tetrafluoroethylene. The figure shows the monomers.

Et billede, der indeholder diagram, linje/række, skitse

Automatisk genereret beskrivelse

Which statement is correct when comparing two batches of FEP and PFTE with the same degree of polymerization?

* **FEP has a longer straightened chain length and a higher molar mass than PFTE**
* FEP has a longer straightened chain length, but not a higher molar mass than PFTE
* FEP has not a longer straightened chain length, but a higher molar mass than PFTE.
* FEP has neither a longer straightened chain length, nor a higher molar mass than PFTE.

Q24: Consider a polyethylene molecule without side branches and a molar mass of 5 kg/mol. What is the ratio between the straightened chain length and the average distance between start and end of the chain molecule (carbon-carbon bonds have a length of and form an angle of )?

Et billede, der indeholder skitse, diagram, cirkel, tegning

Automatisk genereret beskrivelse

* About 18
* About 15
* About 13
* **About 11**

Q25: The figure shows the phase diagram of the binary alloy system Ru-Zr.

Et billede, der indeholder diagram, Teknisk tegning, linje/række, Plan

Automatisk genereret beskrivelse

Where does a eutectoid transformation occur in the binary system ruthenium zirconium?

Eutectoid transformation is the break down of a single solid phase into two different solid phases as it cools. This happens at 90,1 wt.% Zr at from to and .

* **A eutectoid transformation occurs at about for 90,1 wt.% Zr.**
* A eutectoid transformation occurs at about for 21,7 wt.% Zr.
* A eutectoid transformation occurs at about for 31 wt.% Zr.
* No eutectoid transformation occurs in the system.

Q26: What is the maximum solubility of Ru in solid zirconium?

It’s at 88 wt.% Zr at about 1200 .

* 0,7 wt.% Ru
* **12 wt.% Ru**
* 88 wt.% Ru
* 99,3 wt.% Ru

Q27: A melt of a ruthenium-zirconium alloy with 38 wt.% Zr is cooled slowly from 2500 to room temperature. Which is the first **solid** phase formed?

is to the right of it when it cools into . We are ONLY looking for the solid part of the phase.

* **RuZr**
* RuZr + L
* Ru
* Ru + L

Q28: A melt of a ruthenium-zirconium alloy with 38 wt.% Zr is cooled slowly from 2500 to room temperature. What is the lowest Zr content in the melt during solidification?

Trick question…

* **38 wt.% Zr**
* 30,9 wt.% Zr
* 28,3 wt.% Zr
* 21,7 wt.% Zr

Q29: A melt of a ruthenium-zirconium alloy with 77,5 wt.% Zr is cooled slowly from 2500 to room temperature. The microstructure at room temperature consists of two phases. Which phases are present and how are they arranged?

* RuZr and as alternating lamellae solely
* RuZr and as alternating lamellae solely
* RuZr and as alternating lamellae with additional RuZr.
* **RuZr and as alternating lamellae with additional .**

Q30: A melt of a ruthenium-zirconium alloy with 77,5 wt.% Zr is cooled slowly from 2500 to room temperature. What is the mass of RuZr at room temperature for a melt of 6,1 kg?

* About 1,6 kg
* **About 2,6 kg**
* About 3,5 kg
* About 4,5 kg

Q31: The ceramic material is a superconductor at low temperatures. At room temperature, has an electrical conductivity of . Consider a wire of this material in the shape of a cylinder in an electrical field of 0,1 along its axis. What must the diameter of the wire be, if it carries a current of under these conditions at room temperature?

Siemens is the reciprocal of (ohms).

* About 1,6
* About 8
* **About 320**
* About 1,6

Q32: Consider a hypothetical metal with an electron mobility of . Moreover, the material has a face-centered cubic structure with a lattice parameter of , a density of , and a molar mass of . What is the electrical conductivity assuming one conduction electron per atom?

* About
* About
* **About**
* About

Q33: Consider the semiconductor Si doped with As. Which of the following statements about the carriers of electricity is correct?

Et billede, der indeholder tekst, diagram, linje/række, Kurve

Automatisk genereret beskrivelse

N\_type: doping of Silicon with element (e.g. Phosporus) that has more valence electron than silicon

P type: doping of Silicon with element (e.g. Aluminium) that has

* The carrier densities are approximately constant at all temperatures.
* **At low temperatures, the carrier densities are given by the doping concentration, at high temperatures, they become similar to that of undoped Si.**
* At low temperatures, there is an equal amount of electrons in the valence band and holes in the conduction band.
* At low temperatures, there is an equal amount of electrons in the conduction band and holes in the valence band.

Q34: Which of the following statements about phonons is **not** correct?

“Phonons can be thought of as quantized [sound waves](http://localhost:3000/wikipedia_en_all_maxi_2023-10.zim/A/Sound_waves), similar to [photons](http://localhost:3000/wikipedia_en_all_maxi_2023-10.zim/A/Photons) as quantized [light waves](http://localhost:3000/wikipedia_en_all_maxi_2023-10.zim/A/Light_waves).”

* Phonons are related to lattice vibrations in crystalline materials.
* Phonons are a collective motion of atoms, giving rise to waves.
* Phonons transport heat well in crystalline materials.
* **Phonons transport electricity well in crystalline materials. (NOT)**

Q35: Consider steady state transport of heat from a sphere with a diameter of 2 m and a uniform wall thickness of 15 cm. The wall has a thermal conductivity of . How much power is required to be generated inside the sphere, if a constant temperature difference has to be maintained such that the inside is 15 K warmer than the outside of the sphere?

Distance of wall to travel through:

Surface of sphere:

Change in temperature:

Thermal conductivity constant:

Power required (Fourier’s law):

* **About**
* About
* About
* About

Q36: Consider simulating the temperature distribution in a rod of metal as a 1D heat transfer problem using the heat equation. The rod is 1 m long. The two ends of the rod are defined at x=0 m (point A) and x = 1 m (point B). In the steady state solution, the temperature in the center of the rod is . Which combination of initial temperature (in the entire rod), boundary condition at point A and boundary condition at point B could NOT have produced this result?

When A: , point B: , the temperature does NOT change. Thus, the temperature could not have changed from to .

* Initial temperature , point A: , point B:
* **Initial temperature , point A: , point B:**
* Initial temperature , point A: , point B:
* Initial temperature , point A: , point B:

Q37: Consider an indexed face set representation of the mesh below.

Et billede, der indeholder linje/række, diagram, Kurve, Parallel

Automatisk genereret beskrivelse

What should the second row of the faces matrix be?

Face 1: (0,1) - (0,0) - (1,0)

Face 2: ?

Face 3: (1,1) - (2,1) - (1,0)

Face 4: (1,0) - (2,1) - (2,0)

Then face 2 must be the last face not yet drawn which is second from the left, including the vertices (0,1) - (1,1) - (1,0); i.e. 1, 2 and 5.

* [1 2 3] | (0,1) - (1,1) - (2,1)
* **[1 2 5] | (0,1) - (1,1) - (1,0)**
* [1 4 6] | (0,1) - (0,0) - (2,0)
* [2 4 5] | (1,1) - (0,0) - (1,0)
* [6 1 3] | (2,0) - (0,1) - (0,0)
* [6 2 5] | (2,0) - (1,1) - (1,0)

Q37: Consider the digital image shown.

Et billede, der indeholder tekst, Font/skrifttype, nummer/tal, typografi

Automatisk genereret beskrivelse

What is the outcome of applying a 3 x 3 median filter centered at row 2, column 3.

Centered at , with:

* 20
* 21
* 37
* 38
* **42**
* 45

Q38: Consider a 3D image of a material consisting of a solid phase and some pores. The image is segmented into solid phase and pores and the volume of the pores is determined to be . The 3D image has and a voxel size of . What is the volume fraction of the pores?

Q39: The figure shows the histogram of one of the six images.

Et billede, der indeholder tekst, diagram, Kurve, linje/række

Automatisk genereret beskrivelseEt billede, der indeholder Rektangel, kvadratisk, skærmbillede

Automatisk genereret beskrivelse

Which image does the histogram correspond to?

There is clearly least of the dark pixels, most of the light pixels and medium of the middle-intensity pixels. Thus, the background is light, there are two rectangles of medium-intensity, and one is dark.

Therefore, the answer is 1.

* **1**
* 2
* 3
* 4
* 5
* 6