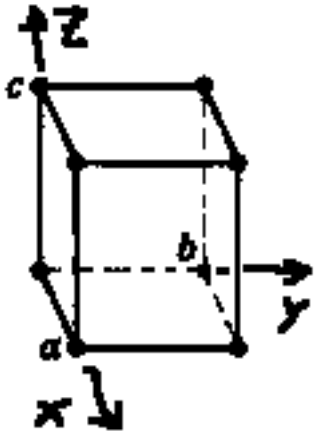
EE 362 Electronic, Magnetic, & Opt. Prop. of Mat'ls Quiz 1 (Spring 2025)

Name KEY A

Instructions: Open notes. Place answers in indicated spaces and show all work for credit.

Sulfur in its alpha state (α-S) has a primitive orthorhombic crystal lattice with lattice constants a = 1.0460 nm, b = 1.2861 nm, and c = 2.4481 nm (assume they are in x-, y-, & z-directions respectively). Find the atomic number and weight of sulfur. Then, find the atomic surface density (top face), atomic volume density, and mass density of α-S.



From periodic table, sulfur has an:

atomic number of 16, and

atomic weight of 32.066.

atoms/top = 4 corners (1/4 atom/corner) = 1 atom

$asd_{\alpha\text{-S}}$ = (# atoms/unit cell)/area = $1/(a\,b) = 1/[1.046\times10^{-9}\,(1.2861\times10^{-9})]$

$\Rightarrow$ **$asd_{\alpha\text{-S}} = 7.4335 \times 10^{17}$ atoms/m^2 = 7.4335×10^{13} atoms/cm^2**

atoms/unit cell = 8 corners (1/8 atoms/corner) = 1 atom

$avd_{\alpha\text{-S}}$ = (# atoms/unit cell)/volume = $1/[abc] = 1/[1.046\times10^{-9}\,(1.2861\times10^{-9})\,2.4481\times10^{-9}]$

$\Rightarrow$ **$avd_{\alpha\text{-S}} = 3.03644 \times 10^{26}$ atoms/m^3 = 3.03644×10^{20} atoms/cm^3**

The mass density md of α-S is

$md_{\alpha\text{-S}} = (avd_{\alpha\text{-S}})\,(A_{r,\alpha\text{-S}})\,/\,N_A = 3.03644 \times 10^{20}$ atoms/cm^3 (32.066)/ $6.02214076 \times 10^{23}$

$\Rightarrow$ **$md_{\alpha\text{-S}}$ = 16,168 g/m^3 = 0.01617 g/cm^3**

(Oops! Lattice constants must have been for a unit cell bigger than a primitive cell as the density of sulfur is ~2.1 g/cm^3 according to google)

atomic number$_S$ = **16** atomic weight$_S$ = **32.066**

atomic surface density$_{\alpha\text{-S}}$ = **7.4335×10^{17} atoms/m^2 = 7.4335×10^{13} atoms/cm^2**

$avd_{\alpha\text{-S}}$ = **3.0364×10^{26} atoms/m^3 = 3.0364×10^{20} atoms/cm^3** mass density$_{\alpha\text{-S}}$ = **0.01617 g/cm^3**

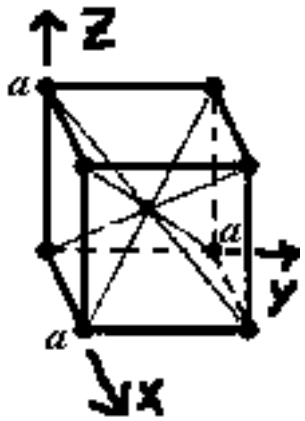
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

EE 362 Electronic, Magnetic, & Opt. Prop. of Mat'ls Quiz 1 (Spring 2025)

Name ___KEY B____

Instructions: Open notes. Place answers in indicated spaces and show all work for credit.

Iron in its alpha state (α-Fe) has a body-centered cubic crystal lattice with lattice constant a = 286.65 pm. Find the atomic number and weight of iron. Then, find the atomic surface density (top face), atomic volume density, and mass density of α-Fe.



From periodic table, iron has an:

atomic number of 26, and

atomic weight of 55.845.

atoms/top = 4 corners (1/4 atom/corner) = 1 atom

$Asd_{\alpha\text{-Fe}}$ = (# atoms/unit cell)/area = $1/a^2 = 1/(286.65\times10^{-12})^2$

$\Rightarrow$ **$asd_{\alpha\text{-Fe}} = 1.217 \times 10^{19}$ atoms/m^2 = 1.217×10^{15} atoms/cm^2**

atoms/unit cell = 8 corners (1/8 atoms/corner) + 1 atom in center = 2 atoms

$avd_{\alpha\text{-Fe}}$ = (# atoms/unit cell)/volume = $2/a^3 = 2/(286.65\times10^{-12})^3$

$\Rightarrow$ **$avd_{\alpha\text{-Fe}} = 8.4913 \times 10^{28}$ atoms/m^3 = 8.4913×10^{22} atoms/cm^3**

The mass density md of α-Fe is

$md_{\alpha\text{-Fe}} = (avd_{\alpha\text{-Fe}})\,(A_{r,\alpha\text{-Fe}})/N_A = 8.4913 \times 10^{22}$ atoms/cm^3 (55.845)/ $6.02214076 \times 10^{23}$

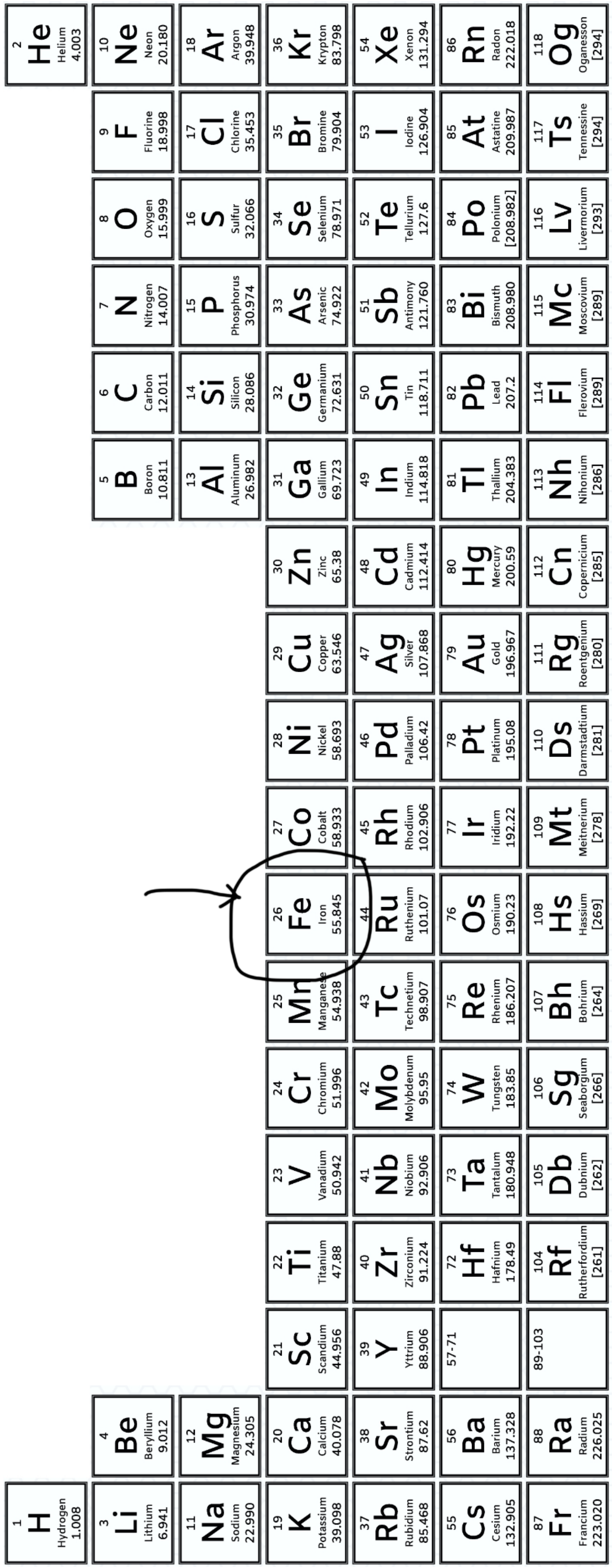
$\Rightarrow$ **$md_{\alpha\text{-Fe}} = 7{,}874{,}220$ g/m^3 = 7.874 g/cm^3**

(Yay! From google, the density of iron is ~7.87 g/cm^3.)

atomic number $_{Fe}$ = ___**26**_____ atomic weight $_{Fe}$ = ___**55.845**_____

atomic surface density $_{\alpha\text{-Fe}}$ = **1.217×10^{19} atoms/m^2 = 1.217×10^{15} atoms/cm^2**

atomic vol. density $_{\alpha\text{-Fe}}$ = **8.49×10^{28} atoms/m^3 = 8.49×10^{22} atoms/cm^3** $md_{\alpha\text{-Fe}}$ = **7.874 g/cm^3**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20 Ca Calcium 40.078
21 Sc Scandium 44.956
22 Ti Titanium 47.88
23 V Vanadium 50.942
24 Cr Chromium 51.996
25 Mn Manganese 54.938
26 Fe Iron 55.845
27 Co Cobalt 58.933
28 Ni Nickel 58.693
29 Cu Copper 63.546
30 Zn Zinc 65.38
31 Ga Gallium 69.723
32 Ge Germanium 72.631
33 As Arsenic 74.922
34 Se Selenium 78.971
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