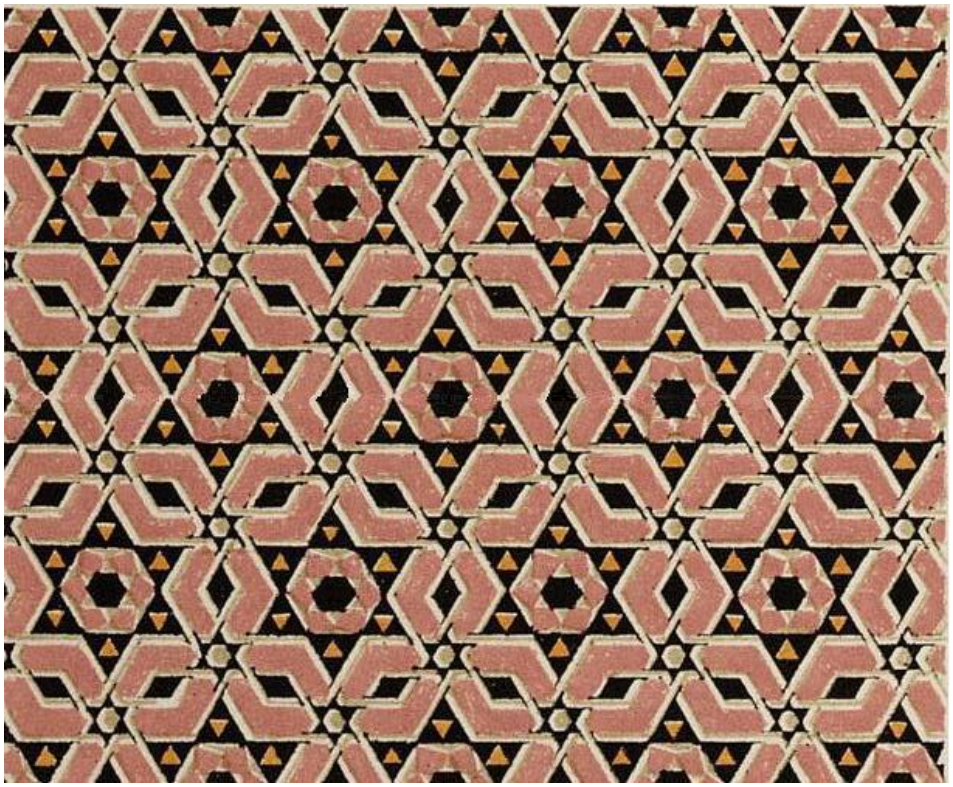
Tabell 1: Några utvalda naturkonstanter:

Namn	Symbol	Värde	Enhet
Ljushastighet	c	$2{,}998.10^{8}$	m/s
Elementarladdning	e	$1{,}602.10^{-19}$	C
Plancks konstant	h	$6{,}626.10^{-34}$	Js
	$\hbar$	$1{,}055.10^{-34}$	Js
Finstrukturkonstanten	α	1/137,04	
Boltzmanns konstant	k_B	$1{,}381.10^{-23}$	J/K
Absoluta nollpunkten		-273,15	°C
Avogadros tal	N_A	$6{,}022.10^{23}$	mol^{-1}
Gaskonstanten	$R = k_B N_A$	8,314	J/(mol K)
Coulombkonstant	$1/(4\pi\epsilon_0)$	$8{,}99.10^{9}$	Nm^2/C^2
Elektriska fältkonstanten	ϵ_0	$1/(\mu_0 c^2)$	As/Vm
Magnetiska fältkonstanten	μ_0	$4\pi \times 10^{-7}$	$\text{Vs/Am} = \text{N/A}^2$
Elektronens massa	m_e	$9{,}109.10^{-31}$	kg
Protonens massa	m_p	$1{,}673.10^{-27}$	kg
Atomära massenheten	amu	$1{,}661.10^{-27}$	kg
Bohr magneton $eh/2m_e$	μ_B	$9{,}274.10^{-24}$	J/K
Bohr radie	a_0	$5{,}292.10^{-11}$	m
Rydberg	R_∞	13,606	eV
Lorentztal	L	$2{,}45.10^{-8}$	$\text{W}\Omega/\text{K}^2$
Madelungkonstant (NaCl)	α	1,747565	
tyngdkraftens acceleration	g	9,81	m/s^2

Tabell 2: Några viktiga data för halvledare:

•	Kisel	Germanium	Galliumarsenid	Indiumantimonid
•	Si	Ge	GaAs	InSb
E_g (eV) vid 300 K	1,1	0,72	1,4	
E_g (eV) vid 0 K	1,21	0,785	1,52	
densitet (g/cm^3)	2,33	5,32		
Atommassa	28,09	72,59		
gitterkonstant a (Å)	5,431	5,657		
n_i (m^{-3}) vid 300 K	$1{,}5.10^{16}$	$2{,}5.10^{19}$	$1{,}1.10^{13}$	
ϵ_r	12	16	11	
m_n^*/m_e	0,43	0,60	0,065	
m_p^*/m_e	0,54	0,28	0,5	
μ_n (m^2/Vs)	0,13	0,38	0,85	
μ_p (m^2/Vs)	0,05	0,18	0,04	

Problem 1. The figure below shows an arabian geometric pattern.



a) Draw in the figure a translation vector **T** that leaves the pattern unchanged. (1p)

Lösning: .....

b) Draw two primitive base vectors **a** and **b**, and a primitive unit cell. (1p)

Lösning: .....

c) Indicate all the lattice points within the figure that are generated by **a** and **b**. (1p)

Lösning: .....

d) Draw a rectangular unit cell in the figure. How many lattice points does it contain? (1p)

Lösning: .....

Problem 2. Potassium chloride KCl has the NaCl structure. The lattice constant is 6.29 Å. Young's modulus is 29.63 GPa. The band gap is 8.5 eV. The refractive index is 1.49.

a) How large is the equilibrium distance between nearest neighbours? (1p)

Lösning: .....

b) Estimate the force constant between nearest neighbours. (1p)

Lösning: .....

c) Given that the resonance frequency is $4.25 \cdot 10^{12}$ Hz, what is your estimate for the reduced mass of KCl (answer in atomic units)? (1p)

Lösning:

d) What is the Einstein temperature of KCl? (1p)

Lösning:

e) Sketch a graph of the specific heat of KCl as a function of temperature. Indicate units on both axes. (1p)

Lösning:

Problem 3. Compare in a figure the stress-strain curves of a ductile material with a Young's modulus of 30 GPa and a brittle material with a Young's modulus of 20 GPa (units on axes). (2p)

Lösning:

Explain why some materials crack, while other materials experience plastic deformation. (2p)

Lösning:

Problem 4. Gold (atomic weight 197) has density 19,3 g/cm^3. There is one valence electron per atom. Gold crystallizes in the *fcc*-structure with lattice parameter 4,08 Å. The resistivity at room temperature is 2,2 $\mu\Omega$ cm.

a) How large is the drift velocity in a gold wire with 1mm diameter 1 if the current is 2 A? (1p)

Lösning:

b) How fast will the temperature of this thread rise? (1p)

Lösning:

c) How large is the deBroglie wavelength of the fastest electrons? (1p)

Lösning:

d) How long is the electron mean free path? (1p)

Lösning:

Problem 5. A *pn* diode was made halfway in a 2 mm long silicon rod with 0.01 mm^2 cross section. The doping on the *p*-side är $2.5 \cdot 10^{19}$ m^{-3} and on the *n*-side $1.0 \cdot 10^{20}$ m^{-3}. The width of the depletion layer on the *n*-sidan är 1,08 μm.

a) How large is the electrical field over the *pn* junction? (1p)

Lösning:

b) How large is the contact potential (the built-in potential)? (1p)

Lösning:

c) Disregarding the junction area, how large is the ohmic resistance of this device? (1p)

Lösning:

d) Explain why the junction blocks the current in the reverse direction. (1p)

Lösning:

Växjö universitet

TENTAMEN

Institution: MSI, Fysik

Examinator: Pieter Kuiper

Datum: January 13, 2006

Tid:

Plats:

Kurskod: FyB702, FyS704

Kurs/provmoment: Solid State Physics I

Hjälpmedel: ruler, calculator, two pages with notes, "Si-crystal"

Namn: .....

Adress: .....

.....

Personnummer: ☐☐☐☐☐☐-☐☐☐☐

Skriv helst lösningarna på tentan. Skriv ditt namn på eventuella tillägsblad.

Den här tentan har 5 problem.

Lycka till!

	1	2	3	4	5	Summa	Betyg
Inlämnad							
Poäng							

Uppvisat legitimation: Ja ☐ Nej ☐

Uppvisat kårlegitimation: Ja ☐ Nej ☐

Tid för inlämning: .....

Tentavaktens signatur: .....