1

Compute the electrical conductivity of a cylindrical silicon specimen 5.1mm in diameter and 51mm in length in which a current of 0.1A passes in the axial direction.

a

A voltage of 12.5V is measured across 2 probes that are separated by 38mm

✓ **Answer**

$\Delta V = 12.5\ V$
$R = \frac{\rho L}{A_c} = \frac{L}{\sigma \pi r^2}$
$\frac{L}{\sigma \pi r^2} = \frac{V}{I}$
$\sigma = \frac{LI}{V \pi r^2}$
$\sigma = 0.015\ \Omega^{-1} mm^{-1}$

b

Now compute the resistance over the entire 51mm of the specimen

✓ **Answer**

$R = \frac{\rho L}{A} = \frac{L}{\sigma A}$
$R = 160\ \Omega$

2

For each of the following pairs of semiconductors, decide which will have the smaller band gap energy, E_g, and then cite the reason for your choice.

a

ZnS and CdSe

✓ **Answer**

CdSe, as the difference in electronegativity is greater

b

Si and C (diamond)

✓ **Answer**

Si, as it has a stronger bond strength

c

Al2O3 and ZnTe

✓ **Answer**

ZnTe

d

InSb and ZnSe

✓ **Answer**

InSb

e

GaAs and AlP

✓ **Answer**

GaAs

3

Germanium to which $5 * 10^{22}\ m^{-3}$ Sb atoms have been added is an extrinsic semiconductor at room temperature, and virtually all the Sb atoms may be thought of as being ionized (i.e. one charge carrier exists for each Sb atom)

a

Is this material n-type or p-type?

✓ **Answer**

n-type, as Sb has more valence electrons than Ge

b

Calculate the electrical conductivity of this material, assuming e- and hole mobilities of 0.1 and 0.05 m^2/V^*s, respectively.

✓ **Answer**

$$\sigma = n(|e|\mu_e + |h|\mu_h)$$
$$\sigma = n|e|0.1$$
$$= 800\ \Omega^{-1}$$

4

Predict whether each of the following elements will act as a donor or an acceptor when added to the indicated semiconducting material. Assume that the impurity elements are substitutional.

Impurity	Semiconductor	Donor/Acceptor?
P	Ge	
S	AlP	
In	CdTe	
Al	Si	
Cd	GaAs	
Sb	ZnSe	

✓ **Answer**

Impurity	Semiconductor	Donor/Acceptor?
P	Ge	Donor
S	AlP	Donor
In	CdTe	Acceptor
Al	Si	Acceptor
Cd	GaAs	Donor
Sb	ZnSe	Acceptor

5

For each of the following pairs of materials, determine which would have the higher electrical conductivity and then cite the reason for your choice.

a

CdS at 293K (room temp) vs. CdS at 500K

✓ **Answer**

500K, higher temperatures increases carrier concentration

b

Al at 293K (room temp) vs. Al at 500K

✓ **Answer**

293K, resistance increases with temperature

c

Si doped with $<10^{20}\ m^{-3}$ donors vs. Si doped with $10^{24}\ m^{-3}$ donors, both at room temperature

✓ **Answer**

Cannot tell, as we need to know the mobility of the electrons

d

Cu with 5% CW vs. Cu with 10% CW

✓ **Answer**

5% CW, Cold Working increases grain boundaries, which increases resistance

e

A 60wt% Sn – 40wt% Pb solder vs. a 50wt% Sn – 50wt% Pb solder, both at room temperature

✓ **Answer**

60wt% Sn, Sn is more conductive than Pb