MAT E 201

Case study 1. Electronic materials

In order to keep laptops from heating up, the cooling device inside of it consists of a power supply, a fan and two connectors (as shown in figure 1). The temperature of the system can reach 45°C, however, the electronic in the system should be kept at 10°C.

Due to low performance, we expect you to replace a section of the previous Ni wire with a new one.

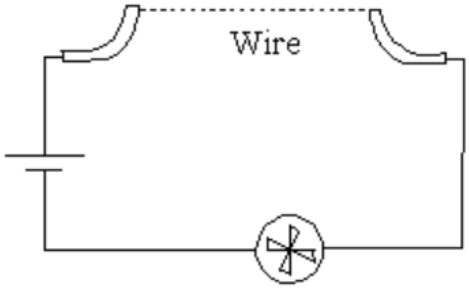
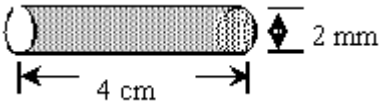


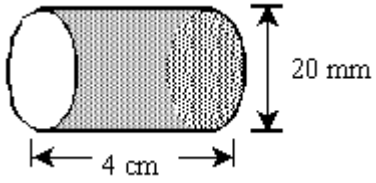
Figure 1 Cooling device set up

Four Ni wires are illustrated below. They are the same temperature, but of different sizes. With which wire size will the fan rotate the fastest?

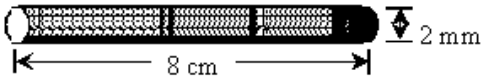
A)



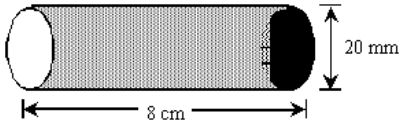
B)



C)



D)



Sadly, the dimensions in the wire didn't change the outcome significantly. We expect you provide us with 3 options to choose a new material that will increase the conductivity to at least 50% more. Since semiconductors (extrinsic) have lower prices, we want you to present at least one semiconductor option. The available dopants are P and As, with a concentration not greater that 0.05 %at.

Consider that the higher the conductivity, the costly the material will become.

The current that will be flowing through the wire is 50 A.

Material	Conductivity at room temperature ($\Omega^{-1}cm^{-1}$)	Structure	Lattice parameter (cm)	α_R (1/°C)	mobility	Eg (eV)
Al	3.77E5	FCC	4.04E-8	0.0043	-	-
Ni	1.46E5	FCC	3.52E-8	0.0069	-	-
Ag	6.80E5	FCC	4.08E-8	0.0041	-	-
Au	4.26E5	FCC	4.07E-8	0.0035	-	-
Cu	5.98E5	FCC	3.61E-8	0.0043	-	-
Ca	3.26E5	FCC	5.58E-8	0.0042	-	-
Ge	0.02	DC	5.65E-8		3900	0.67
Si	4E-6	DC	5.43E-8		1350	1.11

$q = 1.6 \times 10^{-19}$ C Ed: P= 0,045 As= 0,049