WebAssign
CH04-HW02-SP12 (Homework)

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PHYS 172-SPRING 2012, Spring 2012
Instructor: Virendra Saxena

Current Score : 19 / 19 **Due :** Tuesday, January 31 2012 11:59 PM EST

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1. 1/1 points | Previous Answers MI3 4.6.X.033

If a chain of 45 identical short springs linked end-to-end has a stiffness of 380 N/m, what is the stiffness of one short spring?

k_s = 17100 N/m

- *Read the eBook*
- Section 4.6

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2. 1/1 points | Previous Answers MI3 4.6.X.035

30 identical springs are placed side-by-side (in parallel), and connected to a large massive block. The stiffness of the 30-spring combination is 8700 N/m. What is the stiffness of one of the individual springs?

k_s = 290 N/m

- *Read the eBook*
- Section 4.6

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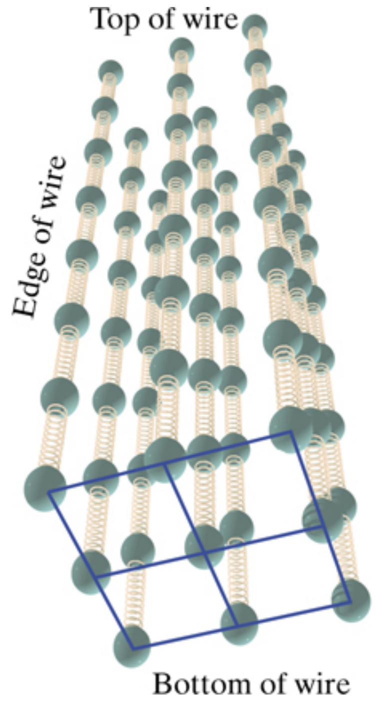
3. 8/8 points | Previous Answers MI3 4.6.P.049

One mole of iron (6×10^{23} atoms) has a mass of 56 grams, and its density is 7.87 grams per cubic centimeter, so the center-to-center distance between atoms is 2.28×10^{-10} m. You have a long thin bar of iron, 2.9 m long, with a square cross section, 0.14 cm on a side.

You hang the rod vertically and attach a 201 kg mass to the bottom, and you observe that the bar becomes 1.46 cm longer. From these measurements, it is possible to determine the stiffness of one interatomic bond in iron.



1) What is the spring stiffness of the entire wire, considered as a single macroscopic (large scale), very stiff spring?

k_s = 134917.808 N/m

2) How many side-by-side atomic chains (long springs) are there in this wire? This is the same as the number of atoms on the bottom surface of the iron wire. Note that the cross-sectional area of one iron atom is $(2.28 \times 10^{-10})^2$ m^2.

Number of side-by-side long chains of atoms = 3.77e13

3) How many interatomic bonds are there in one atomic chain running the length of the wire?

Number of bonds in total length = 1.27e10

4) What is the stiffness of a single interatomic "spring"?

$k_{s,i}$ = 45.45 N/m

An interatomic bond in iron is stiffer than a slinky, but less stiff than a pogo stick. The stiffness of a single interatomic bond is very much smaller than the stiffness of the entire wire.

- *Read the eBook*
- Section 4.6

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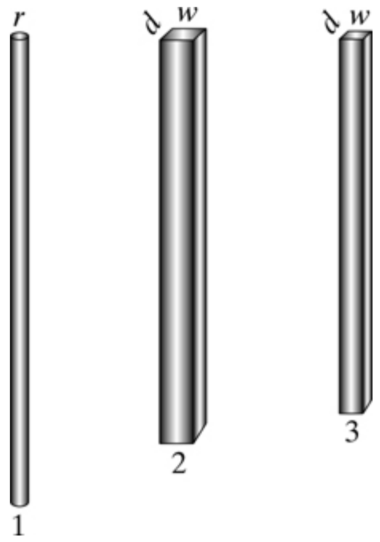
4. 2/2 points | Previous Answers MI3 4.6.X.041

Suppose you are going to measure Young's modulus for three rods by measuring their stretch when they are suspended vertically and weights are hung from them, as shown.



Rod 1 is 3.8 meters long and cylindrical with radius 8 mm (1 millimeter is 0.001 m). Rod 2 is 2.4 meters long by 14 mm wide by 3 mm deep. Rod 3 is 2.8 meters long by 9 mm wide by 9 mm deep. The definition of Young's modulus, $Y = (F/A)/(\Delta L/L)$, includes the quantity A, the cross-sectional area.

(a) What is the cross-sectional area of rod 1?

A = 2.012e-4 m^2

(b)) What is the cross-sectional area of rod 2?

A = 4.2e-5 m^2

(c)) What is the cross-sectional area of rod 3?

A = 8.1e-5 m^2

- *Read the eBook*
- Section 4.6

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5. 5/5 points | Previous Answers MI3 4.6.P.054

A hanging wire made of an alloy of nickel with diameter 0.07 cm is initially 2.5 m long. When a 41 kg mass is hung from it, the wire stretches an amount 1.31 cm. A mole of nickel has a mass of 59 grams, and its density is 8.9 g/cm^3.

Based on these experimental measurements, what is Young's modulus for this alloy of nickel?

Y = 1.99e11 N/m^2

As you've done before, from the mass of one mole and the density you can find the length of the interatomic bond (diameter of one atom). This is 2.22×10^{-10} m for nickel. As shown in the textbook, the micro quantity $k_{s,i}$ (the stiffness of one interatomic bond) can be related to the macro property Y:

$k_{s,i}$ = 44.178 N/m

- *Read the eBook*
- Section 4.6

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6. 2/2 points | Previous Answers MI3 4.6.X.039

Two wires with equal lengths are made of pure copper. The diameter of wire *A* is twice the diameter of wire *B*. When 10 kg masses are hung on the wires, wire *B* stretches more than wire *A*. You make careful measurements and compute Young's modulus for both wires. What do you find?

- ○ $Y_A > Y_B$
- ◉ $Y_A = Y_B$
- ○ $Y_A < Y_B$

✓

- *Read the eBook*
- Section 4.6

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