On density

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Warm-up problems

1. Write down Hooke's law in words.
2. From the Hooke's law section of the homework booklet:
   (a) Answer question 1.
   (b) Answer question 2.
3. Write down a definition of the Young's modulus for a material. Make sure that you explain all terms and symbols used, and give the usual units used for quantities.

Regular problems

4. From the Hooke's law section of the homework booklet:
   (a) Answer question 3.
   (b) Answer question 4.
5. From the Stress and Strain section of the homework booklet:
   (a) Answer question 2.
   (b) Answer question 3.
6. From the Young's modulus section of the homework booklet:
   (a) Answer question 1.
   (b) Answer question 3.
7. Answer question 2 from the Young's modulus section of the homework booklet.
8. (a) Answer question 4 from the Stress and Strain section of the homework booklet.
   (b) Answer question 4 from the Young's modulus section of the homework booklet.

Extension problems

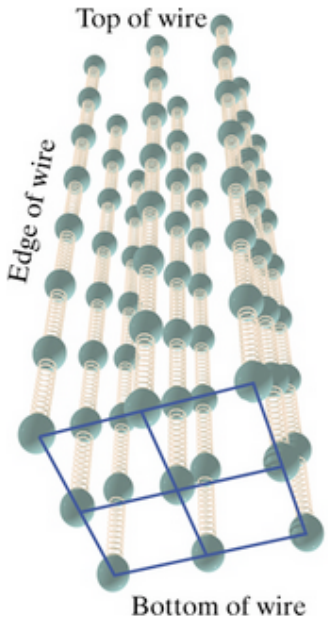
9. Answer question 5 from the Stress and Strain section of the homework booklet.

Fact File
$E_p = mgh$
$E_k = \frac{1}{2}mv^2$
$F = \frac{\Delta mv}{\Delta t}$

10. One mole of tungsten (6.02×10^{23} atoms) has a mass of 184 g, and its density is $19.3\,\mathrm{g\,cm^{-3}}$, so the centre-to-centre distance between atoms is 2.51×10^{-10} m. You have a long thin bar of tungsten, 2.5 m long, with a square cross section, 0.15 cm on a side. You hang the rod vertically and attach a 415 kg mass to the bottom, and you observe that the bar becomes 1.26 cm longer. From these measurements, it is possible to determine the stiffness of one interatomic bond in tungsten.

    (a) What is the spring constant for the entire wire, considered as a single macroscopic (large scale), very stiff spring?

    (b) 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 tungsten wire. Note that the cross-sectional area of one tungsten atom is $(2.51 \times 10^{-10})^2$ m^2.



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

    (d) What is the spring constant of a single atomic "spring"?

[Chabay & Sherwood, *Matter and Interactions*, 3rd edition, Wiley, 2011, problem 4.P.49]