2021

Question 1: Box Jump Force; Question 2: Frisbee Dogs

Larry Weinstein
Old Dominion University, lweinste@odu.edu

Original Publication Citation
Weinstein, L. (2021) Question 1: Box jump force; Question 2: Frisbee dogs. *The Physics Teacher*, 59(5) 366 https://doi.org/10.1119/10.0004890

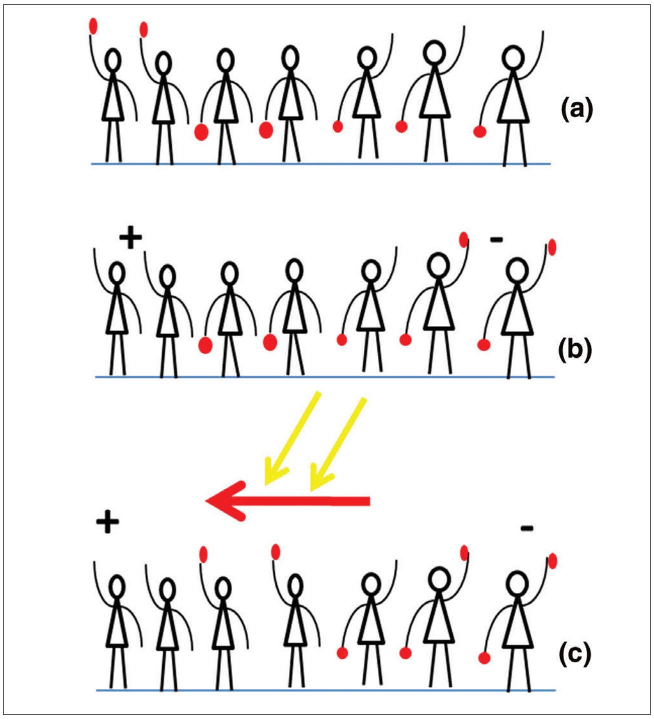

Fig. 4. The solar cell. When both types of doping are carried on the same semiconductor, free negative and positive charges are added (a). Their mutual attraction realizes positive and negative regions (the p-n junction) that act as an external voltage difference (b). If solar radiation strikes onto the doped semiconductor, an electric current can therefore flow in an external circuit (c).

id-state electrical conductivity, useful for explaining such concepts to junior secondary school students and effective to introduce the basic concepts of the solar cell operation, has been presented. The activity proposed is implemented "using" each student as a neutral atom and arranging the class in regular positions (as a chain or a two-dimensional lattice) that mime a solid structure. The electrical properties of the matter can then be explained following the indications reported in Figs. 1–3, where conductors, insulators, and semiconductors are, respectively, discussed. In Figs. 3(b) and (c), the class understands finally how a semiconductor can turn into a conductor, by the effect of the light or from the doping process. The student arrangements reported in Figs. 4(a)–(c), respectively, show how in a semiconductor where both the doping types (n and p) coexist (a), a region characterized by a voltage V can be created (the p-n junction) (b) so that the current I generated by a radiation impinging on the semiconductor can now give rise to an electric power $P = I{*}V$. It is finally worth noting that this sort of "human atom model" can be tailored to the specific class levels to ease the introduction of more complicated physical concepts.

References

1. "Theory of Solar Cells," Wikipedia, https://en.wikipedia.org/wiki/Theory_of_solar_cells, accessed Jan. 28, 2020.
2. J. L. Gray, "The Physics of the Solar Cell," in *Handbook of Photovoltaic Science of Engineering*, edited by A. Luque and S. Hegedus (John Wiley & Sons Ltd, 2003), p. 102.
3. B. J. Feldman, "An introduction to solar cells," *Phys. Teach.* **48**, 306 (May 2010).
4. C. D. Mickey, "Solar photovoltaic cells," *J. Chem. Educ.* **58**, 418 (1981).
5. F. Herrmann and P. Würfel, "The semiconductor diode as a rectifier, a light source, and a solar cell: A simple explanation," *Am. J. Phys.* **74**, 591 (July 2006).
6. B. A. Whitworth, J. L. Chiu, and R. L. Bell, "Kinesthetic investigations in the physics classroom," *Phys. Teach.* **52**, 91–93 (Feb. 2014).
7. AJ Richards and Eugenia Etkina, "Kinesthetic learning activities and learning about solar cells," *Phys. Educ.* **48**, 578 (2013).

Research Director, Head of Photovoltaic and Sensor Applications Laboratory, ENEA TERIN-FSD-SAFS. P.le E. Fermi 1, 80055 Portici (Napoli) taly; girolamo.difrancia@enea.it

Fermi Questions

Larry Weinstein, **Column Editor**
Old Dominion University, Norfolk, VA 23529;
weinstein@odu.edu

◗ Question 1: Box jump force

The record for a standing high jump (jumping from the ground to a platform of height h) is 67 in. How much force did the athlete exert during his jump? (*Thanks to Rocco Lapenta for inspiring this question.*)

◗ Question 2: Frisbee dogs

How many dogs jumped to catch a frisbee yesterday? (*Thanks to Radiolab for suggesting the question.*)

Look for the answers online at tpt.aapt.org under "Browse," at the very end of the current issue.

Question suggestions are always welcome!

For more Fermi questions and answers, see *Guesstimation 2.0: Solving Today's Problems on the Back of a Napkin,* by Lawrence Weinstein (Princeton University Press, 2012).

DOI: 10.1119/10.0004890