

Physics 100: Homework Solutions #10

Chapter 25, 26 and 27: due Dec 11

1) A magician places an aluminum ring on a table, under which is hidden an electromagnet (i.e. a coil of wire that may carry a current). When the magician says “abracadabra” (and discreetly pushes a switch that turns on the current in the coil), the ring jumps in the air. Explain his magic trick.

The changing magnetic field produced when the current starts to flow in the coil induces a current in the aluminum ring, since the ring lies in the magnetic field of the coil. This current, in turn, generates a magnetic field that opposes the field produced by the magnet under the table. The aluminum ring becomes, momentarily, a magnet that is repelled by the hidden magnet, hence it jumps in the air.

2) Can an efficient transformer step up energy? What about power? Explain your answer.

No. A step-up transformer increases the voltage, but the current decreases proportionally so that the total power and energy is the same. No device can step up energy – this is a fundamental law in physics, energy cannot be created nor destroyed.

3) What is the same about radio waves and light? What is different about them?

Radio waves and light are both electromagnetic waves, i.e. they are both transverse waves consisting of oscillating electric and magnetic fields at right angles to each other. They differ in their frequency and wavelength.

4) Is glass transparent to light of frequencies that match its own natural frequencies?

No, glass is not transparent to those waves, because of resonance: they drive the glass molecules to oscillate at their natural frequencies, building up amplitude and holding onto the energy long enough that collisions can occur whereby the energy is transformed to heat in the glass (i.e. absorbed).

5) How could you use the colored spotlights at a play to make the yellow clothes of a performer suddenly appear black?

Shine the blue spotlight on the performer, since blue is the complementary color to yellow, so is all absorbed, i.e. no light is reflected, i.e. the clothes will appear black.

6) If the sky on a certain planet in the solar system were normally orange, what color would sunsets be?

Sunsets would be white minus orange, i.e. blue, since the orange is scattered away from the sunbeam.

7) Your own clicker question