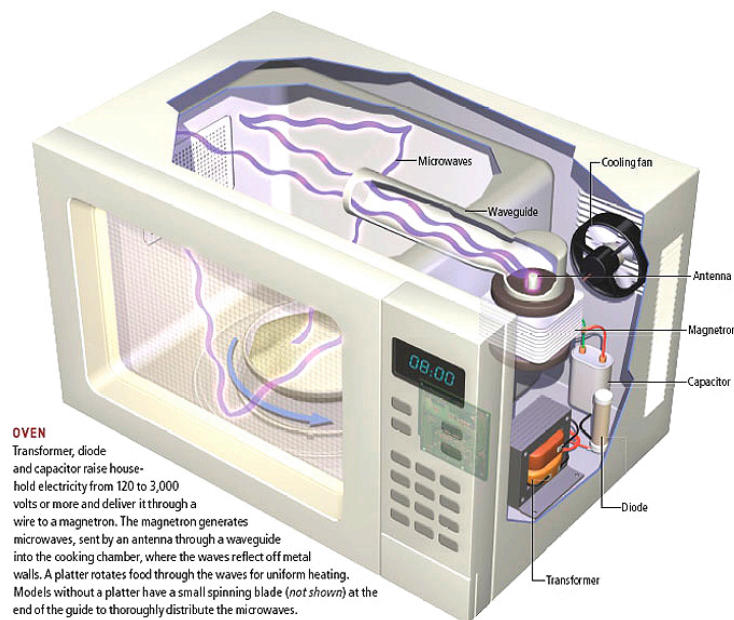


## Microwave Ovens: EE Quals Question 2013

### A. C. Fraser-Smith

(1) I start by stating that we are going to talk about how microwave ovens work and I then ask what is actually meant by ‘microwaves’ here? Are we dealing with ultrasound or electromagnetic waves? Micro implies something small – how small?”

It is not all that simple distinguishing between the use of ultrasound or em waves in a microwave oven simply by looking at one. The prohibition against putting metal objects inside was considered a clue, as was the grill (assumed to be metal) in the window. Having been told that em waves were used is not a particularly bad answer. Turning to the “micro,” many students state that it relates to the wavelength of the waves, i.e., they are around  $10^{-6}$  of a meter. At this stage they are told that the frequency of operation of typical commercial microwave ovens is 2.45 GHz – some students know this! So, what is the wavelength (in free space), assuming, say that the frequency is  $\sim 3$  GHz? A quick computation of  $\lambda = c/f$  gives  $\lambda = 0.1\text{m}$  or 10 cm. Obviously the “micro” is a misnomer. A few students knew that when it first became possible to generate microwaves in the late 1930’s the wavelengths were “micro” in comparison with the wavelengths of the radio waves in common use at the time. (2 points)



(2) Given that there is some device within a microwave oven that generates microwaves and radiates them into the chamber of the oven, what, in your opinion, are the important features of the oven from the electromagnetic point of view?

The device generating the microwaves is a magnetron with an attached antenna. Many students knew this but it was treated as being knowledge and not considered