Approaching the GRE Physics

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02/27-28/11

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Approach is Important

- Because you know how to do a problem does NOT mean you know how to do it on the GRE
- The name of the game is speed, not rigor.
- Many apparently complicated questions are asking one of two basic questions:
  - Can you reason physically?
  - Do you know basic physics facts?
- You won't have time to solve everything the hard way.
  - You have just under two minutes per problem.
  - Many can be solved much faster than this.

Advice

- Learn to reason physically
- Know things
  - e.g., Kepler's laws, the energy emitted by a blackbody, etc.
- Learn to approximate
- When you solve a practice problem, ask yourself if you could have done it faster

3. A satellite of mass m orbits a planet of mass M in a circular orbit of radius R. The time required for one revolution is

(A) independent of M

(B) proportional to $\sqrt{m}$

(C) linear in R

(D) proportional to $R^{3/2}$

(E) proportional to R^2

This could be done by solving the relevant kinematic equations. But that would be a huge waste of time!

The way to solve this one is to know Kepler's 3rd Law:

$$T^2 \propto R^3$$

10. A 3-microfarad capacitor is connected in series with a 6-microfarad capacitor. When a 300-volt potential difference is applied across this combination, the total energy stored in the two capacitors is

(A) 0.09 J
(B) 0.18 J
(C) 0.27 J
(D) 0.41 J
(E) 0.81 J

Here you must remember the energy stored in a capacitor:

$$\frac{1}{2}CV^2$$

Of course, you must also know how capacitors in series combine. If you remember these things, the problem is trivial – if not, it's basically impossible.

13. Two stars are separated by an angle of 3×10^{-5} radians. What is the diameter of the smallest telescope that can resolve the two stars using visible light ($\lambda \cong 600$ nanometers)? (Ignore any effects due to Earth's atmosphere.)

(A) 1 mm
(B) 2.5 cm
(C) 10 cm
(D) 2.5 m
(E) 10 m

You should know the resolving power of a telescope of diameter D is:

$$\theta \sim \frac{\lambda}{D}$$

There's a numerical correction factor on this relation, but even if you don't remember it, it's okay! This basic relation will get you close enough to the right answer here.

18. The energy required to remove both electrons from the helium atom in its ground state is 79.0 eV. How much energy is required to ionize helium (i.e., to remove one electron) ?

(A) 24.6 eV
(B) 39.5 eV
(C) 51.8 eV
(D) 54.4 eV
(E) 65.4 eV

The way to solve this one is to reason physically - or know the ionization potential of helium.
Ask yourself, would it be harder or easier to remove the first electron compared to the second?

It should be easier to remove the first, because when there are two electrons, one is pushing away on the other, making it easier to strip off. Therefore, it should take less than half of 79.0 eV to get the first one off – (A).

33. If a charged pion that decays in 10^{-8} second in its own rest frame is to travel 30 meters in the laboratory before decaying, the pion's speed must be most nearly

(A) 0.43×10^8 m/s
(B) 2.84×10^8 m/s
(C) 2.90×10^8 m/s
(D) 2.98×10^8 m/s
(E) 3.00×10^8 m/s

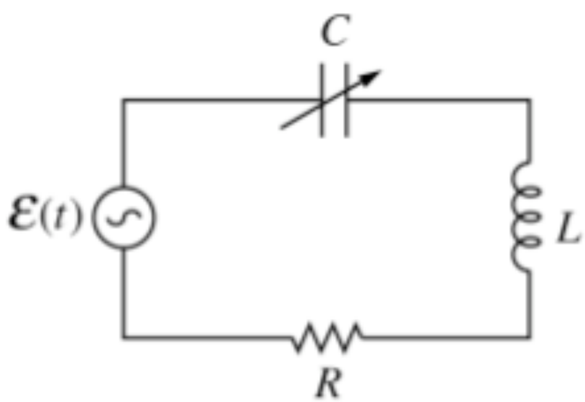
The rigorous way to solve this is to write down the time dilation factor, multiply by v, set equal to 30, and solve. But this is hard.

A much simpler method is to ask yourself, is this a big or a small relativistic effect? Note that if there were no time dilation, and the particle traveled at light speed, it would only get 3 meters. In fact, it gets 30 meters – a BIG effect! So the velocity must be close to (~99%) light speed, so (D) is the answer.

35. If the absolute temperature of a blackbody is increased by a factor of 3, the energy radiated per second per unit area does which of the following?

(A) Decreases by a factor of 81.
(B) Decreases by a factor of 9.
(C) Increases by a factor of 9.
(D) Increases by a factor of 27.
(E) Increases by a factor of 81.

You must know that the total energy emitted by a blackbody is proportional to the fourth power of its temperature. If you do, this problem takes less than 10 seconds.



38. An AC circuit consists of the elements shown above, with $R = 10{,}000$ ohms, $L = 25$ millihenries, and C an adjustable capacitance. The AC voltage generator supplies a signal with an amplitude of 40 volts and angular frequency of 1,000 radians per second. For what value of C is the amplitude of the current maximized?

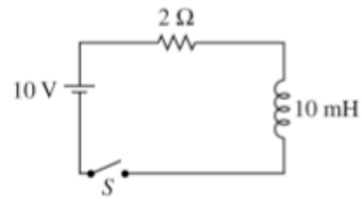
(A) 4 nF
(B) 40 nF
(C) 4 μF
(D) 40 μF
(E) 400 μF

Remember that resonance occurs when:

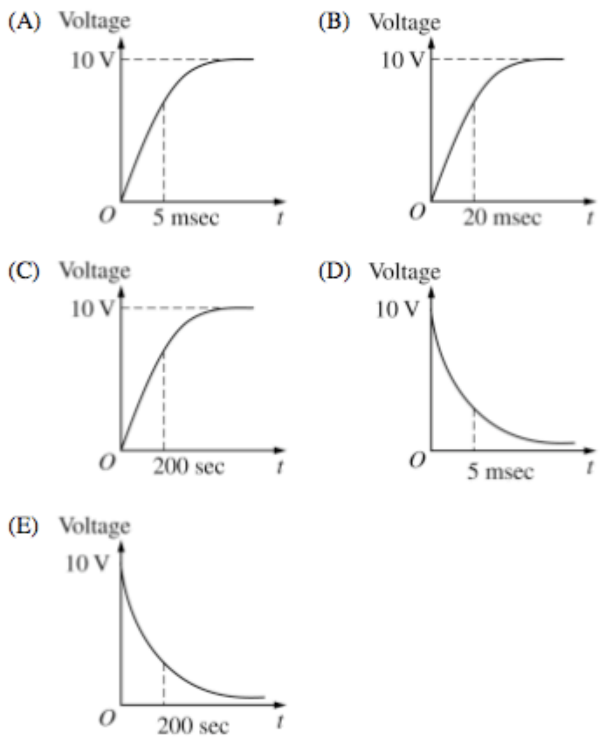
$$\omega = \frac{1}{\sqrt{LC}}$$

Note the extra (unnecessary) information designed to distract you…

Whenever you see a circuit and the question asks something like how to maximize the current, they are asking about this resonance relation.



40. In the circuit shown above, the switch S is closed at $t = 0$. Which of the following best represents the voltage across the inductor, as seen on an oscilloscope?



Inductors respond to CHANGE in current, so they reach highest voltage the moment the switch is flipped. Then they drop off. So it's either (D) or (E).

And it happens pretty fast, by human standards…so not (E). Therefore (D). Note that physical reasoning (probably based on experience in electronics lab) saves you from having to remember the inductor time constant equation.

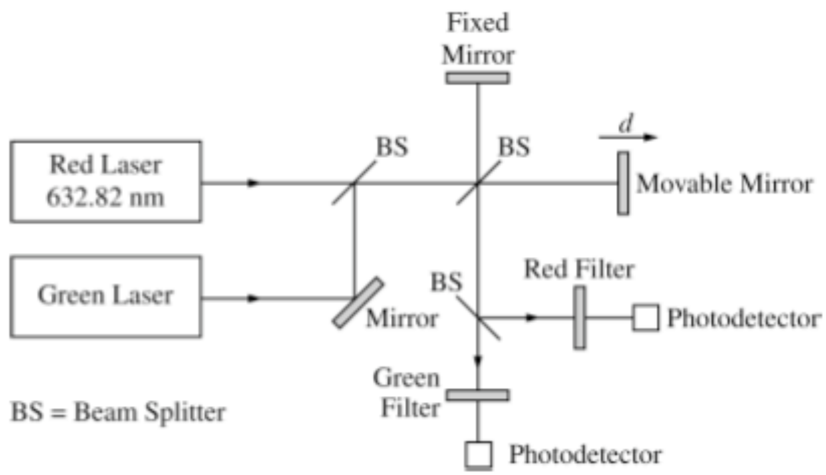
66. A sample of radioactive nuclei of a certain element can decay only by γ-emission and β-emission. If the half-life for γ-emission is 24 minutes and that for β-emission is 36 minutes, the half-life for the sample is

(A) 30 minutes
(B) 24 minutes
(C) 20.8 minutes
(D) 14.4 minutes
(E) 6 minutes

No math, just reasoning - solving this one the long way takes a lot of time, at least for me.

Here's the physical reasoning:
If decays can happen in two different ways, the resulting half-life is shorter than for either process alone, so not (A) or (B).

But it can't be shorter than half of the shorter half-life, so not (E). In fact, the resulting half-life must be between half of one half-life and half of the other. (Convince yourself of this). Therefore the answer is (D).



100. A Michelson interferometer is configured as a wavemeter, as shown in the figure above, so that a ratio of fringe counts may be used to compare the wavelengths of two lasers with high precision. When the mirror in the right arm of the interferometer is translated through a distance d, 100,000 interference fringes pass across the detector for green light and 85,865 fringes pass across the detector for red (λ = 632.82 nanometers) light. The wavelength of the green laser light is

(A) 500.33 nm
(B) 543.37 nm
(C) 590.19 nm
(D) 736.99 nm
(E) 858.65 nm

What they are really asking: Do you know the wavelength of green light? Many physicists will know that typical green laser light is 540 nm in wavelength.

Summary

- The examples were meant to convince you of the importance of physical reasoning, approximation, and knowing things to doing well on the GRE Physics
- I would say that many if not most GRE physics problems can be solved in under 20 seconds if thought about correctly.
  - Note that you get NO points for showing your work on this test – you only get points for right answers. Therefore, try to find tricks!
- A caveat is that there are some problems for which the solution cannot be found other than by using the standard techniques. But you can save yourself time for these by quickly knocking out the others!
- A final piece of advice: aggressively eliminate answers and take best guesses if you can get it down to 1 out of 3.