Name: _____ Student I.D.: _____

Practice Exam 4A

Physics 100, Spring 2007

Wednesday, May 16th 2007

Useful Equations and Numbers

Acceleration due to gravity...
on Earth = 10 m/s^2
on Mars = 3.7 m/s^2
on the Moon = 1.6 m/s^2

$$(wave\ speed) \ = \ wavelength \times frequency$$

$$frequency = \frac{1}{period}$$

$$f_{max} = T(Kelvin) \times 10^{11}\ Hz/Kelvin$$

$$T(Kelvin) = T(Celsius) + 273$$

$$speed\ of\ light \ = \ 300,000,000\ m/s = 3 \times 10^8\ m/s$$

$$E_{photon} = h\,f$$

$$h = 6.62 \times 10^{-34}\ J/Hz$$

$$Angle\ of\ Incidence = Angle\ of\ Reflection$$

1 $Hz = 1\ \frac{cycle}{sec} = \frac{1}{sec}$	1 $km\ = 1,000\ m = 0.6\ miles$
1 $MHz\ = \ 1,000,000\ Hz = \ 10^6\ Hz$	1 $hour = \ 3,600\ seconds$
1 $minute = \ 60\ seconds$	1 $g\ = \ 10\ m/s^2$
1 $m/s = \ 3.6\ km/hour$	1 $Newton\ = \ 1\ \frac{kg\ m}{s^2}$
1 $m\ = \ 3.2\ feet$	1 $Joule\ = \ 10,000,000\ ergs$
20 $m/s\ = \ 45\ mph$	1 $mile/minute\ = \ 60\ mph$

DO NOT OPEN EXAM UNTIL INSTRUCTED TO DO SO!
TURN OFF YOUR CELL PHONE!

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Relax! Be sure to write you name and SID on all of the pages. Show your work on all short answer questions! Look on page 1 for a list of handy equations and relations! Keep in mind that this is a long test, so if you're stuck on a problem, move on to the next one!

IF YOU HAVE QUESTIONS ON ANYTHING, RAISE YOUR HAND AND I WILL COME TO YOU!

Good luck!

Section 1. **True/False (1 pt. each)**
Warm up!

_____ Blue light is more strongly scattered in the atmosphere, which causes the sky to appear blue and sunsets to appear red.

_____ The energy of a photon is proportional to its wavelength.

_____ The hotter something is, the higher the frequency of light that it gives off.

_____ Electromagnetic waves tend bend towards regions where they travel more quickly.

_____ The fundamental difference between visible light and ultraviolet radiation is the difference in wavelengths/frequencies.

_____ The wavelength of 400 nm light traveling in water is shorter than 400 nm light traveling in air.

_____ An ultraviolet photon has less energy than an infrared photon.

_____ Blue light has a smaller frequency than red light.

_____ When an electron in an atom decays and gives off a photon, it can do so through *spontaneous emission* or *electrophosphorescent emission.*

_____ If an atom can emit 540 nm light, then it can absorb 540 nm light, too.

_____ If a beam of light is coherent, then all the photons that make it up have the same frequency, phase, and direction of travel, but not the same wavelength.

_____ A object that is fluorescing is absorbing light of one frequency and emitting light at a lower frequency.

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Section 2. **Multiple Choice (2 pts. each)**
Choose the single best answer unless instructed to do otherwise.
Hint: they're not all (C)!

1. How is it that astronomers can tell if stars many light-years away are moving away or towards us?
   (a) This is a trick question: they can't!
   (b) They can look at how Fraunhofer lines are Doppler shifted.
   (c) They can measure the peak emission wavelength of the star and determine its temperature.
   (d) They can use laser-rangers from Earth to determine how far away the stars are.
2. Which of the following are examples of electromagnetic waves (circle all that apply)?
   (a) x-rays
   (b) radio waves
   (c) visible light
   (d) microwaves
   (e) ultrasonic waves
3. Which of the following light source(s) is best described by the following statement?

   > Light is generated by heating up a filament to a very high temperature, usually by passing electricity through it. The frequency of the emitted light is proportional to the temperature of the filament.

   (a) Incandescent light bulb
   (b) Fluorescent light bulb
   (c) LASER
   (d) Neon Sign
   (e) Phosphorescent light bulb
4. Which of the following is/are true?
   (a) The speed of light in warm air is slower than in cold air because the atoms in cold air don't take as much of its energy.
   (b) The speed of light in warm air is faster than in cold air because the gas molecules are moving faster and therefore Doppler shift the light to higher velocities than cold air would.
   (c) The speed of light in warm air is faster than in cold air because the density of warm air is lower so that there are fewer atoms per unit volume to slow the light down.
   (d) The speed of light in cold air is faster than in cold air because the density of cold air is lower so that there are fewer atoms per unit volume to slow the light down.
   (e) The speed of light in warm air and cold air is the same because it's *sound waves* that travel in air– light doesn't need a medium..

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Section 3. **Short Answer Questions (10 pts. each)**

5. You are swimming underwater and look up to see a bird sitting in a tree.
   (A) Would the bird appear to be closer or farther away from you than it actually is?
   (B) In the figure below, *draw at least two light rays* that support your answer to part **(A)**.

Figure 1: You're swimming underwater and look up to see a bird. See Problem 5

6. Imagine what would happen if the Earth's atmosphere scattered green light much more strongly than red and blue light and that it scattered red light just as strongly as blue light.
   (A) What color would the noon sky be?
   (B) What color would sunsets be?
   (C) What color would the Sun look like?
   (D) During a lunar eclipse, what color would the moon appear to be?
   (E) What color would dessert 'water' mirages be?

7. **Quick Calculations:**
(A) If you were 300,000,000,000,000 m (3×10^{14} m) away from the Sun when it suddenly 'turned off,' how long would it take for you to know?
(B) How long, in years, will aliens on a planet 500 *light years* away have to wait to see this season's finale of *America's Next Top Model*? Assume that the alien's planet is not moving with respect to the Earth and that the TV signal is being carried by radio waves.
(C) Imagine it's a warm day. What is the peak electromagnetic emission frequency of your skin, assuming that it is $27°C$?
(D) Using your answer from part **(C)**, what peak wavelength would your skin radiate at?
(E) Compared to the energy of a 150 nm photon, how much energy does a 600 nm photon have?

8. An energy level diagram for an imaginary atom is drawn below.
   (A) How may different wavelengths of light can the atom emit?
   (B) How many different wavelengths of light can the atom absorb?
   (C) Which energy level is the ground state?
   (D) If this atom were to fluoresce, describe how a photon might be emitted, taking into account all of the required steps starting with the excitation of the electron in the atom to the emission of the final photon. Note that there is no unique solution to this question.

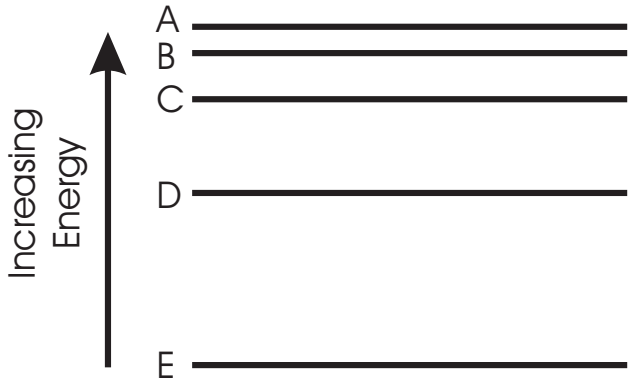

Figure 2: The energy levels for the fictitious atom in Problem 8

9. A large ship is coming towards shore and is communicating with a land-based command tower using radio waves. An interesting thing happens: as the ship approaches the shore, the communications signal gets stronger, then weaker, then stronger again. Explain what is happening using words and a diagram. *Hint: radio waves can bounce off of water.*

THIS IS THE LAST PAGE OF PRACTICE EXAM 4A. CONGRATULATIONS!