PHYS 252   FINAL EXAM   5/3/18   Dr. Holmes   NAME____Key_____________

DO ALL 15 PROBLEMS. THE WORTH OF EACH PROBLEM IS MARKED [ ] BESIDE THE PROBLEM. SHOW YOUR WORK FOR PARTIAL CREDIT.

1) A ray of light in water (assume n = 1.33 for water) hits a water/air (assume n = 1.00 for air) interface at an angle of 65 degrees **with respect to the SURFACE** of the interface.

a) What is the angle of reflection **measured from the SURFACE**?

[1]___**65^o**_________.

b) What is the angle the transmitted ray in the air makes **with the NORMAL** (if totally reflected, answer TIR)?

[3] ____**34.2^o**_______.

c) Can rays of light in the water be totally reflected from the water/air interface?

[1] ____**yes**__.

d) Can rays of light in the air be totally reflected from the air/water interface?

[1] ____**no**___.

2) a) Draw a diagram showing the eye, lens, object and image for a person wearing glasses to correct for **near-sightedness**: [4]

b) If the person with near-sightedness can make out an object as far as (but no further than) 35 cm without glasses, what should the focal length of the person's glasses be if the person is to make out an object that is at a distance of 50 m away?

[4] ____**-35.2 cm**____.

3) **DESIGN** a lens that has the above focal length (from Question 2 part b) and **DRAW A PICTURE** of the lens making sure to show relative curvatures. [6]

n_{glass} = _________ R_1 = ____________ R_2 = ____________

Picture:

4) Laser light of wavelength 632 nm is directed through a double slit with a distance of 0.15 mm between slits and each slit having a width of 0.030 mm. The screen is 9 meters away. a) How far apart are adjacent bright spots on the screen?

[3] ___**3.79 cm**_____. b) If the distance between slits is decreased, will the distance between adjacent bright spots decrease, increase, or remain the same?

[1] __**increase**____. c) If the width of each of the two slits is increased, will the distance between adjacent bright spots decrease, increase, or remain the same?

[1] ___**same**__________.

d) If the wavelength of the light is decreased, will the distance between adjacent bright spots decrease, increase, or remain the same?

[1] ____**decrease**___.

For problems 5&6: A camera with a 50 mm focal length lens takes a picture of a newspaper with print that is 5 mm in size and the paper is 80 meters away. The person uses an f-stop of 4 (meaning the diameter of the opening to the lens is 50 mm/4 = 12.5 mm) and time exposure of 1/120 sec. The film is 24 mm x 36 mm in size.

5 a) What is the object distance?

[1] ____**80 m**_______. b) How far should the lens be from the film? (If the distance is close to the focal length, be sure to indicate whether the distance is a little more than or a little less than the focal length.)

[3] _____**50.03 mm**____. c) What is the size of the print on the film?

[2] __**3.13 μm**___________ .

6) Use the information on the camera above.

a) What angle does the print size make with the lens at the 80 meter distance? [2] _**3.58×10^{-3} °**.

b) What is the smallest angle this camera can resolve using the f-stop of 4?

[3] ___**3.08×10^{-3} °**_.

c) If the film is enlarged, will you be able to resolve the letters well enough to be able to read the paper from the enlarged picture? (answer definitely, just barely or not quite, or definitely not)

[1] ____**definitely not**______.

7) A "blue" star has a surface temperature of 25,000 K. This star has a radius of 10 million km, 15 time bigger than our sun (recall that the surface area of a sphere is $4\pi r^2$).
a) Assuming the star is a perfect blackbody, what is the **wavelength** of the peak radiation of the star?

[3] **1.16×10^{-7} m = 116 nm** . b) How much total **power** does the star emit (in Watts) ?

[3] **2.79×10^{31} W**.

Assume there is a planet 150 million kilometers away from the star, the same distance the earth is away from our sun. c) What is the **power per area** from the star on the planet at that planet's distance from the star (in Watts/m^2)?

[2] **9.87×10^{7} W/m^2** .

8 a) If the cut-off frequency for light to eject photo-electrons from a particular metal is 360 nm, what is the work function for this metal?

[4] **3.45 eV** . b) What kind of light is this (if visible, what color) ?

[1] **UV** . c) Will light of wavelength 410 nm be able to eject electrons from the metal?

[1] **no** .

9) a) What is the ground state energy of the hydrogen atom?

[2] **-13.6 eV = 2.18×10^{-18} J** .

b) How much energy is emitted when the electron falls from the n=4 state to the n=2 state in the hydrogen atom?

[3] **2.55 eV = 4.08×10^{-19} J** . c) What type of photon is this (e.g., ultraviolet, infrared, etc. (if visible, specify the color):

[1] **blue-green** .

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10) Two explosions (call them # and $) are seen by observer A: the $ explosion happens 1,500 meters to the right of the #, and the $ explosion happens 3 microseconds after the # explosion. Observer B is moving with a speed of .678c to the right with respect to the A observer.
a) What does observer B measure for the distance between the two explosions?

[3] ____**1,210 m**__________. b) Did the $ explosion happen to the right or left of explosion # according to observer B?

[1] __**right**_______. c) What does observer B measure for the time difference between the two explosions?

[3] ____**-0.53 µs**_____. d) Which explosion happened first (# or $) as determined by observer B?

[1] _**#**__________.

11) A space ship moving at a speed of .666c toward the earth (as measured by both the earth and the spaceship) fires a missile going toward the earth at a speed of .888c relative to the space ship. a) What speed would an earth observer measure for the missile?

[3] _**.976 c**______.

b) If the missile were fired at a speed of .888c away from the earth (as measured by the spaceship) instead of toward it (with the spaceship still going .666c away from the earth), what speed would the earth observer measure for the missile?

[2] ____**.543 c away**_

c) If the missile were replaced by a light pulse directed away from the earth, what speed would the earth measure for the speed of the light pulse?

[2] _**1.000 c**_______________.

12) A photon has energy 1.66 MeV. a) What is the wavelength of light that has photons of this energy?

[2] ___**7.49×10^{-13} m**_____. b) What type of light is this (IR, UV, radio, etc.; if visible, what color is it)?

[1] ___**gamma**_____. c) What is the mass of this photon?

[2] _**2.95×10^{-30} kg**_____.

d) What is the rest mass of this photon?

[1] ____**0**___________. e) What is the momentum of this photon? [2] __**8.85×10^{-22} kg*m/s**_.

Mass of Hydrogen atom (proton + electron) = 1.00782 amu;
mass of neutron = 1.008665 amu; mass of electron = .00055 amu;
rest mass energy of an amu = 931.5 MeV.

If you do not know the symbol of an element but only know its atomic number and mass number, then use X as the symbol of the element.

13) a) What is the total nuclear binding energy for lead-207 ($_{82}Pb^{207}$) which has an atomic mass of 206.9759 amu)?

[3] __**1,629 MeV**___. b) What is the binding energy per nucleon?

[1] _**7.87 MeV/amu**_.

c) Is this binding energy per nucleon greater, the same, or less than that for uranium-235 ($_{92}U^{235}$ has an atomic mass of 235.0439 amu)?

[1] ____**greater**_____.

14) Fill in the missing particle(s), given that there are no stable isotopes of uranium (U); there is 1 stable isotope of Co at 59.

[1] $_{92}U^{235}$ goes to **$_{90}X^{231}$** + alpha + energy

[3] $_{27}Co^{58}$ goes to **$_{26}X^{58}$** + **$_{+1}\beta^{0}$** + **$_{o}\upsilon^{o}$**

[3] $_{27}Co^{60}$ goes to **$_{28}X^{58}$** + **$_{-1}\beta^{0}$** + **anti - $_{o}\upsilon^{o}$**

15) a) What is the activity of a sample of 1 gram of $_{27}Co^{58}$ given that its half life is 71 days?

in Bq: in Curies:

[3] _____**1.17×10^{15}**________ [1] _**31,592**____________.

b) What will be the activity of the 1 gram sample of Co^{58} (in Bq) after 5 years?

[3] ____**2.14×10^{7} Bq**______.