Use the following information for problems 1 and 2.
A beam of white light with frequency between $4.00 \times 10^{14}$ Hz and $7.90 \times 10^{14}$ Hz is incident on a sodium surface, which has a work function of 2.28 eV.

1) What is the range of frequencies in this beam of light for which electrons are ejected from the sodium surface?
   a) $4.00 \times 10^{14}$ Hz to $7.90 \times 10^{14}$ Hz
   b) $4.00 \times 10^{14}$ Hz to $6.44 \times 10^{14}$ Hz
   c) $5.10 \times 10^{14}$ Hz to $7.90 \times 10^{14}$ Hz
   d) $5.50 \times 10^{14}$ Hz to $7.90 \times 10^{14}$ Hz

2) What is the maximum kinetic energy of the photoelectrons that are ejected from this surface?
   a) $9.96 \times 10^{-20}$ J
   b) $1.59 \times 10^{-19}$ J
   c) $2.65 \times 10^{-19}$ J
   d) $5.24 \times 10^{-19}$ J

3) When light of a particular wavelength and intensity shines on the surface of a given metal, no electrons are ejected. Which of the following changes will most likely cause the emission of photoelectrons?
   a) Decreasing the frequency of the light
   b) Increasing the intensity of the light
   c) Decreasing the wavelength of the light
   d) Increasing the wavelength of the light

4) What is the de Broglie wavelength for a Helium atom (atomic mass=4.002603 u) traveling at a speed of $10^3$ m/s? Use the conversion factor $1$ u = $1.66054 \times 10^{-27}$ kg.
   a) $4.0 \times 10^{-11}$ m
   b) $1.0 \times 10^{-10}$ m
   c) $6.2 \times 10^{-8}$ m
   d) $2.5 \times 10^{-12}$ m

5) The neutral pion ($\pi^0$) is an unstable particle produced in high-energy particle collisions. Its mass is 264 times that of the electron, and it exists for an average lifetime of $8.4 \times 10^{-17}$ s before decaying into 2 gamma-ray photons. Find the uncertainty in the mass of the pion, expressed as a fraction of its mass. $\Delta m/m$ is approximately
   a) 0.25
   b) $2 \times 10^{-4}$
   c) $6 \times 10^{-8}$
   d) $3 \times 10^{-11}$

6) You and a friend travel through space in identical spaceships. Your friend informs you that he has made some length measurements and that his ship is 150m long and yours is 120m long. What is the relative speed of the two ships?
   a) 0.1c
   b) 0.3c
   c) 0.6c
   d) 0.8c
Physics 6C Final Practice Questions

7) A laser is used to move the electron in a hydrogen atom from the n=2 to the n=4 state. What is the wavelength of the laser light used to excite this electron?
   a) 380 nm  
   b) 490 nm  
   c) 520 nm  
   d) 630 nm

8) Assume the excited hydrogen atoms in problem 7 will emit photons until they fall back to the ground state. What is the minimum wavelength of the emitted photons?
   a) 91 nm  
   b) 97 nm  
   c) 103 nm  
   d) 487 nm

9) An object is 4m away from a wall. You are to use a concave mirror to project an image of the object on the wall, with the image 2.25 times the size of the object. What should the radius of curvature of the mirror be?
   a) 1.1m  
   b) 2.2m  
   c) 4.4m  
   d) 5.5m

10) A $^{239}$Pu (plutonium) nucleus typically decays by emitting an α-particle with an energy of about 5.1 MeV. What is the resulting daughter nucleus?
   a) $^{235}$U  
   b) $^{235}$Pu  
   c) $^{235}$Th  
   d) $^{237}$U

11) Nucleus X has 10 times as many nucleons as nucleus Y. Compared to Y, X has
   a) a larger radius and about the same density  
   b) a larger radius and a smaller density  
   c) a smaller radius and about the same density  
   d) a larger radius and a larger density

12) Originally the decay rate of a sample was 16 decays per second. Now it has a rate of 2 decays per second. The half-life is 5 years. How many years have passed?
   a) 40 years  
   b) 25 years  
   c) 20 years  
   d) 15 years

13) An ancient bone has been recovered from an archeological dig. It is determined that the ratio of the isotope carbon-14 to total carbon is only 20% of the ratio currently present in the atmosphere. The half-life of carbon-14 is 5730 years. How old is the bone?
   a) 9,220 years  
   b) 11,460 years  
   c) 13,300 years  
   d) 17,190 years
14) $^{16}_7\text{N}$ is an unstable isotope of nitrogen with a half-life of about 7 seconds. When it undergoes $\beta^-$ decay an electron, an antineutrino, and one other particle are emitted. What is the other particle?
   a) $^{17}_7\text{N}$
   b) $^{16}_6\text{C}$
   c) $^{16}_8\text{O}$
   d) $^{18}_9\text{F}$

15) A light ray is in water is incident at an angle of 22.8° on an oil film with thickness 560 nm and index of refraction 1.45. Does the light ray bend toward or away from the normal? Assume that the index of refraction of water is 1.33.
   a) Toward
   b) Away
   c) The ray does not bend at all.
   d) The ray is completely reflected.

16) An oil film floats on water. The refractive index of the oil is 1.4 and the index for water is 1.33. The film appears blue because it reflects light with wavelength 400 nm very well. Calculate the minimum thickness of the oil film.
   a) 71 nm
   b) 100 nm
   c) 143 nm
   d) 200 nm

17) A single-slit experiment is performed with light of wavelength of 500 nm, and the first dark fringe appears at a distance of 4cm from the central bright maximum. If this experiment is now performed with the same setup, but underwater, how far from center will the first dark fringe be? The index of refraction of water is 1.33.
   a) 2 cm
   b) 3 cm
   c) 4 cm
   d) 5 cm

18) A double-concave lens is made from glass with index of refraction $n=1.6$. The radius of curvature is 90cm for each side. Find the focal length of this lens when used in air.
   a) 50cm
   b) -90cm
   c) -75cm
   d) -50cm

19) The sun produces energy by nuclear fusion reactions, in which matter is converted to energy. The rate of energy production is $3.8 \times 10^{26}$ Watts. How many kilograms of mass does the sun convert to energy each second?
   a) $4.2 \times 10^9$ kg/s
   b) $6.1 \times 10^7$ kg/s
   c) $1.3 \times 10^{18}$ kg/s
   d) $9.0 \times 10^{16}$ kg/s
20) Calculate the mass defect for the decay of $^8\text{Be}$ into two alpha particles. The atomic mass of $^8\text{Be}$ is 8.005305 u, the mass of an alpha particle is 4.00148 u, and the mass of an electron is 0.000549 u. Also, 1 u = 931.5 MeV.

- a) 4.00 MeV
- b) 2.18 MeV
- c) 0.14 MeV
- d) 0.08 MeV

21) Polarizer 1 has a vertical transmission axis. Polarizer 2 has a transmission axis tilted 45° from the vertical, and polarizer 3 has a horizontal transmission axis. The light incident on polarizer 1 is polarized vertically. If polarizer 2 is removed, what will be the effect on the intensity of light at point $P$?

- a) the intensity will be zero (no light will emerge from polarizer 3)
- b) the intensity will increase by a factor of 2
- c) the intensity will decrease, but will be greater than zero
- d) the intensity will be unchanged

22) At a point in space an electromagnetic wave is propagating in the negative $y$ direction. At a certain instant, the magnetic field of the wave at this point is in the positive $x$ direction. At this point and this instant, the electric field of the wave is

- a) in the positive $z$ direction
- b) in the positive $x$ direction
- c) in the negative $y$ direction
- d) in the negative $z$ direction

23) An astronaut traveling with a speed $v$ relative to Earth takes her pulse and measures 70 beats per minute. Mission control on Earth, which monitors her heart, observes a rate of 43 beats per minute. What is the astronaut’s speed relative to Earth?

- a) 0.5c
- b) 0.7c
- c) 0.8c
- d) 0.9c

**ANSWERS:** 1)d 2 b 3)c 4)b 5)c 6)c 7)b 8)b 9)c 10)a 11)a 12)d 13)c 14)c 15)a 16)a 17)b 18)c 19)a 20)c 21)a 22)d 23)c