Physics 180B Name ___________________________

Test 4 - 120 Points

Answer 10 of the 13 Multiple Choice questions. Cross off 3 questions.

1. A rocket is traveling toward the earth at 3/4c when it ejects a missile forward at 3/4c relative to the rocket. The speed of the missile as measured by an observer on earth is (6 pts)

a. 3/2c b. c c. 15/16c d. 24/25c

2. A square measuring 2m x 2m is moving toward from observer A along a direction parallel to one of its sides at a speed such that gamma = 4. The area of this square, as measured by observer A. (6 pts)

a. $1/4m^2$ b. $1/2m^2$ c. $4m^2$ d. $2m^2$

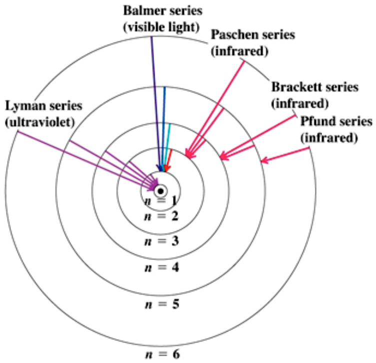
3. The twin paradox arises from the fact that (6 pts)

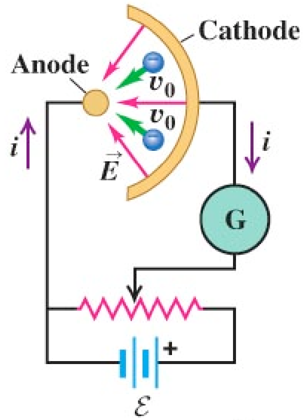
a. all Inertial frames are equivalent and both twins can correctly argue that they are younger than the other twin when they get back together.
b. only one twin ages more than the other twin.
c. both twins are identical and moving away from each other at the same speed.
d. both twins are not identical that one twin is accelerating.

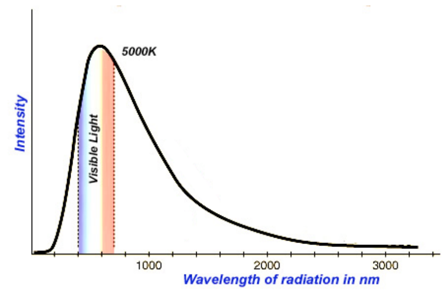
4. What led Einstein and others to the realization that time was not absolute? (6 pts)

a. That the Galiliean concept of relativity was not correct at slow speeds.
b. That time is dilated depending on the difference in the measurements of the speed of light in another frame of reference.
c. The speed of light varies depending on how fast the observer is moving relative to the frame of reference of the light.
d. That the speed of light is always c no matter how fast one is moving relative to the frame of reference of the light.

5. Experimental outcomes forced physicists to reevaluate Classical Theory. Correctly label the diagrams below 3 pts







Compton Effect, Line Spectra, PhotoElectric Effect, BlackBody Radiation, Rutherford Scattering

The particle nature of light is demonstrated through the _______ by the release of electrons from a metal surface. Only light with ___________ is capable of releasing electrons from the surface even at extreme intensity. Scientists shined light of the same wavelength onto a metal surface and discovered that the electrons released from the metal had the same__________. 3 pts

a. line spectra, sufficient energy, kinetic energy
b. photoelectric effect, sufficient energy, wavelength
c. photoelectric effect, sufficient energy, kinetic energy
d. compton effect, kinetic energy, wavelength

6. Light falling on a metal surface causes electrons to be emitted from the metal by the photoelectric effect. As we increase the intensity of this light, but keep its wavelength the same (there may be more than one correct answer), 3 pts

a. the number of electrons emitted from the metal increases.
b. the number of electrons emitted from the metal does not change.
c. the maximum speed of the emitted electrons does not change.
d. the maximum speed of the emitted electrons increases.

Light falling on a metal surface causes electrons to be emitted from the metal by the photoelectric effect. As we increase the frequency of this light, but do not vary anything else (there may be more than one correct answer), 3 pts

a. the number of electrons emitted from the metal increases.
b. the maximum speed of the emitted electrons increases.
c. the maximum speed of the emitted electrons does not change.
d. the work function of the metal increases.

7. The hypothetical atom $^{37}_{17}X$ contains (there may be more than one correct choice) V

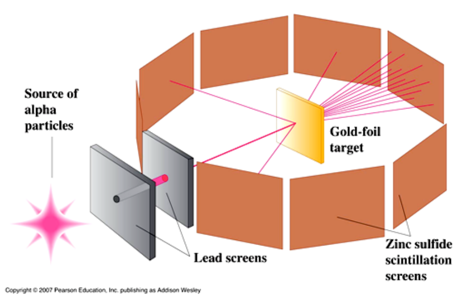
A. 17 orbital electrons.
B. 37 protons.
C. 17 protons.
D. 20 neutrons.
E. 54 nucleons.

8. In a nuclear accident, a lab worker receives a dose of 20 rads of radiation of x rays having an RBE of 1. If instead he had been exposed to the same amount of energy from alpha particles having an RBE of 20, his exposure would have been (there may be more than one correct choice) (6 pts)

A. D rads.
B. 20 D rads.
C. D rem.
D. 20 D rems.

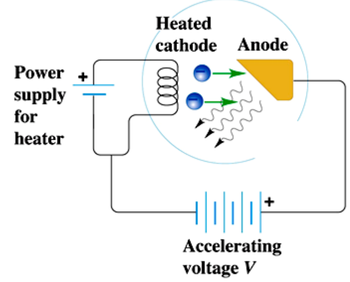
9. ___________ discovered that shooting ______ particles through gold foil produced a backscattering effect that could not be explained by the Thomson model of the atom. Thomson's model suggested that _________ (raisins) were embedded in a positive mass (muffin). ___________ experiment suggested that the _________ mass was concentrated at the center of a __________ atom. (6 pts)

a. Rutherford, electrons, electrons, positive, Thomson, mostly empty
b. Bohr, alpha, electrons, positive, Rutherford, concentrated
c. Einstein, alpha, protons, positive, Rutherford, concentrated
d. Rutherford, alpha, electrons, positive, Rutherford, mostly empty

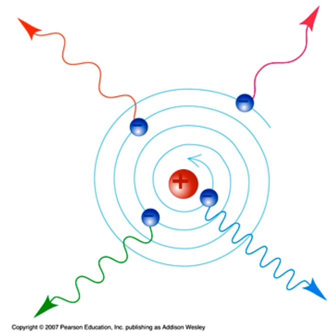


10. The power supply is sufficiently powerful enough to 'boil off' _________ which are accelerated toward the ____________. The ____________ of the these electrons is sufficient to penetrate the electron cloud around atoms of the _____________. These accelerated electrons can collide with the _____________ electron of the anode material. When the anode electron closest to the nucleus is knocked out of orbit, a(an) ___________ is released after other electrons fall into replace it. These photons are the electromagnetic rays that radiologists want to image the inside of bodies. (6 pts)

a. cathode electrons, anode material, kinetic energy, anode material, innermost, X-ray photon
b. cathode protons, cathode material, kinetic energy, anode material, innermost, X-ray photon
c. cathode electrons, anode material, mass energy, anode material, outerermost, Gamma ray photon
d. cathode electrons, anode material, kinetic energy, anode material, outermost, X-ray photon



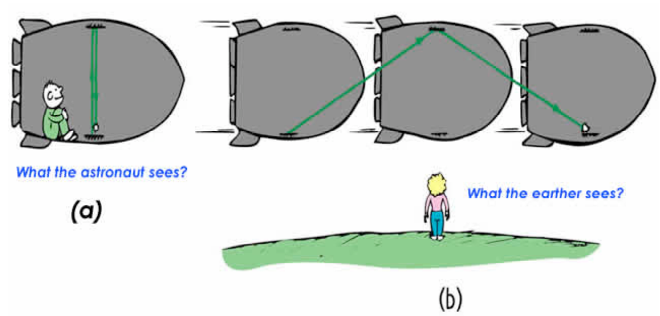
11. This diagram represents (6 pts)



a. Rutherford's Experiment - 4 electrons being scattered of a gold nucleus.
b. Compton's Paradox - 4 different electrons releasing 4 different photons.
c. Plancks Problem - One electron getting captured by a proton and emitting a continuous spectrum of radiation.
d. Bohr's Paradox - An electron spiraling into the nucleus emitting a continuous spectrum of radiation.
e. Einsteins Problem- 4 Photons being emitted from excited electrons.

12. In the diagram (6 pts)

a. The girl is Einstein's daughter and she studied physics from the master. The light travels at the same speed in both reference frames. She suggests that this diagram is a paradox which cannot be solved.
b. The boy is discovering that the light seems faster to him in his frame of reference.
c. The girl is discovering that the light seems to be faster in her frame of reference.
d. The boy sees the light travel slower in his frame of reference than in the girl's frame of reference.



13. What is the percentage of radiation dose that we get from the environment compared with that obtained through our technological society. (3 pts)

a. 18:82 b. 82:18 c. 25:75 d. 50:50

What is worse gamma radiation or alpha radiation? (3 pts)

a. Neither! The are both good for you!
b. Alpha radiation because it is high energy and a very large particle!
c. Gamma radiation because it is high energy and very small!
d. It depends on where the exposure (radiation) occurs (inside or outside of your body).

Answer 5 of the 8 problems below. Cross off three problems, please.

1. Inside a spaceship flying past the earth at 24/25 the speed of light, a pendulum is swinging. If each swing takes 2.50 s as measured by an astronaut performing an experiment inside the spaceship, how long will the swing take as measured by a person at mission control on earth who is watching the experiment? If each swing takes 2.50 s as measured by a person at mission control on earth, how long will it take as measured by the astronaut in the spaceship?

2. An unstable particle is created in the upper atmosphere from a cosmic ray and travels straight down toward the surface of the earth with a speed of 0.9988 c relative to the earth. A scientist at rest on the earth's surface measures the particle to have been created at an altitude of 52.0 km. As measured by the scientist, how much time does it take the particle to travel the 52.0 km to the surface of the earth. Use the length contraction formula to calculate the distance from where the particle was created to the surface of the earth, as measured in the particle's reference frame. In the particle's frame, how much time does it take the particle to travel from where it is created to the surface of the earth? Calculate this time by the time dilation formula. Calculate this time from the distance calculated in part (b).

3. An imperial spaceship, moving at high speed relative to the planet Arrakis, fires a rocket toward the planet with a speed of 0.930 c relative to the spaceship. An observer on Arrakis measures the rocket to be approaching with a speed of 0.380 c. What is the speed of the spaceship relative to Arrakis? Is the spaceship moving toward or away from Arrakis?

4. A space probe is sent to the vicinity of the star Capella, which is 45.2 light years from the earth. (A light year is the distance light travels in a year.) The probe travels with a speed of 0.995 c relative to the earth. An astronaut recruit on board is 22.0 years old when the probe leaves the earth. What is her biological age when the probe reaches Capella, as measured by the astronaut? What is her biological age when the probe reaches Capella, as measured by someone on earth?

5. The photoelectric work function of potassium is 2.35 eV. If light having a wavelength of 270 nm falls on potassium, find the stopping potential in volts. If light having a wavelength of 270 nm falls on potassium, find the kinetic energy, in electron volts, of the most energetic electrons eject. If light having a wavelength of 270 nm falls on potassium, find the speeds of the most energetic electrons ejected.

6. To investigate the structure of extremely small objects, such as viruses, the wavelength of the probing wave should be about one-tenth the size of the object for sharp images. But as the wavelength gets shorter, the energy of a photon of light gets greater and could damage or destroy the object being studied. One alternative is to use electron matter waves instead of light. Viruses vary considerably in size, but 50.0 nm is not unusual. Suppose you want to study such a virus, using a wave of wavelength 5.00 nm. If you use light of this wavelength, what would be the energy (in eV) of a single photon? If you use an electron of this wavelength, what would be its kinetic energy (in eV)? Is it now clear why matter waves (such as in the electron microscope) are often preferable to electromagnetic waves for studying microscopic objects?

7. Calculate the total binding energy of the nuclei of Fe-56 (of atomic mass 55.934937 u). Calculate the total binding energy of the nuclei of Pb-207 (of atomic mass 206.9759 u). Calculate the binding energy per nucleon for Fe-56. Calculate the binding energy per nucleon for Pb-207.

8. One of the problems of in-air testing of nuclear weapons (or, even worse, the *use* of such weapons!) is the danger of radioactive fallout. One of the most problematic nuclides in such fallout is strontium (Sr-90), which breaks down by beta decay with a half-life of 28 years. It is chemically similar to calcium and therefore can be incorporated into bones and teeth, where, due to its rather long half-life, it remains for years as an internal source of radiation. What is the daughter nucleus of the Sr-90 decay? What percent of the original level of Sr-90 is left after 56 years? How long would you have to wait for the original level to be reduced to 4.88×10^{-2} % of its original value?