

Physics 10: Physics for future Presidents  
Final Examination  
December 12, 2001

last name \_\_\_\_\_ first  
name \_\_\_\_\_ SID \_\_\_\_\_

-----  
Essay questions: pick one and write a few paragraphs that include the most important points. The essay is worth 30 points. (The total of the multiple choice questions is worth 50 points.)

A. A friend of yours says, "Plutonium is the most dangerous material known to man. It has a half-life of 24 thousand years. The government wants to store this underground at Yucca Mountain. They shouldn't be allowed to do this, until they can prove that it will be safe there for 24 thousand years!" Describe how you might respond to this, with an emphasis on relevant facts and real dangers.

OR

B. The military used several new technologies in the Afghanistan war that were not available 20 years ago. Discuss these technologies and the principles upon which they were based.

OR

C. Explain how the nuclear chain reaction can lead to the release of tremendous amounts of energy, and give examples of other kinds of "chain reactions" (i.e. phenomena in which the doubling rule applies).

-----  
Rainbows show different colors because:

- droplets of water have different sizes
- in water, different frequencies have different velocities
- the direction of light "spreads" because the wavelength is short
- droplets of water change the color of air molecules

When food is dropped from airplanes over Afghanistan, it is not damaged because:

- the food is chosen to withstand impacts of 500 miles per hour
- parachutes are used to keep the impact velocity under 20 miles per hour
- the food contains little retro-rockets that fire just before it hits, slowing the impact
- air resistance slows the food to under 100 miles per hour

The fastest earthquake wave is the

- L wave
- S wave
- P wave
- F wave

You feel the tremors of an earthquake. You dive under a table. 10 seconds later you feel another, stronger shaking. The distance to the epicenter is about:

- 2 miles
- 5 miles
- 10 miles
- 50 miles

We know that the inner part of the Earth is liquid because:

- No S waves move across it
- We can detect the flow of material from the emitted sound
- At such great pressures, everything becomes liquid
- neutrinos pass through it and show the pattern

The same note is heard on two pianos. Beats are heard once per second. From this we deduce:

- at least one of the pianos is out of tune (the notes are at the wrong frequency)
- both pianos are out of tune
- the pianos have been accurately tuned
- the pianos will sound especially pleasant if played together

Very long wavelength water waves travel:

- at the same speed as short wavelength waves
- slower than short wavelength wave
- faster than short wavelength waves
- some faster, some slower, depending on frequency

A terrorist who wants to build an atomic bomb would most like to obtain:

- U-235
- Li-D (lithium deuteride)
- plutonium
- tritium

Strontium-90 is:

- a key element in the design of nuclear reactors
- a coating used on hydrogen bombs to increase fallout
- added to fission bombs to moderate the neutrons
- a fission fragment with a half-life of 28 years

Plutonium is most like to cause cancer if

- eaten
- rubbed on the skin
- inhaled
- its presence triggers panic

The crack of a bullwhip occurs when

- the end moves faster than the speed of sound
- the end triggers an electron avalanche and makes a spark
- the end smacks against the air, briefly creating ions
- the end causes a phase change in the vacuum

When backpacking without a tent, Muller will sleep under a tree, so he will be dry when he wakes up. Dew doesn't form under a tree because:

- the tree radiates infrared energy to keep the ground warm
- the tree blocks wind which cools the ground
- moisture is absorbed by the tree, making the ground dry
- ultraviolet radiation is reflected by the leaves of the tree

If you double the temperature of the tungsten filament of a light bulb, the energy emitted

- remains approximately the same
- increases by a factor of 2
- increases by a factor of 4
- increases by a factor of 16

When a person moves at a velocity near the speed of light, which of the following are true --compared to a person at rest. (check all that are applicable):

- he doesn't age as rapidly
- his length gets longer
- his mass increases
- his energy increases

If the velocity is  $(12/13)c$ , then the gamma function is:

- $\sqrt{5/13}$
- $13/5$
- $5/3$
- none of the above

Most of the energy of an ordinary tungsten-filament light bulb is emitted in the color:

- ultraviolet
- green
- red
- infrared

Stinger missiles are guided by

- GPS
- infrared
- the atmospheric sound channel
- laser guidance

If the sun were made into a black hole, its radius would be approximately

- one centimeter
- one meter
- the size of Berkeley
- the size of the Earth

A solar cell is about 3 feet by 3 feet square. The power of sunlight hitting this cell (not the power in electricity coming from the cell) is approximately:

- 1/10 horsepower
- 1 horsepower
- 10 horsepower
- 100 horsepower

Compared to TNT, a typical meteor with the same mass has energy that is

- 10 x smaller
- equal
- 10 x larger
- 100 x larger

If you double the energy content of a kilogram of gas, the temperature of the gas (measured on the absolute K scale):

- is unchanged
- increases by the square-root of 2
- doubles
- is multiplied by 4

Compared to the chemical energy in a single molecule, the nuclear energy is greater by a factor of about:

- 100
- 1,000
- 100,000
- 1,000,000

Radioactive fallout from the Hiroshima bomb was relatively small because:

- the bomb exploded at high altitude
- it was made from uranium, rather than from plutonium
- it was not boosted
- it was a thermonuclear explosion

The number of nuclear warheads in the United States stockpile, over the last ten years, has been closest to which of the following numbers:

- 666
- 1000
- 10,000
- 100,000

In a one-minute counting interval, a student counts exactly 1,000,213 radioactive decays, using a Geiger counter. When the experiment is repeated, which of the following results would be surprising? (check all that are applicable; this question can be a little tricky, so be careful!)

- 1,000,213
- 1,001,044
- 1,414,289
- 999,544

To make a road-sign brighter at night, it is often covered with:

- tiny glass beads
- fluorescent dyes
- chemicals that make white "whiter than white"
- flat mirrors to reflect the light

A piece of glass is shaped like a pyramid. The side of the pyramid is tilted at 45 degrees with respect to the horizontal. A beam of light is inside the glass, moving horizontally. When it emerges from the tilted surface of the glass, it will be moving:

- perfectly horizontally
- in a direction that is tilted upward (so it will eventually go into space)
- in a direction that is tilted downward (so it will eventually hit the ground)

The speed of light in glass is approximately:

- 1.5 c
- (2/3) c
- c
- 0.999 c

A pianist plays two keys: middle C, and the C above middle C (i.e. an octave higher). The speed of sound for the higher frequency, compared to that for the lower frequency, is (careful: possibly a trick question):

- the same
- 2 x faster
- 2 x slower
- sqrt(2) faster

During a typical day, sound emitted near the ground tends to bend:

- upwards, towards the sky
- downward, towards the ground
- not at all; it goes straight

Alcoholic beverages have their radioactivity tested by the U.S. government to

- make sure they won't cause cancer
- make sure they were not manufactured from oil
- make sure they were not imported
- make sure they weren't stored in radioactive containers

The following kind of radiation is most potent at making other atoms radioactive:

- fission fragments
- alpha radiation
- beta radiation
- neutron radiation

The dose of radiation that gives you a 50% chance of dying from radiation poisoning is approximately (careful: I said radiation poisoning, not cancer):

- 1 Sievert = 100 rem
- 3 Sievert = 300 rem
- 25 Sievert = 2500 rem
- 100 Sievert = 10,000 rem

A radioactive material has a half-life of 5 years. After 25 years, the amount of radioactivity is reduced to:

- 0
- 1/5 of its original amount
- 1/25 of its original amount
- 1/32 of its original amount

To determine the age of a rock believed to be about a billion years old, the most likely method we would chose would be:

- C-14 dating
- Potassium-argon dating
- fission fragment dating
- tritium dating

When light passes through the surface of glass, the light that bends the most is:

- red
- yellow
- green
- blue

When you walk through the detector at the airport,

- you are being x-rayed
- you are passing through a metal detector
- you are passing through an explosives detector
- you are passing through a device that will detect even plastic knives

The World Trade Center buildings collapsed because of:

- the impact of the airplanes damaged the structure
- the TNT carried on board the planes by the terrorists
- the sudden explosion of the airplane fuel
- the slow burning of the airplane fuel

The substance which is most toxic in the list below, per gram, is:

- botulism (toxin)
- anthrax spores
- plutonium
- arsenic

A key idea that made the nuclear bomb possible was

- the discovery of the equation  $E = mc^2$
- the discovery that neutrons were emitted when nuclei fission
- the discovery of natural plutonium in the Earth
- the recognition that tritium was radioactive

Hybrid vehicles run on:

- electric and solar power
- solar power and gasoline
- electric power and gasoline
- nuclear power and gasoline

To place a kilogram into space, using an optimum method, should take how much gasoline fuel?

- about 1 gram
- about 1 kilogram
- about 25 kilograms
- about 100 kilograms

A rocket is a wasteful method for sending things to space. The energy it takes, using a rocket, compared to using an elevator, is a factor of:

- 25
- 100
- 250
- 1000

The greatest energy for one gram of material comes from

- fusion
- a meteor
- a comet
- TNT
- fission

Diamonds sparkle in many colors due to their

- high dispersion
- high index of refraction
- hardness
- fluorescence
- polarization

Why do people squint to see better? Because squinting:

- reduces the light
- bends the lens to make it stronger
- reduces the blur size
- They don't see better. They only think they do.

When an opening gets smaller, a wave that passes through it:

- spreads more
- spreads less
- stays the same
- changes its wavelength

Old people (e.g. Prof. Muller) need reading glasses because:

- their pupils can't contract as well
- their eyes become less sensitive to visible light
- their lenses become less flexible
- they forget how to read

In one millionth of a second, light will travel (caution: possibly a trick question):

- about 1 foot
- about 1000 feet
- from one side of a computer chip to the other
- from the Earth to the Moon

kWhr is a unit of

- power
- temperature
- electric current
- energy