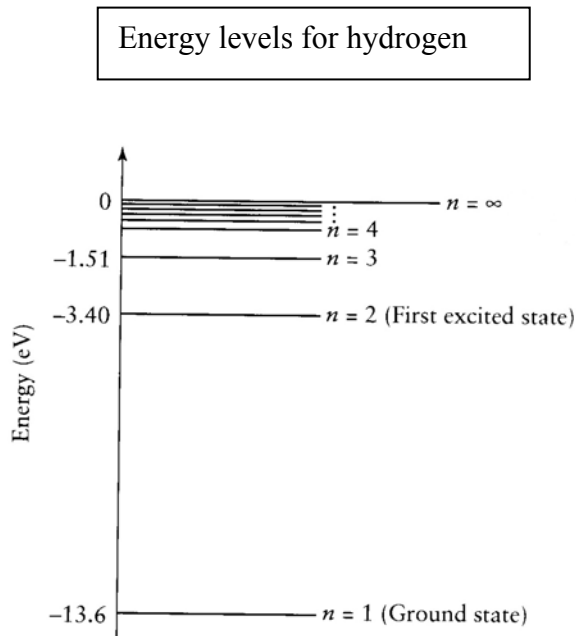


PHYS 102--Concepts of Physics II
University of Virginia
Final Exam, May 6th, 2006

Helpful information:

Acceleration due to gravity near surface of Earth is $9.8 \text{ m/s}^2 = 32 \text{ ft/s}^2 = 22 \text{ mph/s}$. There are 1609.3 meters per mile. 1 food calorie = 4186 joules. There are 3.28 feet in one meter. The speed of light is $3 \times 10^8 \text{ m/s}$. Planck's constant $h = 6.6 \times 10^{-34} \text{ Joule-seconds}$. The mass of an electron is $9.1 \times 10^{-31} \text{ kg}$. On the surface of the Earth, 1 kg weighs 2.2 pounds. 1 atomic mass unit ("amu") = $1.660559 \times 10^{-27} \text{ kg}$. 1 eV = $1.6 \times 10^{-19} \text{ Joules}$. The speed of sound through air is about $1/5^{\text{th}}$ of a mile per second.



The first four elements on the periodic table are hydrogen, helium, lithium, and beryllium.

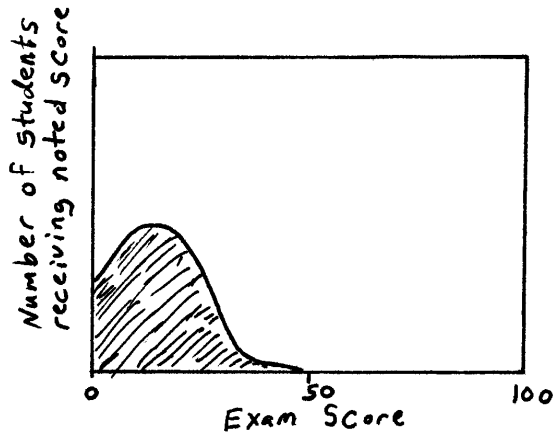
Manganese (Mn) is element number 25, followed by Iron (Fe), Cobalt (Co), Nickel (Ni), Copper (Cu) and Zinc (Zn).

Make sure you have **33** questions.

Pick the one best answer.

1. The graph below is known as a(n) _____ and the exam was apparently _____.

- (a) Histogram; too easy
- (b) Histogram; too difficult
- (c) Epigram; too difficult
- (d) Epigram; too easy
- (e) Isobar; too difficult



2. There is a good reason that mercury is used in a barometer instead of water, even though water is also a liquid and much safer. Recall this reason, and then answer the following: What was used to demonstrate this principle in class?
- (a) Ice cubes in a microwave oven
 - (b) A student on the catwalk with a long straw
 - (c) A water pistol shooting directly upwards
 - (d) Standing waves on a rope, illuminated by a strobe light
 - (e) A bowling ball dropped onto a plate of “packing peanuts”
3. ^{226}Ra undergoes γ -decay, releasing a gamma ray of energy 0.186 MeV. What is the wavelength of the gamma ray, and the final product? (MeV = million electron volts)
- (a) 6.67×10^{-12} m, ^{225}Ra
 - (b) 6.67×10^{-12} m, stays ^{226}Ra
 - (c) 6.67×10^{-6} m, ^{225}Ra
 - (d) 6.67×10^{-6} m, stays ^{226}Ra
 - (e) 6.67×10^{-12} m, ^{227}Ra

4. Which of the following is NOT true of ^{12}C and ^{13}C ?
- (a) a sample of each has the same melting temperature
 - (b) when made into methane gas (CH_4), $^{13}\text{CH}_4$ moves faster than $^{12}\text{CH}_4$
 - (c) ^{13}C is heavier than ^{12}C
 - (d) both are isotopes of carbon
 - (e) an atom of each has the same number of electrons
5. Which of the following cannot be dated using radio-carbon dating?
- (a) a paperback book
 - (b) a wood carving
 - (c) a gold statue
 - (d) a human skeleton
6. According to your textbook, the ^{14}C in our atmosphere
- (a) is continually replenished when cosmic rays strike nitrogen
 - (b) will be gone by about the year 3000
 - (c) is only replenished when a star explodes in our galaxy
 - (d) was formed at the same time as the Earth, about 4.5 billion years ago
 - (e) decays into Boron-14
7. A particular shade of green light near the middle of the rainbow has a frequency of 5.4×10^{14} Hz. Now suppose you build an electron microscope, and design it so that the electrons move at 1% of the speed of light. By what factor would your electron microscope exceed a green-light microscope in its resolution of details?
- (a) 1800
 - (b) 2000
 - (c) 2300
 - (d) 2500
 - (e) 2800
8. In the context of photography, the extent to which an object is out of focus can be characterized by a numerical measurement known as the
- (a) non-focus triangulation
 - (b) radius of grain
 - (c) circle of confusion
 - (d) focal length
 - (e) focal plane

9. Suppose you go to Paris, and climb to the very top of the Eiffel Tower (303 meters). You wish to supply yourself with energy by eating Jelly Belly jelly beans, which contain 4 calories each. If your body converts energy with only 20% efficiency, and your mass is 62.1 kg, how many jelly beans must you consume?

- (a) 35
- (b) 55
- (c) 79
- (d) 103
- (e) 137

10. Which (one or more) of the following is/are true about obtaining energy from atomic nuclei?

- I. the fission of uranium into smaller nuclei, about the size of iron, releases energy
- II. the fission of plutonium into smaller nuclei, about the size of iron, releases energy
- III. the fusion of deuterium into helium releases energy
- IV. the fission of iron into smaller nuclei releases energy

- (a) I and II only
- (b) I and III only
- (c) II and III only
- (d) I, II and III only
- (e) I, II, III and IV

11. How far does Earth's gravitational influence extend?

- (a) to the ionosphere
- (b) to the edge of Earth's atmosphere
- (c) to the Moon
- (d) to Pluto
- (e) to infinity

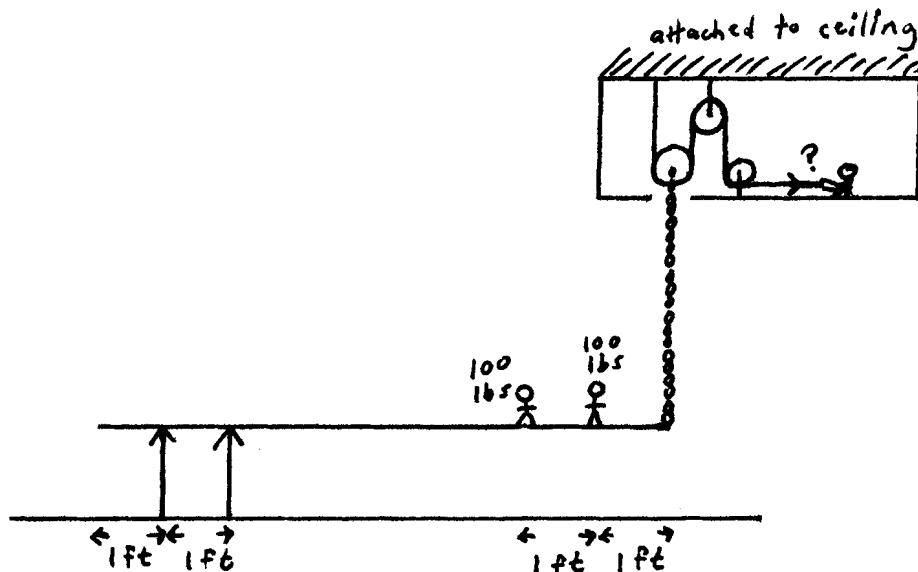
12. Imagine that you place a bowling ball on a spring scale in three different situations:
- I. On the surface of the Moon
 - II. On the surface of the Earth, with normal air conditions
 - III. On the surface of the Earth, inside a room with all the air removed

In which situation will the scale read the most? the least?

- (a) II, I
- (b) III, I
- (c) III, II
- (d) I, II
- (e) II, III

13. As shown below, a plank of length 8-feet rests on top of, but is not attached to, two supports. The plank itself has negligible weight. To prevent it from tipping, a chain is attached to the end which is controlled via rope and pulleys by a "stagehand". The stagehand gets bored keeping the plank exactly horizontal, so he experiments. He finds that if he pulls with a slightly smaller force F_1 the chain-end of the plank will fall slightly below horizontal, and if he pulls with a slightly larger force F_2 the chain-end will rise slightly above horizontal. Find $F_2 - F_1$.

- (a) 2.57 lbs
- (b) 3.57 lbs
- (c) 4.57 lbs
- (d) 5.57 lbs
- (e) 6.57 lbs



14. After a rain storm you can often see two rainbows—the primary and the secondary. The colors of a secondary rainbow are in _____ order as compared to the primary. The reason for this is _____.
- (a) the same; water does not change the energy of the light
 - (b) the same; different colors of light refract different amounts
 - (c) reverse; red light has higher energy than blue light
 - (d) reverse; the light reflects off of a dust particle after refraction by a water droplet
 - (e) reverse; the light undergoes an additional reflection inside the water droplet
15. The first hydrogen bomb tested by the U.S. was code-named _____ and used _____ to heat the deuterium fuel to very high temperatures.
- (a) Mike; a fission-type nuclear bomb
 - (b) Mike; TNT and powerful lasers
 - (c) Mike; plastic explosives and powerful lasers
 - (d) Trinity; a fission-type nuclear bomb
 - (e) Trinity; TNT and powerful lasers
16. A large ship of mass one million kilograms has run out of fuel for its engines. But, there are two cannons on the top deck, both aiming horizontally off the back of the ship. Each cannon fires a 50 kg cannonball at a speed of 90 m/s every second (so that a total of two cannonballs are fired every second). If the ship starts from rest and travels through the water with no friction, about how long will it take to travel one mile?
- (a) 10 minutes
 - (b) 25 minutes
 - (c) 45 minutes
 - (d) 1 hour and 15 minutes
 - (e) 2 hours and 45 minutes
17. The ceiling of an arena is 20 meters above the floor. What is the minimum speed that a thrown ball must have in order to reach the ceiling?
- (a) 12.1 m/s
 - (b) 14.9 m/s
 - (c) 19.8 m/s
 - (d) 22.3 m/s
 - (e) 27.7 m/s

18. While performing a photoelectric-effect experiment, it is found that using light of a certain color does successfully eject electrons from the metal. Which one of the following changes, if implemented, might cause the experiment to fail?

- (a) doubling the intensity of the light
- (b) decreasing the intensity of the light to half the original value
- (c) doubling the frequency of the light waves used
- (d) halving the frequency of the light waves used

19. A particular hydrogen atom has its electron in the $n = 2$ state. What must be the minimum frequency of a photon that will ionize the atom from this level?

- (a) 8.24×10^{14} Hz
- (b) 9.24×10^{14} Hz
- (c) 1.024×10^{15} Hz
- (d) 1.124×10^{15} Hz
- (e) 1.224×10^{15} Hz

20. The word “Radar” stands for

- (a) Radio Detecting and Ranging
- (b) Radio and Doppler Absorption Ranging
- (c) Reflection and Doppler Absorption Ranging
- (d) Reflection and Downrange Reconfirmation
- (e) Radio and Doppler and Refraction

21. A Foley person

- (a) Creates sound effects for movies
- (b) Pushes the camera during motion picture production
- (c) Is an expert on the chemistry of iron compounds
- (d) Makes the final electrical connections before a nuclear bomb test
- (e) Traditionally warned the residents of nearby communities before a nuclear bomb test

22. Copper-64 is very unstable, having a half-life of 12.7 hours. It undergoes beta decay, and therefore transforms into

- (a) Copper-65
- (b) Nickel-64
- (c) Nickel-65
- (d) Zinc-64
- (e) Zinc-65

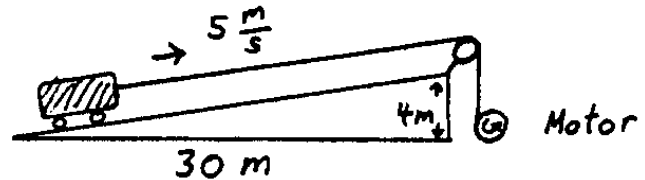
23. In the previous problem, about how long would it take for 99% of a sample of Copper-64 to decay? (Pick the best/most likely answer.)
- (a) 12 hours
 - (b) 24 hours
 - (c) 36 hours
 - (d) 48 hours
 - (e) 80 hours
24. The military leader of the Manhattan project was
- (a) Leslie Groves
 - (b) Dwight Eisenhower
 - (c) Robert Oppenheimer
 - (d) Edward Teller
 - (e) George Patton
25. During the Manhattan project, where was the ^{235}U separated from ^{238}U ?
- (a) New Mexico
 - (b) New York
 - (c) Tennessee
 - (d) Washington D.C.
 - (e) Washington state
26. If two deuterium nuclei fuse to form a new nucleus plus a lone proton, what is the identity of this new nucleus?
- (a) ^2H
 - (b) ^4H
 - (c) tritium
 - (d) ^3He
 - (e) ^4He
27. After our nuclear weapons discussion in class, we watched a “song of social protest” music video featuring
- (a) A man and his prom date outside a bomb shelter
 - (b) A small tree growing in the ruins of Hiroshima, Japan
 - (c) A small tree growing in the “ruins” of New York City
 - (d) A photo of planet Earth, and then an animation showing Earth as the “core” of a fission-type atomic bomb
 - (e) “The running of the bulls” in Pamplona, Spain, with the bulls replaced by high energy gamma rays.

28. In the context of photography, “perspective” can be changed

- (a) only by changing the focal length of the lens
- (b) only by changing the camera-to-subject distance
- (c) by either changing the focal length of the lens or the camera-to-subject distance
- (d) in many ways, but none involves changing the focal length of the lens or the camera-to-subject distance

29. As shown in the figure, an 800-kg car is pulled up an incline (height = 4 m, base length = 30 m) by an electric motor, at a constant speed of 5 meters per second. If the car rolls without friction, what must be the power output of the motor?

- (a) 4881 watts
- (b) 4981 watts
- (c) 5081 watts
- (d) 5181 watts
- (e) 5281 watts



30. Imagine an ordinary rubber ball, such that the harder one squeezes it, the more it compresses (for example, a racquetball). The ball has a mass of 0.05 kg. The following problem cannot be solved exactly with the information given, but using your knowledge of physics you should be able to eliminate all of the answers but one.

The ball is dropped from a height of 2 meters above the floor. It falls, is in contact with the floor for a total time of 10 milliseconds, and then rebounds to the starting height. Find the ratio of (maximum force the floor exerts on the ball) to (weight of the ball).

- (a) 10
- (b) 25
- (c) 50
- (d) 100
- (e) 200

31. One gallon of ordinary water weighs about 8.33 pounds (on the surface of the Earth). (Ordinary water contains the lightest isotope of hydrogen, and ^{16}O .) How much more would a gallon of “heavy water” weigh? (In “heavy water”, the hydrogen is replaced by deuterium.)
- (a) 0.53 pounds
 - (b) 0.63 pounds
 - (c) 0.73 pounds
 - (d) 0.83 pounds
 - (e) 0.93 pounds
32. In nice round numbers, the explosive yield of a hydrogen bomb is about _____ times greater than a bomb of similar size using chemical explosives.
- (a) one thousand
 - (b) ten thousand
 - (c) one million
 - (d) ten million
 - (e) one billion
33. The reason that the ^{239}Pu bomb could use less than a critical mass was that
- (a) the plutonium was surrounded by uranium
 - (b) the plutonium was surrounded by a heavy isotope of hydrogen
 - (c) the density of the plutonium was increased
 - (d) the plutonium was maintained as two separate pieces until detonation
 - (e) the fissionable core was maintained at a temperature close to absolute zero

End of exam.