

Name _____

University of Virginia Physics Department
PHYS 101--Concepts of Physics I--Final Exam
December 10th, 2005

- **Correctly bubble in all 9 digits of your student ID# on the bubble sheet.**
- **Make sure you have

29

 questions**
- **Please answer all questions. There is no penalty for guessing.**

Helpful information:

Acceleration due to gravity at surface of Earth is $9.8 \text{ m/s}^2 = 32 \text{ ft/s}^2 = 22 \text{ mph/s}$.

speed of light is $3 \times 10^8 \text{ m/s}$

there are 1609.3 meters per mile;

there are 3.28 feet in one meter

there are 4186 Joules in 1 food calorie.

1 Newton = 0.2248 pounds

the Earth's axis is tilted by 23.5 degrees

the radius of the Earth is 4000 miles

mass of an electron = $9.1 \times 10^{-31} \text{ kg}$

satellite in geosynchronous orbit is 26,300 miles from center of Earth

1. All of the following demonstrations are related to electricity. Which one was NOT performed in class?
 - (a) Student's hair repelled apart when touching Van de Graaff generator
 - (b) Observed light bulb filament under microscope
 - (c) Watched 100-watt light bulb explode in vacuum chamber
 - (d) Burned up a fuse by connecting several light bulbs in same circuit
 - (e) Melted light bulb filament when used without surrounding glass

2. The professor on the video discussing Black Holes made the interesting speculation that perhaps
 - (a) The outer 3 planets of our solar system are actually Black Holes
 - (b) There is a Black Hole in between our Sun and the planet Mercury
 - (c) There is a Black Hole at the center of our Sun
 - (d) There is a Black Hole at the center of the Milky Way galaxy
 - (e) Our entire universe is a Black Hole in someone else's universe

3. An official Major League baseball weighs about 0.32 pounds (on the surface of the Earth). If all of its mass could be completely converted to energy, how many days could this energy run the entire United States? For purposes of this problem, assume the U.S. population is 300 million people, and that each person uses 500 watts continuously.
 - (a) about 1 day
 - (b) about 7 days
 - (c) about 30 days
 - (d) about 90 days
 - (e) about 1000 days

4. Because of its location on the Earth, attempting to receive satellite television signals at the North Pole would not work. Using your knowledge of the orbits these satellites have, and the information on the front page of this exam, calculate the direction a receiving dish would have to be pointed at the North Pole. (Pick the closest answer.)
 - (a) 6 degrees above the horizon
 - (b) exactly at the horizon
 - (c) 6 degrees below the horizon
 - (d) 9 degrees below the horizon
 - (e) 12 degrees below the horizon

5. On the first day of Spring, in Charlottesville, which one of the following phases of the Moon will reach the highest point in the sky?

- (a) new Moon
- (b) half-illuminated on the right
- (c) full Moon
- (d) half-illuminated on the left

6. “Reverberation” can be described as _____. Concert halls are designed to have how much reverberation?

- (a) a single echo; as little as possible
- (b) a single echo; as much as possible
- (c) repeated reflections of sound; as little as possible
- (d) repeated reflections of sound; a moderate amount
- (e) repeated reflections of sound; as much as possible

7. As stated on your recent homework assignment:

For a city in the northern hemisphere, the maximum and minimum expected angles of the sun are given by the following formulas:

$$\text{max angle} = 90 - \text{Latitude} + \text{Tilt of Earth} \quad \text{min angle} = 90 - \text{Latitude} - \text{Tilt of Earth}$$

Use your knowledge and context of this to answer the following. Paris, France is located at 48.7 degrees north latitude. On the first day of summer, what is the shortest shadow that a 6-foot-tall person, standing vertically on level ground, will cast?

- (a) 2.0 feet
 - (b) 2.2 feet
 - (c) 2.4 feet
 - (d) 2.6 feet
 - (e) 2.8 feet
8. You are standing in a bus, facing forward, at a stop sign. Suddenly the bus begins driving forward, and you feel like you are thrown backward. The force pulling you backward is
- (a) air resistance
 - (b) friction between your shoes and the floor
 - (c) the inertia of the bus
 - (d) your inertia
 - (e) there is no force; you are observing from an improper frame of reference

9. The astronauts in the orbiting Space Shuttle feel weightless because
- (a) they are so far from Earth that the gravitational pull is negligible
 - (b) they are in free-fall, with an acceleration of 9.8 m/s^2
 - (c) they are in free-fall, with an acceleration of less than 9.8 m/s^2
 - (d) they are in free-fall, with an acceleration of more than 9.8 m/s^2
10. A pilot is kidnapped from Earth by extra-terrestrials in 1945, flies around on a spaceship at high speed, and is returned to the Earth in 1977 (so that 32 years pass on Earth). Yet, the pilot has only aged 1 year. How fast, on average, must the spaceship have been travelling, as a percentage of the speed of light? (Make our usual approximation that the Earth is an inertial reference frame.)
- (a) 95.951 % of the speed of light
 - (b) 96.951 % of the speed of light
 - (c) 97.951 % of the speed of light
 - (d) 98.951 % of the speed of light
 - (e) 99.951 % of the speed of light
11. A 150-pound person is climbing on a “StairMaster”. If each step is 23 centimeters high, and the person climbs at a rate of 80 steps per minute, how many food calories will this person burn in 30 minutes, assuming his body is 20% efficient at converting food calories into useful work?
- (a) 18
 - (b) 88
 - (c) 165
 - (d) 329
 - (e) 440
12. During the Science Fiction lectures, we watched Superman perform several amazing feats. Which one of them was followed up by video of a very similar stunt by “Homer Simpson” of the TV animated series “The Simpsons”?
- (a) saving a school bus from crashing off a bridge
 - (b) catching a woman who has just fallen from a building
 - (c) lifting a very large rock over his head
 - (d) using X-ray vision to inspect someone’s lungs
 - (e) flying through the air with a blue cape hung from his shoulders

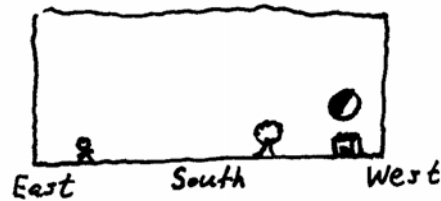
13. (For this problem, ignore air resistance). Lois Lane falls from a building for 9 seconds, before Superman catches her and brings her to rest in 0.4 seconds. During this catch, Lois experiences a deceleration of
- (a) 12.3 g's
 - (b) 17.8 g's
 - (c) 22.5 g's
 - (d) 27.0 g's
 - (e) 31.0 g's
14. In the film excerpt we watched from "20 Million Miles to Earth" a creature
- (a) emitted green light from its eyes with no apparent source of energy
 - (b) withstood very high temperatures without being burned
 - (c) was transported 20 million miles in an impossibly short time
 - (d) was transported 20 million miles in the same amount of time it would take light to travel that distance
 - (e) grew to a large size with no apparent source of food
15. All of the following are related to magnetism. Which one was NOT shown in class as a demonstration?
- (a) A compass needle deflected by a wire carrying electric current
 - (b) Lining up iron filings on the magnetic stripe of a New York City subway card
 - (c) Removing the coating from an audio cassette with a cotton swab dipped in fingernail polish remover
 - (d) Watching a small permanent magnet float over a superconductor
 - (e) Bouncing marbles on a loudspeaker
16. Humans ears hear best near which of the following frequencies?
- (a) 20 Hz
 - (b) 90 Hz
 - (c) 4,000 Hz
 - (d) 13,000 Hz
 - (e) 20,000 Hz

17. During class we watched an extensive excerpt from an old (circa 1960's) video showing an experiment measuring the speed of electrons. The electrons were accelerated through various voltages, and their speeds were plotted on a graph. It was found that the actual results differed wildly from the prediction of the "classical" or Newtonian physics theory. In class, what was eventually revealed to be the incorrect assumption in the Newtonian theory?

- (a) Newton's formula for kinetic energy was wrong
- (b) Newton thought that electrons had the same mass as protons
- (c) Newton thought that all electrons travelled at the speed of light
- (d) Newton was using a value for the speed of light which was about 10 times too high
- (e) Newton was using a value for the speed of light which was about 100 times too high

18. On a particular day in Charlottesville, you are looking towards the south and see the Moon in the position shown in the drawing. Approximately what time is it, using standard time (not daylight savings time)? (The white portion of the Moon is illuminated.)

- (a) 6 am
- (b) 10 am
- (c) 2 pm
- (d) 6 pm
- (e) 10 pm



19. If an electron is accelerated through 3.82 million volts, it will gain kinetic energy of 6.112×10^{-13} Joules. Newtonian mechanics predicts that this electron will have a speed of about four times the speed of light which is of course incorrect. Calculate the actual speed, as predicted by special relativity (and which is confirmed by experiment).

- (a) 99.1 % of the speed of light
- (b) 99.2 % of the speed of light
- (c) 99.3 % of the speed of light
- (d) 99.4 % of the speed of light
- (e) 99.5 % of the speed of light

20. If the Moon is half-illuminated on the left side as viewed from Charlottesville, where in the sky would you expect to find it at 6 am?

- (a) just rising in the east
- (b) just setting in the west
- (c) high up in the southern half of the sky
- (d) high up in the northern half of the sky
- (e) below the horizon, so you would not be able to see it

21. In your reading on magnetism in Ostdiek and Bord, which of the following was NOT covered?
- (a) Use of strong magnets in shoes and their purported medical effects
 - (b) Electromagnets and their use in doorbells
 - (c) The use of magnets in particle accelerators such as Fermilab in Illinois
 - (d) The construction of loudspeakers
 - (e) Digital sound reproduction as used by CDs and DVDs
22. A 75-Watt light bulb and a 1000-Watt hairdryer are wired in parallel to a 120-volt power supply. What is the total current supplied by the power supply? (Pick the closest answer.)
- (a) 4 amps
 - (b) 6 amps
 - (c) 8 amps
 - (d) 9 amps
 - (e) 11 amps
23. In the previous problem, what is the resistance of the light bulb? Of the hairdryer?
- (a) 192 ohms; 14.4 ohms
 - (b) 14.4 ohms; 192 ohms
 - (c) 13.4 ohms; also 13.4 ohms
 - (d) 144 ohms; 19.2 ohms
 - (e) 19.2 ohms; 144 ohms
24. Which of the following is NOT true about gravity?
- (a) Clocks run slower in more intense gravitational fields
 - (b) Horizontal speed has no effect on vertical gravitational acceleration
 - (c) Gravity is the strongest force in the universe
 - (d) The gravitational force becomes weaker as you move away from the body causing it, such as the Earth
25. Einstein proposed two postulates of Special Relativity. Meanwhile, one conventional hypothesis said that the ether did not exist ("no ether") while another said that there was an ether ("yes ether"). His postulate regarding frame of reference fit within the conventional _____ hypothesis. His postulate regarding the speed of light fit within the conventional _____ hypothesis.
- (a) yes ether; yes ether
 - (b) yes ether; no ether
 - (c) no ether; yes ether
 - (d) no ether; no ether

26. The “solstice” is named after the time(s) of the year when
- (a) the Earth slows in its orbit around the sun
 - (b) the Earth speeds up in its orbit around the sun
 - (c) the change in the effective tilt of the Earth is most rapid
 - (d) the change in the effective tilt of the Earth is least rapid
 - (e) Isaac Newton first “solved” the mathematical problem of planetary orbits
27. A person throws a ball upward and it eventually falls back to the person’s hand. The following question pertains to the ball’s flight just after it leaves the person’s hand, until just before it falls back into his hand: On the way up the ball’s acceleration is _____, at the top its acceleration is _____, and on the way down its acceleration is _____.
- (a) upward; zero; downward
 - (b) downward; zero; downward
 - (c) upward; downward; downward
 - (d) downward; downward; downward
 - (e) downward; zero; upward
28. Which one of the following statements best describes the “Doppler effect”?
- (a) It applies to sound but not to light.
 - (b) It applies to light but not to sound
 - (c) It applies to both sound and light
 - (d) It applies to neither sound nor light
29. The newest U.S. paper currency contains a strip which “fluoresces” when exposed to ultraviolet light. Therefore, when illuminated by a “black light” the strip will emit which of the following? (This was demonstrated in class.)
- (a) radio waves
 - (b) microwaves
 - (c) infrared light
 - (d) visible light
 - (e) ultraviolet light

**End of exam.
Have a great Winter Break.**

