PHYS 101--Concepts of Physics
University of Virginia
Midterm Exam
11:00 – 11:50 am, October 12, 2005

Helpful information:

Acceleration due to gravity near surface of Earth is 9.8 m/s^2 = 32 ft/s^2 = 22 mph/s.
1 Newton = 0.225 pounds. 1 food calorie = 4186 Joules. There are 1609 meters per mile.
Burning 1 gallon of gasoline releases 133 million Joules of energy.

This test is multiple choice. Pick the **one best answer**. There are **25** questions.

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1. "Tuesday" is named after which celestial object?

   (a) Mars
   (b) Jupiter
   (c) Venus
   (d) Saturn
   (e) Pluto

2. A student was lifted during class with the rope/pulley/chair system. About halfway up she found

   (a) a pack of M&M candy, which she kept.
   (b) a green laser pointer, which she pointed at the floor.
   (c) a red laser pointer, which she pointed at the audience.
   (d) that the face of the television was quite scratched.
   (e) A dry-erase marker, and wrote "Beat Boston College."

3. As viewed from Charlottesville, you notice that on a particular day the Moon is half-illuminated on the left. On that day, what time will the Moon set, and how long until the next full Moon? (Use the no-tilt model of the Earth.)

   (a) noon; one week
   (b) noon; three weeks
   (c) midnight; one week
   (d) midnight; three weeks
   (e) 6 pm; one week.

4. Each of the time periods below has the same duration. During which of these choices, in Charlottesville, will the length of the day (time between sunrise and sunset) increase, and furthermore show the greatest increase?

    (a) April 1 - 8
    (b) June 1 - 8
    (c) June 23 – 30
    (d) September 21 – 28
    (e) December 21 - 28

5. 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

6. Which one of the following demonstrations was NOT seen in class?

    (a) using a glass tube, powder blown through a flame
    (b) shaving cream in vacuum chamber—volume expands
    (c) Donald Duck with his "back against the wall" on a rotating table
    (d) extremely frozen can of Coke dropped onto a pillow—breaks in half despite softness of pillow
    (e) rapidly spinning gyroscope—hang a weight from it and it precessed

7. Which of the following was NOT covered in the assigned reading from your textbook (Ostdiek and Bord)?

    (a) strobe photographs of two falling bodies with different masses
    (b) contact area as determining factor in magnitude of friction force
    (c) artificial gravity in a rotating space station
    (d) conversion of potential to kinetic energy by a child's swing
    (e) linear momentum imparted to the Earth by collision with asteroids that may have killed off dinosaurs

8. The system of plastic recycling codes contains _____ different types of plastic, plus one miscellaneous category.

    (a) 5
    (b) 6
    (c) 7
    (d) 8
    (e) 9

9. On a particular day in Charlottesville, you see the Moon half-illuminated on the left, at its highest point in the sky for that day. The time is therefore about _____ and the Moon is in the _____ half of the sky.

    (a) 6 AM; southern
    (b) 6 AM; northern
    (c) 6 PM, southern
    (d) midnight; southern
    (e) midnight; northern

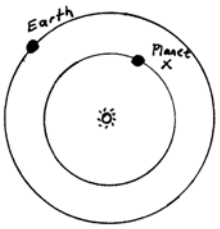
10. If you descend a two-mile-high mountain on a road which is stated to be “7 percent grade”, what is the length of the road? (Pick the closest number.)

    (a) 0.28 miles
    (b) 1.4 miles
    (c) 14 miles
    (d) 29 miles
    (e) 286 miles

11. In the previous problem, if a car was to slide down the road experiencing no friction (for example, if the road was icy), find its acceleration. [Hint: use the concept of work to find the force on the car in the direction it’s moving, and go from there.]

    (a) 0.14 m/s^2
    (b) 0.69 m/s^2
    (c) 2.1 m/s^2
    (d) 4.9 m/s^2
    (e) 6.86 m/s^2

12. The view shown is from above the North Pole. Ignoring the tilt of the Earth, and assuming the planets move a negligible amount during an Earth day, at approximately what time will planet X rise, standard time, as viewed from the Earth?



(a) midnight
(b) 4 AM
(c) 9 AM
(d) 1 PM
(e) 6 PM

13. In the previous problem, leave the Earth where it is, but move Planet X a certain fraction of its orbit counter-clockwise. By what fraction of its orbit would it have to be moved in order to rise at 8 PM?

(a) $1/4^{th}$ the way around
(b) $1/3^{rd}$ the way around
(c) ½ the way around
(d) $2/3^{rd}$ the way around
(e) It's impossible—it will never rise at 8 pm.

14. A 1500 kg car is moving at 20 meters per second (about 45 mph), when it brakes and comes to rest. If friction-type brakes are used, about how many such stops are needed to waste 1 gallon of gasoline?

(a) 39
(b) 112
(c) 277
(d) 443
(e) 690

15. 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

16. As viewed from Charlottesville, a full Moon will be highest in the sky at what time of the year?

    (a) spring
    (b) summer
    (c) fall
    (d) winter
    (e) both summer and winter, but neither fall nor spring

17. A ball is dropped from a certain height and its descent is timed to be 1.1 seconds ± 0.2 seconds. You can therefore be fairly certain that the height is between about _____ and _____.

    (a) 4.0 meters; 8.3 meters
    (b) 4.7 meters; 8.7 meters
    (c) 3.8 meters; 6.1 meters
    (d) 5.7 meters; 6.1 meters
    (e) 5.8 meters; 6.0 meters

18. Which of the following was NOT called a "wandering star" by the ancients?

    (a) the Moon
    (b) the Sun
    (c) Mercury
    (d) the star Betelgeuse in the constellation Orion

19. Two hydrogen atoms can combine into a hydrogen molecule, $H + H \rightarrow H_2$, and release energy. The reason it is favorable for them to combine is that _____, and this reaction was discussed in class because _____.

    (a) each electron can be attracted to two protons; it occurs often in a candle flame
    (b) two protons can combine into a smaller nucleus; it occurs often in a candle flame
    (c) each electron can be attracted to two protons; it's simple enough to understand
    (d) two protons can combine into a smaller nucleus; it's simple enough to understand

20. Which of the following is NOT true regarding a candle flame?

    (a) water is released during the reaction
    (b) oxygen enters primarily from the top
    (c) the wax contains a lot of carbon and hydrogen
    (d) much of the energy is released in the form of infrared radiation
    (e) the reaction ceases in zero gravity

21. The reason given in class as to "why clocks run clockwise" was that people who built clocks originally saw the sun

    (a) in the Southern half of the sky, and it moved from right to left
    (b) in the Southern half of the sky, and it moved from left to right
    (c) in the Northern half of the sky, and it moved from right to left
    (d) in the Northern half of the sky, and it moved from left to right

22. The total air pressure inside a certain automobile tire is 57.0 psi (pounds per square inch). If the outside air pressure is 14.7 psi, the gauge pressure of the tire is

    (a) 14.7 psi
    (b) 29.4 psi
    (c) 42.3 psi
    (d) 57.0 psi
    (e) 71.7 psi

23. A person vertically lifts (using a rope) an object with mass 50 kilograms, through a height of 3 meters, in a time of 45 seconds. Find the number of food calories burned during this lift.

    (a) 0.35 food calories
    (b) 4.8 food calories
    (c) 12.9 food calories
    (d) 24.3 food calories
    (e) 24.9 food calories

24. Two identical small steel balls (air drag is negligible) fall to the ground in a very specific way: They are released from the same height at the same time. But one is released from rest, and the other is launched horizontally. The one launched horizontally hits the ground

    (a) first, because its total speed is greater
    (b) first, because the gravitational force on it is greater
    (c) at the same time as the other, because its total speed is greater
    (d) at the same time as the other, because the gravitational force on it is greater
    (e) at the same time as the other, even though the gravitational force on it is less

25. In analogy to a chemical reaction, imagine pushing a rock up a hill, after which it rolls down into a valley and ends up lower than its starting point. Continuing this analogy, the energy needed to push the rock up the initial hill would best be called the

    (a) activation energy
    (b) weight of the rock
    (c) inertia of the rock
    (d) energy released
    (e) power output

End of exam.