Physics 107:
Ideas of Modern Physics

Exam 2
Oct. 25, 2006

Name_____

ID #_____   Section #_____

On the Scantron sheet,
1) Fill in your name
2) Fill in your student ID # (not your social security #)
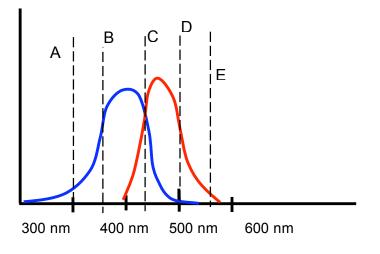3) Fill in your section # (under ABC of special codes)

Useful constants: c= speed of light = 3×10^8 m/s
                           sound speed in air = 340 m/s
                           k = electric constant = 9×10^9 N m^2/C^2
                           g= accel. of gravity on Earth = 10 m/s^2
                           G= gravitational constant = 6.7×10^{-11} N-m^2/kg^2

1. a

2. A 1020 Hz tone is generated by a speaker. What is the wavelength of the sound wave?

    a. 0.10 m
    b. 3.0 m
    c. 1.0 m
    d. 0.50 m
    e. 0.33 m

3. An example of a longitudinal wave is

    a. a water wave.
    b. a sound wave.
    c. an electromagnetic wave.
    d. a wave on a rope.
    e. a frequency wave.

4. In your room you have two speakers in different corners. Sitting at your desk, you are 2 meters from one of the speakers, and 2.25 meters from the other. At which frequency would the sound waves you hear tend to cancel (total sound is quieter)?

    a. 340 Hz
    b. 680 Hz
    c. 1360 Hz
    d. 170 Hz
    e. 250 Hz

5. Your Badger radio network broadcasts on AM 1310.
    This frequency is 1,310 kHz (1 kHz = 1000 Hz). How many football fields long is one wavelength (1 football field ~ 91 meters)?

    a. 0.1
    b. 0.25
    c. 0.4
    d. 1.1
    e. 2.5

6. An observed source of magnetic fields is:

   a. magnetic monopoles
   b. magnetic currents
   c. electric charges
   d. voltage currents
   e. electric currents

7. The force between two charged particles 0.4 m apart is found to be repulsive, with magnitude 2×10^{-10} N.
   What is the force when the separation is reduced to 0.2 m?

   a. 4.0×10^{-10} N, attractive.
   b. 4.0×10^{-10} N, repulsive
   c. 8.0×10^{-10} N, repulsive
   d. 0.5×10^{-10} N, attractive.
   e. 1.0×10^{-10} N, repulsive

8. Suppose an eye has only two cones with spectral sensitivities shown here. Which combinations of lights will give the same color perception?

   a. A&E same as C
   b. B&D same as C
   c. A&C same as D
   d. B&E same as D
   e. B&C same as D

   300 nm   400 nm   500 nm   600 nm

9. Your microwave oven beams electromagnetic radiation at the food inside, and the food warms by absorbing the radiation. The oven is approximately a resonant cavity, with one wavelength of microwave radiation fitting inside the length. If the oven has a length of 15 cm (0.15 m), find the operating frequency. (1 Giga-Hertz=10^9 Hz)

   a. 2.0 Giga-Hertz
   b. 1.0 Giga-Hertz
   c. 0.1 Giga-Hertz
   d. 0.2 Giga-Hertz
   e. 20 Giga-Hertz

10. An electron moves continuously up and down in one corner of room. An experimenter in the opposite corner of the room measures at his location

    a. an electromagnetic wave.
    b. an unchanging electric field.
    c. an unchanging magnetic field.
    d. a charge.
    e. a current.

11. We observe that all the galaxies around our galaxy are moving away from us. What principle is used to make this observation.

    a. We simply see that the light from a given star is fainter year by year.
    b. The Doppler effect, we see that the typical light from the stars is shorter wavelength than expected for stationary stars.
    c. The Doppler effect, we see that the typical light from the starts is lower frequency that expected for stationary stars.
    d. General relativity, we measure that the curvature of the space around us is getting smaller as the other galaxies get further away.
    e. General relativity, we measure that the curvature of the space around us is getting larger as the other galaxies get further away.

12. Einstein's special theory of relativity is valid in inertial reference frames. An inertial reference frame is one that

    a. is stationary.
    b. moves as constant speed.
    c. moves at constant velocity.
    d. moves at constant acceleration.
    e. shows no gravitational force.

13. One space ship is catching up to and passing another on the same trip between two stars. The passing ship moves at 0.9c and the other ship at 0.45c. The passing ship flashes its headlights before passing. An observer on the slower ship measures the light from the headlights to be moving at what speed relative to the slower ship?

    a. 1.0c
    b. 0.45c
    c. 0.0c
    d. 1.45c
    e. 1.67c

14. A man on a fast motorcycle moving at 0.5c relative to an observer on the ground throws a baseball at 0.4c in the motorcycle reference frame. How, fast is the ball moving according to the observer on the ground?

    a. 0.90c
    b. 0.10c
    c. 0.64c
    d. 0.75c
    e. 0.60c

15. An astronaut travels by the Earth at $0.6c$. Someone stationary on Earth holds a meter stick. The astronaut measures the lengths of this meter stick to be.

    a. Less than one meter.
    b. More than one meter.
    c. Exactly one meter.
    d. Need to know Earth velocity.
    e. Depends on Earth reference frame.

16. A 25 year-old astronaut travels to a nearby star and back at a speed of $0.8c$, leaving behind her twin on Earth. The Earth twin measures the star to be 8 Light-Years away. When the astronaut returns, how does her biological age compare to the Earth twin?

    a. same age
    b. 13.3 years younger
    c. 10 years younger
    d. 8 years younger
    e. 8 years older

17. As the spaceship in 16 flies away the twin on earth notices that when she looks at the clock on the spaceship using a telescope it moves slower than her clock. The twin on the spaceship sees that when she looks at the clock on the earth it also moves slower than her clock. How is this paradox resolved?

    a. During the return trip they observe the opposite effect and are the same age when they reunite.
    b. The laws of special relativity only hold when two objects are close together and when the second twin is further away her clock starts is observed to run more slowly by both of them.
    c. The laws of special relativity only hold when two objects are close together and when the second twin is further away her clock is observed to run more quickly by both of them.
    d. The laws of special relativity only hold in inertial reference frames and when the ship is accelerating clocks run such that the person on the ship is younger when they reunite.
    e. We don't know what happens because the experiment has never been done

18. An astronaut in a spaceship moves relative to an Earth observer. The Earth observer measures the time interval between heart beats of the astronaut. As the speed of the astronaut gets closer and closer to the speed of light (assume the astronaut does not get excited), the earth observer sees that the time between the astronaut's heart beats

    a. increases without bound
    b. decreases, getting arbitrarily close to zero.
    c. increases, but never exceeds *c*, the speed of light.
    d. decreases, approaching *c*/10.
    e. increases for positive speeds, decreases for negative speeds.

19. The equivalence principle of general relativity says that

    a. space and time are equivalent, and should be plotted together.
    b. energy and mass are equivalent, and can be transformed to each other.
    c. time dilation is equivalent to length contraction.
    d. gravity is equivalent to an accelerating reference frame without gravity.
    e. all space-time metrics are equivalent.

20. As the speed of a massive particle approaches the speed of light, the relativistic mass of the particle

    a. approaches the rest mass.
    b. does not change.
    c. increases without bound.
    d. increases slightly.
    e. decreases to zero.

21. General relativity would say that two balls of different masses accelerate at the same rate toward the Earth because

    a. speed of light is same in all reference frames.
    b. the inertial mass and gravitational mass are identical.
    c. only the relative velocities of the earth and balls matter.
    d. all objects follow the shortest path in spacetime.
    e. relativistic momentum is different than Newtonian momentum.