Review Problems

1. A 3 kg block is sliding on a horizontal, frictionless surface at 10 meters/second. The block collides head-on with a second 2 kg block, and the blocks stick together.
   a. What was the initial KE of the 3 kg block?
   b. What was the initial momentum of the 3 kg block?
   c. What is the speed of both blocks immediately after they collide and stick together?
   d. What was the impulse delivered to the 2 kg block during the collision?
   e. If the blocks slide forward after the collision and up a 30° frictionless incline, how high would the blocks rise (vertically, above their original level) on that incline?
   f. If the 3 kg block bounced off after colliding with the 2 kg block instead of sticking, would the 2 kg block slide higher, lower, or to the same height on the incline? Why?

2. A car of mass 1500 kg is moving at a constant speed of 20 m/s around a horizontal track with a radius of 100 meters.
   a. What is the centripetal acceleration of the car?
   b. How much centripetal force is required to keep the car moving in a circle?
   c. What is the required coefficient of friction between the car tires and the road to keep the car moving at 20 m/s?
   d. Would the required coefficient of friction be higher, lower, or the same for a 2500 kg truck travelling at 20 m/s along the same track? Explain.
   e. A maniacal roller-coaster designer builds a coaster using cars of 1500 kg completing a vertical loop of radius 100 meters (like the track above on edge). What is the minimum speed needed by the cars to complete the loop?

3. A 500 kg satellite is in circular orbit around the Earth at a radius of 3×10^7 meters. (Mass of Earth = 6×10^{24} kg, radius of Earth = 6.4×10^6 meters)
   a. What is the speed of the satellite?
   b. How long does it take for the satellite to complete one orbit?
   c. What is the gravitational force of the satellite on the Earth?

4. A mass of 8 kg is hung from spring with a k = 200 N/m.
   a. How far does the spring stretch when the mass is allowed to come to equilibrium?

The 8 kg mass is then attached to the spring, pulled out 0.5 meters from the balance point, and allowed to oscillate horizontally on a frictionless surface.

   b. What is the amplitude of the oscillations?
   c. What is the period of the oscillations?
   d. What is the maximum speed of the mass?
   e. How long would a pendulum have to be to have the same period?

5. Students in a much colder climate than ours plan to measure the speed of sound outdoors on a fairly cold day. They find that a tuning fork of frequency 128 Hz begins to resonate in a tube open at both ends when the tube reaches a length of 1.25 meters.
   a. Draw a picture of the waveform set up in the tube.
   b. What is the speed of sound in air on that day?
   c. What frequency tuning fork would be required to resonate the 1.25 meter tube if one end of the tube were capped?

6. The speed of light in air is approximately 3×10^8 m/s.
   a. What is the wavelength of a light wave of frequency 1×10^{14} Hz?
   b. If the wave passes into glass with n = 1.5, what is the speed of the wave in the glass?
   c. What is the frequency of the wave in the glass?
   d. What is the wavelength of the wave in the glass?
   e. If the wave enters the glass at an angle of 35°, at what angle does it refract?

7. At center court in the Meadowlands Arena, a screaming fan 20 meters away in the stands makes a sound equal to 40 dB in intensity.
   a. Approximately how loud are 10,000 fans screaming equally loudly?
   b. Approximately how far away would these fans need to be for the sound level to retrn to 40 dB?

8. A man stands 2.5 meters in front of a diverging mirror and sees an image of himself that is 50 cm behind the mirror.
   a. Sketch the setup, and determine the focal length of the mirror.
   b. What is the algebraic sign of the focal length? Explain.
   c. What is the magnification of the image?
   d. Is the image real or virtual? Erect (upright) or inverted?

9. Explain how colors are generated in the following situations:
   a. When looking at a particular book jacket, the color yellow is seen.
   b. When the sun shines on the water droplets produced by a fine spray from a hose, a color spectrum is seen.
   c. When a CD is twirled in the light, flashes of rainbow colors are seen.
   d. The sun appears to be red when it rises.
   e. A thin film of soapy water on a white dish appears to be flashing green and purple.

10. A 12 volt battery is connected to a 3 ohm resistor in parallel to a 1 ohm and a 5 ohm resistor in series.
   a. Draw the circuit.
   b. Calculate the equivalent resistance of the circuit.
   c. Which resistor draws the least power?
   d. What is the voltage across the 5 ohm resistor?
   e. How much energy does the battery lose in 30 seconds?
   f. How much charge does the battery pump in 30 seconds?

11. Answer the following questions briefly:
   a. What are the significant differences between a motor and a generator?
   b. What are the significant differences between a DC motor and an AC motor?
   c. Explain how the three right-hand-rules are used (what are they used to find, and in what situations are they applied?).
   d. If you observe a charged particle travelling in a straight line in a magnetic field, what can you conclude about the field?

12. A parallel plate capacitor is hooked to a 60 Volt battery and allowed to charge fully. The plates of the capacitor are 2 cm apart.
   a. Draw the capacitor and battery, and draw the field lines between the plates (leave extra room between the plates so your drawing will be clear).
   b. What is the strength of the field between the plates?
   c. What is the force on a +0.00025 Coulomb charge placed between the plates?
   d. How much energy is needed to move the above charge from the negative plate to the positive plate?
   e. If the plates were moved further apart while connected to the same battery, would the field strength between the plates increase, decrease, or remain the same? Why?