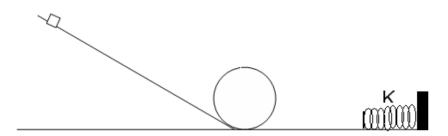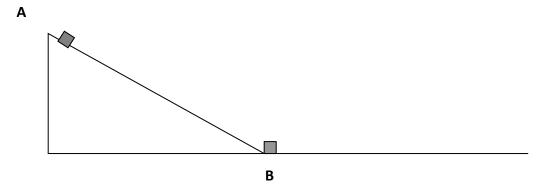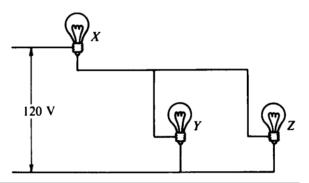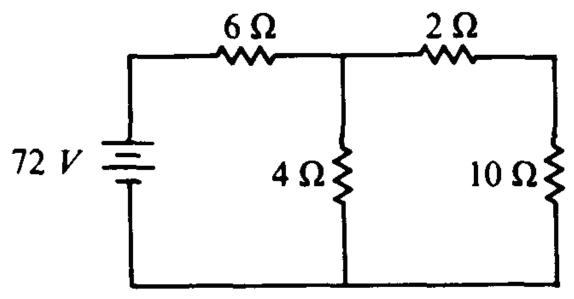## Physics Honors
Final Exam
Review Problems

1. A small block, with a mass of 250 g, starts from rest at the top of the apparatus shown above. It then slides without friction down the incline, around the loop and then onto the final level section on the right. The maximum height of the incline is 80 cm, and the radius of the loop is 15 cm and the spring constant is 115 N/m.

    a. Find the initial potential energy of the block
    b. Find the velocity the block at the bottom of the loop
    c. Find the velocity of the block at the top of the loop.
    d. What is the normal force on the block at the lowest point of the loop?
    e. What is the normal force on the block at the highest point of the loop?
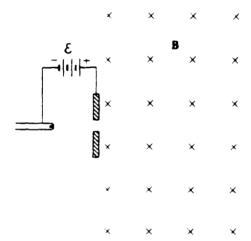   f. How much will the block compress the spring before momentarily coming to a stop?

A

B

2. A track consists of a frictionless incline plane, which is a height of 0.5 m, and a rough horizontal section with a coefficient of kinetic friction 0.02. Block A, whose mass is1.5 kg, is released from the top of the incline plane, slides down and collides instantaneously and inelastically with identical block B at the lowest point. The two blocks move to the right through the rough section of the track until they stop.

 a. Determine the initial potential energy of block A.
 b. Determine the kinetic energy of block A at the lowest point, just before the collision.
 c. Find the speed of the two blocks just after the collision.
 d. Find the kinetic energy of the two blocks just after the collision.
 e. How far will the two blocks travel on the rough section of the track?
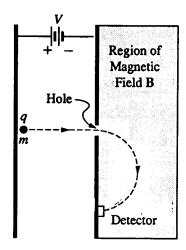 f. How much work will the friction force do during this time?

120 V

3. In the circuit shown above, X, Y. and Z represent three light bulbs, each rated at 60 watts, 120 volts. Assume that the resistances of the bulbs are constant and do not depend on the current.

   a. What is the resistance of each bulb?
   b. What is the equivalent resistance of the three light bulbs when arranged as shown?
   c. What is the total power dissipation of this combination when connected to a 120-volt source as shown?
   d. What is the current in bulb X ?
   e. What is the potential difference across bulb X ?
   f. What is the potential difference across bulb Z ?

6 Ω   2 Ω

72 V

4 Ω   10 Ω

4. The circuit shown above includes a 72 V battery and four resistors. Find the following:

   a. the total resistance of the circuit
   b. the current in the battery
   c. the current in the 10-ohm resistor
   d. the potential difference across the 10-ohm resistor
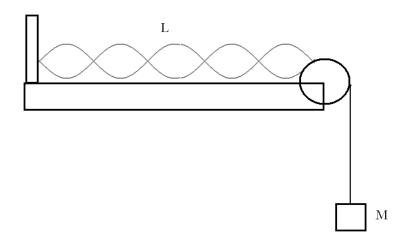
5. An electron from a hot filament in a cathode ray tube is accelerated through a potential difference, ε. It then passes into a region of uniform magnetic field B, directed into the page as shown above. The mass of the electron is m and the charge has magnitude e.

   a. Find the potential difference ε necessary to give the electron a speed v as it enters the magnetic field.
   b. On the diagram above, sketch the path of the electron in the magnetic field.
   c. In terms of mass m, speed v, charge e, and field strength B, develop an expression for r, the radius of the circular path of the electron.
   d. An electric field E is now established in the same region as the magnetic field, so that the electron passes through the region undeflected.
      i.   Determine the magnitude of E.
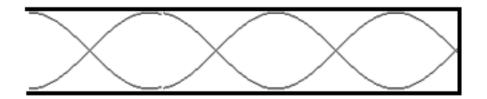   ii.   Indicate the direction of E on the diagram above.

6. A particle of mass m and charge q is accelerated from rest in the plane of the page through a potential difference V between two parallel plates as shown above. The particle is injected through a hole in the right-hand plate into a region of space containing a uniform magnetic field of magnitude B oriented perpendicular to the plane of the page. The particle curves in a semicircular path and strikes a detector. Neglect relativistic effects throughout this problem.
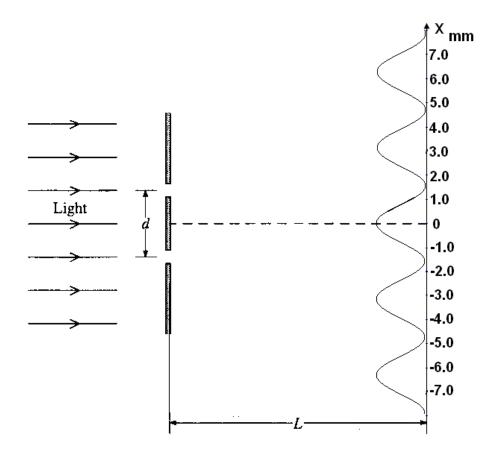
    a.
       i. State whether the sign of the charge on the particle is positive or negative.
      ii. State whether the direction of the magnetic field is into the page or out of the page.

    b. Determine each of the following in terms of m, q, V, and B.

       i. The speed of the charged particle as it enters the region of the magnetic field B.
      ii. The force exerted on the charged particle by the magnetic field B.
     iii. The distance from the point of injection to the detector.
     iv. The work done by the magnetic field on the charged particle during the semicircular trip.

L

M

7. A string with a length of 7.5 m resonates in five loops as shown above. The string linear density is 0.025 kg/m and the suspended mass is 1.5 kg.

    a. What is the wavelength?
    b. What is the wave speed?
    c. What is the frequency of oscillations?
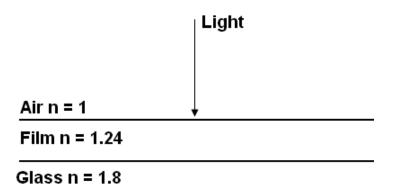   d. What will happen to the number of loops if the suspended mass is increased?

8. A sound wave resonates in a pipe closed on one end as shown above. The length of the pipe is 1.5 m.

   a. Which harmonic is shown in the pipe?
   b. What is the wavelength of the sound?
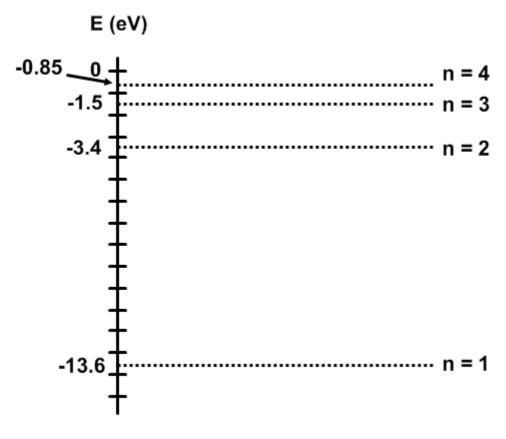   c. What is the fundamental frequency?
   d. What is the third harmonic?

9. Monochromatic light strikes a double-slit apparatus as shown above. The separation between the slits is 0.3 mm. As result of diffraction an interference pattern is produced on the second screen 4.5 m away.

    a. What property of light does this experiment demonstrates?
    b. Find the wavelength of the incident light based on the interference pattern.

    The double-slit apparatus is submerged into water (n = 1.33)
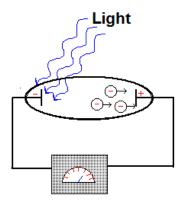
    c. What is the frequency of the light in water?
    d. What is the wavelength of the light in water?
    e. What happens to the distance between two adjacent fringes in water?

| Light

Air n = 1

Film n = 1.24

Glass n = 1.8

10. The glass surface is coated with a thin film and illuminated with monochromatic light of wavelength 570nm.

   a. What is the frequency of the incident light in vacuum?
   b. What is the frequency of light in the film?
   c. What is the speed of light in the film?
   d. What is the wavelength of light in the film?
   e. Calculate the minimum thickness of the film required to produce no reflected light.
   f. Calculate the minimum thickness of the film required to produce maximum intensity of the reflected light.

E (eV)

-0.85 ___ 0 ————————————————————————————————— n = 4
     -1.5 ————————————————————————————————— n = 3

     -3.4 ————————————————————————————————— n = 2

    -13.6 ————————————————————————————————— n = 1

11. A free electron is captured by a proton. As a result, two photons are emitted. The energy of the first photon is 1.5 eV.
    a. What is the wavelength of this photon?
    b. What is the energy of the second photon?
    c. What is the wavelength of the second photon?
    d. On the diagram, show the arrows associated with the transitions.
    e. If instead only one photon was emitted, what would be its frequency?

Light

12. An experiment is conducted to investigate the photo-electric effect with a metal plate. It was found when the wavelength of the incident light is less than 650 nm the plate starts emitting electrons.

      a. What is the threshold frequency of the plate?
      b. What is the work function of Barium?

The wavelength of the incident light is changed to 350 nm.

      c. What is the kinetic energy of photo-electrons?
      d. What is the stopping voltage required?