Addis Ababa University
Department of Physics
Phys 1011 Worksheet II

Conceptual Questions

1. An ideal gas expands while the pressure is kept constant. During this process, does heat flow into the gas or out of the gas? Justify your answer.
2. What should you do to the length of the string of a simple pendulum to (a) double its frequency; (b) double its period; (c) double its angular frequency?
3. A proton is placed in a uniform electric field and then released. Then an electron is placed at this same point and released. Do these two particles experience the same force? The same acceleration? Do they move in the same direction when released?
4. Two protons are released from rest when they are 0.750 nm apart. (a) What is the maximum speed they will reach? When does this speed occur? (b) What is the maximum acceleration they will achieve? When does this acceleration occur?
5. A cylindrical rod has resistance *R*. If we triple its length and diameter, what is its resistance, in terms of *R*?
6. In which 120-V light bulb does the filament have greater resistance: a 60-W bulb or a 120-W bulb? If the two bulbs are connected to a 120-V line in series, through which bulb will there be the greater voltage drop? What if they are connected in parallel? Explain your reasoning.

Problems

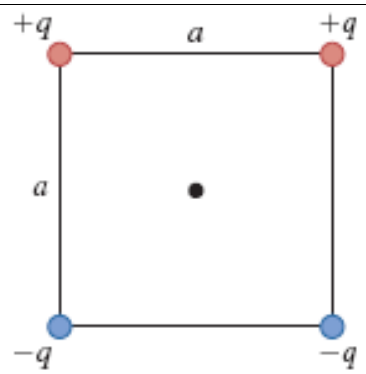
1. One thermometer is calibrated in degrees Celsius, and another in degrees Fahrenheit. At what temperature is the reading on the thermometer calibrated in degrees Celsius three times the reading on the other thermometer?
2. A piece of dry ice (solid carbon dioxide) sitting in a classroom has a temperature of approximately –79 °C.
   a. What is this temperature in kelvins?
   b. What is this temperature in degrees Fahrenheit?
3. A 2.0 kg metal object with a temperature of 90 °C is submerged in 1.0 kg of water at 20 °C. The water-metal system reaches equilibrium at 32 °C. What is the specific heat of the metal?
4. You are given a sample of metal and asked to determine its specific heat. You weigh the sample and find that its weight is 28.4 N. You carefully add 1.25 x 10^4 J of heat energy to the sample and find that its temperature rises18.0^{o}C. What is the sample's specific heat?
5. A 200 g piece of copper at a temperature of 450 K and a 100 g piece of aluminum at a temperature of 200 K are dropped into an insulated bucket containing 500 g of water at 280 K. What is the equilibrium temperature of the mixture?
6. A 15.0-g bullet traveling horizontally at 865 m/s passes through a tank containing 13.5 kg of water and emerges with a speed of 534 m/s. What is the maximum temperature increase that the water could have as a result of this event?
7. The internal energy of a gas is 500 J. The gas is compressed adiabatically, and its volume decreases by 100 cm^3. If the pressure applied on the gas during compression is 3.00 atm, what is the internal energy of the gas after the adiabatic compression?
8. How much heat is required to convert 12.0 g of ice at -10.0^{o}C to steam at 100.0^{o}C. Express your answer in joules, calories, and Btu.
9. An insulated beaker with negligible mass contains 0.250 kg of water at a temperature of 75.0^{o}C. How many kilograms of ice at a temperature of -20.0^{o}C must be dropped into the water to make the final temperature of the system at 40.0^{o}C?
10. During an isothermal compression of an ideal gas, 335 J of heat must be removed from the gas to maintain constant temperature. How much work is done by the gas during the process?
11. When a body of unknown mass is attached to an ideal spring with force constant 120 N/m, it is found to vibrate with a frequency of 6.00 Hz. Find (a) the period of the motion; (b) the angular frequency; (c) the mass of the body.
12. An object is undergoing SHM with period 0.900 s and amplitude 0.320 m. At t = 0, the object is at x = 0.320 m and is instantaneously at rest. Calculate the time it takes the object to go (a) from x = 0.320 m to x = 0.160 m and (b) from x = 0.160 m to x = 0.
13. A 1.50-kg mass on a spring has displacement as a function of time given by the equation

$$x(t) = (7.40\ cm)\cos\left[(4.16\ s^{-1})t - 2.42\right].$$

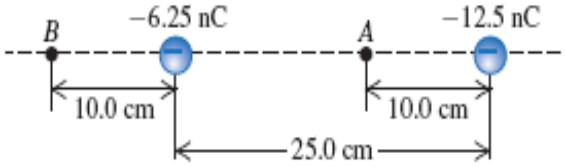
Find (a) the time for one complete vibration; (b) the force constant of the spring; (c) the maximum speed of the mass; (d) the maximum force on the mass; (e) the position, speed, and acceleration of the mass at t = 1.00 s; (f) the force on the mass at that time.

14. A small block is attached to an ideal spring and is moving in SHM on a horizontal, frictionless surface. The amplitude of the motion is 0.250 m and the period is 3.20 s. What are the speed and acceleration of the block when x = 0.160 m?
15. A mass is oscillating with amplitude *A* at the end of a spring. How far (in terms of *A*) is this mass from the equilibrium position of the spring when the elastic potential energy equals the kinetic energy?
16. Two small plastic spheres are given positive electrical charges. When they are 15.0 cm apart, the repulsive force between them has magnitude 0.220 N. What is the charge on each sphere (a) if the two charges are equal and (b) if one sphere has four times the charge of the other?
17. Two point charges are placed on the -axis as follows: Charge $q_1 = 4.00\ nC$ is located at $x = 0.200\ m$, and charge $q_2 = 5.00\ nC$ is at $x = -0.300\ m$. What are the magnitude and direction of the total force exerted by these two charges on a negative point charge $q_3 = -6.00\ nC$ that is placed at the origin?

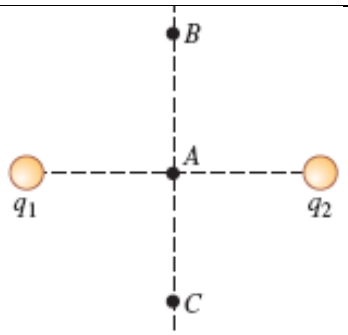
18. Four point charges are placed at each corner of a square with side length a. The charges all have the same magnitude q. Two of the charges are positive and two are negative, as shown in the diagram. What is the direction of the net electric field at the center of the square due to the four charges, and what is its magnitude in terms of q and a?



19. Two point charges show in the diagram are separated by 25.0 cm. Find the net electric field these charges produce at (a) point A and (b) point B. (c) What would be the magnitude and direction of the electric force this combination of charges would produce on a proton at A?

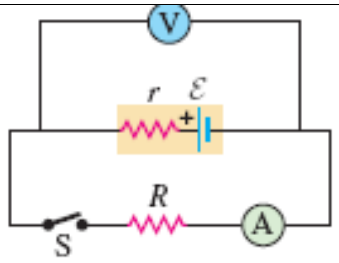


20. The two charges q_1 and q_2 shown in the diagram have equal magnitudes. What is the direction of the net electric field due to these two charges at points *A* (midway between the charges), *B*, and *C* if (a) both charges are negative, (b) both charges are positive, (c) q_1 is positive and q_2 is negative.

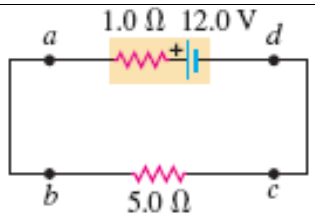


21. A point charge $q_1 = 2.40\ \mu C$ is held stationary at the origin. A second point charge $q_2 = -4.30\ \mu C$ moves from the point $x = 0.150\ m, y = 0$ to the point $x = 0.250\ m, y = 0.250\ m$. How much work is done by the electric force on q_2?
22. A charge of $28.0\ nC$ is placed in a uniform electric field that is directed vertically upward and has a magnitude of$4.00 \times 10^4 V/m$. What work is done by the electric force when the charge moves (a) $0.450\ m$ to the right; (b) $0.670\ m$ upward; (c) $2.60\ m$ at an angle of 45.0^0 downward from the horizontal?
23. A silver wire 2.6 mm in diameter transfers a charge of 420 C in 80 min. Silver contains 5.8×10^{28} free electrons per cubic meter. (a) What is the current in the wire? (b) What is the magnitude of the drift velocity of the electrons in the wire?

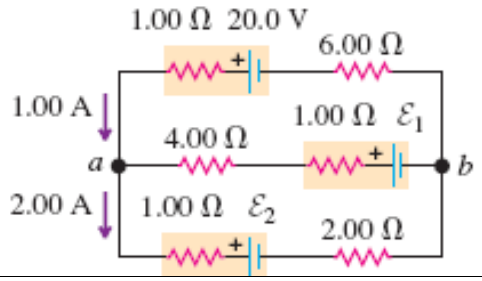
24. When switch S in the diagram is open, the voltmeter V of the battery reads 3.08 V. When the switch is closed, the voltmeter reading drops to 2.97 V, and the ammeter A reads 1.65 A. Find the emf, the internal resistance of the battery, and the circuit resistance R.



25. In the circuit show in the diagram, find (a) the rate of conversion of internal (chemical) energy to electrical energy within the battery; (b) the rate of dissipation of electrical energy in the battery;
(c) the rate of dissipation of electrical energy in the external resistor.



26. Find the emfs ε_1 and ε_2 in the circuit shown, and find the potential difference of point *b* relative to point *a*.



27. The magnitude of the magnetic force on a particle with charge –2*e* moving with speed $v = 1.0 \times 10^5$ m/s is 3.0×10^{-18} N. What is the magnitude of the magnetic field component perpendicular to the direction of motion of the particle?
28. An electron with a speed of 4.0×10^5 m/s enters a uniform magnetic field of magnitude 0.040 T at an angle of 35° to the magnetic field lines. The electron will follow a helical path. a) Determine the radius of the helical path. b) How far forward will the electron have moved after completing one circle?
29. A straight wire of length 2.00 m carries a current of 24.0 A. It is placed on a horizontal tabletop in a uniform horizontal magnetic field. The wire makes an angle of 30.0° with the magnetic field lines. If the magnitude of the force on the wire is 0.500 N, what is the magnitude of the magnetic field?
30. A circular coil with a radius of 10.0 cm has 100 turns of wire and carries a current, *I* = 100 mA. It is free to rotate in a region with a constant horizontal magnetic field, b = 0.0100 T, directed in the positive x- axis. If the unit normal vector to the plane of the coil makes an angle of 30.0° with the horizontal, what is the magnitude of the net magnetic torque acting on the coil?

31. A 0.360-m-long metal bar is pulled to the left by an applied force *F*. The bar rides on parallel metal rails connected through a 45.0 Ω resistor, as shown in the diagram, so the apparatus makes a complete circuit. The circuit is in a uniform 0.650-T magnetic field that is directed out of the plane of the figure. At the instant when the bar is moving to the left at 5.90 m s, (a) is the induced current in the circuit clockwise or counterclockwise and (b) what is the rate at which the applied force is doing work on the bar?

