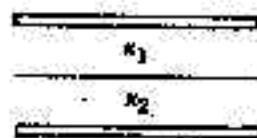
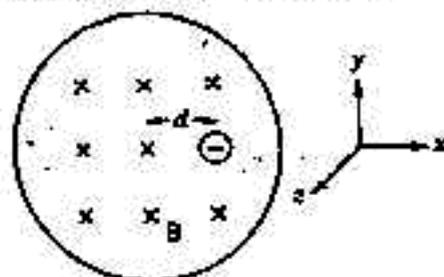


Note: There are 20 questions in this test. Each gets 5 points. Please list answers on the first page of your answer sheet; otherwise they will not be graded. Formal calculations which are not required must start from the second page.

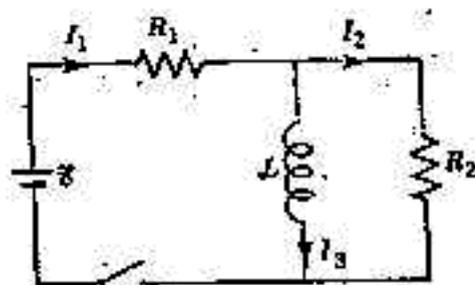
1. The rocket of mass M has a thrust T . What is the apparent weight of an astronaut on takeoff from the earth? The mass of the astronaut is m .
2. In a conical pendulum of length l , a bob moves in a horizontal circle with constant speed v_0 . Find the angle of the rope to the vertical.
3. If a power P supplied to an object of mass m is constant, find the distance traveled in a straight horizontal line in time t . The object starts at rest.
4. A disk of radius R is oriented in a vertical plane and spinning about its axis with angular velocity ω_0 . If the spinning disk is set down on a horizontal surface without sliding, find the translational center-of-mass velocity.
5. Three stars of equal mass m rotate in a circular path of radius r about their center of mass. They are equidistant from each other. Find the angular velocity of the motion.
6. A uniform rope of length l hangs vertically. Calculate the time required for a pulse to travel from the bottom end to the support.
7. Two moles of an ideal diatomic gas ($\gamma = 7/5$) are heated from 0°C to 100°C . Calculate the heat absorbed with constant pressure. (The gas constant is $R = 8.31 \text{ J/mol.K.}$)
8. A steam engine with 50% of the ideal Carnot efficiency takes in superheated steam at 227°C and discharges steam at 127°C . Its mechanical power output is 200 kW. For a period of one hour find the change in entropy of the cold reservoir.
9. A nonconducting sphere of radius R has a total charge Q spread uniformly throughout its volume. Find the electric potential energy of the sphere.
10. A parallel plate capacitor is half-filled with a dielectric slab of constant κ_1 , while the other half contains a slab of constant κ_2 as shown in figure. Express the resulting capacitance in terms of C_0 , the capacitance with no dielectric.



11. An electron is orbiting a proton in a hydrogen atom. A weak magnetic field \vec{B} is turned on normal to the plane of the orbit. If the radius of the orbit is unchanged, find the angular velocity changed.
12. A nonconducting disk of radius R has a uniform surface charge density σ and rotates about its central axis at angular frequency ω . Calculate the magnetic field at the center of the disk. Let the magnetic permeability constant be μ_0 .
13. An electron is at a distance d from the axis of a solenoid. The magnetic field in the solenoid is uniform and changed linearly with time according to $B = at$. Obtain the electric force on the electron.



14. Consider the circuit shown in figure. Find the steady current through the inductor.



15. The components of the electric field of a plane electromagnetic wave are $E_x = E_0 \sin(ky + \omega t)$, $E_y = E_z = 0$. What is the magnetic field $\vec{B} = (B_x, B_y, B_z)$?
16. Let θ_c be the critical angle for total internal reflection and θ_p be the polarizing (Brewster) angle. Find the relationship between θ_c and θ_p .
17. If a grating is 2 cm wide, how many lines per millimeter are needed to resolve the two sodium lines at 589.0 nm and 589.6 nm in the first order?
18. The electron in the hydrogen atom is in the $n = 2$ state. What is its potential energy?
19. An impenetrable box extends from $x = -L/2$ to $x = L/2$. What is the normalized wave functions for the ground state?
20. The potential energy of a simple harmonic oscillator is given by $U = m\omega^2 x^2/2$. Let $\psi = A \exp(-Bx^2)$ be a solution of the Schrödinger wave equation. What are B and the energy of the state?