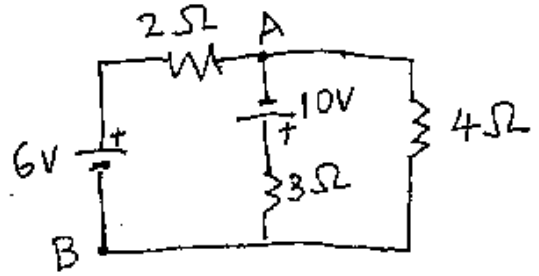
請列出計算過程

1.(20%) Consider a thin disk of uniform mass density, total mass M and radius R. (a) Calculate the gravitational force that this disk exerts on a point mass m at height Z along the axis that is perpendicular to the surface of the disk and goes through the center. (Hint: Divide the disk into concentric rings.) (b)Discuss the result for $Z << R$, and for $Z >> R$.

2.(15%) A large cubical block of wood 0.80 m on each side floats in water, with 30 cm of the block above the surface of the water. (a) What is the density of the wood? (b) Suppose that the block is pushed down below the equilibrium level by a distance d . What is the magnitude of the restoring force that pushes the wood back toward the equilibrium level? (c) Calculate the frequency for the block that bobs in the water. ($d < 30$ cm).

3.(15%) One liter of nitrogen gas at an intital temperature of 300K expands at a constant pressure of 2 atm against a piston, thereby doing work to raise a total mass of 10 kg. The gas is allowed to expand to a volume of 2 L. (a) How high can the mass be lifted ? (b) What is the final temperature of the gas ?

4.(15%) In the circuit shown in the right figure, find the current that passes through each of the resistors and the potential difference $V_A - V_B$.



5.(15%) The magnetic field at the earth's equator is approximatly of magnitude 0.5 G (1 T = 10000 G). If a proton moves horizontally perpendicular to the magnetic field oriented so as to deflect the proton upward. What is the velocity of the proton so that the magnetic force just cancels the gravitational force on t he proton leaving it in horizontal flight ?

6.(20%) Consider a case of Campton scattering in which a photon collides with a free electron and scatters backward while it gives up half its energy to the electron . (a) What are the frequency and energy of the incident photon? (b) What is the electron's momentum after the collision?

Some physical constants

1 atm = 101300 Pa $e = 1.6 \times 10^{-19}$ C $m_p = 1.67 \times 10^{-27}$ kg

$m_e = 9.11 \times 10^{-31}$ kg $h = 6.63 \times 10^{-34}$ J·s $c = 2.998 \times 10^{-8}$ m/s