107 學年度第一學期 普通物理第二次期中考 A卷

1. A lightning flash may transfer up to 50 C of charge through a potential difference of 10^8 V. (a) How much energy does this involve? State your answer in eV. (b) For how long could this much energy light a 60-W bulb? **(10 points)**

2. In a parallel-plate capacitor, the plates are separated by 0.8 mm. The plates carry charges ±80 nC and there is an electric field of magnitude 3×10^5 V/m between the plates. Find: (a) the potential difference; (b) the capacitance; (c) the plate area. **(10 points)**

3. A parallel-plate capacitor has plates of area 50 cm² separated by 2.5mm. It is connected to a 12-V battery. Find: (a) the capacitance; (b) the energy stored; (c) the electric field; (d) the energy density in the electric field. **(10 points)**

4. A parallel-plate capacitor with a plate separation d is connected to a battery with a potential difference $2V$. The plates are pulled apart till the separation is $2d$. What is the change in each of the following quantities: (a) the potential difference; (b) the charge on each plate; (c) the energy stored in the capacitor? **(10 points)**

5. The beam current in a color TV tube is 2.5 mA. The beam cross section is circular with radius 0.5 mm. (a) How many electrons strike the screen per second? (b) What is the current density? **(10 points)**

6. A cylindrical tube of length l has an inner radius a and an outer radius b, as shown in the right Figure. The resistivity is ρ. What is the resistance between the ends? **(10 points)**
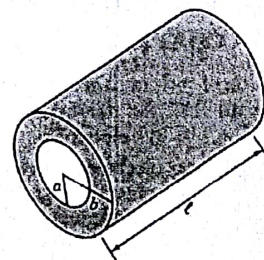

7. The two headlights of a car require a total of 15 A supplied at 12 V. Given that the combustion of 1 L of gasoline releases 3×10^7 J and that the conversion to electrical power has an efficiency of 20%, how much gasoline is consumed in one hour for this purpose alone? **(10 points)**

8. A motor operating at 120 V draws 10 A while lifting a 2000 kg block vertically upward at a constant 3.0 cm/s. Find: (a) its horsepower; (b) the percentage efficiency of the conversion of electrical power to mechanical power. **(10 points)**

9. A radioactive uranium nucleus has a charge 92 e. It can spontaneously decay into a thorium nucleus with charge 90 e and a helium nucleus (α particle) of charge 2 e. Just after the decay, the helium and the thorium are 2×10^{-15} m apart. (a) What is the electrostatic force between them? (b) What is the acceleration of the α particle, whose mass is 6.7×10^{-27} kg? **(10 points)**

10. In the quark model of elementary particles, a proton consists of two "up" (u) quarks, each charge $2e/3$, and a "down" (d) quark of charge $-e/3$. Support these particles lie equally spaced on a circle of radius 1.2×10^{-15} m, as in right figure. Find the magnitude of the electrostatic force on each quark. **(10 points)**
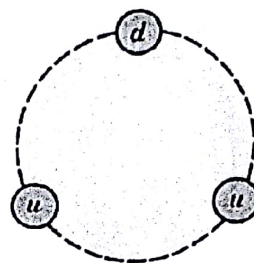
11. Two infinite lines of charge with equal linear charge densities λ C/m are placed along the x and y axes, as shown in the right figure. What is the electric field strength at an arbitrary point (x, y)? **(10 points)**
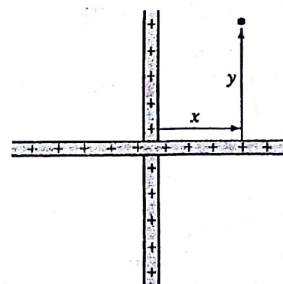
12. A nonconducting sphere of radius R has a uniform charge density ρ throughout its volume. Determine the electric field at a distance r from the center for (a) $r < R$; (b) $r > R$. Do your results agree at $r = R$? **(10 points)**

13. Repeat Problem 12 for the nonuniform density $\rho(r)=Ar$, where A is a constant. Express your answer in term of the total charge Q. **(10 points)**

14. Two concentric spherical metal shells have radii a and b, respectively. The inner shell of radius a has charge Q, while the other shell has charge $-2Q$. Sketch V and E as function of r, the distance from the center. **(10 points)**

Note: Total 140 points; 各題計算過程需詳述，否則不與計分。