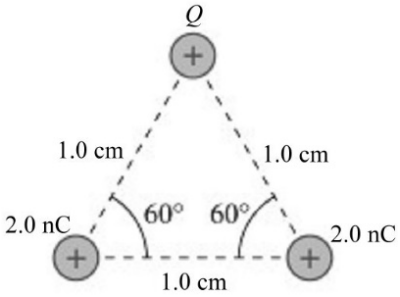
105 學年第二學期 普通物理 B 第一次期中考試題
Wolfson Ch 20-24 (第三版)；2017/03/21, ***8:20 am – 09:50 am***

A

(i) 依空格號碼順序在第二張**正面**寫下所有填充題答案，不要寫計算過程。
(ii) 依計算題之順序在第二張**反面**以後寫下演算過程與答案，**每題從新的一頁寫起**。
Constants: $k = (4\pi\varepsilon_0)^{-1} = 9.00\times10^9$ N · m^2·C^{-2}, $\varepsilon_0 = 8.85\times10^{-12}$ C^2 · N^{-1} · m^{-2}

Part I. Filling the blank (5 points per blank)

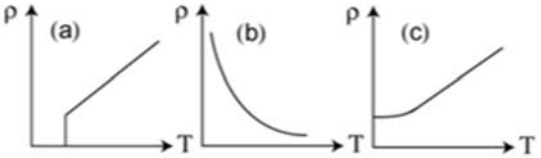
• In the figure Q = 5.8 nC. What is the magnitude of the force on the charge Q?



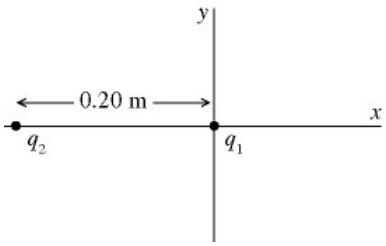
【1】 N

• A neutral hollow spherical conducting shell of inner radius 1.00 cm and outer radius 3.00 cm has a +2.00-μC point charge placed at its center. Find the surface charge density on the outer surface of the shell. 【2】 μC/m^2

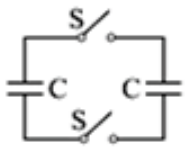
• Consider the resistivity versus temperature curves of three different type materials shown in right figure. Which curve is for superconductor? 【3】



• In the figure, charge $q_1 = 3.1\times10^{-6}$ C is placed at the origin and charge $q_2 = -8.7\times10^{-6}$ C is placed on the x-axis, at x = -0.20 m. Where along the x-axis can a third charge Q = -8.3 μC be placed such that the resultant force on this third charge is zero? 【4】 m.

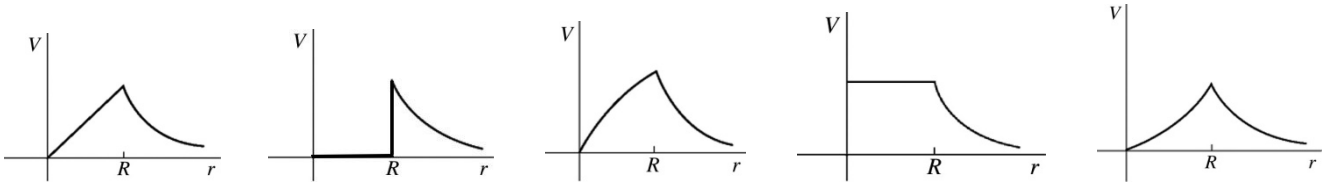


• A system consists of two identical capacitors (each with capacitance C) as shown in the right figure. Initially, one of the capacitor stores energy and the voltage across the capacitor is V. The other one stores nothing. After both switches S are closed and the system reaches stable state, the total energy stored in the system is 【5】.



• A conducting sphere of radius R carries an excess positive charge and is very far from any other charges. Which one of the following graphs best illustrates the potential (relative to infinity) produced by this sphere as a function of the distance r from the center of the sphere? 【6】

(A) (B) (C) (D) (E)



• At a distance D from a very long (essentially infinite) uniform line of charge, the electric field strength is 1000 N/C. At what distance from the line will the field strength to be 2000 N/C? 【7】

• The work to move a 10 μC charge against a 12 V potential difference is 【8】 μJ.

• A wire has a resistance of R_1. The resistance of another wire, made of the same material, that is half as long and has half the diameter, is R_2. The ratio R_2 / R_1 is 【9】.

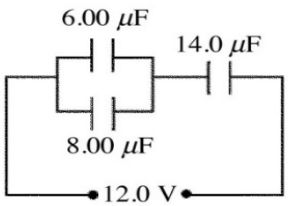
• A conducting sphere is charged up such that the potential on its surface is 100 V (relative to infinity). If the sphere's radius were twice as large, but the charge on the sphere were the same, what would be the potential on the surface relative to infinity? 【10】 V

• A light bulb is connected to a 110V source. What is the resistance of the bulb if it is a 100W bulb? 【11】 Ω

• A parallel-plate capacitor with plate separation of 1.0 cm has square plates, each with an area of 6.0×10^{-2} m^2. What is the capacitance of this capacitor if a dielectric material with a dielectric constant of 2.4 is placed between the plates, completely filling them? 【12】 F

• The resistivity of gold is 2.44×10^{-8} Ω · m at room temperature. A gold wire that is 0.9 mm in diameter and 14 cm long carries a current of 940 mA. What is the electric field in the wire? 【13】 V/m

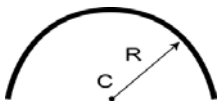
• Two capacitors of capacitance 6.00 μF and 8.00 μF are connected in parallel. The combination is then connected in series with a 12.0-V voltage source and a 14.0-μF capacitor, as shown in the figure.



(a) What is the equivalent capacitance of this combination? 【14】 μF
(b) What is the charge on the 6.00-μF capacitor? 【15】 μC

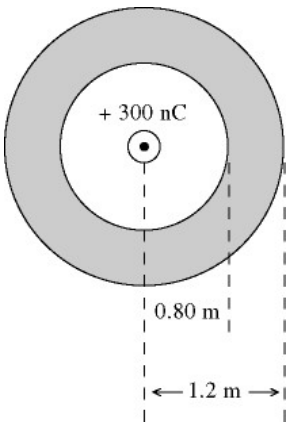
Part II Problems (10 points per problem)

1. A thin plastic rod has uniform linear positive charge density λ distributed along a semicircular arc (半圓弧) of radius R. What is the magnitude of the electric field at the center of the arc (point C)?



2. A sphere of radius R carries charge Q distributed uniformly over its surface. Calculate the electric energy stored in the electric field and express your result in terms of R, Q, and k.

3. A hollow conducting spherical shell has radii of 0.80 m and 1.20 m, as shown in the figure. The shell carries a net excess charge of -500 nC. A point charge of +300 nC is present at the center.



(a) What is the surface charge density on the inner spherical surface?
(b) What is the radial component of the electric field at a point 0.60 m from the center?
(c) What is the radial component of the electric field at a point 1.50 m from the center?

Part I Answer Sheet

A【1】	1.8×10^{-3}	= B【9】		B【1】	0.30 (-0.30 扣一分，一元二次方程式多算一個解扣一分)
A【2】	177	= B【12】		B【2】	$D/2$
A【3】	a	= B【10】		B【3】	50
A【4】	0.30 (-0.30 扣一分，一元二次方程式多算一個解扣一分)	= B【1】		B【4】	121 or 120
A【5】	$CV^2/4$	= B【11】		B【5】	7.00
A【6】	D	= B【13】		B【6】	36.0
A【7】	$D/2$	= B【2】		B【7】	120
A【8】	120	= B【7】		B【8】	2
A【9】	2	= B【8】		B【9】	1.8×10^{-3}
A【10】	50	= B【3】		B【10】	a
A【11】	121 or 120	= B【4】		B【11】	$CV^2/4$
A【12】	1.3×10^{-10}	= B【14】		B【12】	177
A【13】	0.036	= B【15】		B【13】	D
A【14】	7.00	= B【5】		B【14】	1.3×10^{-10}
A【15】	36.0	= B【6】		B【15】	0.036

Part II Answer Sheet

【A1 = B2 】

$$E=\int dE_y=\int_0^{\pi}\frac{k\lambda R\sin\theta}{R^2}d\theta=\frac{k\lambda}{R}\int_0^{\pi}\sin\theta d\theta=\frac{2k\lambda}{R}=\frac{\lambda}{2\pi\varepsilon_0 R}$$

【A2 = B3 】

$$U=\frac{\epsilon_0}{2}\int E^2dV=\frac{\epsilon_0}{2}\int_R^{\infty}(\frac{kQ^2}{r^2})^2\,4\pi r^2dr=\frac{kQ^2}{2R}=\frac{Q^2}{8\pi\epsilon_0 R}$$

【A3 = B1 】

(a) -3.73×10^{-8} C/ m^2, (b) +7500 N/C, (c) -800 N/C. (分數分配 4pts, 3pts, 3pts，沒寫單位一個扣0.5分)

(a) $-300nC/(4\pi\times0.80^2m^2)=-37.3\times10^{-9}$ C/ $m^2=-3.73\times10^{-8}$ C/ m^2

(b) $4\pi\times0.60^2\times Er = 300nC/\varepsilon_0$, $Er=300nC/(4\pi\varepsilon_0\times0.60^2) = (300nC/0.60^2)\times9.00\times10^9 = 7500N/C$

(c) $4\pi\times1.50^2\times Er = -200nC/\varepsilon_0$, $Er = -200nC/(4\pi\varepsilon_0\times1.50^2) = (-200nC/1.50^2)\times9.00\times10^9 = -800N/C$ (沒寫負號或沒表達方向向內扣0.5分)