Beijing-Dublin International College

SEMESTER I FINAL EXAMINATION - 2019/2020

Beijing-Dublin International College

《UNIVERSITY PHYSICS 2》 BDIC2008J

Dr. Hao ZHU

Dr. Boyang LIU

Time Allowed: 95 minutes

Instructions for Candidates

Full marks will be awarded for complete answer to All questions.

BJUT Student ID: _____ UCD Student ID: _____

I have read and clearly understand the Examination Rules of both Beijing University of Technology and University College Dublin. I am aware of the Punishment for Violating the Rules of Beijing University of Technology and/or University College Dublin. I hereby promise to abide by the relevant rules and regulations by not giving or receiving any help during the exam. If caught violating the rules, I accept the punishment thereof.

Honesty Pledge：_____ (Signature)

Instructions for Invigilators

Non-programmable calculators are permitted.

No rough-work paper is to be provided for candidates.

Part 1: Multiple Choice (3 marks each question, 30 marks altogether)

1. Of the charge Q initially on a tiny sphere, a proportion q is to be transferred to a second, nearby sphere. Both spheres can be treated as particles and are fixed with a certain separation. For what value of q/Q will the electrostatic force between the two spheres be maximized?

(A) 0.25
(B) 0.5
(C) 2
(D) 4

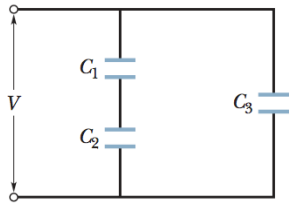
2. A proton is released from rest in a region of space with nonzero electric field. Which of the following statements is true?

(A) The proton will move towards the region with lower potential.
(B) The proton will move towards the region with higher potential.
(C) The proton will move along a line of constant potential.
(D) Nothing can be concluded unless the direction of the electric field is known.

3. For the polarization density in dielectrics $\vec{P} = \varepsilon_0 \chi \vec{E} = \varepsilon_0(\varepsilon_r - 1)\vec{E}$, which of the following statements is NOT true?

(A) The electric field in above equation is the total field.
(B) The electric susceptibility χ of dielectrics just depends on its property.
(C) The electric susceptibility χ has unit.
(D) In vacuum, the electric susceptibility χ is zero and the relative permittivity ε_r is 1.

4. Try to find the equivalent capacitance of the combination as shown in the figure below. Assume that C_1 is 10.0 μF, C_2 is 5.0 μF, and C_3 is 4.0 μF.

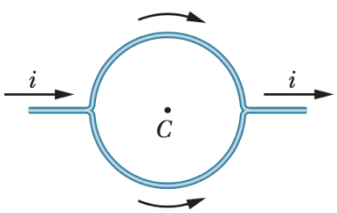


(A) 3.16 μF
(B) 5.25 μF
(C) 7.33 μF
(D) 9.15 μF

5. What uniform magnetic field, applied perpendicular to a beam of electrons ($m_e = 9.1 \times 10^{-31}$ kg) moving at 1.30×10^6 m/s, is required to make the electrons travel in a circular arc of radius 0.350 m?

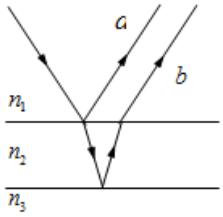
(A) 2.11×10^{-5} T
(B) 3.27×10^{-5} T
(C) 6.34×10^{-5} T
(D) 7.19×10^{-5} T

6. A straight conductor carrying current $i = 5.0$ A splits into identical semi-circular arcs with the radius 1 m as shown below. What is the magnetic field at the center C of the resulting circular loop? (Hint: $\mu_0 = 4\pi \times 10^{-7}$ N/A^2)



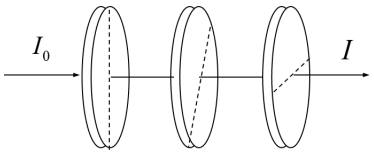
(A) 1.00×10^{-6} T
(B) 0
(C) -1.00×10^{-6} T
(D) None of these and Happy New Year

7. A ray of light is incident on a thin film. Two of the reflected rays are shown. Assume that rays *a* and *b* undergo a phase change because of differences in the indices of refraction. Which would be the proper ordering of the indices?



(A) $n_1 > n_2 > n_3$
(B) $n_2 > n_3 > n_1$
(C) $n_3 > n_2 > n_1$
(D) None of these; the specified phase changes cannot occur.

8. There are three polarizing sheets. The polarizing directions of the first and the third are perpendicular. The angle between the first and the second polarizing sheets is 60°. If the unpolarised incident light has intensity I_0, what is the transmitted intensity I through the device?



(A) $3I_0/8$ (B) $3I_0/16$ (C) $3I_0/32$ (D) 0

9. What is the De Broglie wavelength of Dr. Hao ZHU, assuming his body weight is 70 kg, and is running at 7 m/s? (Hint: $h = 6.63 \times 10^{-34}$ J · s)

(A) 1.35×10^{-36} m
(B) 2.75×10^{-36} m
(C) 3.25×10^{-36} m
(D) 5.75×10^{-36} m

10. Light strikes a sodium(Na) surface, causing photoelectric emission. The stopping potential for the ejected electrons is 5.0 V, and the work function of sodium is 2.2 eV. What is the wavelength of the incident light? (Hint: $h = 6.63 \times 10^{-34}$ J · s; $c = 3 \times 10^8$ m/s; $1\text{eV} = 1.6 \times 10^{-19}$ J)

(A) 130 nm
(B) 150 nm
(C) 170 nm
(D) 190 nm

Part 2: Blank Filling (20 marks altogether)

1. (3 points) The integral form of Maxwell equations is

$$\int_S D \cdot \mathrm{d}S = \int_V \rho \mathrm{d}V \qquad \text{(A)}$$

$$\int_L E \cdot \mathrm{d}l = -\int_s \frac{\partial B}{\partial t} \cdot \mathrm{d}S \qquad \text{(B)}$$

$$\int_S B \cdot \mathrm{d}S = 0 \qquad \text{(C)}$$

$$\int_L H \cdot \mathrm{d}l = \int_s (\delta + \frac{\partial D}{\partial t}) \cdot \mathrm{d}S \qquad \text{(D)}$$

Determine which equation in the following descriptions is related to.

(1) The changing magnetic fields must be accompanied with electric fields. _____
(2) Magnetic field lines never have end points, they always form closed loops. _____
(3) There are electric fields surrounding a charge. _____

2. (4 marks) In a single slit Fraunhofer diffraction experiment, incident wave length is $\lambda = 600$ nm, slit width is $a = 0.60$ mm, and focal length is $f = 60$ cm. Then the linear width of the central bright fringe is _____. The distance between two 3rd diffraction minima on both sides of the central diffraction maximum is _____.

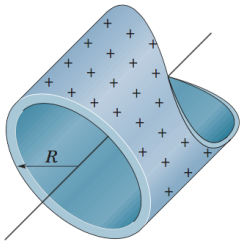
3. (4 marks) A parallel-plate capacitor has plane area S and separation d. When inserting a conductor plate with a thickness d_1 into the capacitor, then the capacitance of the capacitor is _____. If the conductor plate moves upward slightly, the capacitance then _____ (increases, decreases, remains).

4. (4 marks) The wave function of a particle is $\psi(x) = \frac{1}{\sqrt{a}} \cos\frac{3\pi x}{2a}$ $(-a \le x \le a)$. The distribution probability of the particle at point x=a/2 is_____. At points x=_____ the distribution probability of the particle is maximum.

5. (5 marks) The angular momentum of a *3d* electron in hydrogen atom is_____ and the possible combinations of four quantum numbers are (__,__,__,__), (__,__,__,__), (__,__,__,__).

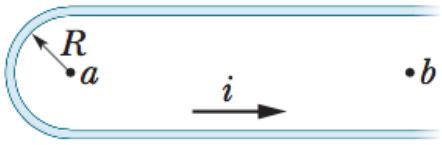
Part 3: Calculation (10 marks each question, 50 marks altogether)

1. The figure shows a section of a long, thin-walled metal tube of radius $R = 3.00$ cm, with a charge per unit length of $\lambda = 2.00 \times 10^{-8}$ C/m. What is the magnitude E of the electric field at radial distance (a) $r = R/2.00$ and (b) $r = 2.00R$? (c) Graph E versus r for the range $r = 0$ to $2.00R$. (Hint: $\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2/(N \cdot m^2)}$)

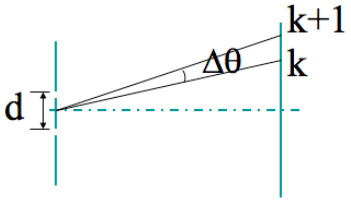


2. A parallel-plate air-filled capacitor having area 40 $\mathrm{cm^2}$ and plate spacing 1.0 mm is charged to a potential difference of 600 V. Try to find (a) the capacitance, (b) the magnitude of the charge on each plate, (c) the stored energy, (d) the electric field between the plates, and (e) the energy density between the plates. (Hint: $\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2/(N \cdot m^2)}$)

3. A current $i = 10$ A is set up in a long conductor formed by bending a wire into a semicircle of radius $R = 5.0$ mm. Point b is midway between the straight sections and so distant from the semicircle that each straight section can be approximated as being an infinite wire. What are the (a) magnitude and (b) direction (into or out of the page) of $\vec{B}$ at a and the (c) magnitude and (d) direction of $\vec{B}$ at b? (Hint: $\mu_0 = 4\pi \times 10^{-7}\ \mathrm{N/A^2}$)



4. In a two-slit interference experiment, $\lambda = 589.3$ nm, the angular distance $\Delta\theta$ between two adjacent fringes is 0.20°. (a) For what wavelength λ, the angular distance will increase by 10%? (b) If the device is put into water ($n = 1.33$), what is the angular distance? (Hint: $\sin\theta \approx \theta$ if $\theta \to 0$)



5. Plane monochromatic waves with wavelength λ=600nm are incident normally on a plane transmission grating. The diffraction angle of the second principal maximum is 30°， and the third principal maxima are missing firstly.

(a) What is the grating constant a+b?

(b) What is the minimum value of a?

(c) How many bright fringes can we observe?