國立中山大學114學年度
碩士班考試入學招生考試試題

科目名稱：普通物理【物理系碩士班】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學 114 學年度碩士班考試入學招生考試試題

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※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（選擇題）

本試卷共 **25** 題，每題均為單選題。每一題均為 **4** 分。答錯均不倒扣。

本試卷所使用之單位縮寫如下表所示:

Unit	**Abbreviation**	**Unit**	**Abbreviation**
second	sec	coulomb	Coul
kilogram	kg	volt	Volt
meter	m	tesla	Tesla
centimeter	cm	ampere	Amp
millimeter	mm	henry	H
kilometer	km	fara	F
nano-meter	nm	watt	W
radiant	rad	Electron volt	eV
joule	Joule	mole	mol
newton	N	absolute temperature	K
hertz	Hz	Atmospheric pressure	atm

本試卷所使用之基本常數如下表所示:

Quantity	**Symbol**	**Approximate value**
Gas constant	R	8.314 (J/mol·K)
Boltzmann constant	k_B	1.38×10^{-23} (Joule/K)
Electric charge	e	1.60×10^{-19} (Coul)
Electron mass	m_e	9.1×10^{-31}(kg)
Permittivity of free space	ϵ_0	8.85×10^{-12} ($Coul^2/N\cdot m^2$)
Permeability of free space	μ_0	$4\pi\times10^{-7}$ (Tesla·m/Amp)
Gravitational constant	G	6.67×10^{-11} ($N\cdot m^2/kg^2$)
Gravitational acceleration	g	9.8 (m/sec^2)
Speed of light	c	3.00×10^{8}(m/s)

1. The permeability of free space is denoted as μ_0, and the permittivity of free space is denoted as ϵ_0. What is the unit of μ_0/ϵ_0?
(A) W^2/Amp^4
(B) $Amp^2/Volt^2$
(C) W/Amp
(D) Volt/Amp

2. The unit of angular momentum is
(A) Joule/sec.
(B) $Joule/sec^2$.
(C) $Joule \cdot sec^2$
(D) Joule·sec.

3. The unit of the electric field E is Volt/m and the unit of the magnetic field B is N/Amp·m. What is the unit of E/B?
(A) W
(B) W/m^2
(C) m/sec
(D) $Joule/m^2$

4. Assume a 70 (Hz) electromagnetic wave is sinusoidal wave propagating in the z-direction with electric field E pointing in x-direction with amplitude E_0=6.00 (Volt/m). What is the amplitude of the magnetic field B_0?
(A) 4.02×10^{-8} (Tesla)
(B) 3.21×10^{-8} (Tesla)
(C) 1.43×10^{-8} (Tesla)
(D) 2.00×10^{-8} (Tesla)

5. Calculate the wavelength of a 95×10^6 (Hz) radio wave with amplitude E_0=5.42.00 (Volt/m).
(A) 4.24 (m)
(B) 3.16 (m)
(C) 5.12 (m)
(D) 2.55 (m)

6. Calculate the self-inductance of a 0.7(m) long air-filled solenoid 3.5(cm) in diameter containing 6300 loops.
(A) 0.068 (H)
(B) 0.043 (H)
(C) 0.077 (H)
(D) 0.054 (H)

7. Calculate the capacitance of a parallel plate capacitor whose plate are 370 (cm^2) and are separated by a 2.3(mm) air gap.
(A) 1.97×10^{-10} (F)
(B) 1.33×10^{-10} (F)
(C) 1.42×10^{-10} (F)
(D) 1.65×10^{-10} (F)

8. An electron travels at the speed 4×10^{7}(m/sec) in a plane perpendicular to a uniform magnetic field. If the resulting radius of circular motion is $r=7.3\times10^{-3}$(m), find the magnitude of the magnetic field B.

(A) 0.024 (Tesla)
(B) 0.043 (Tesla)
(C) 0.031 (Tesla)
(D) 0.052 (Tesla)

9. A magnet moves at high speed relative to an observer and passes by an electron that is stationary relative to the same observer. At the instant the north pole of the magnet passes directly beneath the electron (as shown in **Figure 1**), in which direction will the force acting on the electron point?

(A) 1
(B) 2
(C) 3
(D) 4

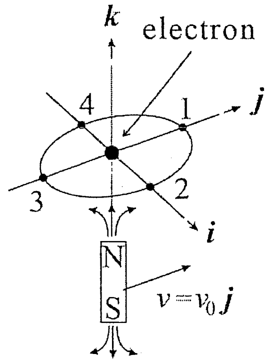

Figure 1

10. There are two inclined planes, with angles $\theta_1=60°$ and $\theta_2=45°$ relative to the horizontal. Two objects with masses $M_1=2$(kg) and $M_2=1$(kg) (both are initially at rest) slide down the inclined planes from the same height h as shown in **Figure 2**. Assuming the time taken to reach the bottom (point A in the figure) are t_1 and t_2 respectively, what is the ratio?

(A) $t_1/t_2=0.816$
(B) $t_1/t_2=1.224$
(C) $t_1/t_2=1.150$
(D) $t_1/t_2=0.707$

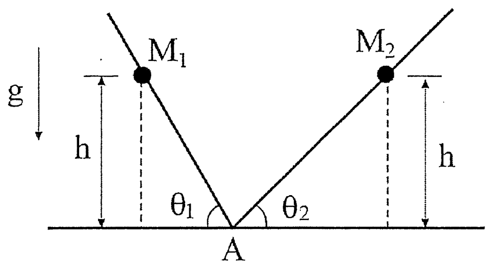

Figure 2

11. Consider the track shown in **Figure 3**. The track AB is one quarter of a circle of radius R=3.0(m) and is frictionless. The horizontal track from B to C has a length of d=4.0(m) and a coefficient of kinetic friction $\mu_k=0.23$. The track CD under the spring is frictionless. The track CD forms an angle $\theta=30°$ with the horizontal plane. A block with a mass of m=2.2(kg) is released from rest at point A. After sliding along the track, it compresses the spring by 0.35 (m) and comes to rest at a distance 0.8 (m) from C. Determine the stiffness constant k for the spring.

(A) 610 (N/m)
(B) 591 (N/m)
(C) 554 (N/m)
(D) 732 (N/m)

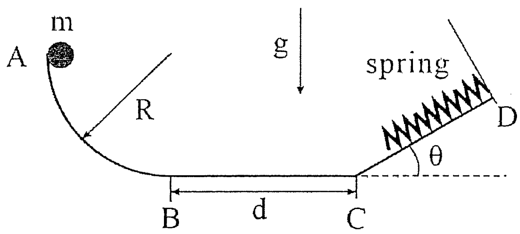

Figure 3

12. Consider a planet moving in an elliptical orbit around the Sun, with an aphelion distance of 2.49×10^{8} (km) and a perihelion distance of 2.06×10^{8} (km). Assuming the mass of the planet is 4.20×10^{30} (kg) and the mass of the Sun is 1.99×10^{30} (kg), what is the orbital period of the planet around the Sun? [we use 1Earth year=31536000 (sec)]
(A) 2.15 Earth year
(B) 1.87 Earth year
(C) 1.62 Earth year
(D) 1.28 Earth year

13. Consider the collision of two objects with masses m_1 and m_2. The initial (before collision) and final (after collision) momenta are denoted as $\boldsymbol{P}_i$ and $\boldsymbol{P}_f$. The momentum difference before the collision is recorded as $\boldsymbol{P}_{1i}-\boldsymbol{P}_{2i}=\boldsymbol{J}_i$, and the momentum difference after the collision is recorded as $\boldsymbol{P}_{1f}-\boldsymbol{P}_{2f}=\boldsymbol{J}_f$. What is the magnitude of the impulse $\boldsymbol{J}$ experienced by each object during the collision?
(A) $|\boldsymbol{J}|=0$
(B) $|\boldsymbol{J}|=|\boldsymbol{J}_i|=|\boldsymbol{J}_f|$
(C) $|\boldsymbol{J}|=|\boldsymbol{J}_i+\boldsymbol{J}_f|/2$
(D) $|\boldsymbol{J}|=|\boldsymbol{J}_i-\boldsymbol{J}_f|/2$

14. Consider a uniform tubes open at both end, which is called the open tube. Suppose an open tube A with a length L has a fundamental frequency f_0. If one-third of A's length is cut off, resulting in open tube B, what is the fundamental frequency f_B? If the open tube B is then connected to another open pipe with one-third of B's length, forming open pipe C, what is the fundamental frequency f_C?
(A) $f_B=(3/2)f_0$, $f_C=(9/8)f_0$
(B) $f_B=(5/2)f_0$, $f_C=(5/8)f_0$
(C) $f_B=(1/3)f_0$, $f_C=(4/3)f_0$
(D) $f_B=(4/3)f_0$, $f_C=(5/3)f_0$

15. A sound source emits a frequency f_0=72 (Hz) when stationary. Suppose the sound source and the observer are moving toward each other as shown in **Figure 4**, each at a speed equal to half the speed of sound, i.e., $v_0=v_d/2$ and $v_s=v_d/2$. What is the frequency f observed by the observer?
(A) f= 144 (Hz)
(B) f= 108 (Hz)
(C) f= 157 (Hz)
(D) f= 216 (Hz)

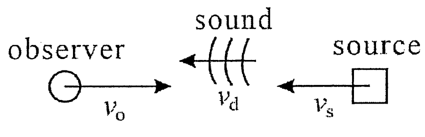

Figure 4

16. Suppose there are two tuning forks (音叉) with vibration frequencies of 240 Hz and 242 Hz. If both tuning forks are sounded together, what frequency does the ear perceive, and how many times per second will the ear hear a loud sound?
(A) 482 (Hz); 2 times each second
(B) 482 (Hz); 4 times each second
(C) 241 (Hz); 2 times each second
(D) 241 (Hz); 4 times each second

17. At a pressure of 1.00 (atm), a sample consisting of 3.00 (mol) of nitrogen gas (N_2) is heated from a temperature of 298(K) to a temperature of 343(K). Assume that the gas can be modeled as the rigid-dumbbell model that can rotate about two axes. Furthermore, suppose that the nitrogen gas can be modeled as an ideal gas. What amount of heat transfer into the sample is required if the pressure is kept constant?

(A) 2.80×10^3 (Joule)

(B) 3.93×10^3 (Joule)

(C) 1.77×10^3 (Joule)

(D) 2.33×10^3 (Joule)

18. A 1.7×10^{-9}(F) capacitor is fully charged by a 450 (Volt) dc power supply. At time t=0, it is disconnected from the power supply and is connected to a 8.5×10^{-2}(H) inductor. Calculate the maximum current I_0 and the total energy U oscillating in the system.

(A) $I_0=3.74\times10^{-2}$(Amp), $U=1.72\times10^{-4}$(Joule)

(B) $I_0=3.74\times10^{-2}$(Amp), $U=2.33\times10^{-4}$(Joule)

(C) $I_0=6.36\times10^{-2}$(Amp), $U=2.33\times10^{-4}$(Joule)

(D) $I_0=6.36\times10^{-2}$(Amp), $U=1.72\times10^{-4}$(Joule)

19. Three conducting plates (each has area A) are connected as shown in **Figure 5**, where d_1=2.00(mm) and d_2 =3.00(mm), and A=250(cm^2). The symbol V represents the potential difference. The gaps between the three conductors are filled with materials having dielectric constants κ_1=3.4 and κ_2=2.1, respectively. Determine the capacitance. Assume that d_1 and d_2 are much less that the dimensions of the plates.

(A) 5.31×10^{-10} (F)

(B) 4.43×10^{-11} (F)

(C) 3.23×10^{-10} (F)

(D) 6.05×10^{-11} (F)

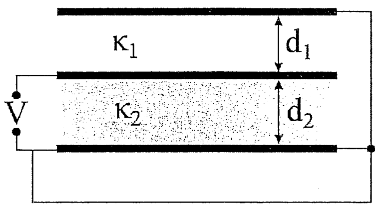

Figure 5

20. Four identical positive point charges (each having the same charge q) are initially at rest and infinitely separated. An amount of work is required to move these point charges to the four corners of a square with edge length L. Suppose there are three charges already positioned as shown in **Figure 6**. Calculate the work needed to bring the fourth charge to point D. We define $\alpha = \frac{q^2}{4\pi\epsilon_0 L}$.

(A) $(4+\sqrt{2})\alpha$

(B) $(4+\frac{1}{\sqrt{2}})\alpha$

(C) $(2+\frac{1}{\sqrt{2}})\alpha$

(D) $(2+\sqrt{2})\alpha$

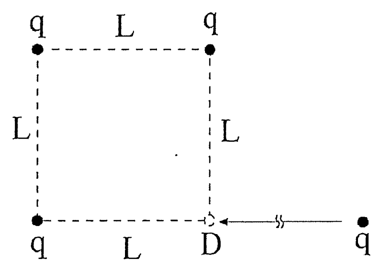

Figure 6

21. As shown in **Figure** 7, a ring of radius R=0.03 (m) lies in a plane with its center at the origin. The ring has a uniformly distributed positive charge Q = 9.0×10^{-9}(Coul). A small charged particle with mass m = 3.8×10^{-6}(kg) and positive charge q = 7.0×10^{-9}(Coul) is placed at a distance d = 0.05 (m) from the axis of the ring and released. Find the speed v of the particle when it is at an infinite distance from the ring. Assume the effects of gravity are negligible.

(A) 2.26 (m/sec)
(B) 2.33 (m/sec)
(C) 2.57 (m/sec)
(D) 3.21 (m/sec)

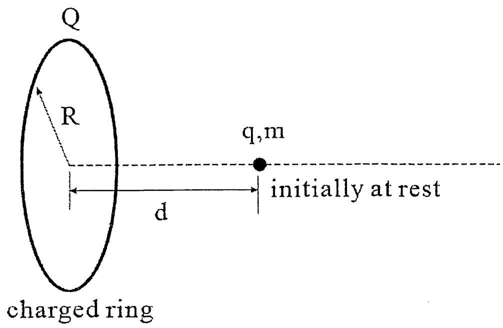

Figure 7

22. Consider a hydrogen-like atom, assuming the electron orbits the nucleus of effective charge 3.7e in a simple planar circular motion, as described by the Bohr model. If the radius of the circular motion is $r=2.2r_0$ where $r_0=0.529\times10^{-10}$(m). What is the magnetic moment of this hydrogen-like atom? [$1/4\pi\epsilon_0 = 8.99\times10^9(\text{N}\cdot\text{m}^2/\text{Coul}^2)$]

(A) 5.83×10^{-23} (Joule/Tesla)
(B) 2.64×10^{-23} (Joule/Tesla)
(C) 6.63×10^{-23} (Joule/Tesla)
(D) 1.67×10^{-23} (Joule/Tesla)

23. The electric dipole moment **p**= p **k** of a molecular is formed by two equal charges of opposite sign +q and –q, separated by a distance $d = 2.4\times10^{-10}$(m) and given q=2.0×10^{-20}(Coul). The electric dipole is placed in a uniform electric field **E**=$3.5\times10^5\boldsymbol{i}+4.2\times10^5\boldsymbol{k}$ (N/Coul) as shown in **Figure 8**. Find the magnitudes of the electric dipole moment of this molecular and the torque $|\boldsymbol{\tau}|$ exerted on the electric dipole.

(A) p=4.8×10^{-30} (Coul·m), and $|\boldsymbol{\tau}| = 2.02\times10^{-24}$ (N·m)
(B) p=9.6×10^{-30} (Coul·m), and $|\boldsymbol{\tau}| = 3.36\times10^{-24}$ (N·m)
(C) p=4.8×10^{-30} (Coul·m), and $|\boldsymbol{\tau}| = 1.68\times10^{-24}$ (N·m)
(D) p=9.6×10^{-30} (Coul·m), and $|\boldsymbol{\tau}| = 4.03\times10^{-24}$ (N·m)

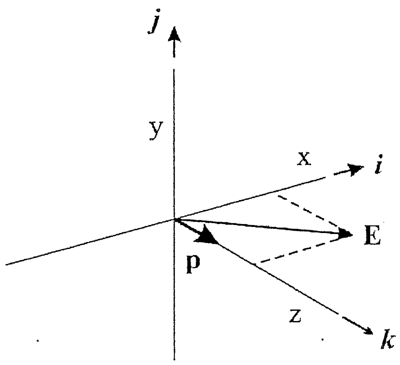

Figure 8

24. On a plane, a massless long rod connects two point masses M_1=2.2 (kg) and M_2=3.1 (kg) at its ends, with a fixed axis of rotation as shown in **Figure 9**, where R_1=0.37(m) and R_2=0.24(m). The axis is perpendicular to the plane of the page. A bullet of mass m=0.2(kg) traveling at a velocity v=15(m/s) perpendicularly strikes M_1 and embeds itself in M_1, causing the rod to rotate about the axis. Calculate the angular velocity.

(A) ω=2.31 (rad/sec)
(B) ω=2.19 (rad/sec)
(C) ω=2.77 (rad/sec)
(D) ω=2.01 (rad/sec)

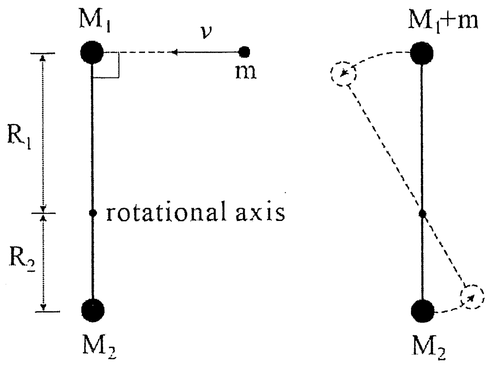

Figure 9

25. In a double-slit interference experiment, the slit separation is 0.48(mm), and the distance to the screen is 1.3(m). Within a range 15(mm) on the screen, 12 bright fringes are observed. Determine the wavelength of the light source used.

(A) 434.1 (nm)
(B) 613.0 (nm)
(C) 722.1 (nm)
(D) 503.5 (nm)