國立成功大學

111學年度碩士班招生考試試題

編　號：38

系　所：物理學系

科　目：普通物理學

日　期：0220

節　次：第 2 節

備　註：不可使用計算機

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Some useful constants

Gas constant $R = 8.314\ J/mol \cdot K$　　　Gravitational constant $G = 6.68 \times 10^{-11} N \cdot m^2/kg^2$

Mass of Sun $= 2.0 \times 10^{30} kg$　　　　　　　　Mass of Earth $= 6.0 \times 10^{24} kg$

Radius of Sun $= 7.0 \times 10^8 m$　　　　　　　　Radius of Earth $= 6.4 \times 10^6 m$

Electron mass $m_e = 9.1 \times 10^{-31} kg$　　　　　Electron charge $e = 1.6 \times 10^{-19} C$

Electric constant (permittivity) $\epsilon_0 = 8.85 \times 10^{-12} C^2/N \cdot m^2$

Magnetic constant (permeability) $\mu_0 = 4\pi \times 10^{-7} T \cdot m/A$

Planck's constant $h = 6.63 \times 10^{-34} J \cdot s$　　　　　$1eV = 1.6 \times 10^{-19} J$

Boltzmann constant $k_B = 1.38 \times 10^{-23} J \cdot K^{-1}$

第一部分：選擇題(20分)

共5題，每題4分，請在答案卷上標明題號並依續作答，答錯不倒扣。

1. A cannon directed straight upward launches a ball with initial speed **V**. The ball reaches a maximum height H in a time T. Then, the same cannon is used to launch a second ball straight upward at a speed **2V**. In terms of H and T, what is the maximum height the second ball reaches and how long does it take to reach that height? **(A)** H, T　**(B)** $2H, T$　**(C)** $2H, 2T$　**(D)** $2H, 4T$　**(E)** $4H, 2T$

2. Which of the following relationships between a particle's acceleration a and its position x indicates simple harmonic oscillation?　**(A)** $a = 3x^2$,　**(B)** $a = 3x$,　**(C)** $a = -4x$,　**(D)** $a = -\frac{2}{x}$　**(E)** $a = -\frac{2}{x^2}$。

3. When a gas undergoes an adiabatic expansion, which of the following statements is true? **(A)** The temperature of the gas does not increase. **(B)** No work is done by the gas. **(C)** No energy is transferred to the gas by heat. **(D)** The internal energy of the gas does not change. **(E)** The pressure increases.

4. In an AC generator, a coil with N turns of wire spins in a magnetic field. Of the following choices, which does **_not_** cause on increase in the emf generated in the coil?　**(A)** replacing the coil wire with one of lower resistance　**(B)** spinning the coil faster　**(C)** increasing the magnetic field　**(D)** increasing the number of turns of wire on the coil.

5. An electromagnetic wave propagates in the $-y$ direction. The electric field at a point in space is momentarily oriented in the $+x$ direction. The magnetic field at that point is momentarily oriented in the **(A)** $+z$ direction **(B)** $-z$ direction **(C)** $-x$ direction **(D)** $+y$ direction.

第二部分 ： 簡答題(50 分)
共 10 題，每題 5 分，請在答案卷上標明題號並依續作答(中英文作答均可，無須詳列計算過程)。

6. A coin of mass 10 gram rolls along a horizontal table with a velocity of 6 cm/s. What is its kinetic energy?

7. Masses m and $3m$ are attached to the two ends of a spring of spring constant k. What is the period of oscillation?

8. Suppose that the radius of the Earth were to shrink by 1 %, its mass remaining the same. Would the acceleration due to gravity g on the Earth's surface increase or decrease, and by what percentage?

9. Water is moving with a speed of 10.0 m/s through a pipe with a cross-sectional area of 6.0 cm^2. The water gradually descends 16 m as the pipe cross-sectional area increases to 12.0 cm^2. What is the speed of water at the lower level?

10. Two identical piano strings of length 0.750 m are each tuned exactly to 440 Hz. The tension in one of the strings is then increased by 1.0 %. If they are now stuck, what is the beat frequency between the fundamentals of the two strings?

11. Calculate the change in entropy of 300 g of water warmed slowly from 20.0 °C to 80.0 °C.

12. A small but measurable current of 1.6×10^{-10} A exists in a metal wire whose diameter is 2.0 mm. The number of charge carriers per unit volume is 8.0×10^{28} m^{-3}. Assuming the current is uniform, calculate the electron drift speed.

13. What is the relation between R,L, and C for critical damping in a series RLC circuit?

14. A long, straight wire carries a current I. A right-angle bend is made in the middle of the wire. The bend forms an arc of a circle of radius r as shown. Determine the magnetic field at point P, the center of the arc.

15. A sinusoidally varying voltage is applied across an 4.00 μF capacitor. The frequency of the voltage is 3.00 kHz, and the voltage amplitude is 20.0 V. Find the displacement current in the capacitor.

第三部分 ： 計算題(30 分)
共 3 題，請在答案卷上標明題號依續作答，並詳列計算過程(中英文作答均可)。

1. [12%] The total mechanical energy of a 2.00 kg particle moving along the x axis is 8.00 J . The potential energy is given as $U(x) = (0.50x^4 - 4.00x^2)$ J , with x in meters. (a) Find the *maximum* velocity. (4%) (b) Find the acceleration of the particle when it is passing through $x = -1.0$ m ? (4%) (c) Calculate the angular frequency of small oscillations about the stable equilibrium points of the potential $U(x)$. (4%)

2. [12%] The electric potential at a perpendicular distance r from a long straight wire of cross-sectional radius a is given by $V(r) = -K \ln \frac{r}{a}$, where K is a constant. (a) Calculate the electric field as a function of distance. (4%) (b) Using Gauss's theorem, determine the charge q per unit length of the wire. (4%) (c) A second identical wire, carrying charge $-q$ per unit length, is placed parallel to the first at a distance d from it. Calculate the potential difference between the wires, assuming that $d \gg a$. (4%)

3. [6%] Light of wavelength 500 nm enters a human eye. Let's estimate the pupil diameter to be of 2 mm. (a) Estimate the limiting angle of resolution for this eye, assuming its resolution is limited only by diffraction. (3%) (b) Determine the minimum separation distance d between two point sources that the eye can distinguish if the point sources are a distance L = 25 cm from the observer. (3%)