

臺灣綜合大學系統 109 學年度學士班轉學生聯合招生考試試題

科目名稱	普通物理 B	類組代碼	共同考科
		科目碼	E0015

※本項考試依簡章規定所有考科均「不可」使用計算機

本科試題共計 三 頁

Some useful constants

Gas constant $R = 8.314 \text{ J/mol}\cdot\text{K}$

Gravitational constant $G = 6.68 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$

Mass of Sun $= 2.0 \times 10^{30} \text{ kg}$

Mass of Earth $= 6.0 \times 10^{24} \text{ kg}$

Radius of Earth $= 6.4 \times 10^6 \text{ m}$

Radius of Sun $= 7.0 \times 10^8 \text{ m}$

Electron mass $m_e = 9.1 \times 10^{-31} \text{ kg}$

Electron charge $e = 1.6 \times 10^{-19} \text{ C}$

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

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

Plank's constant $h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$

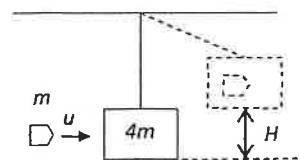
1 eV $= 1.6 \times 10^{-19} \text{ J}$

Boltzmann constant $k_b = 1.380 \times 10^{-23} \text{ J}\cdot\text{K}^{-1}$

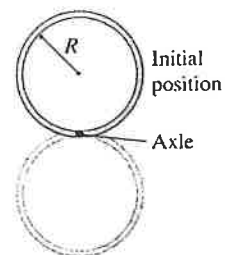
第一部分：填充簡答題（80 分）

共 16 題，每題 5 分，請於答案卷上依序作答並標明題號（無需詳列計算過程）。

- In a circular motion, the radius $r = 20 \text{ m}$, and the tangential speed $v = t^2 + 1$, where t is in unit s and v is in unit m/s. What are magnitudes of the instantaneous tangential acceleration and centripetal acceleration at $t=3 \text{ s}$?
- A car of mass m moves on a frictionless road. At $t = 0$, the driver shuts the engine off, and the car has speed v_0 . After that, the only force acting on the car is the air drag force: $\vec{F} = -Av\hat{v}$, where A is a constant, and \vec{v} is the velocity. For $t \geq 0$, find the speed of the car as a function time t .
- A bullet of mass m is fired into a suspended block of mass $4m$ with a speed u . The bullet then embeds in the block and raises the block. What is the maximum raised height H ?



- An object of mass m is initially at rest on a frictionless horizontal plane. If a constant power P acts on this object for t duration, how far will it travel during this interval?
- A thin ring of mass M and radius R rotates about an axis through its edge. The ring starts at its highest point and is given a very small push to start its rotation. What is the angular velocity at the lowest point?



- A uniform spherical planet has mass M and radius R . A very thin tunnel passes from one end of the planet, through the planet center, and then out from the other end of the planet. A particle of mass m fell into one end of the tunnel and then performed simple harmonic motion. Find the angular frequency of the simple harmonic motion.

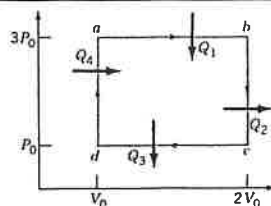
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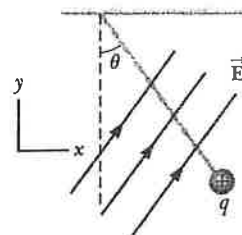
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7. One mole of an ideal monatomic gas is taken around the reversible cycle as shown in the figure. Find the efficiency of the heat engine.



8. (True or False?) An *irreversible* engine works in cycles. When the engine returns to its initial state, the entropy change of the engine is zero.

9. A charged cork ball of mass m is suspended on a light string in the presence of a uniform electric field as shown in the right figure. When $E = A \mathbf{i} + B \mathbf{j}$, where A and B are positive quantities, the ball is in equilibrium at the angle θ . The tension in the string is _____.

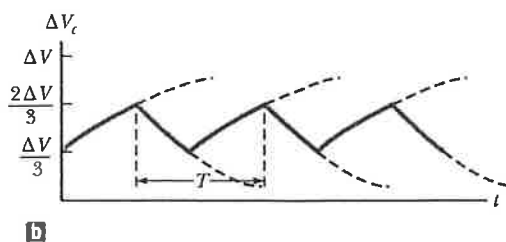
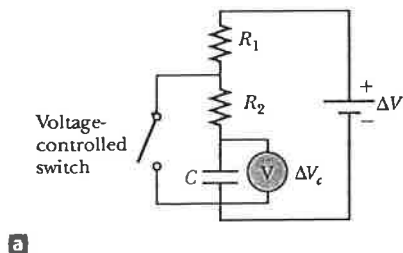


10. A solid insulating sphere of radius R has a nonuniform charge density that varies with r according to the expression $\rho = Ar^2$, where A is a constant and $r < R$ is measured from the center of the sphere. (a) Show that the magnitude of the electric field outside ($r > R$) the sphere is _____.

11. A particle with charge q is located at $x = 2R$, and a particle with charge $-2q$ is located at the origin. The equipotential surface that has zero potential is a sphere centered at $(-4R/3, 0, 0)$ and having a radius _____.

12. Consider two long, parallel, and oppositely charged wires of radius r with their centers separated by a distance D that is much larger than r . Assuming the charge is distributed uniformly on the surface of each wire, show that the capacitance per unit length of this pair of wires is _____.

13. The switch in the following figure a closes when $\Delta V_C > 2/3 \Delta V$ and opens when $\Delta V_C < 1/3 \Delta V$. The ideal voltmeter reads a potential difference as plotted in following figure b. What is the period T of the waveform in terms of R_1 , R_2 , and C ?



14. A bar of mass m and resistance R slides without friction in a horizontal plane, moving on parallel rails as shown in the following figure. The rails are separated by a distance d . A battery that maintains a constant emf \mathcal{E} is connected between the rails, and a constant magnetic field B is directed perpendicularly out of

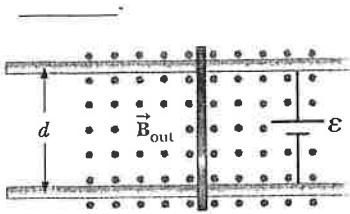
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the page. Assuming the bar starts from rest at time $t = 0$, show that at time t it moves with a speed



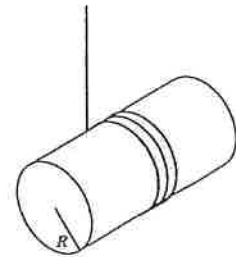
15. High-power lasers in factories are used to cut through cloth and metal. One such laser has a beam diameter of 1.00 mm and generates an electric field having an amplitude of 0.700 MV/m at the target. Find the power delivered by the laser.

16. The rest energy of a proton is 938 MeV, and the total energy of a proton is twice its rest energy. Find the momentum of the proton in MeV/c units, c is the speed of light.

第二部分：計算題（20分）

共 2 題，每題 10 分，請於答案卷上 **依序作答** 並 **標明題號**（中英文作答均可，需詳列計算過程）。

- A solid cylinder of mass M and radius R is rounded by a string.
 - If the solid cylinder unwinds on the vertical string without spinning, what is the tension of the string? (5 points)
 - If the string is pulled to have the cylinder spin but not fall, what is the angular acceleration of the cylinder? (5 points)



- A light source emitting radiation at frequency 7.00×10^{14} Hz is incapable of ejecting photoelectrons from a certain metal. In an attempt to use this source to eject photoelectrons from the metal, the source is given a velocity toward the metal.
 - When the speed of the light source is equal to $0.280 c$, photoelectrons just begin to be ejected from the metal. What is the work function of the metal? (5 points)
 - When the speed of the light source is increased to $0.900 c$, determine the maximum kinetic energy of the photoelectrons. (5 points)