

臺灣綜合大學系統 111 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 3 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) $\mu_0 = 4\pi \times 10^{-7} \text{ T}\cdot\text{m/A}$

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

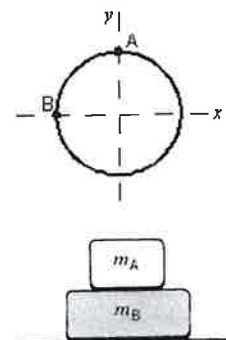
$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$

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) 。

1. A toy moves with constant speed around a circle. The radius of the circle $R=3 \text{ m}$. When the toy is at point A, its velocity is $6 \text{ m/s } \hat{i}$. When it is at point B, what is its acceleration (vector)?

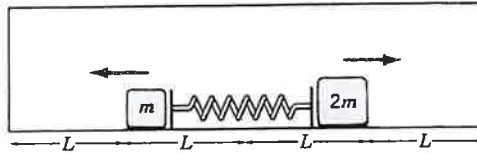


2. Block A of mass $m_A = 2 \text{ kg}$ is on block B of mass $m_B = 5 \text{ kg}$. The lower block is on a frictionless surface while the coefficient of static friction $\mu_s = 0.25$ between the two blocks. If they are moving together at constant velocity, $v=5 \text{ m/s}$, what is the frictional force between A and B?

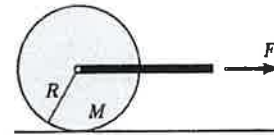
3. A particle starts from rest ($v = 0$) at time $t = 0$ and moves along the x axis. If the net force on it is proportional to t , its kinetic energy will be proportional to t^n . What is the value of n ?

4. A thin rod of length a varies in its composition in such a manner that its linear mass density is $\lambda(x) = cx$, where x is the distance from one end. Locate the position of center of mass (CM) relative to $x=0$.

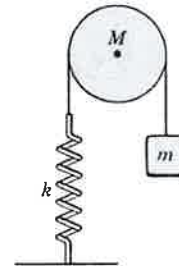
5. Two blocks of masses m and $2m$ are held against a massless compressed spring within a box of mass $3m$ and length $4L$ whose center is at $x=0$. All surfaces are frictionless. After the blocks are released they are each at a distance L from the ends of the box when they lose contact with the spring. Both blocks keeps moving until they collide with the box and stick to it. Find the distance of the center of the box moves from $x=0$ after both blocks stick to the box.



6. A lawn roller is a solid cylinder of mass M , radius R , and rotational inertia $I=MR^2/2$. It is pulled at its center by a horizontal force of magnitude F and rolls without slipping on a horizontal surface. Find the acceleration of the cylinder.



7. A block of mass m is attached to a vertical spring via a string that hangs over a pulley of mass M and radius R . The rotational inertia of the pulley $I=MR^2/2$. The string does not slip. Find the angular frequency (ω) of the simple harmonic motion.



8. The wave function of a wave is:

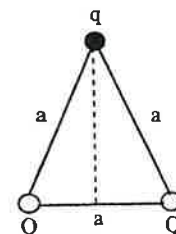
$$y(x, t) = 0.3\sin(0.4x + 40t + 0.6)$$

where x and y are in centimeters (cm) and t is in second (s). Find the wave velocity.

9. Two small charged objects repel each other with a force F when separated by a distance d . If the charge on each object is reduced to one-fourth of its original value and the distance between them is reduced to $d/2$, the force becomes: _____.

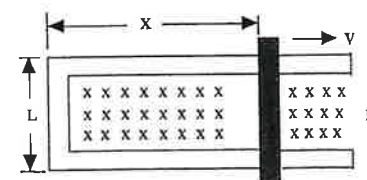
10. A conducting sphere of radius 0.01 m has a charge of 1.0×10^{-9} C deposited on it. The magnitude of the electric field in N/C just outside the surface of the sphere is: _____

11. The two charges Q are fixed at the vertices of an equilateral triangle. If $k = 1/(4\pi\epsilon_0)$, the work required to move q from the other vertex to the center of the line joining the fixed charges is: _____.



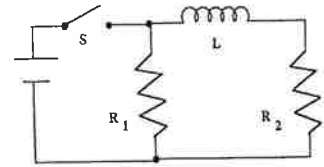
12. Two conductors are made of the same material and have the same length. Conductor A is a solid wire of diameter 1 mm. Conductor B is a hollow tube of inside diameter 1 mm and outside diameter 2 mm. The ratio of their resistance, R_A/R_B , is: _____

13. A rod with resistance R lies across frictionless conducting rails in a uniform magnetic field B , as shown. Assume the rails have negligible resistance. The force that must be applied by a person to pull the rod



to the right at constant speed v is: _____

14. When the switch S in the circuit shown is closed, the time constant for the growth of current in R_2 is: _____.



15. Consider the four Maxwell equations:

I $\int \vec{E} \cdot d\vec{A} = \frac{q}{\epsilon_0}$

II $\int \vec{B} \cdot d\vec{A} = 0$

III $\int \vec{E} \cdot d\vec{s} = -\frac{d\Phi_B}{dt}$

IV $\int \vec{B} \cdot d\vec{s} = \mu_0 I + \epsilon_0 \mu_0 \frac{d\Phi_E}{dt}$

Which of these equations would have to be modified if magnetic poles were discovered: _____?

16. A spectral line of a certain quasar is observed to be “red shifted” from a wavelength of 500 nm to a wavelength of 1500 nm. Interpreting this as a Doppler effect, the speed of recession of this quasar is: _____ C (C is the light speed).

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）。

- Find the change in entropy (ΔS) for n moles of an ideal monatomic gas (single-atom gas) in the following process:
 - The temperature changes from T_1 to T_2 at constant volume. (5 points)
 - The volume changes from V_1 to V_2 at constant temperature. (5 points)
- Robert Hofstadter won the 1961 Nobel Prize in Physics for his pioneering work in studying the scattering of 20-GeV electrons from nuclei.
 - What is the γ factor for an electron with total energy 20.0 GeV? (5 points)
 - Find the wavelength of the electron. (5 points)