臺灣綜合大學系統107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各考科均「不可以」使用計算機　　本科試題共計 4 頁

Some useful constants

Gas constant $R = 8.314$ J/mol·K

Gravitational constant $G = 6.68\times10^{-11}$ N·m^2 /kg^2

Mass of Sun = 2.0×10^{30} kg

Mass of Earth = 6.0×10^{24} kg

Radius of Earth = 6.4×10^{6} m

Radius of Sun = 7.0×10^{8} m

Electron mass $m_e = 9.1\times10^{-31}$ kg

Electron charge $e = 1.6\times10^{-19}$ C

Electric constant (permittivity) $\epsilon_0 = 8.85\times10^{-12}$ C^2 /N·m^2

Magnetic constant (permeability) $\mu_0 = 4\pi\times10^{-7}$ T·m/A

Plank's constant $h = 6.63\times10^{-34}$ J·s

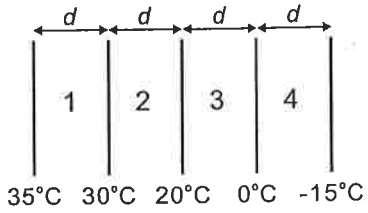
1 eV = 1.6×10^{-19} J

Boltzmann constant $k_b = 1.380\times10^{-23}$ J·K^{-1}

第一部分：簡答題（70 分）

共 14 題，每題 5 分，請於答案卷上**標明題號**並**依序作答**（中英文作答均可，無需詳列計算過程）。

1. A 0.50-kg object moves on a horizontal frictionless circular track with a radius of 2.5 m. An external force of 3.0 N, always tangent to the track, causes the object to speed up as it goes around. If it starts from rest, then at the end of one revolution the radial component of the force of the track on it is.
2. A simple gyroscope consists of a wheel ($M = 2.0$ kg, $R = 0.75$ m, $I = 1.1$ kg·m^2) rotating on a horizontal shaft. If the shaft is balanced on a pivot 0.50 m from the wheel, and the wheel rotates at 500 rev/min, what is the precession frequency of the wheel?
3. A spherical shell has inner radius R_1, outer radius R_2, and mass M, distributed uniformly throughout the shell. What is the magnitude of the gravitational force exerted on the shell by a point particle of mass m, located a distance d from the center, outside the inner radius and inside the outer radius?
4. A simple pendulum is suspended from the ceiling of an elevator. The elevator is accelerating upwards with acceleration a. What is the period of this pendulum, in terms of its length L, g and a?
5. The sinusoidal wave $y(x,t) = y_m \sin(kx - \omega t)$ is incident on the fixed end of a string at $x = L$. What is the equation that describes the reflected wave?
6. The diagram shows four slabs of different materials with equal thickness, placed side by side. Heat flows from left to right and the steady-state temperatures of the interfaces are given. Please rank the materials according to their thermal conductivities, smallest to largest.



7. A sample of argon gas (molar mass 40 g) is at four times the absolute temperature of a sample of hydrogen gas (molar mass 2 g). What is the ratio of the *rms* speed of the argon molecules to that of the hydrogen?

　背面有題，請繼續作答。

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8. An ideal gas of N monatomic molecules is in thermal equilibrium with an ideal gas of the same number of diatomic molecules and equilibrium is maintained as temperature is increased. What is the ratio of the changes in the internal energies $\Delta E_{dia} / \Delta E_{mon}$?

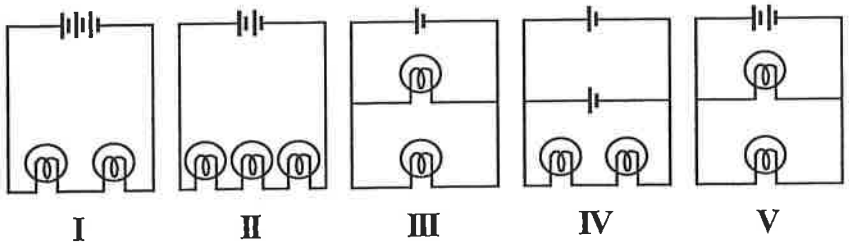
9. The temperature of n moles of a gas is increased from T_i to T_f at constant pressure. If the molar specific heat at constant pressure is C_p and is independent of temperature, then what is the change in the entropy of the gas?

10. The thermodynamic state of gas changes configuration from one with 3.8×10^{18} microstates to one with 7.9×10^{19} microstates. The Boltzmann constant is 1.38×10^{-23} J/K. What is the change in entropy?

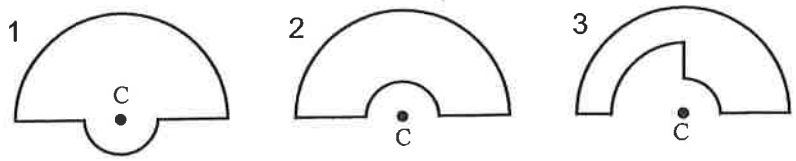
11. The table below gives the electric flux through the ends and round surfaces of four Gaussian surfaces in the form of cylinders. Rank the cylinders according to the charge inside, from the most negative to the most positive.

	left end	right end	rounded surface
cylinder 1:	$+2 \times 10^{-9}$ N·m²/C	$+4 \times 10^{-9}$ N·m²/C	-6×10^{-9} N·m²/C
cylinder 2:	$+3 \times 10^{-9}$ N·m²/C	-2×10^{-9} N·m²/C	$+6 \times 10^{-9}$ N·m²/C
cylinder 3:	-2×10^{-9} N·m²/C	-5×10^{-9} N·m²/C	$+3 \times 10^{-9}$ N·m²/C
cylinder 4:	$+2 \times 10^{-9}$ N·m²/C	-5×10^{-9} N·m²/C	-3×10^{-9} N·m²/C

12. In the following diagrams, all light bulbs are identical and all *emf* devices are identical. In which circuit (I, II, III, IV, V) will the bulbs be dimmest?



13. The diagrams show three circuits consisting of concentric circular arcs (either half or quarter circles of radii r, $2r$, and $3r$) and radial lengths. The circuits carry the same current. Please rank them according to the magnitudes of the magnetic fields they produce at C, least to greatest.



14. The following figure shows the energy levels for an electron in a finite potential energy well. If the electron makes a transition from the $n = 3$ state to the ground state, what is the wavelength of the emitted photon?

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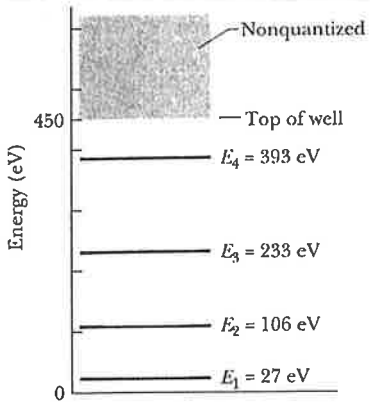
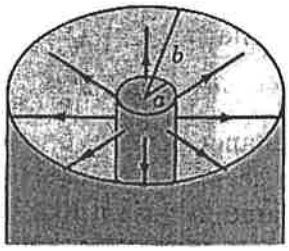


第二部分：複選題（30 分）

共 3 題，每題 10 分，**全對才給分**，請於答案卷上**標明題號**並**依序作答**。

1. A cylindrical capacitor consists of a central conductor of radius a surrounded by a cylindrical shell of radius b, as shown in right figure. We assume that the cable is long enough for us to neglect end effects and the linear charge on the central conductor is λ C/m. ($k = 1/4\pi\varepsilon_0$)



(A) The electric field in the region a < r < b is $E_r = k\lambda/2r$

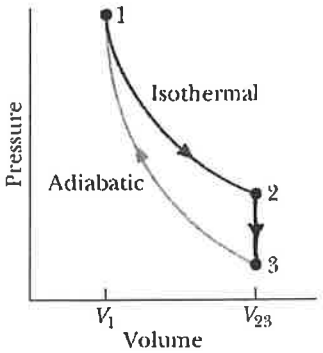
(B) The electric field in the region a < r < b is $E_r = 2k\lambda/r$

(C) The potential difference between the conductors is $k\lambda$ ln(b/a)

(D) The potential difference between the conductors is $k\lambda$ (b/a)

(E) The capacitance of a length L assuming that air is between the plates: $C = 2\pi\varepsilon_0 L/\ln(b/a)$

2. In the right figure $V_{23} = 3V_1$, and n moles of a diatomic ideal gas are taken through the cycle with the molecules rotating but not oscillating. Which of the following is/are correct?



(A)The molar heat capacity $C_V = (5/2)R$

(B) The ratio of the pressures $P_1/P_3 = 3$

(C) The ratio of the temperatures $T_1/T_3 = 3^{0.4}$

(D) Change in the internal energy for the complete cycle is $\Delta E_{int} = 0$

(E) In process 1 → 2, the work done is $W_{12} = RT_1 \ln 3$

3. In the figure below, the conducting rod has length L= 0.1 m and is being pulled along horizontal frictionless conducting rails at a constant velocity with v = 5 m/s. The rails are connected at one end with a metal strip. The rod has resistance of 0.4 Ω and the rails and connector have negligible resistance. A uniform magnetic field B = 1.2 T out of the page fills the region in which the rod moves. It is correct that

(A) the magnitude of the *emf* induced in the rod is 0.6 V

(B) the induced current is 1.5 A

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(C) the induced current is clockwise

(D) the leftward external force needed to keep the rod moving at constant velocity is 1.8 N

(E) the power associated with the force is 3.0 W