編號： 42

國立成功大學 106 學年度碩士班招生考試試題

系　　所：物理學系

考試科目：普通物理學

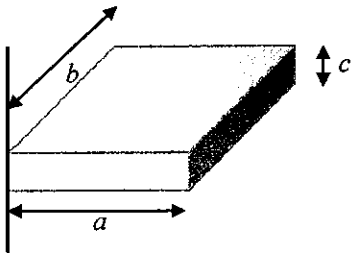
考試日期：0214，節次：2

※ 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。

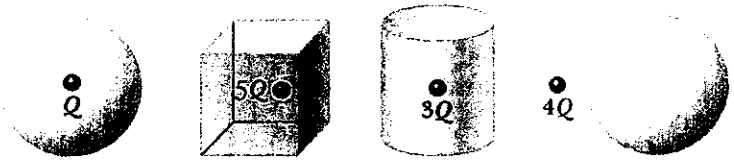
第一部分：簡答題（60 分）

共 12 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. The uniform solid block in right figure has mass 0.2 kg and edge lengths a = 5.0 cm, b = 8.0 cm, and c = 2.0 cm. Calculate its rotational inertia about an axis through one corner and perpendicular to the large faces.

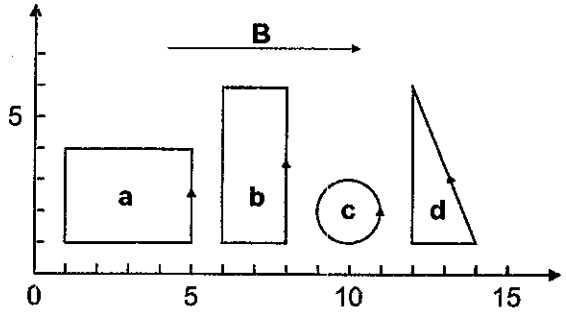


2. The work done by a force on a particle moving between any two points is independent of the force taken by the particle, the force is called conservation force. Please write down a **non-conservation force** you known that is **NOT** satisfied above property.
3. An elevator (mass 5000 kg) is to be designed so that the maximum acceleration is 0.05 g. What is the **maximum force** the motor should exert on the supporting cable?
4. Please give the statements of the **first law of thermodynamics**.
5. Calculate the **minimum thickness** of a soap-bubble film that results in constructive interference in the reflected light if the film is illuminated with light whose wavelength in free space is 600 nm. The index of refraction of the soap film is 1.33.
6. Rank the electric fluxes through each Gaussian surface shown in the following figure **from largest to smallest.**



7. Use a plot of E versus r to describe the electric field magnitude versus distance r from the center of a **solid charged insulating sphere** of radius a.
8. Consider a uniformly wound solenoid having N turns and length l. Assume l is much longer than the radius of the windings and the core of the solenoid is air. Please calculate the inductance of the solenoid.
9. A magnetic field exerts a torque on each of the current-carrying single loop of wire shown in the following figure. The loops lie in the xy plane, each carrying the **same magnitude current**, and the

uniform magnetic field points in the positive x direction. Rank the loops by the magnitude of the torque exerted on them by the field **from largest to smallest.**



10. Please use the current-voltage curves to describe the **ohmic and nonohmic materials.**

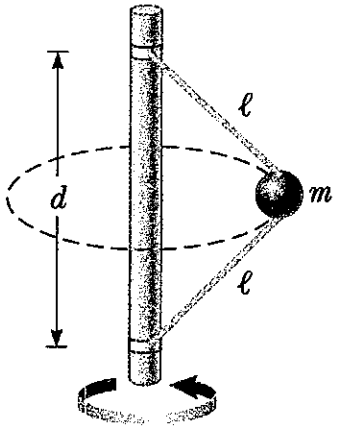
11. A crew on a spacecraft watches a movie that is two hours long. The spacecraft is moving at high speed through space. Does an **earth-based observer** watching the movie screen on the spacecraft through a powerful telescope measure the duration of the movie to be longer than, shorter than, or equal to two hours?

12. There are four starts shown in a telescope color photograph. Start A appears to glow red, start B appears to glow orange, start C appears to glow dark red, whereas start D looks blue in color. Please rank the starts by their surface temperatures **from lowest to highest.**

第二部分：計算題（40 分）

共 3 題，請於答案卷上標明題號依序作答，並詳列計算過程（中英文作答均可）。。

1. In right figure, a 2.0 kg ball is connected by means of two massless strings, each of length l = 2.0 m, to a vertical, rotating rod. The strings are tied to the rod with separation d = 1.5 m and are taut. The tension in the upper string is 30 N.



(a) What are the tension in the lower string? **(5 points)**

(b) What are the magnitude of the net force F_{net} on the ball? **(5 points)**

(c) What are the speed of the ball? **(5 points)**

2. In Millihan's oil drop experiment, the drops are first held motionless by application of a uniform field E. Next, the field is switched off and the drops are allowed to fall in air until they reach the terminal speed v_T. The fluid resistance is given by Stokes law, $F=6\pi\eta r v_T$, where η is the coefficient of viscosity and r is the radius. The condition for falling at the terminal speed is $6\pi\eta r v_T = m_{\text{eff}}\, g$. The effective mass of a drop is $m_{\text{eff}} = 4/3\pi r^3(\rho - \rho_A)$, where ρ is the density of the drop and ρ_A is the density of the air, which has a buoyant effect. Show that the charge on a drop is given by

$$q = \frac{18\pi}{E}\sqrt{\frac{\eta^3 v_T^3}{2(\rho-\rho_A)g}}.$$ **(10 points)**

3. The radial part of the wavefunction for the 1s state in hydrogen is

$\Psi_{1s}(r) = \frac{1}{\sqrt{\pi a_0^3}} e^{-\frac{r}{a_0}}$, where a_0 is Bohr radius.

(a) What is the radial probability density function for hydrogen atom in its ground state? **(5 points)**

(b) Show that the most probable value of r for electron in the ground state of the hydrogen atom. **(5 points)**

(c) Calculate the probability that the electron in the ground state of hydrogen will be found outside the first Bohr radius **(5 points)**

(hint: using the partial integration $\int x^2 e^{-x} dx = -(x^2 + 2x + 2)e^{-x}$)