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

類組：B30

科目名稱：普通物理 A

科目代碼：E0014

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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 $= 2.0\times10^{30}$ kg

Mass of Earth $= 6.0\times10^{24}$ kg

Radius of Earth $= 6.4\times10^{6}$ m

Radius of Sun $= 7.0\times10^{8}$ 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 $= 1.6\times10^{-19}$ 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. Suppose you have a pendulum clock which keeps correct time on Earth (acceleration due to gravity = 9.8 m/s^2). Without changing the clock, you take it to the Moon (acceleration due to gravity = 1.6 m/s^2). For every hour interval (on Earth), what is the time interval that the Moon clock will record?
2. The plate areas and plate separations of five parallel plate capacitors are:
   capacitor 1: area A_0 separation d_0
   capacitor 2: area $2A_0$ separation $2d_0$
   capacitor 3: area $2A_0$, separation $d_0/2$
   capacitor 4: area $A_0/2$, separation $2d_0$
   capacitor 5: area A_0, separation $d_0/2$
   Please rank these according to their capacitances from greatest to least.
3. A window washer attempts to lean a ladder against a frictionless wall. He finds that the ladder slips on the ground when it is placed at an angle of less than θ_0 to the ground but remains in place when the angle is greater than θ_0. What is the coefficient of static friction between the ladder and the ground?
4. A solid wheel with mass M, radius R, and rotational inertia $MR^2/2$, rolls without sliding on a horizontal surface. A horizontal force F is applied to the axle and the center of mass has an acceleration a. What are the magnitudes of the applied force F and the frictional force f of the surface?
5. The temperatures T_C of the cold reservoirs and the temperatures T_H of the hot reservoirs for four Carnot heat engines are
   engine 1: $T_C = 400$K and $T_H = 500$K
   engine 2: $T_C = 500$K and $T_H = 600$K
   engine 3: $T_C = 400$K and $T_H = 600$K

背面有題，請繼續作答。

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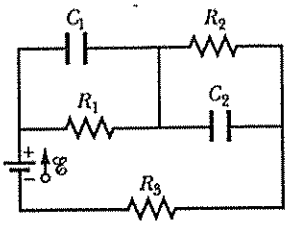
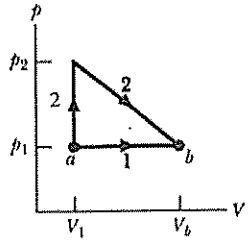
engine 4: $T_C = 600K$ and $T_H = 800K$

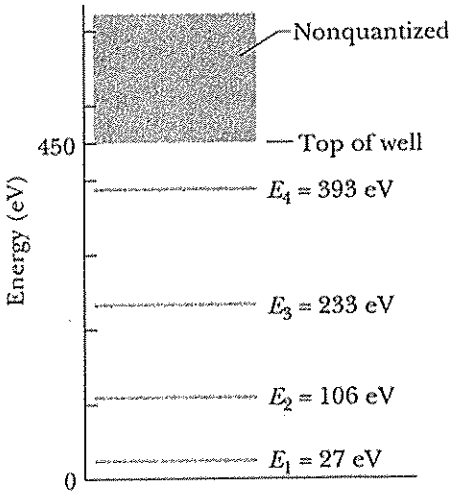
Please rank these engines according to their efficiencies, greatest to least.



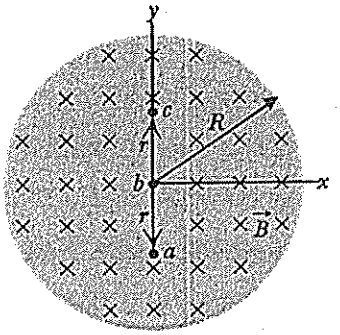
6. In right figure, R_1=5 Ω, R_2=10 Ω, R_3=15 Ω, C_1=5 μF, C_2=10 μF and the ideal battery has *emf*=20 V. Assuming that the circuit is in the steady state, then what is the total energy stored in the two capacitors?
7. Two conducting spheres are far apart. The smaller sphere carries a total charge Q. The larger sphere has a radius that is twice that of the smaller and is neutral. After the two spheres are connected by a conducting wire, what are the charges on the smaller and larger spheres?
8. Star S1 is moving away from us at a speed of 0.8*c* (*c* is the speed of light). Star S2 is moving away from us in the opposite direction at a speed of 0.5*c*. What is the speed of S1 as measured by an observer on S2?
9. The *P*-*V* diagram in right figure shows two paths along which a sample of gas can be taken from state a to state b, where $V_b = 3V_1$. Path 1 requires that energy equal to 5 p_1V_1 be transferred to the gas as heat. Path 2 requires that energy equal to 5.5 p_1V_1 be transferred to the gas as heat. What is the ratio of p_2 / p_1?



10. The figure shows the energy levels for an electron in a finite potential energy well. If an electron in the *n* = 2 state absorbs a photon of wavelength 2.0 nm, what is the kinetic energy of the electron while it escapes the well?



11. Right figure shows a uniform magnetic field *B* confined to a cylindrical volume of radius *R*. The magnitude of *B* is decreasing at a constant rate of 10 mT/s. In unit-vector notation, what is the initial acceleration of an electron released at point *a* (*r*=5 cm)?



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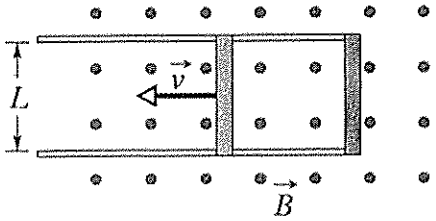
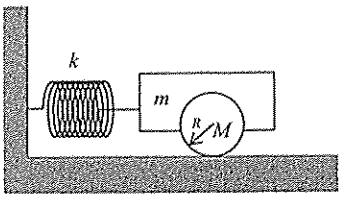
12. In the figure below, the conducting rod has length L= 0.1 m and is being pulled along horizontal frictionless conducting rails at a constant velocity with v = 5 m/s. The rails are connected at one end with a metal strip. The rod has resistance of 0.4 Ω and the rails and connector have negligible resistance. A uniform magnetic field B = 1.2 T out of the page fills the region in which the rod moves. What is the induced current (shown in its magnitude and direction)?



13. A wooden rod of uniform cross section and of length l is hinged at the bottom of a tank which is filled with water to a height $h = l/3$. If the density of wood is 0.45 g/cm^3, find the angle θ from the vertical at which the rod is in equilibrium.

14. A cart consists of a body of mass m and two wheels, each of mass M and radius R. The cart is attached to a spring of constant k. The other end of the spring is fixed to a wall as shown in right figure. Please write down an expression for the horizontal oscillatory motion of the cart.



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 vertical chain has length L and mass M. It is released with the bottom just touching a table.
   (A) The force on the table is induced by the weight of the chain and the momentum exchange when the chain touching the table.
   (B) The force on the table as a function of distance y fallen by the top end is Mgy/L.
   (C) The force on the table as a function of distance y fallen by the top end is $2Mgy/L$.
   (D) The force on the table as a function of distance y fallen by the top end is $3Mgy/L$.
   (E) The maximum force is $2Mg$.

2. Which of the following statements are true?
   (A) If a metal sphere is charged, the extra charge will be uniformly distributed over the volume of the sphere.
   (B) On the line between two positive charges, there is a point where the electric field is zero.
   (C) A positive charge will always be attracted to a metal surface, but a negative charge will be repelled.
   (D) Good insulators do not conduct electricity well because they are usually doped with small amounts of impurities.

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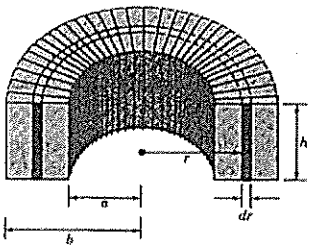
(E) On the line between two positive charges, the electric potential is never zero.

3. A toroidal coil is tightly wound with N turns and carries a current I. We assume that it has a rectangular cross section, as shown in right figure.



(A) The magnetic field strength within the toroid is $B = \frac{\mu_0 NI}{2\pi r}\left(\frac{a}{b}\right)$

(B) The magnetic field strength within the toroid is $B = \frac{\mu_0 NI}{2\pi r}$

(C) The total energy within the toroid is $U = \frac{\mu_0 N^2 I^2 h}{4\pi}\ln\left(\frac{b}{a}\right)$

(D) The self-inductance of the toroid is $L = \frac{\mu_0 N^2 h}{2\pi}\left(\frac{b}{a}\right)$

(E) The self-inductance of the toroid is $L = \frac{\mu_0 N^2 h}{2\pi}\ln\left(\frac{b}{a}\right)$