

國立交通大學 99 學年度碩士班考試入學試題

科目：普通物理(4012)

考試日期：99 年 3 月 14 日 第 2 節

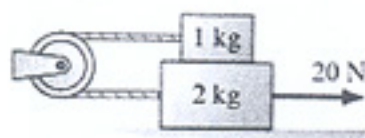
系所班別：電子物理學系 組別：電物系甲組

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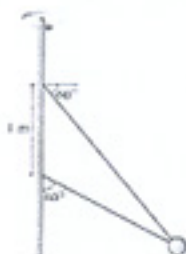
【不可使用計算機】*作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符!!

Part I: 單選題(40%, 每題 5 分, 不倒扣) 使用答案卡作答

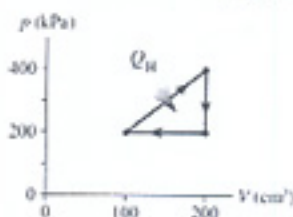
1. An ideal rope pulls on the lower block in the figure below with a tension force of 20 N. The coefficient of kinetic friction between the lower block and the surface is 0.16. The coefficient of kinetic friction between the lower block and the upper block is also 0.16. What is the acceleration of the 1.0 kg block?



- (A) 6.67 m/s^2 (B) 5.62 m/s^2 (C) 5.10 m/s^2 (D) 4.05 m/s^2
2. The figure below shows two wires tied to a 3.3 kg sphere which revolves in a horizontal circle at constant speed. At this particular speed the tension is the same in both wires. What is the speed?



- (A) 2.21m/s (B) 2.51m/s (C) 2.91m/s (D) 3.13m/s
3. Two piano strings are supposed to be vibrating at 132 Hz, but the piano tuner hears three beats every 2.0 second when they are played together. By what percent must be the tension be increased or decreased to bring them in tune.
- (A) $\pm 1.1\%$ (B) $\pm 2.2\%$ (C) $\pm 3.3\%$ (D) $\pm 4.4\%$
4. The figure below shows a cycle for a heat engine for which it contains 0.015 moles of N_2 gas. What is the thermal efficiency?



- (A) 5.5% (B) 6.67% (C) 10.0% (D) 14.3%

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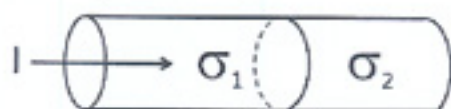
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5. An inductor, a resistor, and a capacitor are connected in series to a source of alternating voltage that produces an alternating current (AC). If the frequency of the generator is increased, which one of the following is correct:
- (A) The impedance will increase.
 (B) The inductive reactance will increase.
 (C) The current will decrease.
 (D) The current will increase.
6. A sphere with a magnetic dipole moment μ and a moment of inertia I about its center is placed in a uniform magnetic field B . The period, T , of small oscillations of the dipole in the field is given by
- (A) $T = \frac{1}{\mu B}$ (B) $T = \mu B$ (C) $T = 2\pi\sqrt{\frac{\mu B}{I}}$ (D) $T = 2\pi\sqrt{\frac{I}{\mu B}}$
7. Two long, straight, cylindrical conductors with resistivities σ_1 and σ_2 , respectively, are joined together as shown in the following diagram. If a uniform total current I flows through the conductors, what is the magnitude of the total free charge at the interface of the two conductors? The radius of each of the conductor is a . (MKS units)



- (A) 0 (B) $\frac{1}{\pi a^2}|\sigma_1 - \sigma_2|$ (C) $\epsilon_0 I |\sigma_1 - \sigma_2|$ (D) $\epsilon_0 I^2 |\sigma_1 - \sigma_2|$
8. An alternating current circuit has resistance R , inductance L and capacitance C in series with a voltage source. Which statement is correct?
- (A) The voltage across the inductor leads the voltage across the capacitor by 180° .
 (B) The voltage across the inductor leads the voltage across the resistor by 180° .
 (C) The voltage across the inductor leads the voltage across the capacitor by 90° .
 (D) The voltage across the capacitor leads the voltage across the inductor by 90° .

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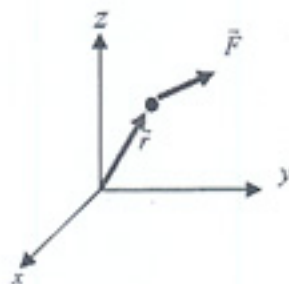
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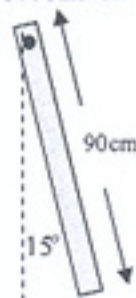
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Part II: 計算題(60%, 每題 15 分) 非選擇題請用答案卷作答

9. For a particle of mass m on which a force \vec{F} is applied, the torque is defined as $\vec{\tau} = \vec{r} \times \vec{F}$ and related to angular momentum $\vec{\ell}$ by $\vec{\tau} = d\vec{\ell}/dt$, where \vec{r} is the position vector of the particle relative to the origin O , as shown in the figure below. (a) Use the definition of torque and above relation to derive the formula of angular momentum in terms of position vector \vec{r} and momentum \vec{p} . (b) Draw the angular momentum on the answer sheet in accord with the figure below (make necessary assumption if needed).



10. A physical pendulum consists of a 90-cm-long, 450-g-mass, uniform rod hung from a nail near one end, as shown in the figure below. The rod is initially set at 15° from its equilibrium position and then is released to conduct damped oscillation. After 8.0 second, the amplitude of oscillation is reduced 5° . The damping force is $b d\theta/dt$ and the angular displacement can be written as $\theta(t) = Ae^{-\alpha t} \cos \omega' t$, (a) find α and proportional constant b of damping force, (b) derive the differential equation of the system from Newton's second law, (c) find the approximate period of the motion.



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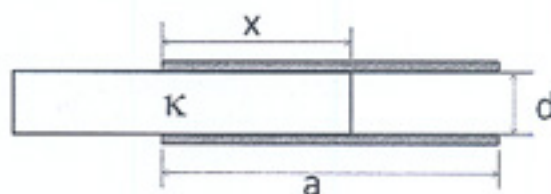
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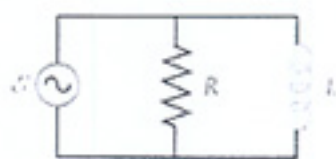
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11. The parallel plates of a given capacitor are square with area $A=a^2$ and separation distance d . If the plates are maintained at a constant potential V , and a square of dielectric slab of constant κ , area $A=a^2$, thickness d is inserted between the capacitor plates to a distance x as shown in the following figure. Let σ_0 be the free charge density at the conductor-air surface. (a) Calculate the free charge density σ_k at the conductor-dielectric surface. (5 points) (b) What is the capacitance? (5 points) (c) What is the magnitude of the force necessary to prevent the dielectric slab from sliding further in between the plates? (5 points)



12. (a) A resistor and an inductor are connected in parallel across an emf $E(t) = E_{\max} \cos(\omega t)$ as shown in the figure below. Use the method of phasors (impedance expressed as vector or complex number), calculate $I(t) = (\frac{E_{\max}}{Z}) \cos(\omega t - \delta)$. What are Z and δ ? (7 points)



- (b) A thin copper ring with area A rotates about an axis perpendicular to a uniform magnetic field \vec{B} . Its initial frequency of rotation is ω_0 . Calculate the time it takes the frequency to decrease to $1/e$ of the original value under the assumption that the energy goes into Joule heat. (Copper has conductivity σ and density ρ) (8 points)

