

【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!!

1. A bowling ball of mass  $M$  and radius  $R$  is thrown along a level surface so that initially ( $t=0$ ) it slides with a linear speed  $v$  but does not rotate. As it slides, it begins to spin, and eventually rolls without slipping. How long does it take to begin rolling without slipping?(Assume that the coefficient of kinetic friction is  $\mu$ ) (10%)
2. A rope of mass  $m$  and length  $L$  is suspended vertically with an object of mass  $M$  hanging at the bottom. Find the time interval for a transverse pulse to travel the length of the rope. (10%)
3. A block of mass  $M$  is connected to a spring of mass  $m$  and oscillates in simple harmonic motion on a horizontal frictionless surface. The force constant spring is  $k$  and the equilibrium length is  $l$ . Assume all portions of the spring oscillate in phase. Find the period of the oscillation. (10%)
4. A 1.00-mol sample of a monatomic ideal gas is taken through the cycle shown in Figure 1. At point  $A$ , the pressure, volume, and temperature are  $P_i$ ,  $V_i$ , and  $T_i$ , respectively. In terms of  $R$  and  $T_i$ , find (a) the total energy entering the system by heat per cycle, (b) the total energy leaving the system by heat per cycle, and (c) the efficiency of an engine operating in this cycle. (d) Explain how the efficiency compares with that of an engine operating in a Carnot cycle between the same temperature extremes. (20%)

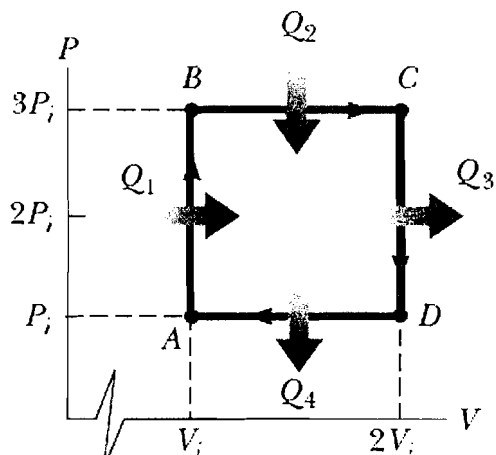


Fig.1

5. A spherical capacitor consists of a spherical conducting shell of radius  $R$  and charge  $-Q$  concentric with a smaller conducting sphere of radius  $r$  and charge  $Q$ . Find the capacitance of this device. (10%)

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6. A conducting rod of length  $L$  parallels to an infinitely long and straight wire carrying a current  $I$ . The rod moves with a constant velocity in a direction perpendicular to the wire. What is the magnitude of electric motive force generated between the ends of the rod? (10%)
7. In a double-slit experiment, as shown in Fig.2, the wavelength  $\lambda$  of the light source is 400 nm, the slit separation  $d$  is 19.5  $\mu\text{m}$ , and the slit width  $a$  is 3.15  $\mu\text{m}$ . (a) What is the intensity ( $I(\theta)$ ) of interference pattern observed at the far screen with angle of  $\theta$ ? (Hint: Express  $I(\theta)$  in terms of  $\lambda$ ,  $d$  and  $a$ .) (b) How many bright interference fringes are within the central peak of the diffraction envelop? (15%)

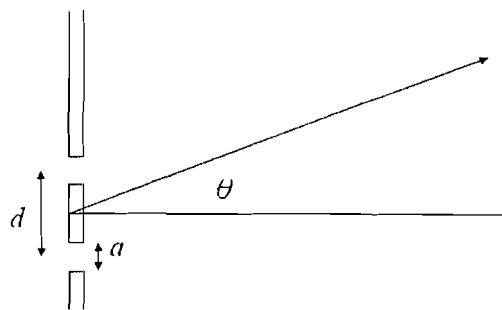


Fig.2: double-slit experiment.

8. A series  $RLC$  circuit has  $R = 200 \Omega$ ,  $L = 250 \text{ mH}$ , and  $C = 10.0 \mu\text{F}$ . The applied voltage has amplitude of 50.0 V. The capacitive reactance is  $100\Omega$ . Find the following amplitudes: (a) the current  $I_{\text{max}}$ , (b) the voltage  $\Delta V_C$  across the capacitor, and (c) the voltage  $\Delta V_L$  across the inductor. (15%)