1. 10% Two blocks with masses $m_1 = 2$ Kg and $m_2 = 3$ Kg hang on either side of a pulley as shown in Fig. 1. Block m_1 is on an incline ($\theta = 30°$) and is attached to a spring whose constant is 40 N/m. The system is released from rest with the spring at its natural length. Find: (a) the maximum extension of the spring; (5%) (b) the speed of m_2 when the extension is 0.5 m. (5%) Ignore friction and the pulley.

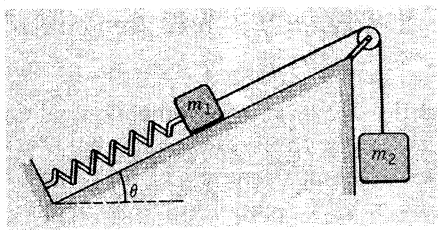

Fig. 1.

2. 10% A uniform rod of length L and mass m is pivoted freely at one end as shown in Fig. 2. (a) What is the angular acceleration of the rod when it is at angle θ to the vertical? (5%) (b) What is the tangential linear acceleration of the free end when the rod is horizontal? (5%) The moment of inertia of a rod about one end is $mL^2/3$.

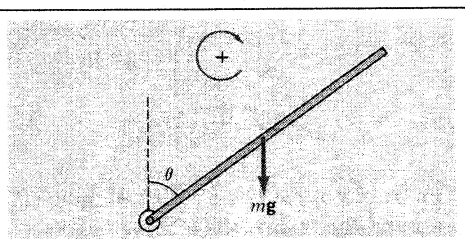

Fig. 2.

3. 15% (a) Rank He、H_2 and CO_2 according to their c_v (constant-volume specific heat) and c_p (isobaric specific heat) respectively. Assume they are all at the same pressure P and temperature T. (5%) (b) Prepare the three gases mentioned above to have equal n (mole number), T and V initially and let them undergo a quasi-static isothermal (等溫) expansion to a volume of $2V$. Please rank these gases according to the work they do on the surroundings and the heat they absorb from the surroundings. (10%)

4. 15% (a) Predict if there is any medium, except vacuum, in which light of different frequencies travels at the same speed. Explain your points. (5%). (b) In Young's double-slit experiment, $y_m = m\lambda L/d$ is used to calculate the position of the mth fringe (y_m) relative to the center of the interference pattern. In this formula, λ, L and d respectively denote the wavelength of the light, the separation between the slits and the distance between the observation screen and the slits. Explain why the slit width does not appear in the formula. (5%) (c) Can we mix blue and yellow lights to produce white light? Explain your points. (5%)

5. 10% Eight point charges each of magnitude q, are located on the corners of a cube of side s, as shown in Fig. 3. (a) Determine the x, y, and z components of the resultant force exerted on the charge located at point A by the other charges. (5 %) (b) What are the magnitude and direction of the resultant force? (5 %)

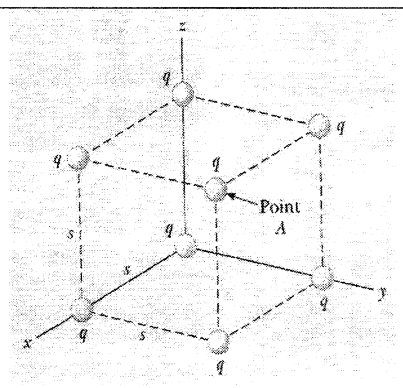

Fig. 3.

6. 15% (a) Find the equivalent capacitance between points a and b for the group of capacitances connected as shown in Fig. 4 if C_1=5.0 μF, C_2=10.0 μF, and C_3=2.0 μF. (8 %) (b) For the network described in the previous problem if the potential difference between points a and b is 60 V, what charge is stored on C_3? (7 %)

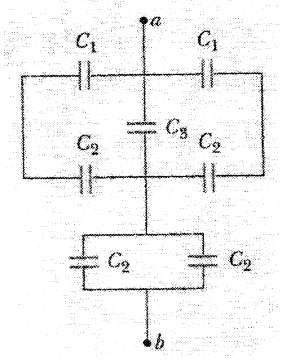

Fig. 4.

7. 10% As an alternative to the RC filters, LC filters are used as both high- and low-pass filters. However, all real inductors have resistance, as indicated in Fig. 5, and this resistance must take into acount. (a) Determine which circuit is the low-pass filter.(5 %) (b) Derive the output/input ratio in each circuit. (5 %)

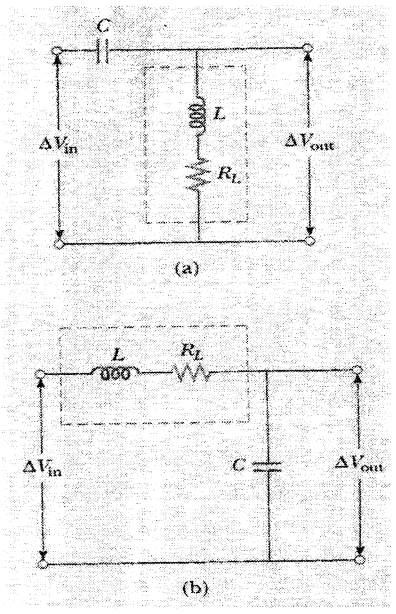

Fig. 5.

8. 15% A sphere of radius R surrounds a point charge Q, located at its center. (a) What is the value of the electric flux Φ_E, in terms of R, Q and θ, through a circular cap of half-angle θ (Fig. 6) ? (10 %) (b) What is the flux for $\theta = 60°$? (5 %)

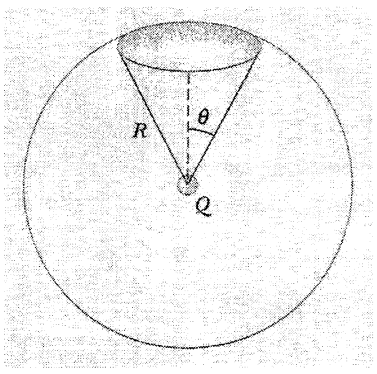

Fig. 6.