系所別：光電科學研究所　科目：普通物理

1. Consider a circuit as shown in Fig.A. Suppose the first emf has a value of $\mathcal{E}_1 = 6v$ and that 15% of the second is 2v. The internal resistance of the two emfs are 0.7Ω for $\mathcal{E}_1$ and 0.3Ω for $\mathcal{E}_2$ respectively. $R_1 = 10\Omega$ and $R_2 = 9\Omega$.
   a) What is the potential difference between point a and point b? Which point has a higher potential?
   b) Suppose we place an ordinary battery in the circuit in Fig. A of part a for the element $\mathcal{E}_2$. Can you use the method in part a to calculate V_{ab} now? Give reason.
   c))Suppose we now use a rechargeable battery such as the battery used in a car for element $\mathcal{E}_2$. Can you use the method in part a to calculate V_{ab} Now? Give reason.

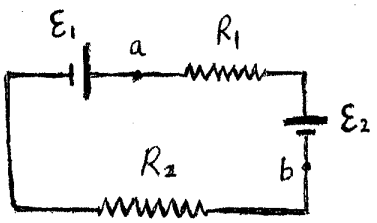

Fig. A

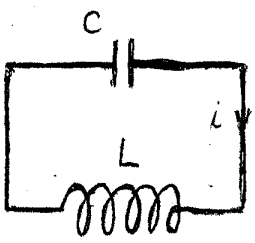

Fig. B

2. Consider the circuit depicted in Fig.B.
   a) Write (不必証明) the expression for the electric energy stored in the capacitor C 21% in terms of C and Q; where Q is the charge stored in the capacitor.
   b) Write (不必証明) the expression for the energy stored in the coil whose inductance is L, and the electric current in it is " i ". What kind of energy is it?
   c) Compare the above system with the mechanical system described in Fig.C in which the spring is weightless and the force constant of it is k. What are the physical quantities in the electric circuit corresponding to m (the mass of the block), k (the force constant), x (the displacement of the mass block from its equilibrium position) and v (the velocity of the mass block), respectively?
   d) In Fig. C the mass vibrates. Does there anything vibrate in the LC circuit? If yes, what is it? What is the vibrating frequency of m in Fig.C, if m = 3000 gm and k = 6 nt/cm. The spring is fixed at one end to a rod which is at rest.
   e) If the rod in Fig.C is vibrating now with a frequency = 300 cycle/sec. What will be the vibrating frequency of m? (You don't have to prove your answer, just tell me the answer)

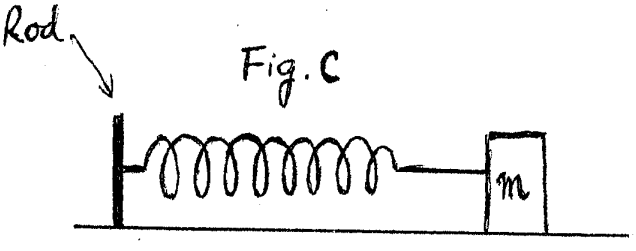

Fig. C

注意：背面有試題

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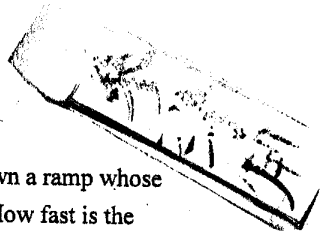
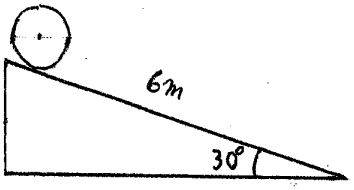


3. a) A disk whose radius is 15 cm and whose mass is 10 kg, rolls from rest down a ramp whose length is 6 m . The ramp is inclined at an angle of 30^{o} to the horizontal. How fast is the disk moving when it reaches the bottom of the ramp? Assume the disk is uniform in density.

14%

b) Now suppose the ramp and the disk are really 100% frictionless, what is the velocity when the disk reaches the bottom of the ramp?

Given that the moment of inertia of a disk is equal to $\frac{1}{2}mr^2$, where "m" is the mass of the disk, and "r" is the radius of the disk.



(4) (18 %) The highest achievable resolving power of a microscope is limited by the wavelength used. Assuming we have to construct a microscope with a resolution of 0.05nm. (a) If an electron microscope is used, what minimum energy of electron is needed ? (b) If a light microscope is used, what minimum energy of photon is needed ? (c) Which microscope seems more practical for this purpose ? Why ?

(5) (12 %) Light of wavelength 0.5um is incident normally on two slits separated by 0.5 cm in x-axis. A screen is located at a distance 10cm from the slits. (a) Sketch the interference pattern observed on the screen. (b) What is the period of the fringes ? (c) What does the interference pattern change when a phase plate with phase retardation of 180 degrees is attached on one of the slits ?

(6) (12 %) (a) Can a virtual image be projected onto a screen ? Why? (b) What is limitation of the light for the imaging equation (1/p+1/q=1/f) ? (c) Why does chromatic aberration occur in simple lenses but not in mirrors ?

(7) (8 %) A concave mirror and a converging lens have the same focal length in air. Do they have the same focal length when immersed in water ? If not, which has the greater focal length ?