所別：光電科學研究所碩士班 一般生 科目：普通物理
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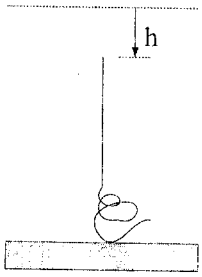
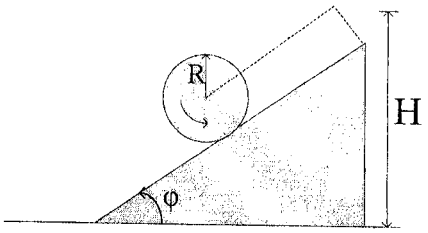
1. A rope of mass per unit length ξ was suspended above a table as shown in the figure. The rope is then released from rest at the top. Show that the force acting on the table when a length h of the rope has dropped to the table is equal to the weight of a length 3h of the rope. (14%)



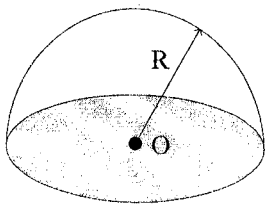
2. Consider a sphere, a disk, and a ring (all with mass M and radius R) rolling without slipping on an inclined plane as shown in the figure. Find the velocity for each of the abovementioned object as they rolled down to the flat ground. Discuss briefly of your results. (12%)



3. A particle of mass m_1 and velocity v_1 strikes head-on a particle of mass m_2 at rest. Show that the ratio of the relative initial velocities to the relative final velocities

$\varepsilon \equiv \frac{|v_2 - v_1|}{|u_2 - u_1|}$ =1 for a perfectly elastic collision; and ε =0 for a totally inelastic collision. (v_2 and v_1 are initial velocities for m_1 and m_2; and u_1 and u_2 are the final velocities for m_1 and m_2, respectively.) (12%)

4. A non-conducting hemisphere with radius R, and the total charge Q was uniformly distributed on the shell. Find the electric field at the center O of the hemisphere as shown in the figure. (12%)



注意：背面有試題

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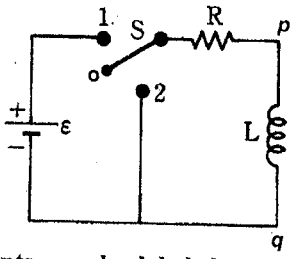
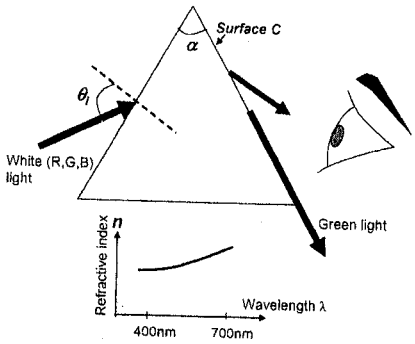
5. Consider an electric circuit as shown. The switch S is initially at the position "o", at time t=0, S is switched to the position "1".



(a) (7%) Derive and plot the current I of the circuit as a function of time for at least 3 time constants and find its steady-state value.

(b) (7%) At a steady-state time $t=t_2$, S is suddenly switched to the position "2". Continue your previous plot at (a) for $t \geq t_2$ for again several time constants. Verify whose potential is higher for the points p and q labeled on the circuit.

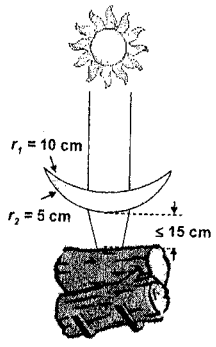
6. A white light, composing of three monochromatic waves in the Red, Green, and Blue regions, respectively, is incident on a prism whose vertex angle is α as shown. One finds at an incident angle of θ_i the Green light is out-emitted along the surface C of the prism as shown.



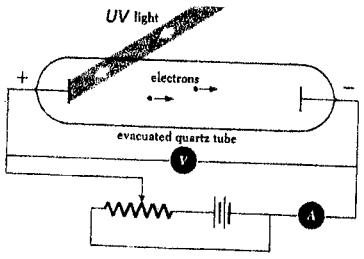
(a) (8%) Derive an expression for the refractive index n_G of the Green light in the prism in terms of θ_i and α.

(b) (5%) According to the dispersion curve of the prism in the visible region as given around, please judge which color of light can emerge from the surface C and be seen by you (indicated by an eye)?

7. (10%) If you got lost in a planet where there got only sun, air (n=1), water (n=4/3), and woods. Suddenly you found a meniscus glass lens (n=1.5) that was suspended over a piece of wood as shown. For some reason, the farthest distance you can separate them was 15 cm. The two radii of curvatures of the lens were 10 cm and 5 cm, respectively. You want to make a fire with them, but obviously the lens failed to focus the sun on the wood surface according to the Lensmaker's formula, $\frac{1}{f} = (n-1)(\frac{1}{r_1} - \frac{1}{r_2})$, where f is the focal length of a lens having a refractive index n and radii of curvatures r_1 and r_2. Could you find a smart way to make a fire with them?



8. A 60W wavelength tunable UV lamp source is illuminated on the metal anode of an apparatus as shown. The measured extinction voltage (遏止電位) V_0 versus the frequency ν of the UV light is also shown nearby.



(a) (5%) What we call for the phenomenon observed with this experiment? How will the experimental plot be modified if one increases the lamp power to 100W?

(b) (8%) Find the intersection value S on the voltage axis and the slope α of the fitted experimental curve in terms of the Planck's constant h, the electronic charge e, and the work function of the anode ϕ_0.