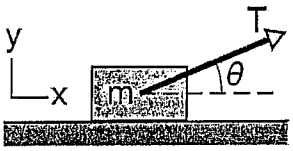
國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：普通物理【物理系碩士班】　　題號：423001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

Useful physical constant: permittivity constant (ε_0: 8.85×10^{-12} $C^2/N{\cdot}m^2$); electron charge (e: 1.6×10^{-19} C)

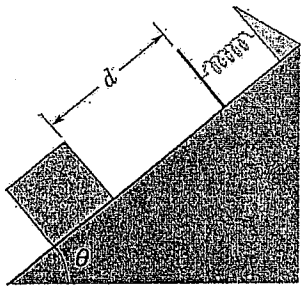
1 [20%]. An initially stationary box of sand is pulled across a floor by a cable with the tension less than 1200 N. The coefficient of static friction between the box and the floor is 0.75.



(a) (10%) What should be the angle between the cable and the horizontal in order to pull the greatest possible amount of sand?

(b) (10%) What is the weight of the sand and box in that situation?

2 [15%]. A spring (k = 200 N/m) is fixed at the top of a frictionless plane inclined at angle 30°. A 1.0 kg block is projected up the plane, from an initial position (d = 0.60 m) with an initial kinetic energy of 16 J, as shown in the figure on the right.

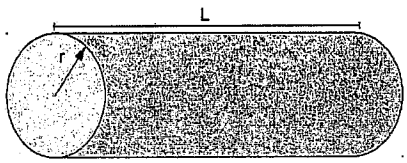


(a) (5%) What is the kinetic energy of the block while it just touches the end of the spring?

(b) (5%) What is the kinetic energy of the block while the spring is compressed 0.20 m?

(c) (5%) With what kinetic energy must the block be projected up the plane if it is to stop momentarily when it has compressed the spring by 0.40 m?

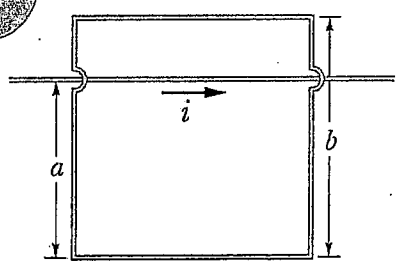
3 [20%]. A long, nonconducting, solid cylinder of radius 5.0 cm has a nonuniform volume charge density $\rho = Ar^2$, where r is the radial distance from the cylinder axis. For A = 2.5 $\mu C/m^5$, what is the magnitude of the electric field at



(a) (10%) r = 4.0 cm?

(b) (10%) r = 6.0 cm?

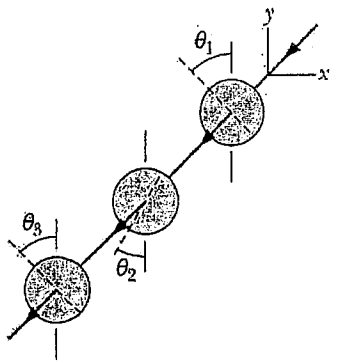
4 [15%]. For the wire arrangement as in the figure on the right, a = 12.0 cm and b = 16.0 cm. The current in the long straight wire changes with time as $i = 4.50\,t^2 - 10.0\,t$, where i is in amperes and t is in seconds.



(a) (10%) Find the emf in the square loop at t = 3.00 s.

(b) (5%) What is the direction of the induced current in the loop?

5 [15%]. An unpolarized light is sent into a system of three polarizing sheets whose polarizing directions make angles of $\theta_1 = \theta_2 = \theta_3 = 60°$ with the direction of the y axis, as indicated in the right figure. Please evaluate what percentage of the initial intensity is transmitted by the system?



國立中山大學104學年度碩士暨碩士專班招生考試試題

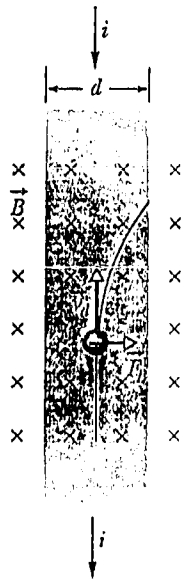
科目名稱：普通物理【物理系碩士班】　　題號：423001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

6 [15%]. A strip of copper 150 μm thick and 4.5 mm wide is placed in a uniform magnetic field B of magnitude 0.64 T, with B perpendicular to the strip (shown in the figure). A current i = 15 A is sent through the strip such that a Hall potential difference V appears across the width of the strip to balance the electric and magnetic contribution in Lorentz force. (The number of charge carriers per unit volume for copper is 8.47×10^{28} electrons/m^3.)

(a) (8%) What is the drift speed in the metal?

(b) (7%) What is the potential difference V across the strip?



國立中山大學 104 學年度碩士暨碩士專班招生考試試題

科目名稱：近代物理【物理系碩士班】　　題號：423002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答計算題）共 1 頁第 1 頁

1. (20%) Explain the following terms
   (a) (5%) Normal Zeeman effect
   (b) (5%) Spin-orbital interaction
   (c) (5%) Franck-Hertz experiment
   (d) (5%) How to obtain the Planck constant experimentally?

2. (20%) Eight identical and non-interacting particles are placed in a cubical box of sides L=0.4 nm. Find the lowest energy of the system (in eV) and list the quantum numbers of all occupied states if (a) (10%) the particles are electrons and (b) (10%) the particles have the same mass as the electron but do not obey the exclusion principle.

3. (20%) (a) (5%) The wavelength of Compton-scattered photons is measured at $\theta = 90^{\circ}$, if $\Delta\lambda/\lambda \sim 1\%$, what is the wavelength of the incident photon? (b) (15%) Can a photon transfer all of its energy to a free electron? *Must be answered mathematically. No point for just "yes" or "no".*

4. (20%) For an electron in a one-dimensional infinite square well of width L, find (a) (5%) $< x >$, (b) (5%) $< x^2 >$, and (c) (5%) Δx. (d) (5%) What is the probability of finding the electron between x = 0. 2 L and x = 0.4 L if the electron is in n=5 state.

5. (20%) The electron is bound to the proton in a hydrogen atom due to the Coulomb force. Now assume that electric charge did not exist and the electron was bound to the proton by the gravitational force to form a hydrogen atom, please derive the corresponding expressions for (a) (8%) the Bohr radius a_o and (b) (7%) energy E_n. (c) (5%) Compute the smallest frequency of the Balmer series. ($G \sim 6.67 \times 10^{-11}\, N\, m^2/Kg^2$)