

1.(8%) A spool of thread rests on a level tabletop, as shown in Fig. 1. The thread is pulled gently so that there is no slippage at P , which is the point of contact between the spool and the tabletop. For each of the thread positions a through d , determine which way the spool will roll. Explain the reasons for your answers. Please note that at position b the line determined by the thread passes through P .

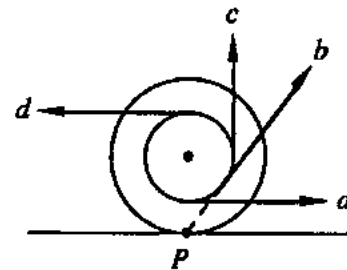


Fig. 1

2.(12%) A block of mass m is placed on a wedge of Mass M (see Fig. 2). If all the surfaces are frictionless.

- Find the horizontal and vertical components of the acceleration of the block and of the wedge with respect to ground.
- Find the normal force between the block and the wedge in terms of m , M , θ , and g .

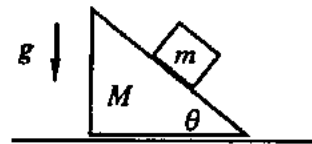


Fig. 2

3.(10%) If the electron gas inside an intrinsic semiconductor and the chemical species in a solution act like ideal gases, which obey the Maxwell-Boltzmann distribution of speeds. Try to explain, qualitatively,

- how to account for the temperature-dependence of an intrinsic semiconductor?
- why by changing the temperature of the solution, we can vary the reaction rate of a chemical reaction?

4.(15%) A Carnot engine that uses one mole of an ideal gas ($\gamma = 5/3$) operates between 500 K and 300 K. The highest and lowest pressures are 500 kPa and 100 kPa. (Note: $1 \text{ Pa} = 1 \text{ N/m}^2$) Find

- the pressure and volume at each "turning" point of the Carnot cycle;
- the net work done per cycle; and
- the efficiency of the engine.

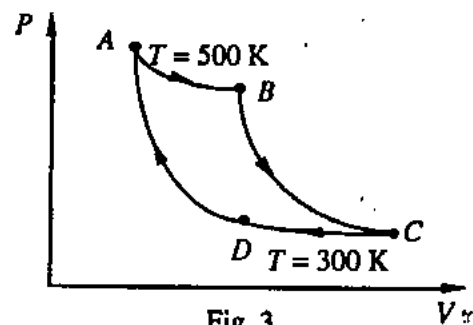


Fig. 3

5.(10%)

- (a) Write down the integral and differential forms the Maxwell's equations.
- (b) What is the physical meaning of each Maxwell's equation?

6.(16%) A metal shell of radius R_1 has a charge Q_1 . It is enclosed by a conducting spherical shell of radius R_2 that has a charge $-Q_2$. Determine:

- (a) the potential of the outer shell, V_2 .
- (b) the potential of the inner shell, V_1 .
- (c) the electric field inside the inner shell.
- (d) under what condition is $V_1 = V_2$?

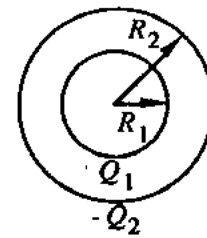


Fig. 4

7.(14%) A long straight wire of circular cross section is made of non-magnetic material (i.e., $K_m = 1$). If the radius of the wire is a and carries a current i which uniformly distributed over its cross section.

- (a) Show that, or explain why, the magnetic field, B , is purely azimuthal?
- (b) Compute the energy per unit length stored in the magnetic field within the wire.

8.(15%) A metal disk (radius = b , thickness = w) is placed in a solenoid with its axis coincident with the axis of the solenoid. The solenoid produces a magnetic field $B = B_0 \sin \omega t$, as shown in Fig. 5.

- (a) Find the induced emf in a ring with radius r and width dr , where $r < b$.
- (b) Find the lengthwise resistance of the ring if the resistivity of the material is ρ .
- (c) What is the value of the eddy current flows around the ring?
- (d) What is the total power loss due to the eddy current in the disk?

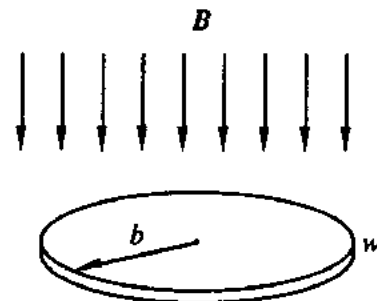


Fig. 5

八十二年度 材料研究所入學考試 普通物理 試題 更正部分：

3.(10%)

(a) ... ~~for the temperature dependence of an intrinsic ...~~

更正為：

(a) ... for the temperature-dependent electric conductivity of an intrinsic ...