Master Entrance Examination in General Physics.

(I) Fill the following blanks. Only the number and your correspondent answer should be written in your answer sheet. In some questions, you should choose one most probable answer in parentheses. (45%; 3% for each blank)

1] The dimensions of a board are measured to be 20.0 ± 0.2 cm by 10.0 ± 0.1 cm. Its area is ___(1)___.

2] The central spot of Newton's rings is ___(2)___ [bright, dark, red, or yellow]

3] In an elastic two dimensional collision of two identical particles, the two particles move apart at ___(3)___ [30, 45, 60, or 90] degrees after collision, if the moving particle collides with the initially rest particle in the same plane.

4] In the forced oscillation, the amplitude attains to ___(4)___ [maximum, minimum, or constant] at resonance state.

5] A Carnot cycle consists of two isothermal and two ___(5)___ operations.

6] In a quasistatic, adiabatic process of ideal gas, the equation that relates pressure p, volume V and ratio of specific heats γ is ___(6)___.

7] If c is the velocity of light, which of the following statements is true? (a) Any velocity can not be greater than c. (b) Velocity can exceed c. (c) Only the particle that carries energy can not have velocity greater than c. The correct answer is ___(7)___ [(a), (b), or (c)]

8] A block of mass m is placed on an inclined plane of a triangular wedge of mass M that is on a horizontal table. All surfaces are frictionless. A system that is fixed on the wedge is ___(8)___ [(a) an inertial reference frame, (b) a noninertial reference frame, or (c) moving with constant velocity]

9] In an RLC series AC circuit, the phase of the potential difference across the inductor L is ___(9)___ [(a) 90° leads the current i, (b) 90° lags i, or (c) in phase with i]

10] In a transformer, equal (10) [voltage, current, resistance or power]
will be transferred between the primary and secondary coils.

11] One important consequence of special relativity is time (11) for a
moving system.

12] According to the Heisenberg uncertainty principle, it is not possible to
measure both the position of a particle and its (12) simultaneously to
arbitrary precision.

13] Albert Einstein won the Nobel prize because of his main contribution
on (13) [(a) special relativity, (b) general relativity, or (c) photoelectric
effect]

14] From the physical point of view, the meaning of "man is mortal" is a
consequence of (14) [(a) conservation of energy and mass, (b)
conservation of charge, (c) increasing entropy, or (d) conservation of mass
] in the universe.

15] The main principle of stimulated emision for laser is (15).

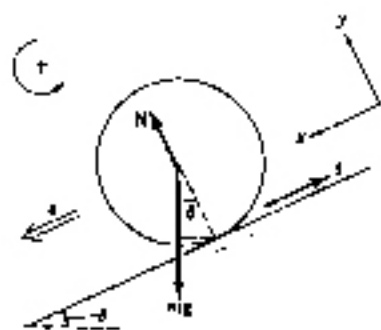(II) Calculate and answer the following problems. (55%).
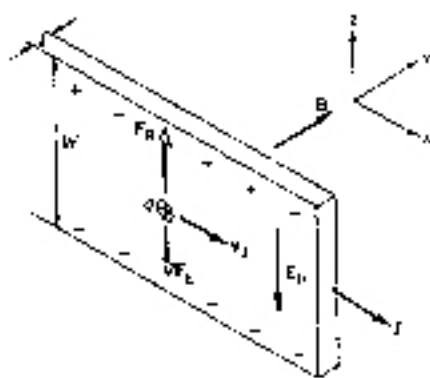

Fig. 1.   Fig. 2.

[1] Fig. 1 shows a sphere of mass M and radius R rolls without slipping down an incline with inclination θ. Find: (a) the moment of inertia of the sphere about a central axis, (b) the linear acceleration of the center of mass of the sphere, (c) the speed of the sphere after it falls a vertical distance H, starting from rest. (d) What is the minimum coefficient of friction required for the sphere to roll without slipping? (4,4,4,4)%

[2] Fig. 2 shows a flat metal strip, of width w and thichness t, in which a current I is flowing. A uniform magnetic field B is applied perpendicular to the strip, a potential difference appears across the width of the strip. (a) Find the Hall potential difference V_H expressed in terms of current I, magnetic field B, strip thickness t, carrier charge density n and charge q. (b) Express the carrier charge density n in terms of current density J_x, magnetic field B_y, charge q and electric field E_z (=E_H in Fig. 2). (4,3)%

[3] Write down the four Maxwell's equations in electromagnetism. (8%)

[4] A dipole with an electric dipole moment p is freely pivoted at its center and has a moment of inertia I about this axis. For small angular displacement θ, the dipole will execute simple harmonic motion in a uniform electric field E. (a) Find the equation of motion for the dipole, (the differential equation for θ). (b) What is the period of oscillation? (c) If the initial conditions for the angular displacement and angular velocity are $\theta(0)=\theta_0$, $\dot{\theta}(0)=0$ respectively, find the solution for $\theta(t)$, angular displacement as a function of time. (3,3,5)%.

[5] The y directed electric field of a plane wave is propagating along X direction and given by

$$E_y = 50 \sin [\pi (0.8 X - 2.4 \times 10^8 t)] \qquad V/m$$

at time t, where x is the notation of multiplication. All quantities are in SI units. Find: (a) the wavelength and the frequency; (b) the average energy density; (c) the amplitude and direction of the magnetic field; and (d) the average Poynting vector, of the wave. (Given constants: $c=3 \times 10^9$ m/s, $\epsilon_0=8.85 \times 10^{-12}$ C^2 / $N.m^2$). (4,3,3,3)%