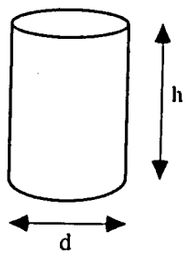
**** Show all steps if there are calculations. ****
**** If equations are used in the answers, clearly define all parameters in them. ****

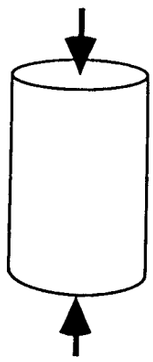
1. Density can be determined by the Archimedes' method. **(10%)**
   (a) State Archimedes' principle.
   (b) A crystal weighs 5 grams when weighed in air, and when submerged and weighed in alcohol (density 0.8 g/cm^3), the crystal weighs 2 grams. What is the density of the crystal?

2. The height of a right circular cylinder is measured as h = 5.0 ± 0.2 cm, and d = 2.0 ± 0.1 cm. What is the volume of the cylinder and how accurately is it known?
   (10%)



3. (a) What are Issac Newton's three laws of motion?
   (b) Explain these three laws using examples from your everyday life.
   (15%)

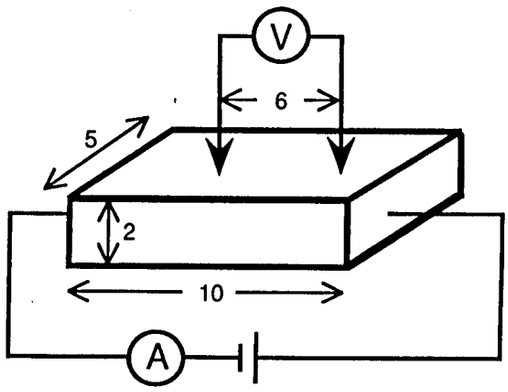
4. An Al_2O_3 ceramic body of cylindrical shape is 4.0000 cm in diameter and 8.0000 cm long. When a load of 12000 kg (compression) is applied along the cylindrical axis, the diameter becomes 4.0005 cm and the length 7.9950 cm. Calculate
   (a) compressive stress (in Pascal),
   (b) compressive strain,
   (c) elastic modulus (Young's modulus; in Pascal), and
   (d) Poisson's ratio
   of this cylindrical Al_2O_3 ceramic body from the information given.
   (15%)



5. Describe (a) Coulomb's law, (b) Gauss' law, (c) Kirchhoff's rules, and (d) Maxwell's equations. **(15%)**

6. Compare and contrast electrical conductivity in insulators, semiconductors, and metals as to (a) their band structures, (b) the types of charge carriers including their concentrations and mobilities, (c) the temperature dependence. **(15%)**

7. Electrical resistivity is determined by measuring voltage and current as shown in the diagram. Sample dimensions are given in cm. If the current reading in the ammeter A is 8 amperes and voltage reading from the voltmeter V is 3 volts, what is the electrical resistance and the electrical resistivity of the sample? **(10%)**



8. Light is traveling in a medium of refractive index $n = 2$ and is incident on flat surface with a medium of refractive index $n = 1$. What can happen to the light beam at the interface? Explain using laws of optics. **(10%)**