1. (15%) "Physics is the study of matter and energy, and their relationships."
   a. Define 'matter' and 'energy.'
   b. Explain the relationship of matter and energy with an example.
   c. There are several kinds of energy. Give one example for each of the following kind of energy and explain briefly (you can find examples from your daily life).
      1) heat energy, 2) mechanical energy, 3) chemical energy, 4) electrical energy.

2. (10%) The dimension of a rectangular bar is measured to have a length of (12.3 ± 0.2) cm, a width of (4.50 ± 0.10) cm, and a height of (6.75 ± 0.05) cm.
   a. Calculate the sum of the length, the width, and the height of the bar (length+width+height), and the uncertainty in the calculated sum.
   b. Also, calculate the volume of the bar and the uncertainty in the calculated volume.

3. (20%) State the following laws and explain each with one example from a basketball game.
   a. Newton's first law of motion
   b. Newton's second law of motion
   c. Newton's third law of motion
   d. Newton's universal law of gravity
   e. the law of conservation of energy

4. (14%)
   a. A load of 102 kg is supported by a wire of length 2 m and cross-sectional area 0.1 cm^2. The wire is stretched by 0.22 cm. Find the tensile stress (in Pa), tensile strain, and Young's modulus (in Pa) for the wire.
   b. The two ends of a steel rod are fixed. What is the thermal stress developed in the rod when the temperature is changed by 80 K?
      Young's modulus of the steel rod is 200 GPa, and the coefficient of linear thermal expansion of the rod is $11.7 \times 10^{-6}\ K^{-1}$.

5. (12%) Compare and contrast electrical conductivity in insulators, semiconductors, and metals as to (a) their energy band structures, (b) the types of charge carriers including their concentrations and mobility, (c) the temperature dependence.

6. (20%) Define and/or briefly describe the followings.
   a. specific heat
   b. fracture toughness (critical stress intensity factor)
   c. dielectric constant
   d. piezoelectricity
   e. ferroelectricity
   f. diamagnetism
   g. ferrimagnetism
   h. birefringence
   i. fluorescence
   j. diffraction

7. (9%)
   a. What is the energy carried by a quantum of light whose wavelength λ = 300 nm?
   b. A sodium (Na) surface is illuminated with this light (λ = 300 nm). Find the kinetic energy of the ejected photoelectrons. [The work function (minimum binding energy of an electron) for sodium metal is 2.46 eV]
   c. Find the cutoff wavelength for sodium. (cutoff wavelength: the maximum wavelength of an incident light to produced photoelectrons)
      (Planck's constant = 6.626×10^{-34} J·s, 1 eV = 1.6×10^{-19} J)