※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

1. (30 pts) One end of a massless spring is placed on a flat surface; the other end points upward. Answer the following questions.

   (a) (15 pts) A mass of 1.0 kg is gently set down on top of the spring, until the spring is compressed by 17 cm to a new equilibrium position. What is the spring constant?

   (b) (15 pts) Now, the 1.0 kg mass is removed and a 2.0-kg mass is set on top of the spring. The spring is then compressed by hand so that the end of the spring is 42 cm lower than the position of the spring with no mass on top. The spring is then suddenly released. What is the maximal kinetic energy of the 2.0-kg mass.

2. (30 pts)A person standing at the harbor entrance sees sinusoidal water waves moving into the harbor. He counts 50 wave crests in 1.0 minutes and he estimate the distance between the crests to be 3.0 m.

   (a) (5 pts) Write an expression for the form of the wave height in terms of x and t, where t represents time and x is the distance measured from the person is standing along the wave traveling direction.
   (b) (5 pts) What is the wave length?
   (c) (5 pts) What is the wave number?
   (d) (5 pts) What is the frequency?
   (e) (5 pts) What is the angular frequency?
   (f) (5 pts) What is the speed of these waves?

3. (20 pts) Let A, B, C, and D mark the four corners of a rectangular plot of grass, where distance(A, B) = distance(C, D) = 10m, and distance(B, C) = distance(A, D) = 5m. Let E be the midpoint of line segment $\overline{AB}$. Let F be the midpoint of line segment $\overline{CD}$. While tall grass covers the area bounded by points A, E, F, and D, short grass covers the area bounded by points E, B, D, and F. A girl runs from point C to point A. Assume that she runs at 1.1 m/s in the tall grass area and 2.2 m/s in the short grass area. Let T^* be the shortest time for her to reach point A.

   (a) Give the path that she will reach point A in the shortest time. (10 pts)
   (b) Give T^*. (10 pts)

4. (20 pts) Draw a typical hysteresis loop common for ferromagnetic materials. Explain hysteresis phenomenon.