Theoretical competition – Problem No.1

Measure the mass in the weightless state

In the spacecraft orbiting the Earth, there is weightless state, so that one cannot use ordinary instruments to measure the weight and then to deduce the mass of the astronaut. Skylab 2 and some other spacecrafts are supplied with a Body Mass Measurement Device which consists of a chair attached to one end of a spring. The other end of the spring is attached to a fixed point of the spacecraft. The axis of the spring passes through the center of mass of the craft. The force constant (the hardness) of the spring is $k = 605.6$ N/m.

1. When the craft is fixed on the pad, the chair (without person) oscillates with the period $T_0 = 1.28195$ s.

Calculate the mass m_0 of the chair ***[2 pts]***.

2. When the craft orbits the Earth the astronaut straps himself into the chair and measures the period T' of the chair oscillations. He obtains $T' = 2.33044$ s, then calculates roughly his mass. He feels some doubt and tries to find the true value of his mass. He measures again the period of oscillation of the chair (without person), and find $T_0' = 1.27395$ s.

What is the true value of the astronaut's mass and the craft's mass? ***[4pts]***

Note: The mass of the spring is negligible and the astronaut is floating.