3. Answer <u>either</u> (a) <u>or</u> (b):

(a) Explain what is meant by and give an example of: i) a conservative force and ii) a non-conservative force. A particle moves under the influence of a conservative force. Show that the total mechanical energy is a constant of the motion. **[10]**

A smooth rod of length 1 m is fixed in the vertical position with one end attached to a horizontal table. A light spring of natural length 1 m has one end attached to a frictionless pivot fixed on the table at a distance of 1 m from the base of the rod with the other end attached to a bead of mass 0.1 kg threaded onto the rod. The bead is lifted to the top of the rod where it is released from rest. The velocity of the bead when it has reached the bottom of the rod is 6 ms^{-1}. Calculate:

i) the value of the spring constant and

ii) the speed of the bead at the mid-point of the rod. **[15]**

(b) Prove that the weight of water displaced by a plank of wood with rectangular cross-section floating horizontally in water is equal to the weight of the plank. **[10]**

An oil-rig consists of three large cylinders, each of mass 250 tonnes, height 30 m, outer diameter 6 m and inner diameter 5.96 m. Two thirds of the mass of each of the cylinders is concentrated at one end so they float with the cylinder's axis vertical. The three floating cylinders are fixed at the corners of an equilateral triangle. To the top of the cylinders is attached a superstructure of mass 300 tonnes and height 5 m. The cylinders are flooded so that the oil-rig floats with the top of the superstructure at the required height of 15 m above the surface of the water. What is the height of the water columns in the cylinders? If the rig escapes from its moorings and oscillates vertically without rotation, what is the frequency of the resulting oscillations? The density of water is 1000 kg/m^3. **[15]**