3 A small wooden block (cuboid) of mass m floats in water, as shown in Fig. 3.1.

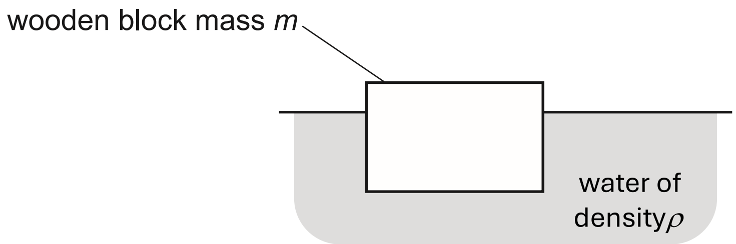

Fig. 3.1

The top face of the block is horizontal and has area A. The density of the water is ρ.

(a) State the names of the two forces acting on the block when it is stationary.

....

[1]

(b) The block is now displaced downwards as shown in Fig. 3.2 so that the surface of the water is higher up the block.

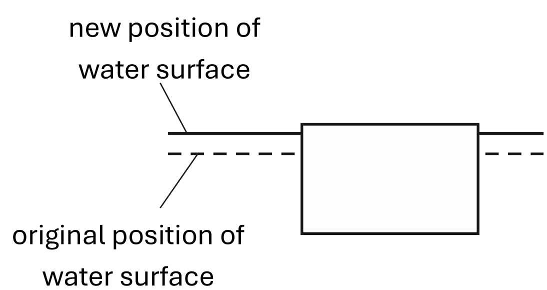

Fig. 3.2

State and explain the direction of the resultant force acting on the wooden block in this position.

....

....

[1]

(c) The block in **(b)** is now released so that it oscillates vertically.

The resultant force F acting on the block is given by

$$F = -Ag\rho x$$

where g is the gravitational field strength and x is the vertical displacement of the block from the equilibrium position.

(i) Explain why the oscillations of the block are simple harmonic.

....

....

....

.... [2]

(ii) Show that the angular frequency ω of the oscillations is given by

$$\omega = \sqrt{\frac{A\rho g}{m}}$$

[2]

(d) The block is now placed in a liquid with a greater viscosity. The block is displaced and released so that it oscillates vertically. The variation with displacement x of the acceleration a of the block is measured for the first half oscillation, as shown in Fig. 3.3.

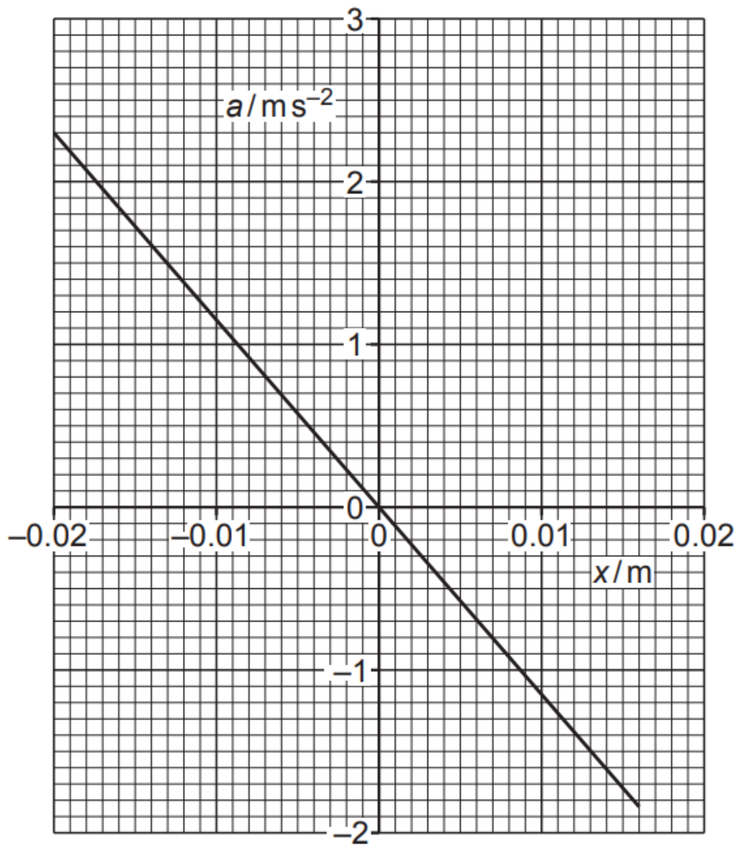

Fig. 3.3

(i) Explain why the maximum negative displacement of the block is not equal to its maximum positive displacement.

....

....

.... [1]

(ii) Use Fig. 3.3 to determine the frequency of the block.

frequency = ... Hz [2]

(iii) The mass of the block is 0.57 kg.

Use Fig. 3.3 to determine the decrease ΔE in energy of the oscillation for the first half oscillation.

ΔE = ... J [3]

[Total: 12]