4 **(a)** A block of wood of mass *m* floats in still water as shown in Fig. 4.1.

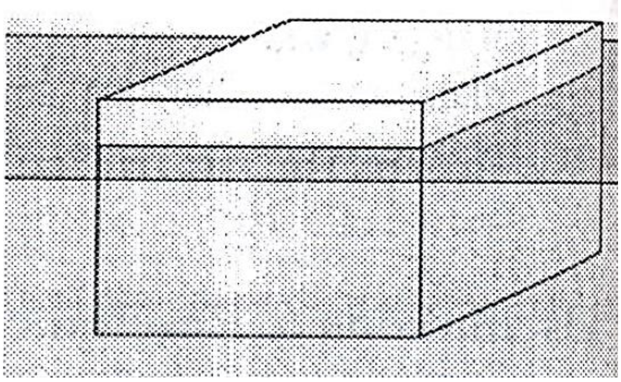

Fig. 4.1

When the block is pushed down into the water, without totally submerging it, and is then released, it bobs up and down in the water with a frequency *f* given by the expression

$$f = \frac{1}{2\pi}\sqrt{\frac{28}{m}}$$

where *f* is measured in Hz and *m* in kg.

Surface water waves of speed 0.90 m s^{-1} and wavelength 0.30 m are then incident on the block. These cause resonance in the up-and-down motion of the block.

(i) Calculate the frequency of the water waves.

frequency = ………………….. Hz [1]

(ii) Calculate the mass of the block.

mass = ………………….. kg [1]

(iii) Describe and explain what happens to the amplitude of the vertical oscillations of the block after the following changes are made independently:

1. water waves of larger amplitude are incident on the block,

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………… [2]

2. the distance between the wave crests increases,

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………… [2]

3. the block now bobs in a more viscous liquid.

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

…………………………………………………………………………… [2]

(b) **(i)** Explain what is meant by *polarised* light.

……………………………………………………………………………………………

…………………………………………………………………………………… [1]

(ii) Explain why two coherent sources of light that are polarised in planes perpendicular to each other will not produce observable interference fringes.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

………………………………………………………………………………………… [2]

(iii) A narrow, parallel beam of unpolarised light of intensity I and amplitude A is directed towards three ideal polarising filters.

The beam meets the first filter with its plane of polarisation vertical. The plane of polarisation of the second filter is at an angle of 45° to the first filter. The third filter has its plane of polarisation at 90° to the first filter, as shown in Fig. 4.2.

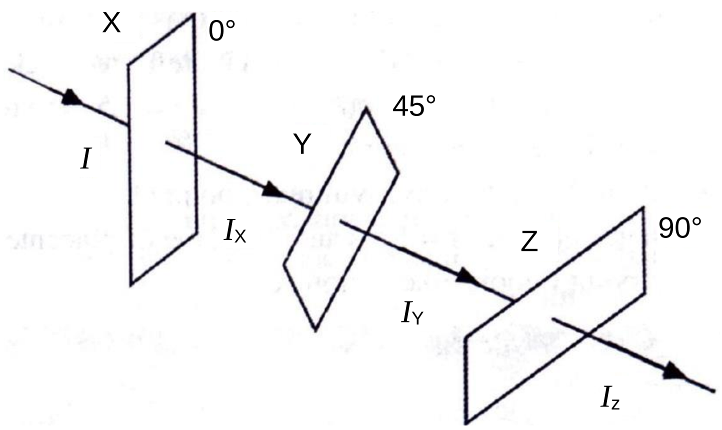

Fig. 4.2

Determine the intensity of the beam, in terms of I, after passing through the third filter.

[3]