

- 5 A solid cylinder is lifted out of oil by a wire attached to a motor. Fig. 5.1 shows two different positions X and Y of the cylinder during the lifting process.

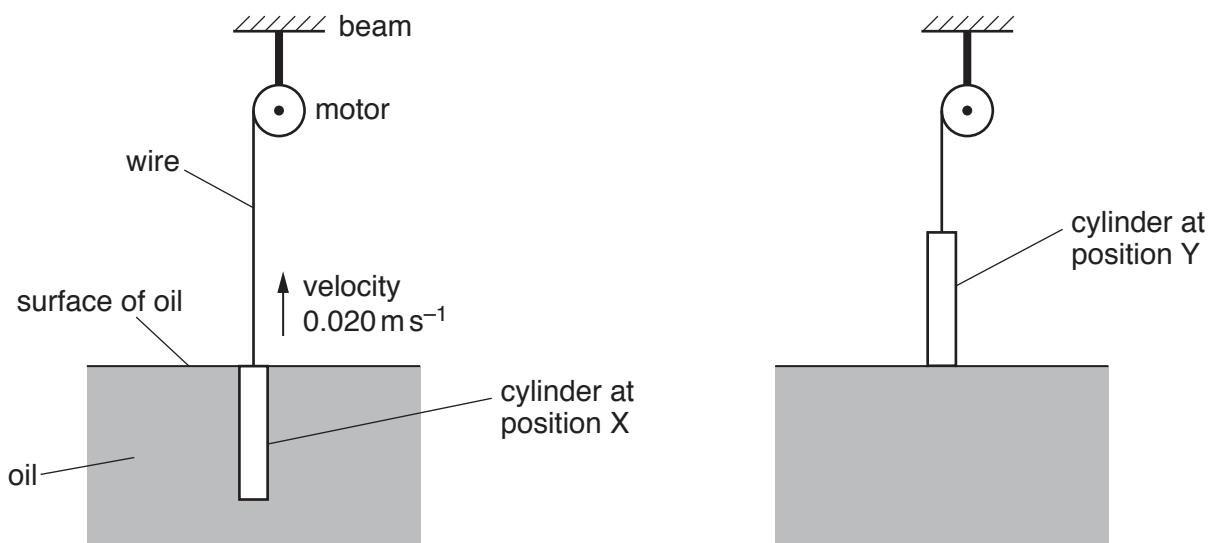


Fig. 5.1

The motor is fixed to an overhead beam.

The cylinder has cross-sectional area 0.018 m^2 , length 1.2 m and weight 560 N.

The density of the oil is 940 kg m^{-3} .

Throughout the lifting process, the cylinder moves vertically upwards with a constant velocity of 0.020 m s^{-1} . The viscous force of the oil acting on the cylinder is negligible.

- (a) Calculate the density of the cylinder.

$$\text{density} = \dots \text{kg m}^{-3} [2]$$

- (b) For the cylinder at position X, show that the upthrust due to the oil is 200 N.

[2]

(c) Calculate, for the moving cylinder at position X,

- (i) the tension in the wire,

tension = N [1]

- (ii) the power output of the motor.

power = W [2]

(d) The cylinder is raised with constant velocity from position X to position Y.

- (i) State and explain the variation, if any, of the power output of the motor as the cylinder is raised. Numerical values are not required.

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[3]

- (ii) The rate of energy output of the motor is less than the rate of increase of gravitational potential energy of the cylinder. Without calculation, explain this difference.

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[Total: 11]