2  (a)  State Newton's first law of motion.

........................................................................................................................................................

....................................................................................................................................................[1]

(b)  A block of weight 15 N hangs by a wire from a remotely controlled aircraft, as shown in Fig. 2.1.
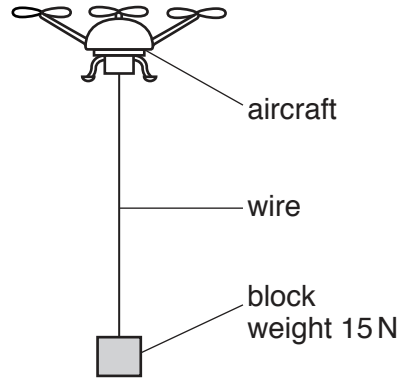


**Fig. 2.1**

The aircraft is used to move the block only in a vertical direction. The force on the block due to air resistance is negligible.

The variation with time *t* of the vertical velocity *v* of the block is shown in Fig. 2.2.
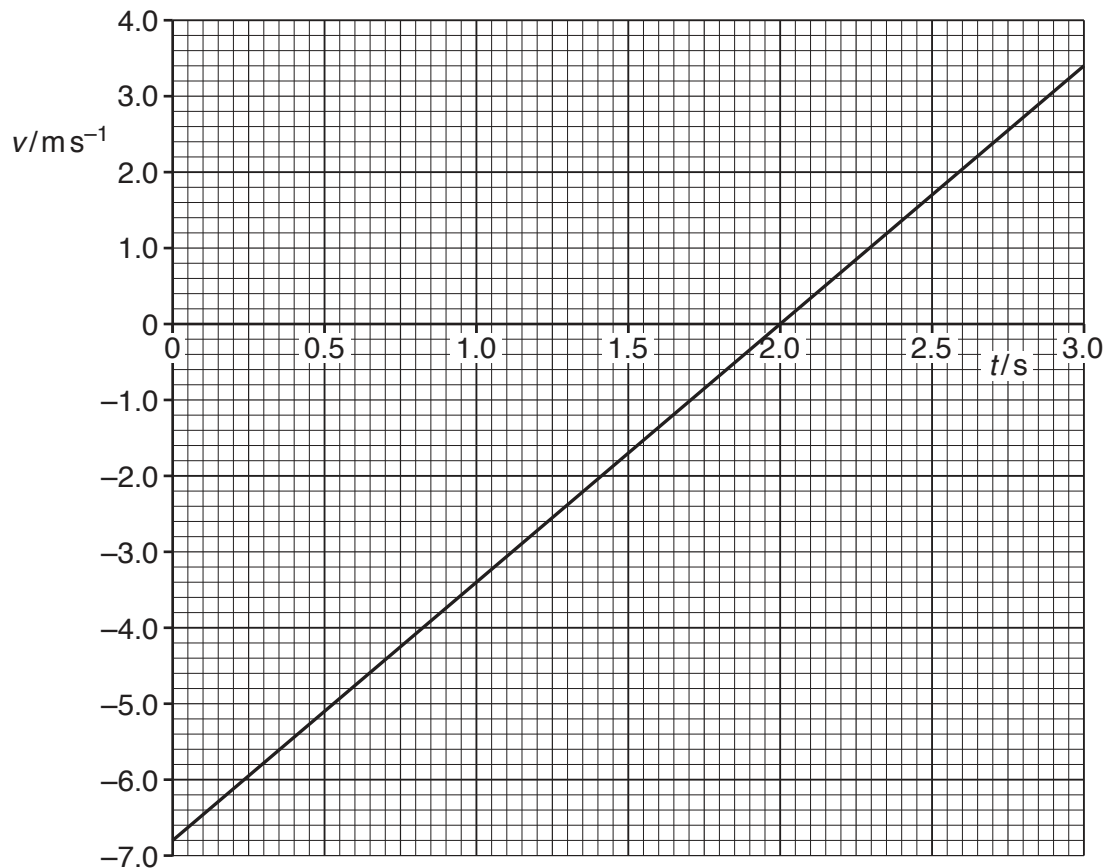The velocity is taken to be positive in the upward direction.



**Fig. 2.2**

**(i)** Determine, for the block,

    **1.** the displacement from time $t = 0$ to $t = 3.0\,$s,

        magnitude of displacement = ........................................................... m

        direction of displacement ...............................................................
                                                                                   [3]

    **2.** the change in gravitational potential energy from time $t = 0$ to $t = 3.0\,$s.

        change in gravitational potential energy = ....................................................... J [2]

**(ii)** Calculate the magnitude of the acceleration of the block at time $t = 2.0\,$s.

        acceleration = ............................................... $m\,s^{-2}$ [2]

**(iii)** Use your answer in **(b)(ii)** to show that the tension $T$ in the wire at time $t = 2.0\,$s is $20\,$N.

                                                                                                                       [2]

**(iv)** The wire has a cross-sectional area of $2.8 \times 10^{-5}\,m^2$ and is made from metal of Young modulus $1.7 \times 10^{11}\,Pa$. The wire obeys Hooke's law.

Calculate the strain of the wire at time $t = 2.0\,s$.

strain = ......................................................... [3]

**(v)** At some time after $t = 3.0\,s$ the tension in the wire has a constant value of 15 N.

State and explain whether it is possible to deduce that the block is moving vertically after $t = 3.0\,s$.

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