**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.

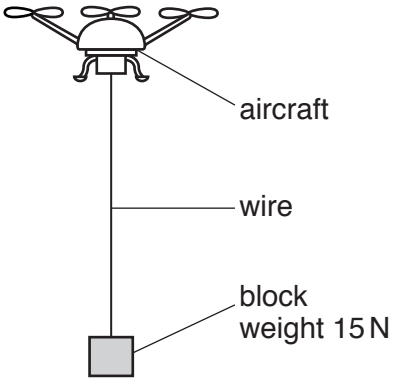


**Fig. 2.1**

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.

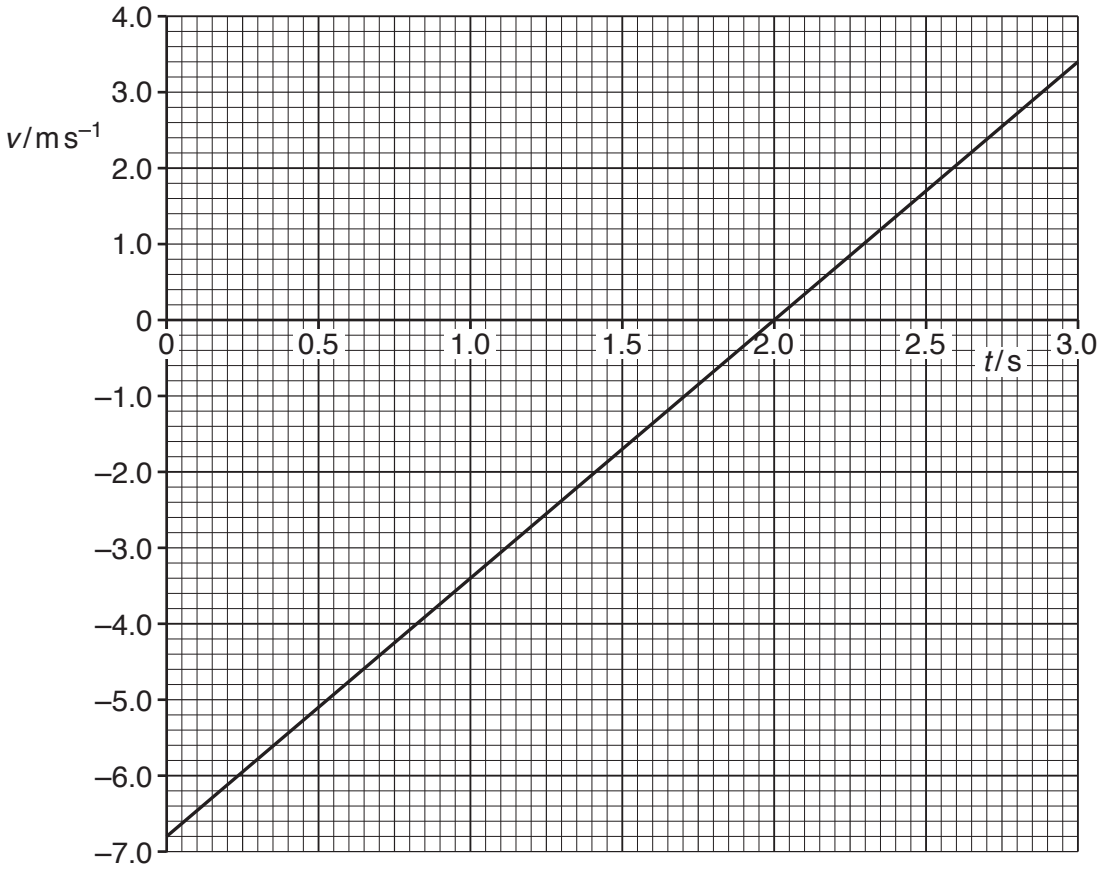


**Fig. 2.2**

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

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

magnitude of displacement = ..... m

direction of displacement .....

[3]

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

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

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

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

**(iii)** your answer in **(b)(ii)** to show that the tension $T$ in the wire at time $t = 2.0\,\text{s}$ 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 $t = 3.0\,s$.

.....

.....

.....

.....[2]