3. [*In this question position vectors are given relative to a fixed origin O*]

A particle P moves under the action of a single force $\mathbf{F}$ newtons.

At time t seconds, where $t \geqslant 0$, the position vector of P, $\mathbf{r}$ metres, is given by

$$\mathbf{r} = (t^3 - 5t)\mathbf{i} + (5t^2 + 6t)\mathbf{j}$$

The mass of P is 0.5 kg.

At time T seconds, P is moving in the direction of the vector $(\mathbf{i} + 2\mathbf{j})$.

(a) Find the value of T.

(5)

(b) Find the magnitude of $\mathbf{F}$ when $t = 2$

(4)