7. [*In this question, the unit vectors* **i** *and* **j** *are in a vertical plane,* **i** *being horizontal and* **j** *being vertically upwards.*]

At time $t = 0$, a particle P is projected with velocity $(4\mathbf{i} + 9\mathbf{j})\,\text{m s}^{-1}$ from a fixed point O on horizontal ground.

The particle moves freely under gravity.

When P is at the point H on its path, P is at its greatest height above the ground.

(a) Find the time taken by P to reach H.

(2)

At the point A on its path, the position vector of P relative to O is $(k\mathbf{i} + k\mathbf{j})\,\text{m}$, where k is a positive constant.

(b) Find the value of k.

(4)

(c) Find, in terms of k, the position vector of the other point on the path of P which is at the same vertical height above the ground as the point A.

(3)

At time T seconds the particle is at the point B and is moving perpendicular to $(4\mathbf{i} + 9\mathbf{j})$

(d) Find the value of T.

(4)

(Total for Question 7 is 13 marks)

TOTAL FOR PAPER IS 75 MARKS