1. Three particles of masses, $2m$, $3m$ and $7m$, are placed at the points with coordinates $(4\lambda, \lambda)$, $(2, 4)$ and $(4, -3)$ respectively, where λ is a constant.

The centre of mass of the three particles is at the point $(\bar{x}, \bar{y})$

(a) Show that $\bar{x} = \dfrac{4\lambda + 17}{6}$

(3)

The centre of mass of the three particles lies at a point on the straight line with equation

$$x - 6y = 6$$

(b) Find the value of λ

(4)

(Total for Question 1 is 7 marks)

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2. A particle P moves on a smooth horizontal surface with velocity $\mathbf{v}\,\text{m}\,\text{s}^{-1}$

At time t seconds, $t \geqslant 0$

$$\mathbf{v} = (t + \sin t)\mathbf{i} + (\cos t - 3)\mathbf{j}$$

At time $t = 0$, the position vector of P relative to a fixed origin O is $2\mathbf{i}\,\text{m}$

(a) Find the exact position vector of P relative to O when $t = \pi$

(4)

The particle P is moving under the action of a single horizontal force, $\mathbf{F}$ newtons.

Given that P has mass $0.5\,\text{kg}$,

(b) show that, at time t seconds, $t \geqslant 0$

$$|\mathbf{F}| = \sqrt{\frac{1 + \cos t}{2}}$$

(5)

(Total for Question 2 is 9 marks)