1 A particle of mass 4 kg is moving with velocity $(2\mathbf{i} + 3\mathbf{j})\,\text{m s}^{-1}$ when it receives an impulse of $(7\mathbf{i} - 5\mathbf{j})\,\text{N s}$.

Find the speed of the particle immediately after receiving the impulse.

(5)

(Total for Question 1 is 5 marks)

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2 Three particles of masses m, $4m$ and km are placed at the points whose coordinates are $(-3, 2)$, $(4, 3)$ and $(6, -4)$ respectively.

The centre of mass of the three particles is at the point with coordinates $(c, 0)$.

Find

(a) the value of k,

(3)

(b) the value of c.

(3)

(Total for Question 2 is 6 marks)

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3. **In this question you must show all stages of your working.**
Solutions relying on calculator technology are not acceptable.

At time t seconds ($t \geqslant 0$) a particle P has position vector $\mathbf{r}$ metres, with respect to a fixed origin O, where

$$\mathbf{r} = (16t - 3t^3)\mathbf{i} + (t^3 - t^2 + 2)\mathbf{j}$$

Find

(a) the velocity of P at the instant when it is moving parallel to the vector $\mathbf{j}$,

(5)

(b) the magnitude of the acceleration of P when $t = 4$

(4)

(Total for Question 3 is 9 marks)
