1. A bead is threaded on a straight wire. The vector equation of the wire is

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

where the unit of length is the metre. The bead is moved from a point A on the wire through a distance of 6 m along the wire to a point B by a force $\mathbf{F} = (7\mathbf{i} + 4\mathbf{j} - 2\mathbf{k})$ N.

Find the magnitude of the work done by $\mathbf{F}$ in moving the bead from A to B.

(Total 4 marks)

2. A bead of mass 0.5 kg is threaded on a smooth straight wire. The forces acting on the bead are a constant force $(2\mathbf{i} + 3\mathbf{j} + x\mathbf{k})$ N, its weight $(-4.9\mathbf{k})$ N, and the reaction on the bead from the wire.

(a) Explain why the reaction on the bead from the wire does no work as the bead moves along the wire.

(1)

The bead moves from the point A with position vector $(\mathbf{i} + \mathbf{j} - 3\mathbf{k})$ m relative to a fixed origin O to the point B with position vector $(3\mathbf{i} - \mathbf{j} + 2\mathbf{k})$ m. The speed of the bead at A is 2 m s^{-1} and the speed of the bead at B is 4 m s^{-1}.

(b) Find the value of x.

(6)
(Total 7 marks)

1. $\mathbf{AB} = k(2\mathbf{i} - \mathbf{j} + 2\mathbf{k})$; $\mathbf{AB} = 6 \Rightarrow k\sqrt{(2^2 + 1^2 + 2^2)} = 6$ M1

$\Rightarrow k = 2 \Rightarrow \mathbf{AB} = 4\mathbf{c} - 2\mathbf{j} + 4\mathbf{k}$ A1

work done $= (7\mathbf{i} + 4\mathbf{j} - 2\mathbf{k}) . (4\mathbf{i} - 2\mathbf{j} + 4\mathbf{k})$ M1

= <u>12J</u> A1 4

2. (a) Reaction **R** is perpendicular to the wire, since the wire is smooth.

Hence **R.d** = 0. B1 1

(b) $\overrightarrow{AB} = (3\mathbf{i} - \mathbf{j} + 2\mathbf{k}) - (\mathbf{i} + \mathbf{j} - 3\mathbf{k}) = 2\mathbf{i} - 2\mathbf{j} + 5\mathbf{k}$ M1

Work energy: $[2\mathbf{i} + 3\mathbf{j} + (x - 4.9)\mathbf{k}].(2\mathbf{i} - 2\mathbf{j} + 5\mathbf{k}) = \frac{1}{2} \times 0.5(4^2 - 2^2)$

M1 A1 A1

$4 - 6 + 5(x - 4.9) = 3 \Rightarrow x = 5.9$ A1 6

[7]

1. More able candidates succeeded easily here in gaining full marks. Weaker candidates failed to treat the vectors properly as vectors, finding only the magnitude of the force × the distance. Some too had difficulty in finding *AB* as a vector quantity (from its magnitude and direction).

2. No Report available for this question.