1. A system of forces consists of two forces $\mathbf{F}_1$ and $\mathbf{F}_2$ acting on a rigid body.

$\mathbf{F}_1 = (-2\mathbf{i} + \mathbf{j} - \mathbf{k})$ N and acts at the point with position vector $\mathbf{r}_1 = (\mathbf{i} - \mathbf{j} + \mathbf{k})$ m.

$\mathbf{F}_2 = (3\mathbf{i} - \mathbf{j} + 2\mathbf{k})$ N and acts at the point with position vector $\mathbf{r}_2 = (4\mathbf{i} - \mathbf{j} - 2\mathbf{k})$ m.

Given that the system is equivalent to a single force **R** N, acting at the point with position vector $(5\mathbf{i} + \mathbf{j} - \mathbf{k})$ m, together with a couple **G** N m, find

(a) **R** ,

(2)

(b) the magnitude of **G**.

(9)
(Total 11 marks)

1. (a) $\mathbf{R} = (-2\mathbf{i} + \mathbf{j} - \mathbf{k}) + (3\mathbf{i} - \mathbf{j} + 2\mathbf{k})$ M1
$= (\mathbf{i} + \mathbf{k})$ A1 2

(b) $\mathbf{G} + (5\mathbf{i} + \mathbf{j} - \mathbf{k}) \times (\mathbf{i} + \mathbf{k})$
$= (\mathbf{i} - \mathbf{j} + \mathbf{k}) \times (-2\mathbf{i} + \mathbf{j} - \mathbf{k}) + (4\mathbf{i} - \mathbf{j} - 2\mathbf{k}) \times (3\mathbf{i} - \mathbf{j} + 2\mathbf{k})$ M1A2ft
$\mathbf{G} + (\mathbf{i} - 6\mathbf{j} - \mathbf{k}) = (-\mathbf{j} - \mathbf{k}) + (-4\mathbf{i} - 14\mathbf{j} - \mathbf{k})$ A3ft

$\mathbf{G} = (-5\mathbf{i} - 9\mathbf{j} - \mathbf{k})$ A1

$|\mathbf{G}| = \sqrt{(-5)^2 + (-9)^2 + (-1)^2} = \sqrt{107}$ Nm M1A1 9

[11]

1. Careful candidates found this question an easy source of marks. A minority were very careless with signs when evaluating cross products and this could lead to a heavy loss of marks in the worst cases. Some candidates either ignored the moment of **R** about the origin or added it to the other moments. Otherwise excellent answers sometimes omitted to find the magnitude of the couple.