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A LEVEL MATHS

(74) Vectors in Mechanics

WORKING AT D/E

(1) Two forces act on a particle of mass $8kg$

$F_1 = (5\mathbf{i} - 2\mathbf{j} + \mathbf{k})N$ and $F_2 = (2\mathbf{i} - \mathbf{j} + 4\mathbf{k})N$

(a) Explain why the resultant force R is such that $R = (7\mathbf{i} - 3\mathbf{j} + 5\mathbf{k})N$

(b) Find the magnitude of R

(c) Using Newtons 2nd Law, explain why the particle will accelerate at $1.14ms^{-2}$ correct to 3SF

(d) A 3rd force now acts on the particle.

$F_3 = (-7\mathbf{i} + 3\mathbf{j} - 5\mathbf{k})N$

Explain why the particle would be in equilibrium if all 3 forces acting on it.

WORKING AT B/C

(1) A particle of mass $4kg$ is acted upon by 3 forces:

$F_1 = \begin{pmatrix} -1 \\ 0 \\ 12 \end{pmatrix} N \quad F_2 = \begin{pmatrix} 10 \\ -3 \\ 1 \end{pmatrix} N \quad F_3 = \begin{pmatrix} 3 \\ 7 \\ 3 \end{pmatrix} N$

(a) Find the acceleration a of the particle in the form $\mathrm{p}\mathbf{i} + \mathrm{q}\mathbf{j} + \mathrm{r}\mathbf{k}$

(b) Hence find $|a|$

(c) The particle is initially at rest. Find the distance covered by the particle in the first 5 seconds after the forces have acted upon it.

(d) Find the angle the acceleration makes with the vector i.

WORKING AT A*/A

(1) Cyril and Doris are trying to keep a ping pong ball in the air using two hairdryers. The ping pong ball has mass 20g. The two hairdryers produce forces of $H_1 = (\mathrm{p}\mathbf{i} - 5\mathbf{j} + \mathrm{r}\mathbf{k})N$ and $H_2 = (2\mathbf{i} + \mathrm{q}\,\mathbf{j} + (\mathrm{r}-1)\mathbf{k})N$ where p, q and r are constants. The hairdryers are applied simultaneously to keep the ping pong ball in the air.

As soon as the hairdryers are turned on the ping pong ball travels directly upwards from a fixed starting point with acceleration $6\mathbf{k}\,ms^{-2}$

Find the values of p, q and r.