1 Let the solid $S$ lying above the cone $z = \sqrt{x^2 + y^2}$ and below the sphere $x^2 + y^2 + z^2 = z$.

1/1 Sketch the profile of this solid in the $xz$-plane.

1/2 Give a description of $S$ in terms of spherical coordinates.

1/b Evaluate the volume of $S$ by using the integral in spherical coordinates.
2. We want to evaluate the integral $\int \int_{R} xy \, dA$ where $R$ is the region in the first quadrant bounded by the lines $y = x$, $y = 3x$ and the hyperbolas $xy = 1$ and $xy = 3$.

2.1 Sketch the domain $R$.

2.2 By using the change of variable $x = \frac{u}{v}$ and $y = v$, give for each boundary of $R$, the equations of the corresponding boundaries of the transformed domain $S$.

2.3 Sketch the domain $S$ and give its definition.
2.4 Give the expression of the integral over $S$ by using the previous change of variables.

3 Evaluate the line integral of $F(x, y, z) = <x, -z, y>$ along the curve $C$ defined by $c(t) = <2t, 3t, -t^2>$ for $-1 \leq t \leq 1$. 