

Session 1

1. Based on a material description of motion, derive simple expressions for the derivatives:

a) $\frac{D}{Dt} \int_V dV$

b) $\frac{D}{Dt} \int_V \phi dV$

c) $\frac{D}{Dt} \int_V \rho \phi dV$

where V is the volume of a fluid parcel, ρ is density and ϕ a scalar field.

2. A ship is steaming northward at a rate of 10 km/h. The surface pressure increases toward the northwest at the rate of 5 Pa/km. What is the pressure tendency recorded at a nearby island station if the pressure aboard the ship decreases at a rate 100 Pa/3 h.
3. Given the motion of the continuum:

$$x = x_0 + kty_0 \quad y = (1 + kt)y_0 \quad z = z_0$$

and the temperature field in the spatial description:

$$T = \alpha(x + y)$$

find

- (a) the material description of the temperature field,
- (b) the velocity field in both material and spatial descriptions,
- (c) the divergence of the velocity field.