(1) True or false:

$$\frac{\partial Q(\vec{r},t_1)}{\partial t} = \frac{DQ(\vec{r}_p\,(t_1),t_1)}{Dt} = \frac{dQ(\vec{r}_{obs}\,(t_1),t_1)}{dt}$$

when $\vec{r} = \vec{r}_p(t_1) = \vec{r}_{obs}(t_1)$. That is, the three derivatives above are equal when the observer (or probe) and the parcel are at the same location, $\vec{r}$, at the same (particular) time, t_1.

(A)True (B) False

(2) True or false: The change or difference in some quantity and the rate of change of that quantity with respect to time have the same dimensions.

(A) True
(B) False

(3) True or false: A *change* or *difference* in some quantity and the *rate of change* of that quantity with respect to time are two different ways of saying the same thing.

- (A) True
- (B) False

(4) True or false: If $Q(\vec{r}, t)$ is a field variable, then so is $\partial Q(\vec{r}, t)/\partial t$ (the local derivative of Q).

(A) True
(B) False

(5) True or false: If $Q(\vec{r},t)$ is a field variable, then so is

$$\nabla Q(\vec{r},t) = (\partial Q/\partial x, \partial Q/\partial y, \partial Q/\partial z)$$
$$= (\partial Q/\partial s, \partial Q/\partial n, \partial Q/\partial z)$$

(the [vector] gradient of Q and its scalar components in any coordinate system, such as rectangular and natural coordinates, where $\vec{r} = (x,y,z) = (s,n,z)$ in these two coordinate systems, respectively).

(A) True
(B) False

(6) What is true about *advection* (of a field variable)?

(A) It is a process that contributes to changes in the field variable over time observed at a fixed location.

(B) It accounts for the transport of the field variable by a fluid to a fixed location from somewhere else.

(C) It has dimensions of the field variable over time.

(D) It depends on (a) the gradient of the field variable (in the direction of the fluid flow) and (b) the speed of the fluid.

(E) All of the above.