

(1) When is a field of some physical property *steady*?

- (A) When the material parcels in the field aren't moving.
- (B) When parcels in the field *conserve* the property (that is, each parcel's value of the property doesn't change over time).
- (C) When the property *at each location* doesn't change over time.**
[“Steady” means not changing (with respect to time) at a fixed location. When this is true at every location, the whole field is steady.]
- (D) When an observer traveling through the field measuring the property *as they go*, measures *no change* in the property.

(2) To visualize a flow pattern, you first mark a fluid parcel. A short distance away in the direction of the fluid parcel's velocity, you mark a second parcel. A short distance away in the direction of the second parcel's velocity, you mark a third parcel, etc.

You then connect the series of marked parcels with a line.
What kind of line is this?

- (A) A streamline**
- (B) A pathline (trajectory)
- (C) A streakline
- (D) A timeline

(3) To visualize a flow pattern, you first mark a fluid parcel. That parcel (if it is moving) leaves and is replaced by a new one at the same location, which you mark. You repeat this process a number of times.

You then connect the series of marked parcels with a line.
What kind of line is this?

- (A) A streamline
- (B) A pathline (trajectory)
- (C) A streakline**
- (D) A timeline

(4) To visualize a flow pattern, you first mark the location of a fluid parcel. A short time later, you mark the location of the same parcel. A short time later, you mark the location of the same parcel (which might have moved again). You repeat this process a number of times.

You then connect the series of locations where you marked the parcel with a line. *What kind of line is this?*

(A) A streamline

(B) A pathline (trajectory)

(C) A streakline

(D) A timeline

(5) To visualize a flow pattern, you first mark a series of adjacent fluid parcels and connect them with a line. A short time later, during which time the parcels might have moved, you mark the same series of parcels and connect them with a line. You repeat this process a number of times at the same time interval.

What is this series of lines called?

- (A) A streamline
- (B) A pathline (trajectory)
- (C) A streakline
- (D) A timeline**

(6) Which of the following types of “field lines” (flow visualization lines) can intersect themselves?

(There might be more than one correct choice; if there is, pick one of them.)

- (A) Streamlines
[The fluid parcel at a point of intersection would have two velocities in different directions. This is impossible.]
- (B) Pathlines (trajectories)**
[The point of intersection would represent the same fluid parcel at the same location but at different times and with different velocities, which is quite possible.]
- (C) Streaklines
[The point of intersection would have to be occupied by two fluid parcels that were marked earlier as they passed through the same streakline origin point at different times, but two fluid parcels can't occupy the same location at the same time.]
- (D) Timelines**
[A timeline represents an arbitrary series of fluid parcels connected by a line, the positions of which are recorded at a series of times. For any one time line in a series of them, a point of intersection would represent one fluid parcel at one location and time, which is entirely OK. For two time lines at different times in a series them, the point of intersection would represent different parcels at the same location at different times, which is entirely possible.]

(7) Which of the following types of “field lines” (flow visualization lines) can intersect other lines of the same type?

(There might be more than one correct choice; if there is, pick one of them.)

- (A) Streamlines
[The point of intersection would require that the single fluid parcel there have two velocities in different directions, which is impossible.]
- (B) **Pathlines (trajectories)**
[The point of intersection would represent two different parcels at the same location at different times with different velocities, which is entirely possible.]
- (C) Streaklines
[The point of intersection would represent two different parcels occupying the same location at the same time, which isn't possible.]
- (D) **Timelines**
[See the second of the two explanations about the “Timelines” option in the previous question.]

(8) Under what circumstance will a streamline and a trajectory that start at the same location and time, be identical?

(A) When the flow is transient

(B) When the flow is steady

[Or, more precisely when the flow direction is steady everywhere along a streamline. In that case, if you imagine picking a fluid parcel at some moment in time, the way you'd construct a trajectory for that parcel and a streamline through that point would produce exactly the same set of points (line/curve) in space.]

(C) When the flow is spatially uniform

(D) When the flow direction is spatially uniform

(9) True or false: At every point along a *streakline*, the streakline is parallel to the velocity of the fluid parcel at that point.

(A) True

(B) False

[Streaklines are not constructed in such a way that requires that the parcel velocities along the streamline are parallel to the streakline. Forces acting on parcels in a streakline can change the velocities of the parcels in all sorts of ways, so that, for example, a streakline could conceivably shift laterally, which would mean that the velocity at no point along the streakline is parallel to the streakline!]

(10) True or false: At every point along a *streamline*, the streamline is parallel to the velocity of the fluid parcel at that point.

(A) True

[Streamlines are constructed, or defined, so that at each point along them, the streamline is tangent (parallel) to the flow velocity at that point.]

(B) False

(11) True or false: At every point along a *trajectory*, the trajectory is parallel to the velocity of the fluid parcel at that point on the trajectory.

(A) True

[Trajectories are constructed, or defined, so that at each point along them, the trajectory is necessarily tangent (parallel) to the parcel velocity at that point.]

(B) False