Make the Right Call

For a sports event, such as a cross-country ski race, a sports commentator would use vivid language to get across the excitement of the race. A scientific description of the race might use some of the same words, but their meanings would be much more precise.

DISTANCE

Symbols: d (in this textbook) d_i (initial distance)
d_f (final distance)
Δd (distance interval, or change in distance)

Calculation: $\Delta d = d_f - d_i$

Standard unit: metre (m)

Distance measures the total length of a journey along every twist and turn of the path. Distance is a **scalar** quantity, so it has a magnitude (size) but no direction. The symbol Δ is pronounced "delta" and means "change in." Thus Δd means "change in distance."

Example: The race covered a distance of 5.62 km along the winding banks of the river.

TIME

Symbols: t t_i (initial time) t_f (final time)
Δt (time interval)

Calculation: $\Delta t = t_f - t_i$

Standard unit: second (s)

Time describes when an event occurs. Stopwatches or timers are usually reset to zero at the beginning of an experiment, so the initial time t_i is usually taken as zero. **Time interval** describes the duration of an event. Time is a scalar quantity.

Example: About 30 min into the movie (time), Amy went out of the theatre for about 5 min (time interval).

POSITION

Symbols: $\vec{d}$ $\vec{d}_i$ (initial position) $\vec{d}_f$ (final position)

Standard unit: metre (m)

Position describes an object's location, as seen by an observer from a particular viewpoint. The observer is usually assumed to be standing still on Earth's surface. In the lab, the object's initial (starting) position $\vec{d}_i$ is usually taken as the reference position or origin (zero). Position is a **vector,** so you must state both its magnitude and direction. The arrow over the letter "d" means "vector."

Example: The collision occurred 24.75 m due south of the flagpole.

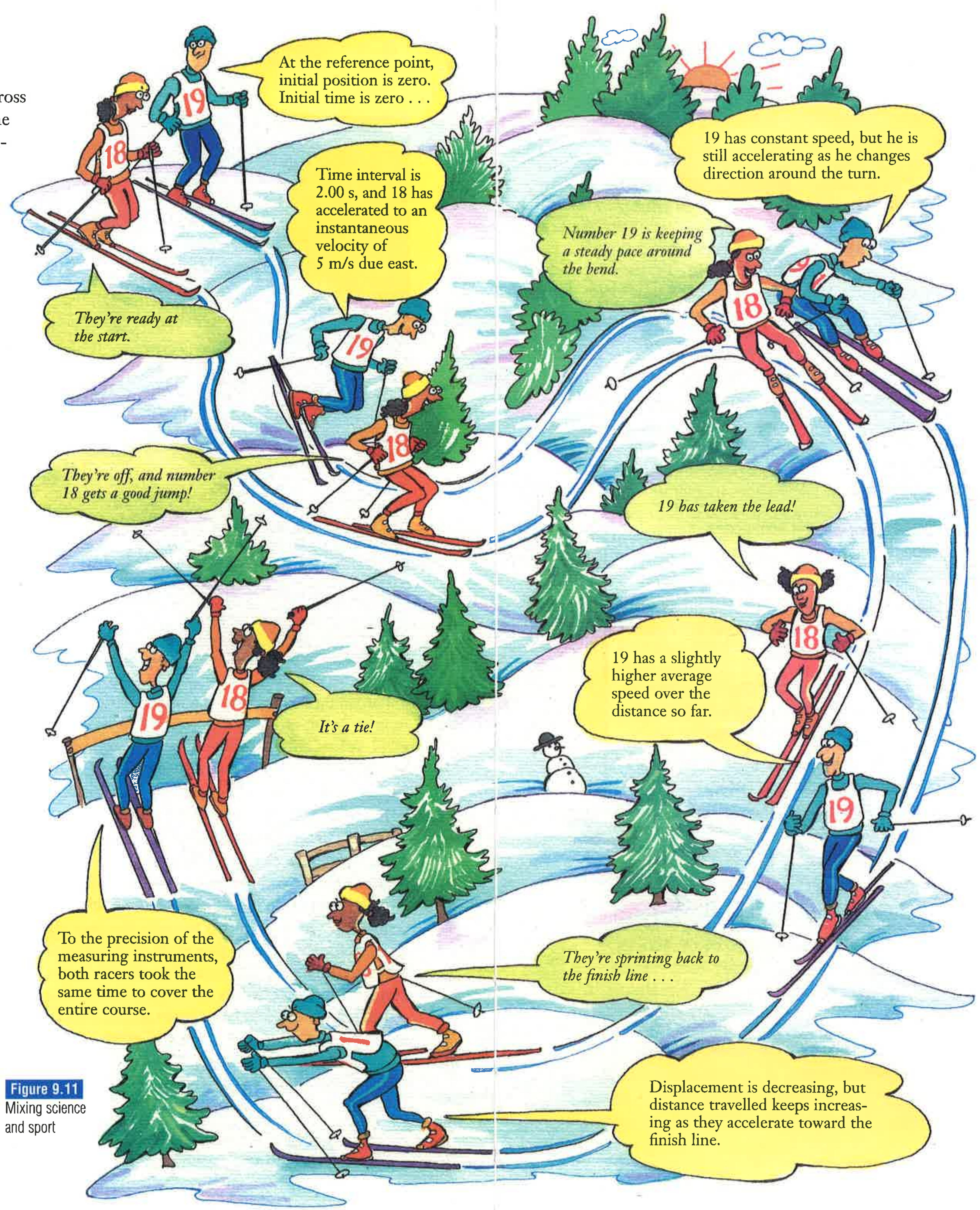

Figure 9.11 Mixing science and sport

DISPLACEMENT

Symbol: $\Delta\vec{d}$

Calculation: $\Delta\vec{d} = \vec{d}_f - \vec{d}_i$

Standard unit: metre (m)

Displacement describes how much an object's position has changed. If the object ends up back where it started, like a runner going completely around a racetrack, its displacement is zero, even if it moved a long way. Displacement is a vector.

Example: We pushed the car, producing a displacement of 4.5 m at an angle of 25° to the road.

VELOCITY

Symbols: $\vec{v}$ $\vec{v}_i$ (initial velocity) $\vec{v}_f$ (final velocity)
$\vec{v}_{av}$ (average velocity)
$\vec{v}_{inst}$ (instantaneous velocity)
Δv (change in velocity)

Calculation: $\Delta\vec{v} = \vec{v}_f - \vec{v}_i$

Standard unit: metres per second (m/s)

Velocity describes the speed and direction of motion. That is, it describes how fast an object's position is changing. The symbol $\vec{v}$ usually means the average velocity over a particular time interval. For clarity, $\vec{v}_{av}$ can be used for the average velocity, with $\vec{v}_{inst}$ representing **instantaneous** velocity (velocity at a specific instant in time). Velocity is a vector.

Example: The aircraft was travelling at 535 km/h, headed N45°W, when the weather warning was received.

SPEED

Symbol: v (in this textbook) or $|\vec{v}|$

Standard unit: metres per second (m/s)

Speed describes how fast something is moving. It has the same meaning in physics and in everyday language. Speed is a scalar and does *not* indicate direction.

Example: The cyclist reached a maximum speed of 12.00 m/s during the race.

ACCELERATION

Symbols: $\vec{a}$ $\vec{a}_{av}$ (average acceleration)
$\vec{a}_{inst}$ (instantaneous acceleration)

Standard unit: metres per second in each second (m/s^2)

Acceleration describes how much an object's velocity changes in a certain time. It results from any change in velocity: speeding up, slowing down, changing direction, or a combination. Acceleration is a vector.

Example: Earth's gravity makes objects accelerate at 9.8 m/s^2 downward.