(1) How does the annual average sun angle at solar noon (that is, the sun angle at noon averaged over a full year) depend on latitude?

(A) * As latitude increases, average sun angle at solar noon *decreases*.

(B) As latitude increases, average sun angle at solar noon *increases*.

(C) Averaged over a full year, sun angle at solar noon is the *same at all latitudes*.

*Correct answer.

(2) Averaged over a whole year, the farther a place is from the equator, the lower the sun angle is at solar noon. Why?

(A) At higher latitudes, the sun is lower in the sky at solar noon.

(B) At higher latitudes, the sun's rays strikes the earth at a lower angle.

(C) * The earth is a sphere, and it's surface curves away from the sun at higher latitudes.

*Correct answer. The other choices just say the same thing as the original statement in different terms but don't offer an explanation.

(3) Averaged over a whole year, how does *insolation* at the earth's surface depend on latitude?

(A) * Insolation *decreases* with increasing latitude.

(B) Insolation *increases* with increasing latitude.

(C) Averaged over a full year, insolation is the *same at all latitudes*.

*Correct answer. Insolation depends on sun angle: the higher the sun angle, the greater the insolation.

(4) Why does the length of daylight vary with time of year (except at one latitude)?

(A) Because the temperature varies with time of year.
(B) Because the distance between the earth and sun varies, thanks to the earth's elliptical orbit.
(C) * Because the amount of each latitude circle lit by the sun varies, thanks to the way that the axis of rotation tilts.
(D) Because of the seasons.

*Correct answer. (A) and (B) require cause-effect relations that make no sense: Air temperature and distance from the sun themselves have no effect on length of daylight.

(5) Which one of the following statements is true at the equator?

(A) * The sun angle at solar noon varies with time of year, but the length of daylight doesn't.

(B) The sun angle at solar noon is greatest at the solstices.

(C) The sun angle and length of daylight are both greatest during the summer.

*Correct statement. At the equator there is no summer or winter as we know them at midlatitudes, ruling out (C). At the equator, solar noon sun angle is greatest (90 degrees) at the equinoxes, ruling out (B). Although solar noon sun angle varies with time of year, the length of daylight at the equator is 12 hours all year long.

(6) Which one of the following statements is true at the poles?

(A) * It is daylight from the spring equinox to the autumn equinox, then dark until the spring equinox again.

(B) It is daylight from the summer solstice to the winter solstice, then dark until the summer solstice again.

(C) The sun appears on the horizon at solar noon for half of the year.

*Correct answer. The wording of (A) is general enough to apply to both poles.

(7) Which one of the statements below is true about any particular place outside the tropics?

(A) The average winter day is shorter than the average autumn day.

(B) On the average, the sun angle at solar noon is lower in winter than in fall.

(C) * On the average, the sun angle at solar noon and the number of hours of daylight are the same in spring and in summer.

*Correct answer. Fall and winter are symmetrical seasons—the sun angles and length of daylight are mirror images of each other, so averaged over each full season the sun angles and day lengths are the same. The same is true of spring vs. summer.

(8) Which one of the statements below is true about any particular place within the tropics (except perhaps the equator) over the course of a year?

(A) The dates of maximum and minimum solar noon sun angle are the same as they are at latitudes in the same hemisphere outside the tropics.

(B) * The dates of maximum and minimum length of daylight are the same as they are at other latitudes in the same hemisphere.

(C) The lowest sun angle at solar noon is higher than the highest noon sun angle at any time of year at any latitude outside the tropics.

(D) The variation in the length of daylight over the course of the year is the same as it is at latitudes outside the tropics.

*Correct answer. See Figure 2-5 in Lab Activity #2: Seasons to accept (B) and reject the others.

(9) Suppose that the orientation of the Earth's axis of rotation relative to the sun were the same as it is currently at the June solstice, all year long.

What would the seasons be like?

(A) Similar to today's, but warmer.

(B) Similar to today's, but warmer in the N. Hemisphere and colder in the S. Hemisphere.

(C) * There would be no seasons.

*Correct answer. A little bit of a trick question because although (B) would be generally true, the seasons exist because the orientation of the axis of rotation relative to the sun (though not relative to the distant stars) changes over the course of the earth's orbit.
No variation relative to the sun ➔ no seasons.

(10) How does the annual-average sun angle (that is, the sun angle, including positive values during the day and negative values at night, averaged over 24 hours for a full year) depend on latitude?

(A) As latitude increases, average sun angle *decreases*.

(B) As latitude increases, average sun angle *increases*.

(C) * Averaged over a full year, sun angle is the *same at all latitudes*.

*Correct answer. At every latitude, over the course of a year the sun is as far below the horizon as it is above it, producing an average of zero, regardless of the latitude. On the other hand, if we averaged only during daylight hours, then (A) would be correct.

(11) How does the annual-average length of daylight (that is, the number of hours of daylight averaged over a year) depend on latitude?

(A) As latitude increases, average length of daylight *decreases*.

(B) As latitude increases, average length of daylight *increases*.

(C) * Averaged over a full year, the length of daylight is the *same at all latitudes*.

*Correct answer. On the average over the course of a year, every latitude has 12 hours of daylight. This illustrates why averages by themselves can fail dismally to capture the full range of behavior of some quantities—the range of extremes and degree of variability can also be illuminating.