Shock Waves

The cone-shaped shock wave produced by a super-sonic aircraft is actually the result of overlapping spherical waves of sound, as shown in Figure 25.22 in your textbook. Sketches (a), (b), (c), (d), and (e) at the left show the "animated" growth of only one of the many spherical sound waves (shown as an expanding circle in the two-dimensional sketch). The circle originates when the aircraft is in the position shown in (a). Sketch (b) shows both the growth of the circle and position of the aircraft at a later time. Still later times are shown in (c), (d), and (e). Note that the circle grows and the aircraft moves farther to the right. Note also that the aircraft is moving farther than the sound wave. This is because the aircraft is moving faster than sound.

Careful examination will reveal how fast the aircraft is moving compared to the speed of sound. Sketch (e) shows that in the same time the sound travels from O to A, the aircraft has traveled from O to B — twice as far. You can check this with a ruler.
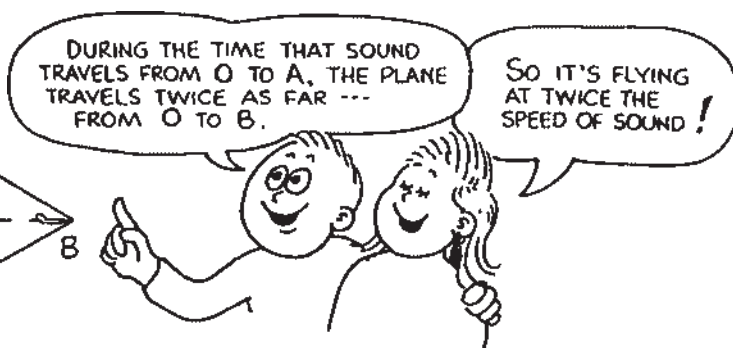
Circle the correct answers.

1. Inspect sketches (b) and (d). Has the aircraft traveled twice as far as sound in the same time in these postions also?
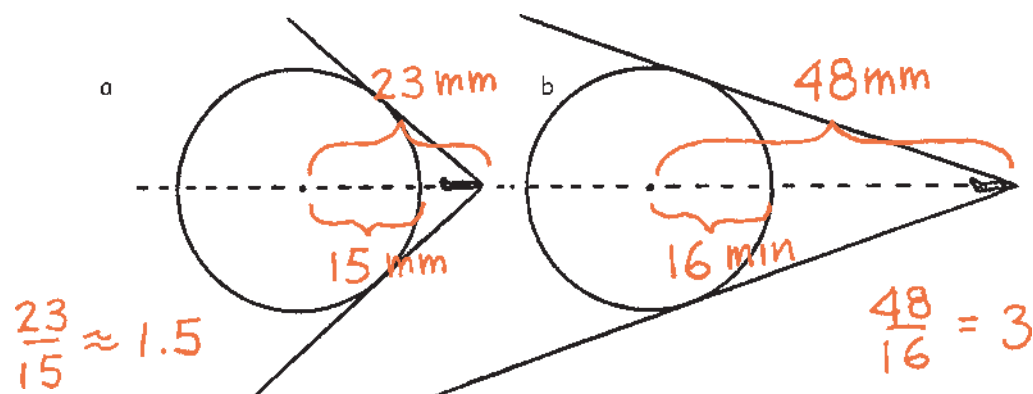
   (Yes) (No)

2. For greater speeds, the angle of the shock wave would be

   (wider) (the same) (narrower).

CONCEPTUAL PHYSICS

3. Use a ruler to estimate the speeds of the aircraft that produce the shock waves in the two sketches below.

a   23 mm   b   48mm

15 mm   16 min

$\frac{23}{15} \approx 1.5$ $\frac{48}{16} = 3$

Aircraft (a) is traveling about ___1.5___ times the speed of sound.

Aircraft (b) is traveling about ___3___ times the speed of sound.
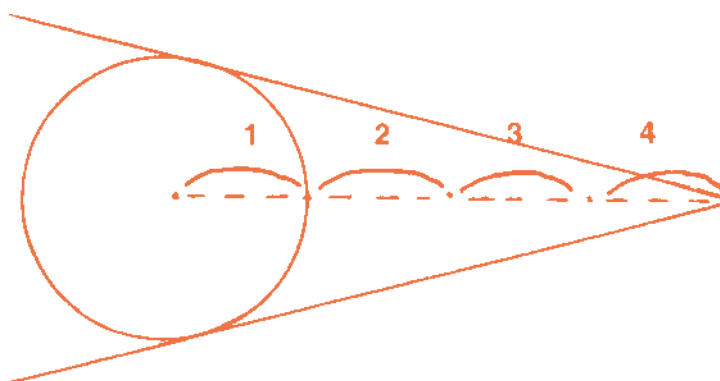
4. Draw your own circle (anywhere) and estimate the speed of the aircraft to produce the shock wave shown below.

1   2   3   4   5
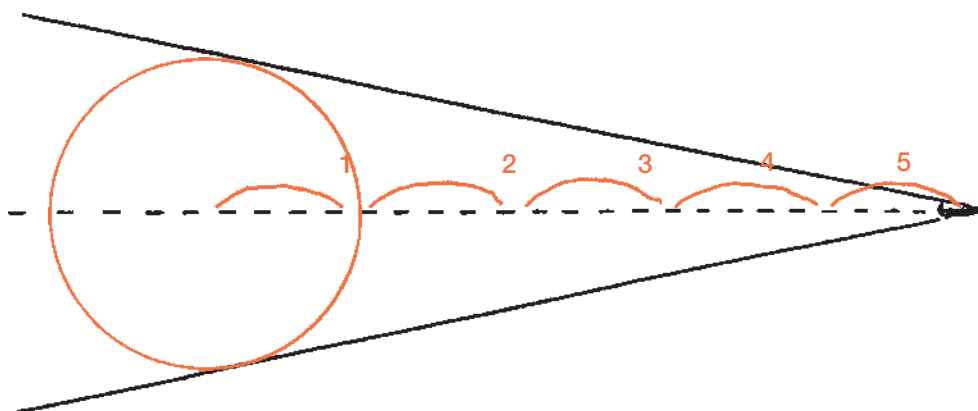
For any sample circle, the distance to the apex of the cone will be 5 times greater than the radius of the circle.

The speed is about ___5___ times the speed of sound.

5. In the space below, draw the shock wave made by a supersonic missile that travels at four times the speed of sound.

1   2   3   4

CONCEPTUAL PHYSICS