# MEASURING FIREWORKS WITH SOUND WORKSHEET

**The Scenario**

It is New Year's Eve and you're in charge of your school's firework display. You've set up a launch area and a grandstand for people to observe from but you need to make sure they are far enough away from the launch area to meet safety standards.

You've left your measuring tape at home and there is no time to go and get it so you decide to use your knowledge of sound waves to determine how far away the launch area is.

*firewings / 123rf.com.*

### Question 1  (1 mark)

You decide to fire 4 test fireworks and use your watch to record the time interval between *seeing* the firework leave the launching chute and *hearing* the launch from the grandstand where you are. If you make the following 4 time recordings, what is the average recording?

*1.24 seconds, 1.17 seconds, 1.56 seconds, 1.21 seconds*

### Question 2  (2 marks)

Using your knowledge of outliers, which recordings should you probably discard? Does this change the average time recording, and if so what is the new average?

### Question 3  (2 marks)

Using this average time interval and assuming the speed of sound is 340 m/s, calculate how far away the launch area is from the grandstand. Does this meet the safety standard if the launch area must be at least 300 meters away from spectators?

### Question 4 (3 marks)

You decide to test another firework but the firing chute malfunctions and a firework comes flying straight towards the grandstand, slamming into the wall. Luckily the impact extinguishes the flame and it doesn't explode.

Now you're curious how fast the fireworks move, you estimate that the firework hit the grandstand 0.5 seconds before you heard it being launched. What was the average speed of the firework and how many times faster than the speed of sound was it going; in other words, what was its Mach number?