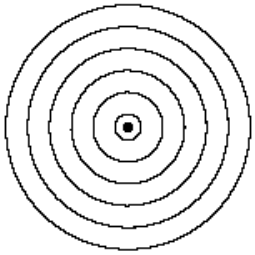
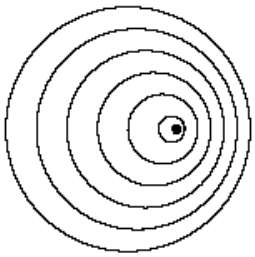
Doppler Effect:

Discuss the racetrack sound phenomenon as well as the passing by in a moving car...approaching train .

The apparent change in frequency of a sound when the source is moving. To an observer in front of the moving sound source the frequency seems higher, while behind the source the frequency seems lower.





Doppler Effect for Sound...

Use (-) when the source is moving towards you (the distance between you is decreasing)
Use (+) when the source is moving away from you (the distance between you is increasing)

$$f = \frac{f_o\, v_s}{v_s \pm v_o}$$

$f \rightarrow$ frequency you hear

$f_o \rightarrow$ original frequency

V_s = speed of sound

V = speed of the object

Ex. 1 Julian is approaching Nick at 140 km/h and screaming at 500Hz. What frequency does Nick hear?
(The speed of sound is 344m/s.)

Ex.2 Calculate the frequency heard by a person if a car travelling at 110 km/h emits a sound with frequency 450 Hz and is

(a) approaching the person.

(b) moving away from the person.

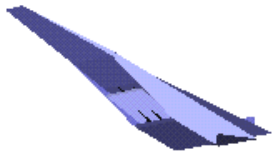
The temperature is 18◦C.

HWK: p. 480 #64 - 66, 69

Mach Number

Glenn Research Center

$$\text{ratio} = \frac{\text{Object Speed}}{\text{Speed of Sound}} = \text{Mach Number}$$



Hypersonic
Mach > 5.0

Supersonic
Mach > 1.0

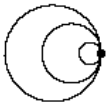
Sonic Boom

Transonic
Mach = 1.0

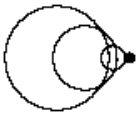
Subsonic
Mach < 1.0

Doppler Effect

Supersonic Speeds



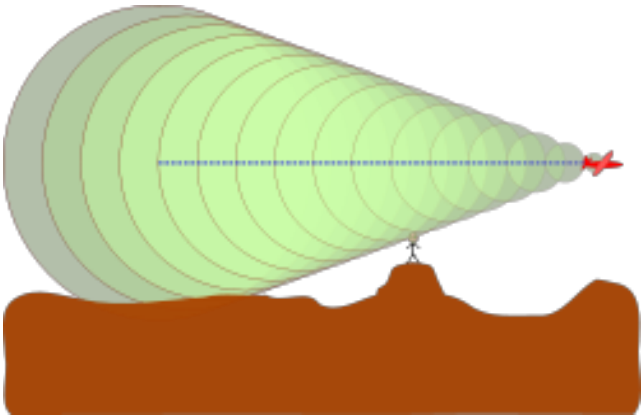
As an airplane approaches the speed of the sound waves it creates, the waves build up and overlap creating what we call the 'sound barrier'. Extra thrust from the planes engines is required to break through.



At supersonic speeds the source moves ahead of the sound waves it creates causing compressions to overlap. This produces a 'shock wave' - a cone of high pressure. If this shock wave hits the ground before its energy is dissipated a sonic boom is heard.

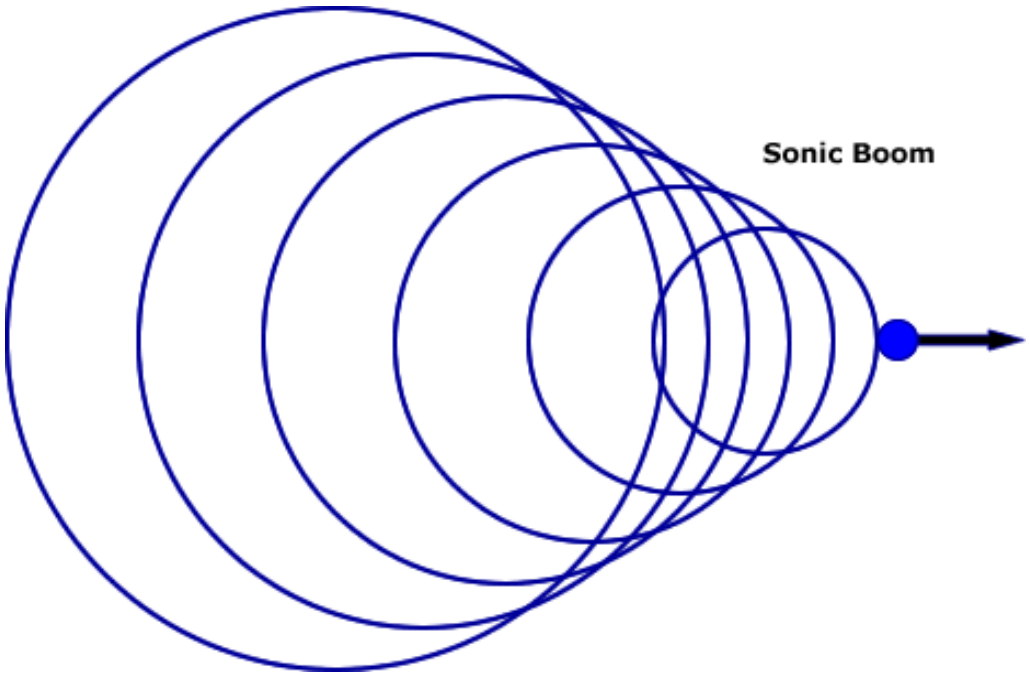
f-18flyby.mpeg

FS14ss.mpeg

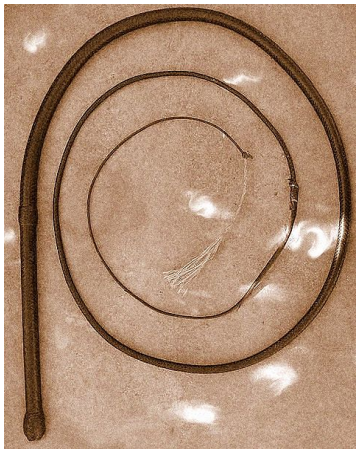


A sonic boom produced by an aircraft. An observer hears the boom when the shock wave, on the edges of the cone, crosses his or her location.

Damage to buildings is possible but not common, threat to livestock and wild animals who may be startled.


Sonic Boom

The cracking sound a bullwhip makes when properly wielded is, in fact, a small sonic boom. The end of the whip, known as the*"cracker"*, moves faster than the speed of sound, thus creating a sonic boom.The whip is quite possibly the first human invention to break the sound barrier .



http://www.youtube.com/watch?v=fTs2mb2EgFE&safety_mode=true&persist_safety_mode=1&safe=active

http://www.youtube.com/watch?v=eA7XSVuUmBM&safety_mode=true&persist_safety_mode=1&safe=active

Airspeed Limitations

602.32 (1) Subject to subsection (2), no person shall operate an aircraft below 10,000 feet ASL at an indicated airspeed of more than 250 knots. (~463 km/h)

(2) No person shall operate an aircraft below 3,000 feet AGL within 10 nautical miles of a controlled airport at an indicated airspeed of more than 200 knots unless authorized to do s in an air traffic control clearance.

(3) Notwithstanding subsections (1) and (2), a person may operate an aircraft at an indicate airspeed greater than the airspeeds referred to in subsections (1) and (2) where the aircraft being operated on departure or in accordance with a special flight operations certificate - special aviation event issued pursuant to
section 603.02 ivilaviation/regserv/affairs/cars/part6/603.htm>.

(4) Where the minimum safe speed for the flight configuration of an aircraft is greater thar speed referred to in subsection (1) or (2), the aircraft shall be operated at the minimum safe speed.

Supersonic Flight
602.33 No person shall operate an aircraft at a true Mach number of 1 or greater.

Concorde

http://www.youtube.com/watch?v=_TS83bFLh8w **

http://www.youtube.com/watch?v=u3hprzN0fHA&safety_mode=true&persist_safety_mode=1&safe=active

Attachments

f-18flyby.mpeg

FS14ss.mpeg