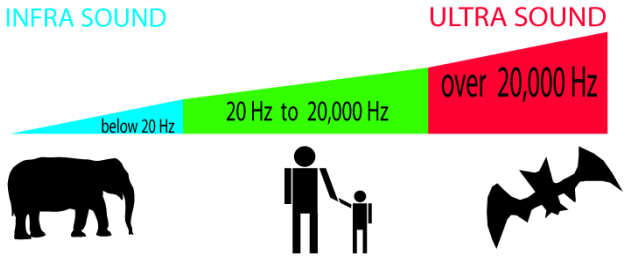
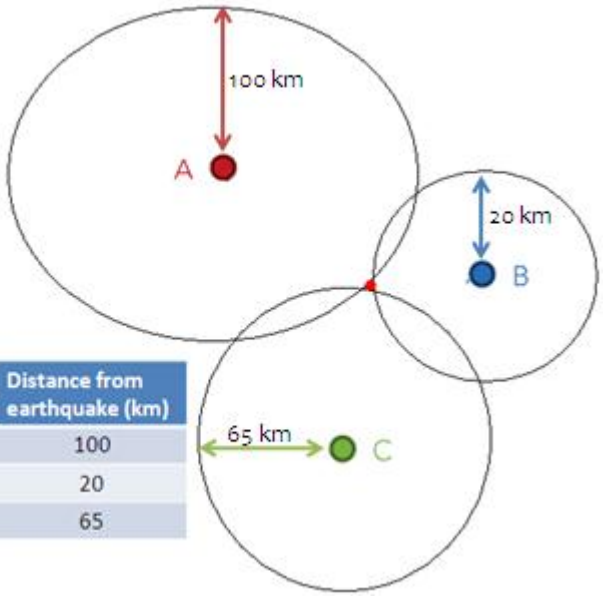
Topic 4 – Waves and the Earth



- **INFRASOUND**
- Sound waves are longitudinal vibrations that must travel through a medium (i.e through a solid, liquid or gas…not through a vacuum)
- Frequency of a sound wave determines its pitch:
  - High frequency→high pitch…low frequency→low pitch
- Sounds with frequencies below 20Hz are called infrasound (humans can't hear these low frequencies of sound, but we can detect them using microphones)
- **Infrasound is used by animals to communicate:**
- Infrasound waves travel further in air (before they become too faint to detect) than sound waves of higher frequencies→infrasound is used by whales and other animals to communicate over long distances
- Using microphones, biologists can pick up infrasounds to study the movement of animals in remote locations
- **Using infrasound for the detection of volcanic eruptions:**
- Natural events such as volcanic eruptions produce infrasound waves
- Infrasound waves can be detected by sensors a long way from the volcano, allowing scientists to predict when eruptions are going to happen
- **Using infrasound for the detection of meteors:**
- Meteors are rocks that fall into the atmosphere from space
- Most meteors burn up in the atmosphere and some explode, however some survive and hit the ground – potentially very dangerous (meteors that hit the ground are called meteorites)
- Scientists use infrasounds to detect the passage of meteors through the atmosphere and also detect any that explode
- **ULTRASOUND**
- Sounds with frequencies above 20,000Hz are called ultrasounds
- Some animals, e.g dolphins, use ultrasound to communicate with each other
- **Sonar:**
- Bats emit ultrasound waves that are reflected by things around them and listen for the echoes in order to locate obstacles and objects in their environment
- Using a similar method, humans use sonar on ships to find out the depth of the sea:
  - A loudspeaker on the ship emits a pulse of ultrasound
  - This spreads through the water, and some is reflected off the sea bed
  - A microphone on the ship detects the echo and the sonar equipment measures the time between the sound being sent out and the echo returning
  - The distance travelled by the sound wave can then be calculated using the equation: distance (m) = speed (m/s) x time (s)
- **Ultrasound scans:**

- Ultrasound can also be used to make images of unborn babies so that doctors can monitor the development of the foetus:
    - A probe is used to emit and receive ultrasound waves
    - A gel is used to stop the ultrasound just reflecting off the skin
    - When ultrasound waves pass from one medium to another (e.g fat or bone), some sound is reflected
    - The time between the pulse being sent out and the echo returning is detected by an ultrasound machine
    - The display shows where the echoes come from→creating the image
- **SEISMIC WAVES**
- Movements inside the Earth, such as earthquakes, cause waves to be transmitted through the Earth – these are called seismic waves
- When seismic waves reach the surface of the Earth, the ground shakes
- Seismometers are instruments that can detect seismic waves, helping scientists to model the structure of the Earth's interior
- **The Earth's interior:**
- Focus: place inside the Earth where rock suddenly moves
- Epicentre: point on the surface of the Earth directly above the focus
- 3 layers of the Earth:
    - The outermost surface of the Earth is called the crust
    - The middle layer is the mantle
    - The innermost layer is the core (liquid on the outside, solid on the inside)
- **P and S waves:**
- An earthquake causes two types of seismic waves within the Earth…:
    - P waves – longitudinal waves:
        - Push and pull on the rock as the wave passes
        - Travel faster than S waves
    - S waves – transverse waves:
        - Move the rock particles from side to side as the wave travels down
        - Travel slower than P waves
- The properties of rocks gradually change with depth (due to increasing heat as you get closer to the Earth's core):
    - →As seismic waves travel deeper towards the Earth's core, their speed increases→they gradually refract upwards and travel on a curved path
- At the boundaries between the different layers, there is a sudden change in rock properties…
    - → seismic waves are refracted sharply and some of the waves may get reflected (back to the surface)
- **DETECTING EARTHQUAKES**
- Scientists use a network of seismometers to detect earthquakes
- In a seismometer trace, the P waves arrive first because they travel faster than S waves
- The time difference between the arrival of the P and S waves is used to work out how far away from a seismometer an earthquake has occurred (the closer together the P and S waves, the closer the earthquake is to the seismometer)
- To work out the precise location of the earthquake's epicentre (point where the earthquake originated), data from 3 or more seismometers is required
- The epicentre of the earthquake is where the three circles meet up**:**



Seismometer	Distance from earthquake (km)
A	100
B	20
C	65

- **Predicting earthquakes:**
- The outermost layer of the Earth - the crust – is made up of tectonic plates
- Tectonic plates are pushed by slow moving convection currents ('heat cycles') in the mantle →the plates move relative to each other
- However, the movement doesn't happen smoothly because friction between the edges of the plates stops them moving
- The forces on the plates build up until they are big enough to overcome the friction. Once friction is overcome, the plates move with a sudden jerk, causing an earthquake
- Most earthquakes occur at boundaries between plates→scientists can study these areas to predict where earthquakes are likely to happen
- However, it's not possible to measure the forces acting on the plates→it's difficult to predict when a sudden movement will happen
- **Predicting tsunamis:**
- If the earthquake happens under the sea, the movement of the sea floor may cause a huge wave called a tsunami
- Scientists can't tell whether or not a tsunami will happen from seismometer traces
- However, pressure sensors detecting tsunami waves can give people at risk several hours' warning