FOCUS	PHYSICS
KNOWLEDGE AREA	WAVES, SOUND AND LIGHT
TOPIC	5 The Doppler effect
SUBTOPIC	5.1 Doppler effect with sound and ultrasound
NAME OF ASSET	5.1.1 Investigate the Doppler effect with sound

TYPE OF ASSET	SIMULATION: Change parameters and observe
SUBTYPE	4P1E
OBJECTIVE	Set parameters to observe the Doppler effect with sound

SUBHEADING: Set the parameters for the movement of the ambulance or the listener and observe the sound.

TEXT FOR BUTTON

Instructions

1. Set the frequency of the sound from the siren of the ambulance.
2. Decide whether you want the listener or the ambulance to move. Click the appropriate button.
3. Decide in which direction and how fast you want the listener or the ambulance to move. Use the slider to set this.
4. Click GO to start the motion.
5. Observe the frequency of the sound heard by the listener.
6. Click RESET to start again.

USER INTERACTION

- Show a South African ambulance and a person standing on the side of the road. Do not show logos or brand names on the ambulance that are recognisable.
- Please use more sophisticated graphics than the ones used in the Gr 12 Physical Sciences animation package titled "Doppler effect with sound".
- The ambulance must be able to move towards or away from the stationary listener. When the ambulance is stationary, the listener must be able to move towards or away from it.
- There must be a slider or something where the user can set the frequency of the sound coming from the siren of the ambulance. Please use a realistic range.
- There must be buttons that allow the user to decide whether the ambulance or the listener must move. If a button is clicked, the corresponding slider becomes active.
- The user must be able to set the speed and direction of movement with the slider. We need two sliders, because the speed range for the ambulance will be different from the speed range for a walking person.

- Something like this maybe.

towards the ambulance   away from the ambulance

towards the listener   away from the listener
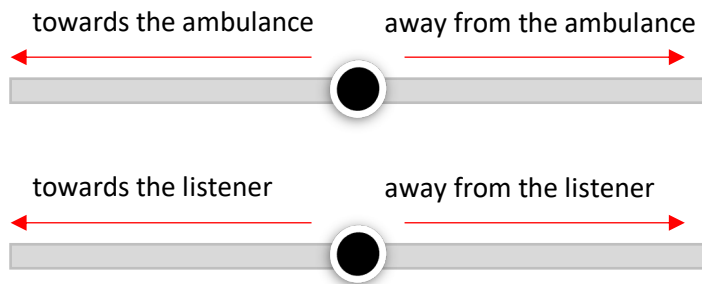
- When the user clicks GO, show movement that corresponds with the parameters that were chosen. **Also show "sound waves" coming from the ambulance and show how the listener observe them as "stretched out" or "packed closer".**
- This asset will be really useful if corresponding sound clips can be built in, i.e. as the movement is shown, the sound as observed by the listener is played.
- Show the following on the screen and populate the values as they become relevant.
  Frequency of sound emitted by ambulance: [BLANK]
  Speed of ambulance: [BLANK]
  Speed of listener: [BLANK]
  Observed frequency heard by listener: [BLANK]
- Note that either the speed of the ambulance or the speed of the listener will be zero. Learners do not have to deal with scenarios where both are moving.
- The range and default values for the different sliders should be as per below:

Frequency of sound emitted by ambulance f_S (Hz)
700
800
900
1 000

Speed of ambulance v_S (m.s^{-1})
0
10
20
30
40
50
60

Speed of listener v_L (m.s^{-1})
0
1
2
3
4
5

- The formula for Doppler effect of sound to be used is given below.

$$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$$

Listener moving towards source AND Source moving towards listener:

$$f_L = \frac{v + v_L}{v - v_S} f_S$$

Listener moving towards source AND Source moving away from listener:

$$f_L = \frac{v + v_L}{v + v_S} f_S$$

Listener moving away from source AND Source moving towards listener:

$$f_L = \frac{v - v_L}{v - v_S} f_S$$

Listener moving away from source AND Source moving away from listener:

$$f_L = \frac{v - v_L}{v + v_S} f_S$$

f_S (Hz)	Ambulance speed v_S (m.s^{-1})	Direction of ambulance	Listener speed v_L (m.s^{-1})	Direction of listener	f_L (Hz)
700	10	TOWARDS	0	-	721,21
700	60	TOWARDS	0	-	850,00
700	60	AWAY	0	-	595,00
700	0	-	1	TOWARDS	702,06
700	0	-	5	TOWARDS	710,29
700	0	-	5	AWAY	689,71
800	60	AWAY	0	-	680,00
900	60	TOWARDS	0	-	1092,86
1 000	60	TOWARDS	0	-	1214,29
1 000	60	AWAY	0	-	850,00

f_S (Hz)	Ambulance speed v_S (m.s^{-1})	Direction of ambulance	Listener speed v_L (m.s^{-1})	Direction of listener	f_L (Hz)
1 000	60	-	5	AWAY	985,29