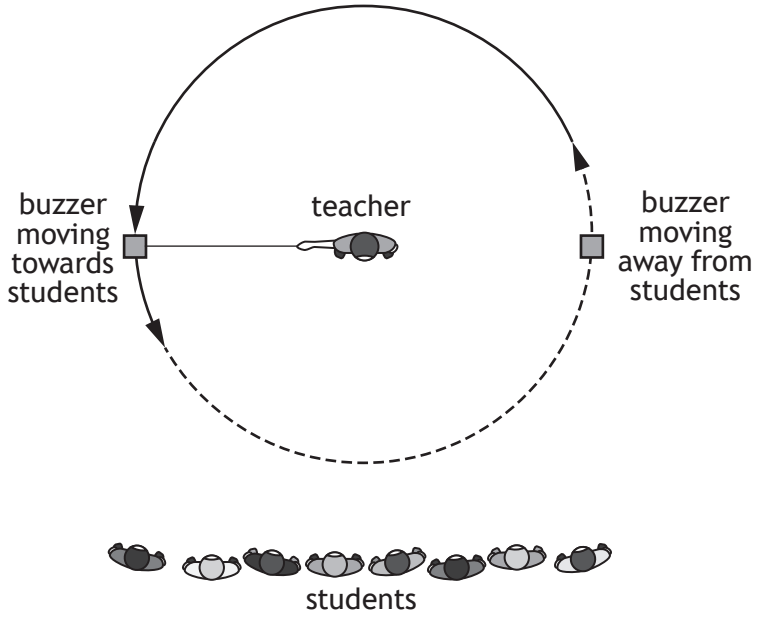
5. A teacher uses a buzzer attached to a string to demonstrate the Doppler effect to a group of students.

The buzzer produces a sound of constant frequency.

The teacher swings the buzzer at a constant speed in a horizontal circle.



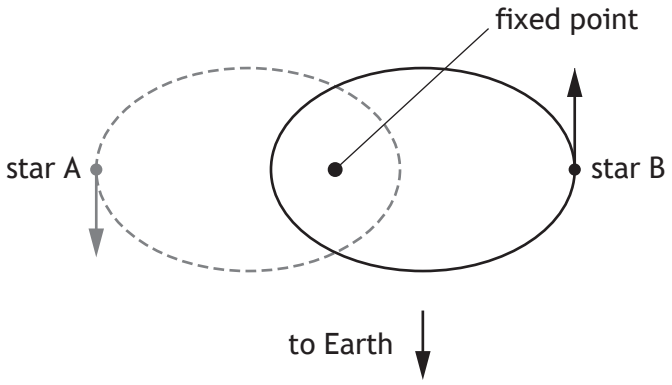
(a) Explain, in terms of wavefronts, why the frequency of the sound heard by the students is lower as the buzzer moves away from them compared to when the buzzer is moving towards them.

You may wish to use a diagram. **2**

5. (continued)

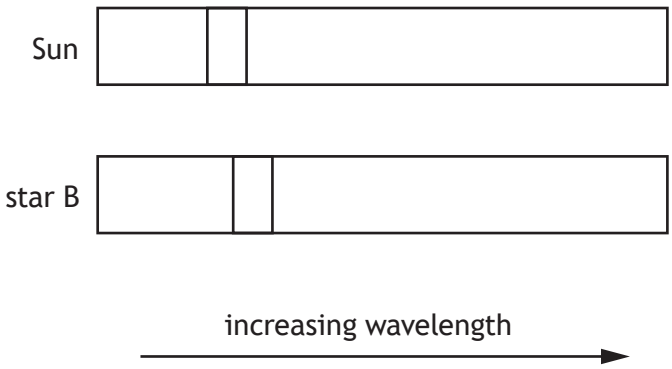
(b) The teacher uses the Doppler effect model to explain observations of the light emitted by a binary star system.

A binary star system consists of two stars that orbit a common fixed point.



Line spectra are obtained from the stars in the binary system and compared with the line spectrum from the Sun.

Part of the line spectra for star B and the Sun are shown below.



5. (b) (continued)

(i) One of the lines in the spectrum from the Sun has a wavelength of 580 nm. The wavelength of the corresponding line in the spectrum from star B has a wavelength of 610 nm.

Calculate the redshift of star B. **3**

Space for working and answer

(ii) Determine the approximate distance from Earth to the binary star system. **5**

Space for working and answer

5. (continued)

(c) (i) At one instant in their orbits around the fixed point, the stars in the binary system are 3.44×10^{12} m apart.

The mass of star A is 2.19×10^{30} kg and the mass of star B is 1.80×10^{30} kg.

Calculate the gravitational force between star A and star B at this instant. **3**

Space for working and answer

(ii) At another point in their orbits the distance between the stars is half that in (c) (i).

State how many times greater the gravitational force between star A and star B is at this point, compared to that in (c) (i). **1**