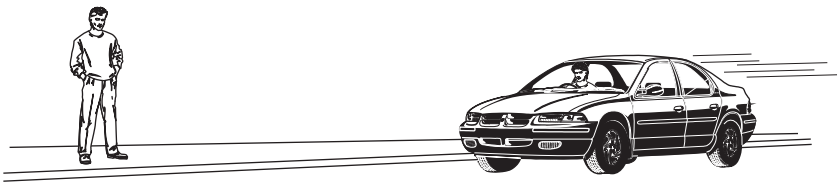
5. (a) A person is standing at the side of a road. A car travels along the road towards the person, at a constant speed of $12\,m\,s^{-1}$. The car emits a sound of frequency 510 Hz.



The person observes that the frequency of the sound heard changes as the car passes.

(i) State the name given to this effect. **1**

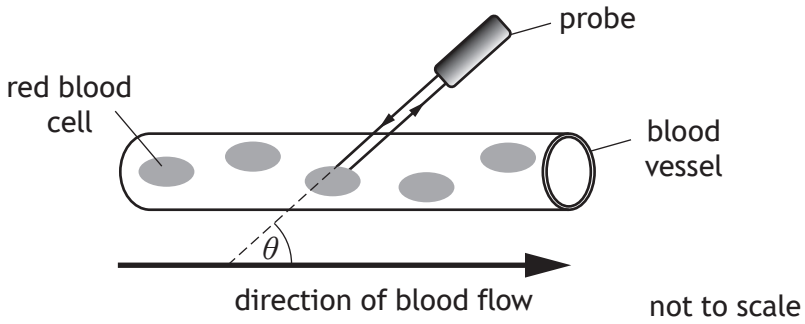
(ii) Calculate the frequency of the sound heard by the person as the car approaches.

The speed of sound in air is $340\,m\,s^{-1}$. **3**

Space for working and answer

MARKS

(b) This same effect is used to determine the speed of red blood cells through blood vessels.



Ultrasound waves are transmitted by a probe. The frequency of the ultrasound waves changes as they reflect from the blood cells. The probe detects the reflected waves.

The velocity of the red blood cells can be determined using the following relationship

$$\Delta f = \frac{2 f \ v_{rbc} \cos\theta}{v}$$

where Δf is the change in frequency

f is the transmitted frequency

v_{rbc} is the velocity of the red blood cells

v is the velocity of the ultrasound

θ is the angle between the direction of the waves and the direction of the blood flow.

The frequency of the ultrasound transmitted by the probe is 3·70 MHz.

The velocity of the ultrasound is 1540 m s^{-1}.

During one test, the angle between the direction of the waves and blood flow is 60·0°. The change in frequency of the ultrasound is 286 Hz.

Calculate the velocity of the red blood cells during this test. **2**

Space for working and answer