4 **(a)** By reference to the direction of the propagation of energy, state what is meant by a *longitudinal* wave and by a *transverse* wave.

longitudinal: .....

.....

.....

transverse: .....

.....

.....

[2]

(b) The intensity of a sound wave passing through air is given by

$$I = Kv\rho f^2 A^2$$

where I is the intensity (power per unit area),
K is a constant without units,
v is the speed of sound,
ρ is the density of air,
f is the frequency of the wave
and A is the amplitude of the wave.

Show that both sides of the equation have the same SI base units.

[3]

(c) **(i)** Describe the *Doppler effect*.

.....

.....[1]

(ii) A distant star is moving away from a stationary observer.

State the effect of the motion on the light observed from the star.

.....

.....

.....[1]

(d) A car travels at a constant speed towards a stationary observer. The horn of the car sounds at a frequency of 510 Hz and the observer hears a frequency of 550 Hz. The speed of sound in air is 340 m s^{-1}.

Calculate the speed of the car.

speed = ... $m\,s^{-1}$ [3]

[Total: 10]