8 (a) (i) State the *principle of superposition*.

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.....

..... [1]

(ii) Explain what is meant when two sources are *coherent*.

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..... [1]

(b) A loudspeaker connected to a signal generator is placed near the open end of a transparent pipe.

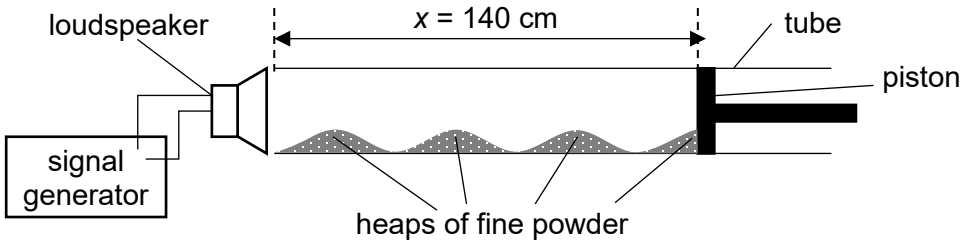

Fig. 8.1

A moveable piston acts as a stopper on the other end of the pipe. Fine powder is scattered along the entire length of *x*.

When the signal generator is set to a frequency of 400 Hz and the piston positioned such that length *x* is 140 cm, the fine powder collects in regularly spaced heaps as shown in Fig 8.1.

(i) Explain how the heaps of fine powder are formed.

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..... [3]

(ii) Determine the speed of sound in the pipe.

speed = ... m s^{-1} [2]

(c) The two ends of a 1.5 m string under tension are fixed to vibrators as shown in Fig. 8.2. Both vibrators are connected in parallel to the same output of a single signal generator.

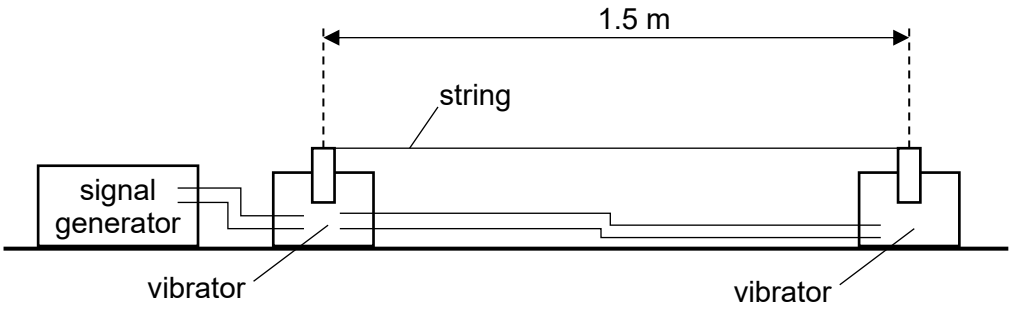

Fig. 8.2

The frequency on the signal generator is slowly increased from the minimum possible. A stationary wave in the string is first observed when the frequency *f* is 150 Hz.

(i) In Fig. 8.3 below, sketch the stationary wave that is formed.

Fig. 8.3

[1]

(ii) Calculate the speed of the wave in the string.

speed = ... m s^{-1} [1]

(iii) Determine the next lowest frequency at which another stationary wave will be observed.

frequency = ... Hz [1]

(d) The volume of a monoatomic ideal gas in a cylinder is $0.50\ m^3$ at a pressure of 101 kPa and a temperature of $27°C$, as shown in Fig. 8.4.

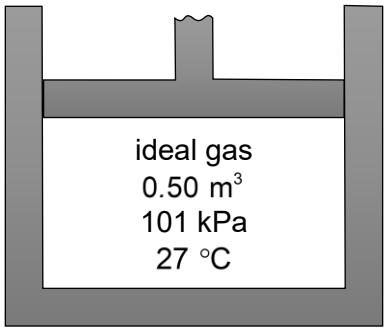

Fig. 8.4

The gas is heated and expands at constant pressure. Its temperature rises to $57°C$.

(i) Use the kinetic model to explain the increase in volume when the gas is heated at constant pressure.

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..... [2]

(ii) On Fig. 8.5, sketch the variation of pressure with volume for the process. Label the graph with appropriate values of pressure and volume.

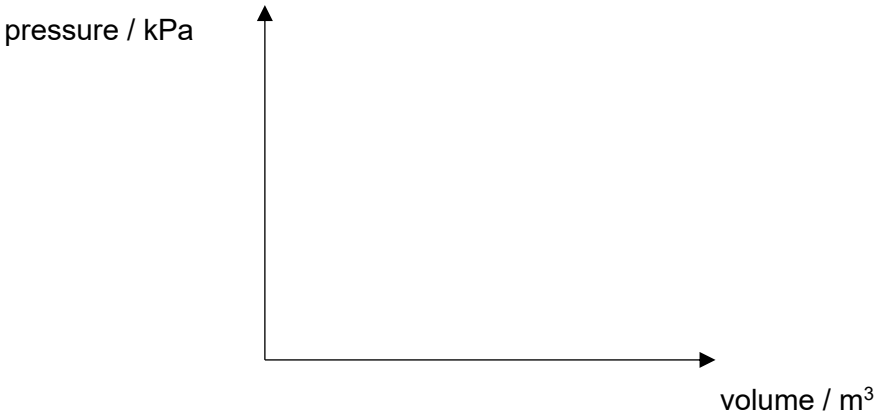

Fig. 8.5

[2]

(iii) Determine the change in internal energy of the ideal gas.

change in internal energy = …….. J [3]

(iv) Show that the average kinetic energy of an ideal gas particle is $E = \frac{3}{2}kT$.

[1]

(v) The ideal gas is identified to be krypton atoms, which are of molar mass of 84.0 g mol^{-1}.

Calculate the root-mean-square speed of a krypton atom after the constant-pressure heating.

root-mean-square speed = …….. m s^{-1} [2]

[Total: 20]