3 **(a)** A satellite passing the planet Neptune communicates with its controller on the Earth using a microwave transmitter with output power 25 W and wavelength 80 mm. Neptune is 4.4×10^{12} m from the Earth at the time when the communication takes place.

(i) State whether the microwaves are longitudinal or transverse.

……..… [1]

(ii) Calculate the time taken for a signal to travel from the satellite to the Earth.

time taken = ……. s [1]

(iii) Assuming the power transmitted by the satellite is radiated uniformly in all directions, calculate the power received on Earth by a dish aerial of effective area 280 m^2.

power = ……. W [3]

(iv) The actual power received at the dish aerial is 1.2×10^{-15} W. Suggest why the actual power received is greater than that calculated in **(a)(iii)**.

……..

……..... [1]

(b) Circular water waves are produced by vibrating dippers at points P and Q, as shown in Fig. 3.1.

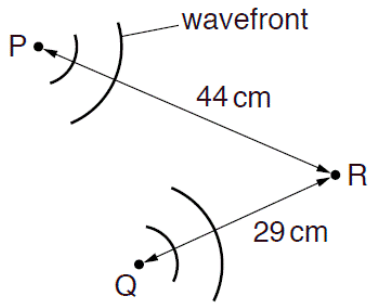

Fig. 3.1

The waves from P alone have the same amplitude at point R as the waves from Q alone. Distance PR is 44 cm and distance QR is 29 cm.

The dippers vibrate in phase with a period of 1.5 s to produce waves of speed 4.0 cm s^{-1}.

(i) Determine the wavelength of the waves.

wavelength = ……. m [2]

(ii) By reference to the distances PR and QR, explain why the water particles are at rest at point R.

……

……

……

……

…… [3]

(c) A loudspeaker is held above a vertical tube of liquid, as shown in Fig. 3.2.

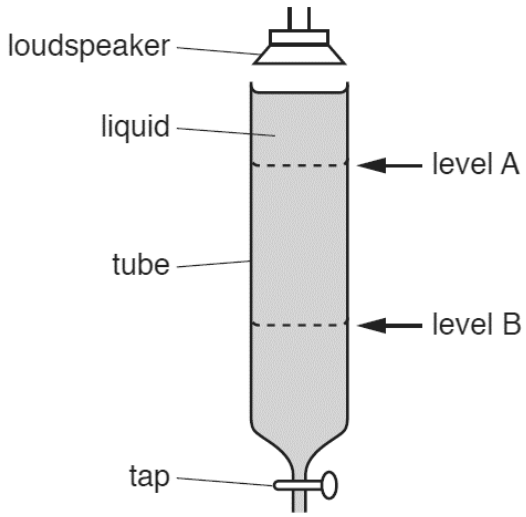

Fig. 3.2

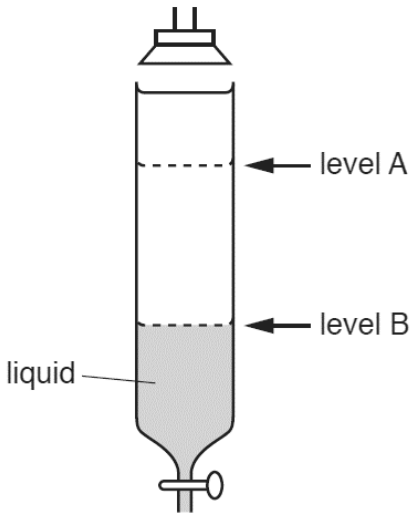

Fig. 3.3

A tap at the bottom of the tube is opened so that liquid drains out at a constant rate. The wavelength of the sound from the loudspeaker is 0.18 m.

A stationary wave is formed when the sound that is heard becomes much louder. This first occurs when the liquid surface reaches level A. The next time that the sound becomes much louder is when the liquid surface reaches level B, as shown in Fig. 3.3.

(i) Explain the formation of a stationary wave in the tube.

……

……

……

……

…… [2]

(ii) Calculate the vertical distance between level A and level B.

vertical distance = …… m [1]

(iii) **On Fig. 3.3**, label with the letter X the positions of maximum pressure variation that are formed in the air column when the liquid surface is at level B.

[1]

[Total: 15]