Section B

Answer **one** question in this Section in the spaces provided.

9 **(a)** **(i)** Explain what is meant by

1. *diffraction*

……..

…… [1]

2. *interference*; and

……..

…… [1]

3. *coherence*

……..

…… [1]

(ii) State two conditions for observable interference of two waves.

……

……

……

…….. [2]

(b) To help guide large ships berth properly into docks, an engineer proposed using interference of electromagnetic (EM) waves. The proposal suggests installing two EM wave emitters P and Q positioned 95 m apart at the edges of the dock gates. The two emitters can be taken to be point sources and they emit radio waves of frequency f_1 in phase.

The ship can be guided by searching for the strong signal radiated along the lines of constructive interference, also known as anti-nodal lines. For safety, it is important for the ship to ensure that it is sailing along the centre-line of the gates, as such the ship needs to "lock on" to the central anti-nodal line.

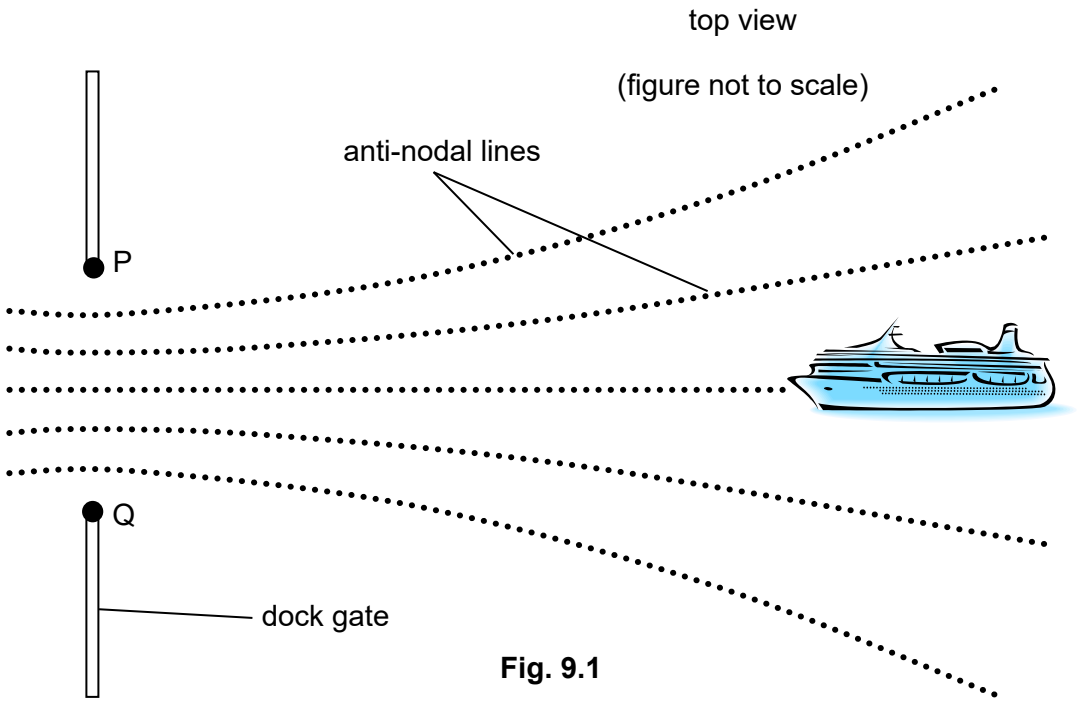

Fig. 9.1

(i) Explain why the centre-line will always be an anti-nodal line regardless of the frequency of the radio waves used.

……

…….. [1]

(ii) State and explain why radio waves are suitable for such a system.

……

……

……

…….. [2]

(iii) Assuming that the ship is sailing along the centre-line, state and explain how the intensity of the resultant signal varies as it approaches the dock gates.

……

……

……

…… [2]

(c) One particular large cargo ship strays off the centre-line as shown in Fig. 9.2.

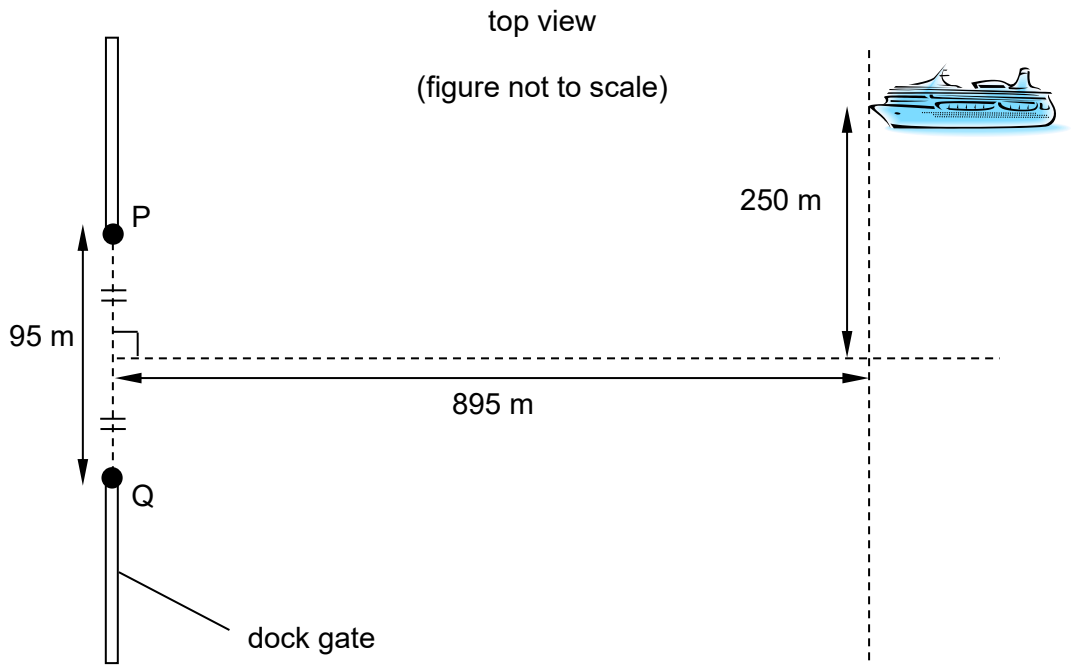

Fig. 9.2

Explain quantitatively (with calculations) whether the ship is on an anti-nodal line, given that f_1 is 23.5 MHz.

……

……

…… [3]

(d) As an additional precaution to ensure that the ship "locks on" to the central anti-nodal line, the emitters can simultaneously emit another radio wave of a different frequency f_2.

(i) Explain how this precaution helps to prevent the ship from "locking on" to the wrong anti-nodal line.

……

……

……

…….. [1]

(ii) Discuss why this additional precaution may still not be fool proof.

……

……

……

…….. [1]

(e) The large cargo ship is carrying loads of new cars. As the cargo ship is cruising, a car which is not secured properly starts to move. A small piece of chewing gum is stuck to the edge of the wheel as shown in Fig. 9.3. A camera records the motion of the car's wheel from the rear view as it is rotating. Assume that the angular velocity of the wheel is constant.

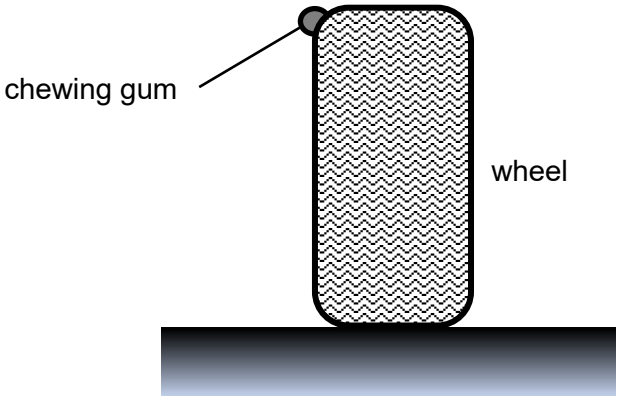

Fig. 9.3

(rear view)

(i) State the type of motion exhibited by the chewing gum from this viewpoint as shown in Fig. 9.3 when the wheel rotates.

…….. [1]

(ii) The car moves at a speed of 5.0 km h^{-1}. Determine the period of the chewing gum, given that the wheel has a diameter of 0.45 m.

period = …….. s [2]

(iii) Hence, determine the maximum vertical acceleration of the chewing gum.

maximum vertical acceleration = …….. m s^{-2} [2]