5 A magnetic sail or magsail was proposed by Zubrin in 1991 to launch a spacecraft into space. A loop of cable is attached to the spacecraft, generating magnetic field. Fig. 5.1 shows a simplified diagram of a magsail, consisting of a circular loop of cable carrying a current I. The spacecraft is propelled by deflecting solar winds which consists of charged particles.

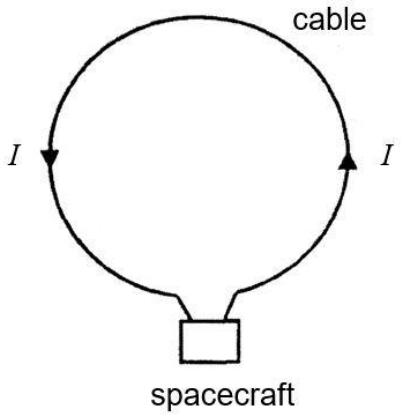

Fig. 5.1

(a) Explain how the magsail gets its propulsion from the deflection of the charged particles of solar winds.

……...

……...

……... [2]

(b) Suggest why the magsail cannot be propelled by photons.

……...

……... [1]

(c) In Fig. 5.2, a magsail carrying a current I of 3.0 kA catches a solar wind consisting protons of kinetic energy 500 keV. The direction of the solar wind is along the plane of the page. The cable forms a circular shape with diameter 128 m.

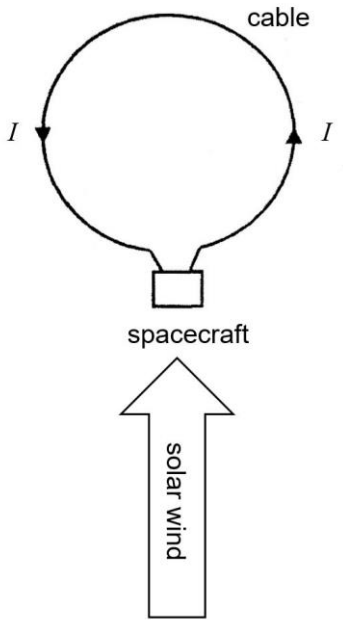

Fig. 5.2

(i) By considering only the magnetic field within the coil, draw the direction of the force experienced by the magsail and label it **F** in Fig 5.2. [1]

(ii) Calculate the speed of the protons.

speed of the protons = …….. m s^{-1} [2]

(iii) Determine the magnetic flux density at the centre of the coil.

magnetic flux density = ……. T [2]

(iv) Hence, calculate the force experienced by a proton passing through the centre of the coil.

force = …… N [2]

[Total: 10]