

**Question 12****(8 marks)**

It is imagined that solar sails made from highly reflective thin sheets of metal might propel spacecraft on solar winds without the need for a propulsion system.

A space agency conducted an experiment to determine the possibility of propelling a spacecraft using a solar sail. To simulate the contribution of photons in solar wind they used a highly collimated (focused) beam of light. This beam of light contained  $2.50 \times 10^{18}$  photons, with each photon having a wavelength of 487 nm. A highly-reflective mirror of mass  $3.00 \mu\text{g}$  was used to simulate the solar sail. The collimated beam is fired at  $90.0^\circ$  to the surface of the highly-reflective mirror in a vacuum.

- (a) Calculate the magnitude of the momentum of each photon. (2 marks)

Answer \_\_\_\_\_ N s

When the photon beam collides with the mirror, momentum (equal to the product of mass and velocity) is conserved and the mirror moves.

- (b) Calculate the recoil velocity of the mirror when the beam of light reflects from it. (4 marks)

Answer \_\_\_\_\_  $\text{m s}^{-1}$

- (c) Outline **two** possible limitations of using solar sail technology to propel a spacecraft. (2 marks)

One: \_\_\_\_\_

\_\_\_\_\_

Two: \_\_\_\_\_