

A level Physics B

H557/02 Scientific literacy in physics

Question Set 4

1

This question is about the New Horizons spacecraft mission to the dwarf planet Pluto.

In July 2015, the Long Range Reconnaissance Imager (LORRI) sent the image shown in **Fig. 1.1a**.



Fig. 1.1 a

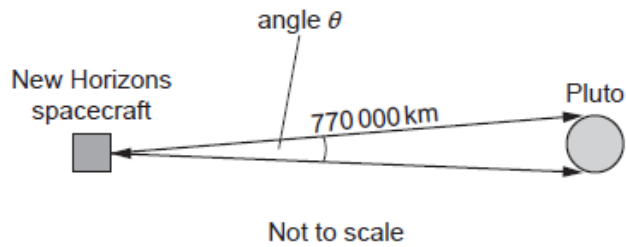


Fig.1.1 b

- (a) It takes 4.5 hours for the radio signal from the spacecraft at Pluto to reach the Earth.

Calculate the distance of the spacecraft from Earth when the signal was transmitted.

distance =m

[2]

- (b) The square image is 1024 pixels wide. The diameter of Pluto is 2700 km.

- (i) Calculate the resolution of the image in km pixel^{-1} .

resolution = km pixel^{-1}

[3]

- (ii) The image in **Fig. 1.1a** was taken at a distance of 770 000 km. The **angular** resolution of LORRI is 5×10^{-6} radian per pixel. This means that each pixel covers an angle of 5×10^{-6} radian.

By calculating how many radians Pluto subtends (angle θ in **Fig. 1.1b**), test whether the value for angular resolution agrees with your value for the resolution in (b)(i). Comment on your answer.

[4]

(c)* New Horizons is powered by a radioisotope thermal generator. This produces electrical power from the thermal energy of decaying plutonium-238.

Explain why solar power is not used for this spacecraft. Use the data below to calculate the energy released per second at launch and the reduction in energy released per second when New Horizons reached Pluto. Comment on your results.

Data:

Mean Sun-Pluto distance = $40 \times$ mean Sun-Earth distance

Amount of plutonium-238 carried by spacecraft: 36 mol

Number of plutonium-238 nuclei in one mole: $6.0 \times 10^{23} \text{ mol}^{-1}$

Half-life of plutonium-238: 87.7 years ($2.8 \times 10^9 \text{ s}$)

Energy released in the decay of one plutonium nucleus: 5.6 MeV

Journey time to Pluto: 9 years

[6]

Total Marks for Question Set 4: 15

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