

In 1990, the Hubble Space Telescope (HST) was launched into a low Earth orbit above the Earth’s atmosphere.

(a) HST orbits the Earth in a circular orbit with a speed of  $7.59\text{ km s}^{-1}$ .

mass of Earth =  $5.97 \times 10^{24}\text{ kg}$   
radius of Earth =  $6.37 \times 10^6\text{ m}$

(i) Show that the height of HST above the surface of the Earth is about  $6 \times 10^5\text{ m}$ .

(3)

(ii) Calculate the increase in the gravitational potential energy as HST is raised, from its initial position at the Earth’s surface, to its orbital height.

mass of HST =  $11\,600\text{ kg}$

(2)

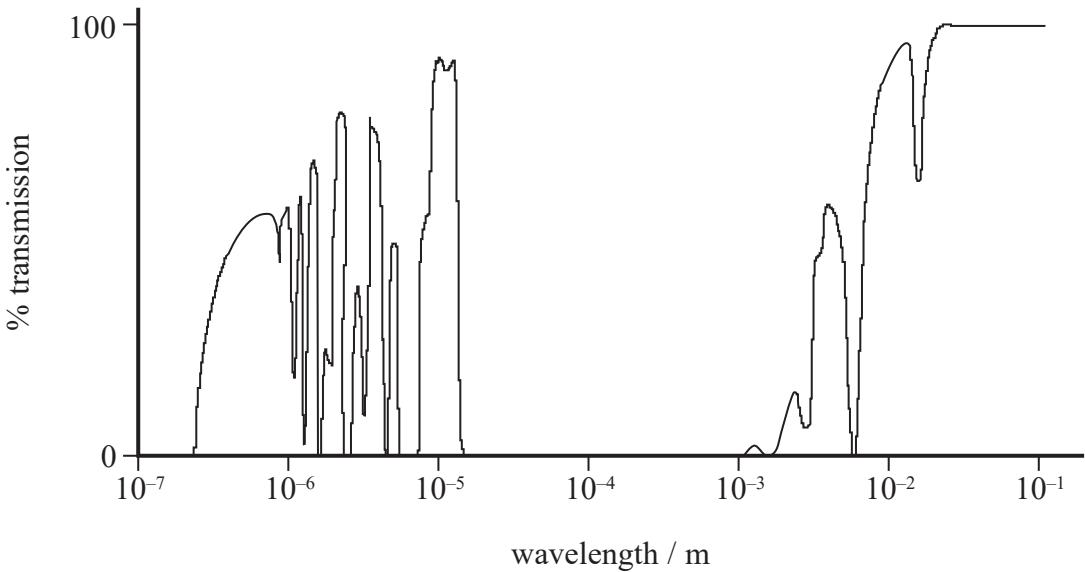
Increase in gravitational potential energy = .....

(iii) A student suggests that giving HST more energy than that required in (ii) would result in the satellite orbiting at a greater height and with a greater speed.

Assess the validity of the student’s suggestion.

(4)

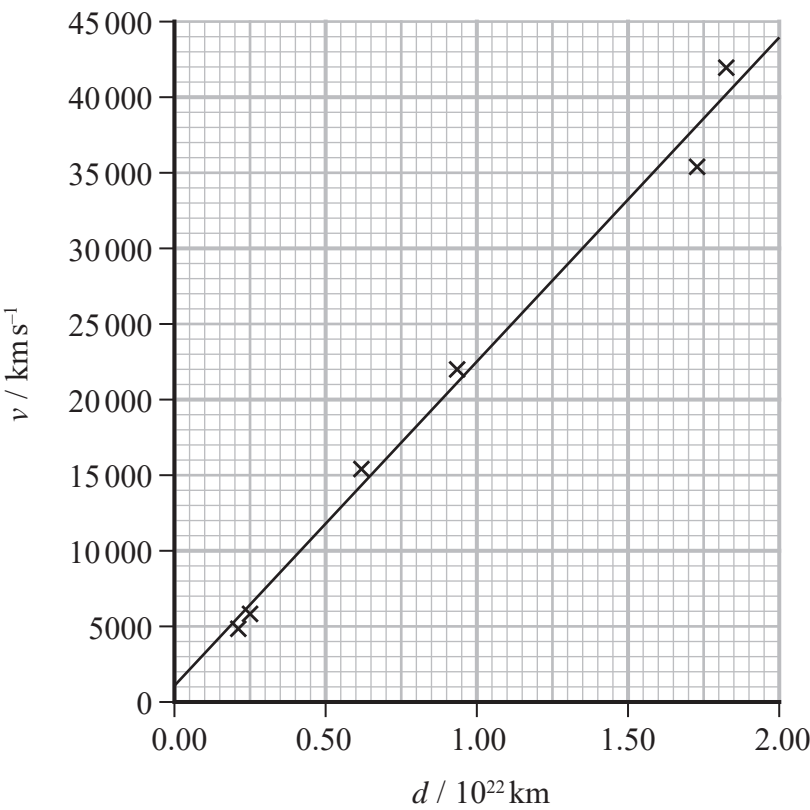
(b) The transmission of electromagnetic radiation through the atmosphere is shown on the graph.



State one advantage shown by this graph of positioning a telescope above the atmosphere.

(1)

(c) High resolution images from HST allow astronomers to make detailed measurements of very distant galaxies. The graph shows how the recessional velocities of distant galaxies depend on their distance from Earth.



Determine an age for the universe.

(3)

Age for the universe = .....

(Total for Question 6 = 13 marks)