17 Astronomers observing stars at the centre of our galaxy have suggested that many of them are orbiting a supermassive black hole. The mass of this black hole is 9.2×10^{36} kg.

(a) Calculate the orbital period for a star in a circular orbit at a distance of 1.9×10^{14} m from a black hole of this mass.

(3)

Orbital period = ...

(b) The star S0-2 is in a highly elliptical orbit around the position of the black hole.

At its point of closest approach, S0-2 is at a distance of 1.8×10^{13} m from the centre of the black hole.

At the most distant point of its orbit, S0-2 is 2.7×10^{14} m from the black hole.

(i) Show that the change in gravitational potential between the closest and most distant points in this orbit is about 3×10^{13} J kg^{-1}.

(2)

(ii) At its point of closest approach, the star is travelling at a speed of 8.1×10^{6} m s^{-1}.

Calculate the speed of S0-2 at the furthest point in its orbit using the change in gravitational potential.

mass of S0-2 = 2.4×10^{31} kg

(3)

Speed = ...

(c) Trigonometric parallax and Hubble's law are two methods used to determine astronomical distances.
Explain whether either of these methods is suitable to determine the distance to S0-2.

(3)

(Total for Question 17 = 11 marks)