Answer **all** the questions in the spaces provided.

1 **(a)** By reference to the definition of gravitational potential, explain why gravitational potential is a negative quantity.

.....

.....

..... [2]

(b) Two stars A and B have their surfaces separated by a distance of 1.4×10^{12} m, as illustrated in Fig. 1.1.

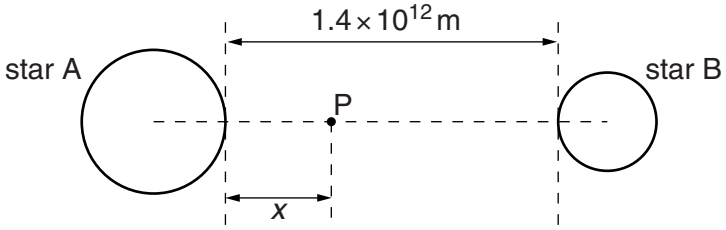

Fig. 1.1

Point P lies on the line joining the centres of the two stars. The distance x of point P from the surface of star A may be varied.

The variation with distance x of the gravitational potential ϕ at point P is shown in Fig. 1.2.

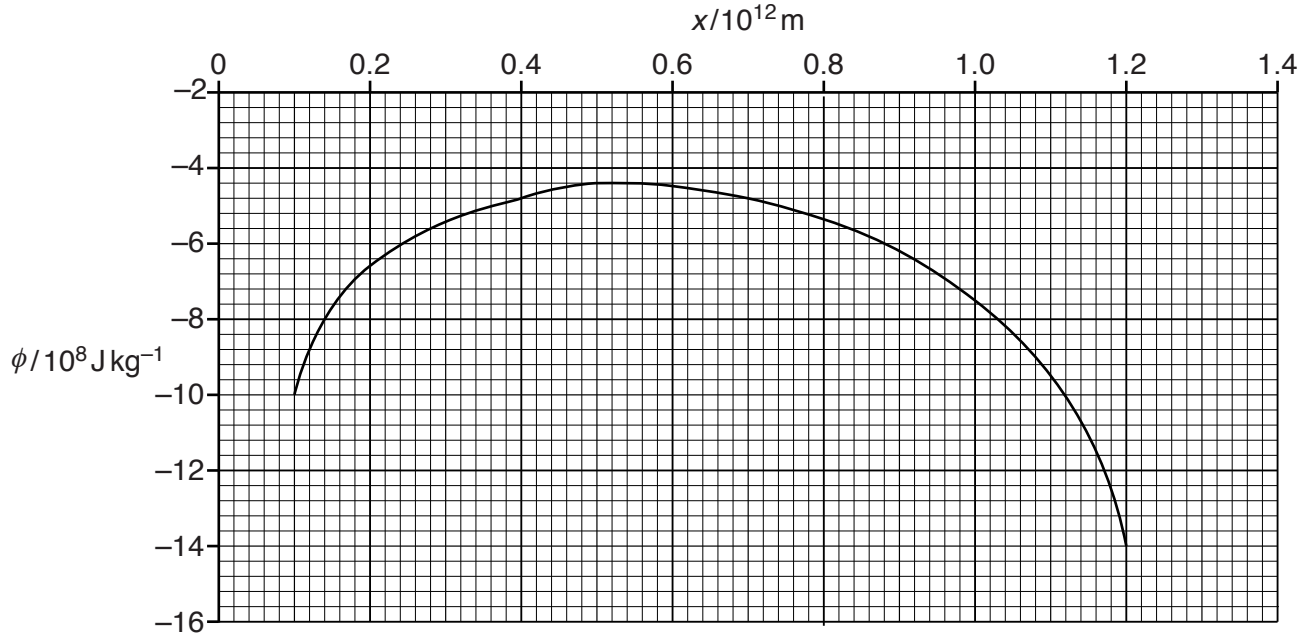

Fig. 1.2

© UCLES 2016

A rock of mass 180 kg moves along the line joining the centres of the two stars, from star A towards star B.

(i) Use data from Fig. 1.2 to calculate the change in kinetic energy of the rock when it moves from the point where $x = 0.1 \times 10^{12}$ m to the point where $x = 1.2 \times 10^{12}$ m.
State whether this change is an increase or a decrease.

change = ... J

.....
[3]

(ii) At a point where $x = 0.1 \times 10^{12}$ m, the speed of the rock is v.

Determine the minimum speed v such that the rock reaches the point where $x = 1.2 \times 10^{12}$ m.

minimum speed = ... $m\,s^{-1}$ [3]

[Total: 8]