

1 (a) Define gravitational field.

.....  
..... [1]

(b) The gravitational field strength  $g$  at a distance  $x$  from the centre of a uniform spherical planet of mass  $M$  is given by the expression

$$g = \frac{GM}{x^2}$$

where  $G$  is the gravitational constant and distance  $x$  is greater than the radius of the planet.

(i) Describe the pattern of the field lines outside the planet that represent the gravitational field due to the planet.

.....  
.....  
..... [2]

(ii) Explain why, for small changes in vertical height near the surface of the planet,  $g$  may be assumed to be constant.

.....  
.....  
..... [2]

(c) Assume that the Earth is a uniform sphere. For the Earth, the product  $GM$  is equal to  $3.99 \times 10^{14} \text{ m}^3 \text{ s}^{-2}$ .

(i) Determine a value, to three significant figures, for the radius  $R$  of the Earth.

$$R = \dots\dots\dots \text{ m} \quad [2]$$

(ii) Calculate the gravitational potential at the Earth's surface. Give a unit with your answer.

$$\text{gravitational potential} = \dots\dots\dots \text{ unit} \dots\dots\dots [2]$$

(d) Explain why the gravitational potential energy of two point masses is always negative.

.....  
.....  
..... [2]