1 **(a)** **(i)** State what is indicated by the direction of the gravitational field line at a point in a gravitational field.

.....

..... [1]

(ii) Explain, with reference to gravitational field lines, why the gravitational field near the surface of the Earth is approximately constant for small changes in height.

.....

.....

..... [2]

(b) A large isolated uniform sphere has mass M and radius R.

Point P lies on a straight line passing through the centre of the sphere, at a variable displacement x from the centre, as shown in Fig. 1.1.

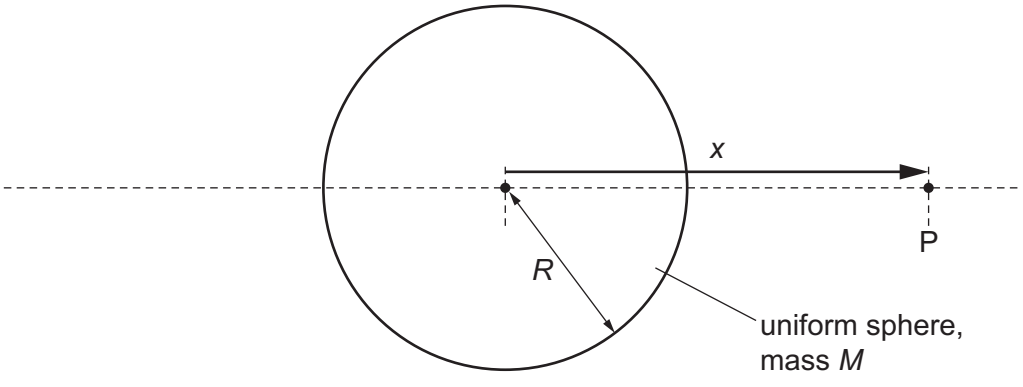

Fig. 1.1

Fig. 1.2 shows the variation with x of the gravitational field g at point P due to the sphere for the values of x for which P is inside the sphere.

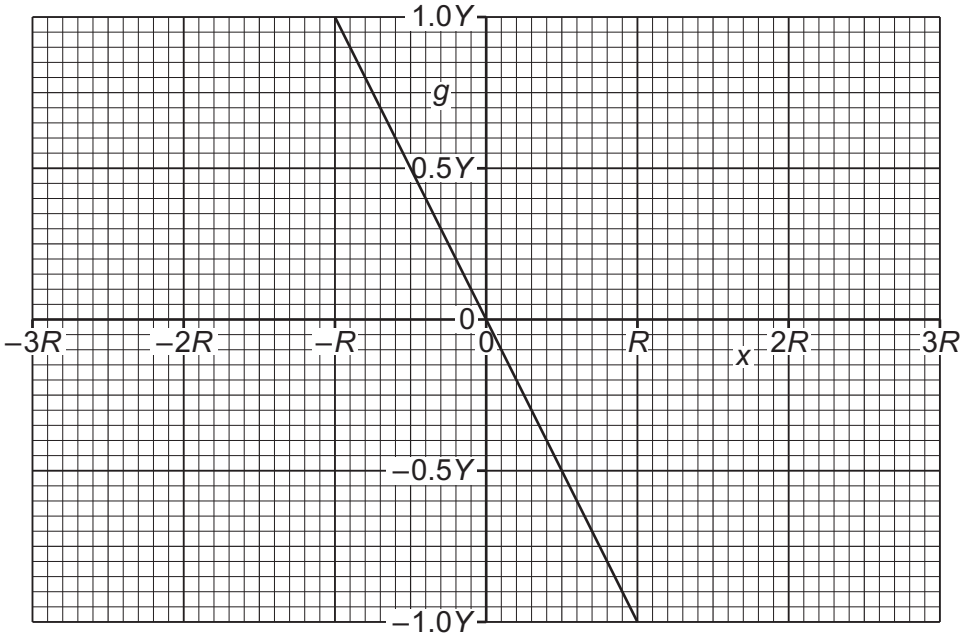

Fig. 1.2

The magnitude of the gravitational field at the surface of the sphere is Y.

(i) Determine an expression for Y in terms of M and R. Identify any other symbols that you use.

[2]

(ii) Explain why, at the surface of the sphere, g always has the opposite sign to x.

.....

.....

..... [2]

(iii) Complete Fig. 1.2 to show the variation of g with x for values of x, up to $\pm 3R$, for which point P is outside the sphere. [3]

[Total: 10]