

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

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..... [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.

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..... [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.

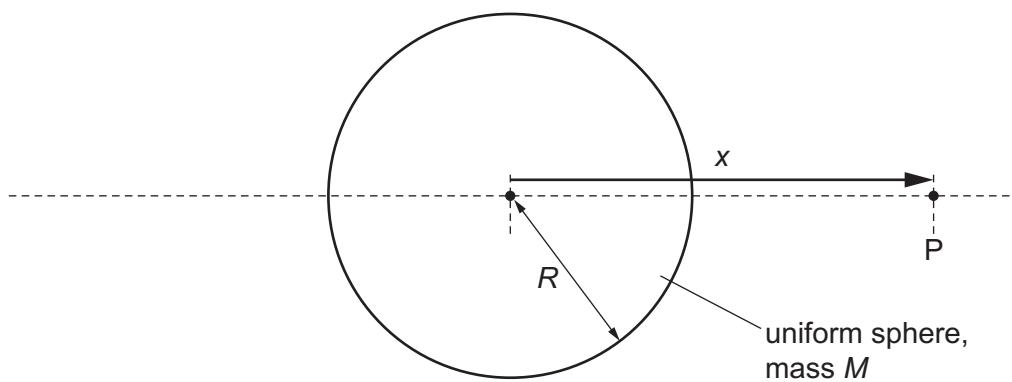
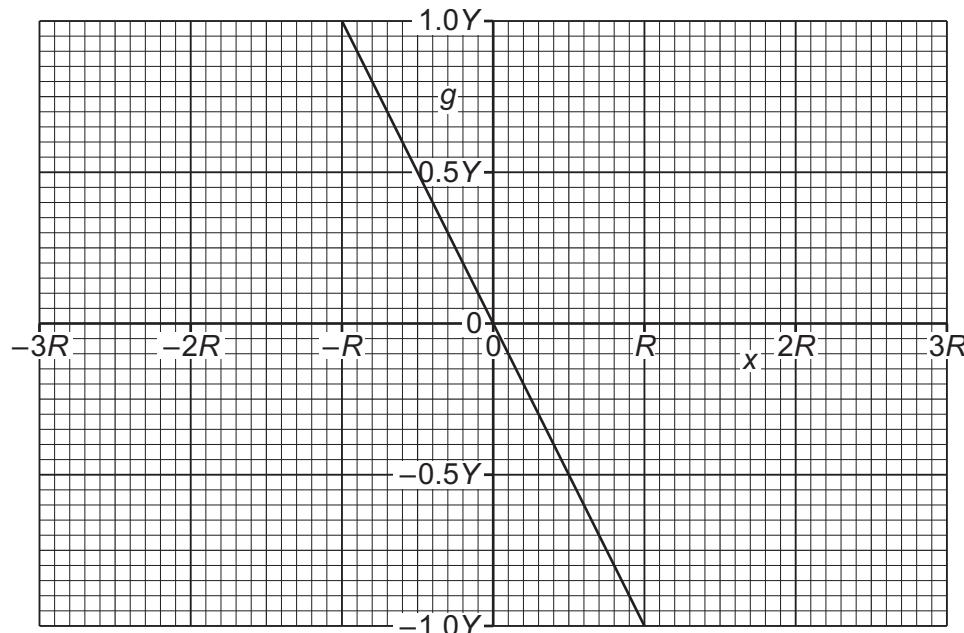


Fig. 1.1

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  $x$ .

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[2]

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

[3]