3 **(a)** **(i)** Define *gravitational potential* at a point.

……

……

…… [1]

(ii) Suggest why, for small changes in height near the Earth's surface, gravitational potential is approximately constant.

……

……

……

…… [2]

(b) An isolated solid sphere of radius r may be assumed to have its mass M concentrated at its centre. The magnitude of the gravitational potential at the surface of the sphere is ϕ.

On Fig. 3.1, show the variation of the gravitational potential with distance d from the centre of the sphere for values of d from $d = r$ to $d = 4r$.

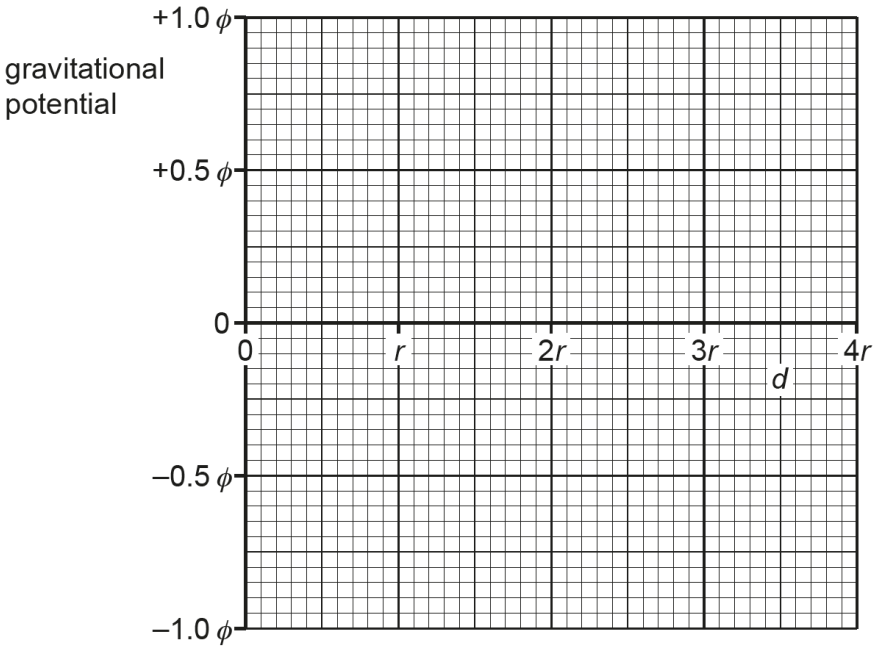

Fig. 3.1

[2]

(c) The sphere in **(b)** is a planet with radius r of 6.4×10^6 m and mass M of 6.0×10^{24} kg. The planet has no atmosphere.

A rock, initially at rest a long distance from the planet, travels towards its surface.

Calculate the change in speed of the rock as its distance from the centre of the planet changes from $4r$ to $3r$.

change in speed = ... m s^{-1} [3]

[Total: 8]