7 **(a)** Explain what is meant by a *gravitational field*.

……………………………………………………………………………………..

……………………………………………………………………………………… [2]

(b) Define *gravitational potential* at a point.

……………………………………………………………………………………..

……………………………………………………………………………………… [1]

(c) A rocket is launched from the surface of the Earth and moves along a radial path, as shown in Fig. 7.1.
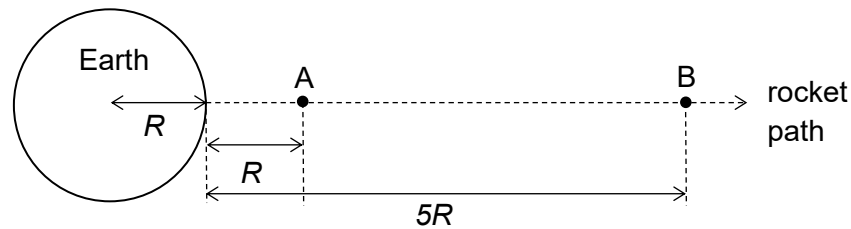

Fig. 7.1

The Earth may be considered as an isolated sphere of radius R and mass M concentrated at its centre. Point A is a distance R from the surface of the Earth.   Point B is a distance $5R$ from the surface.

(i) Show that the difference in gravitational potential between points A and B is given by the expression

$$\Delta\phi = \frac{GM}{3R}$$

where G is the gravitational constant.

[1]

(ii) The rocket motor is switched off at point A. During the journey from A to B, the rocket has a constant mass of 4.7×10^4 kg and its kinetic energy changes from 1.7 TJ to 0.72 TJ.

For the Earth, the product GM is 4.0×10^{14} N m^2 kg^{-1}.

Use the expression in **c(i)** to determine the distance from A to B. State an assumption that you have made.

distance = ……………………… m

assumption: …………..…………………………………………………………….. [4]

(iii) Upon reaching point B, the rocket is set to orbit in a circular path around the Earth.

Calculate the speed of the orbiting rocket.

speed = ……………………… m s^{-1} [2]

(d) Define *electric field strength* at a point.

....

.... [1]

(e) State one similarity and one difference between the electric field lines and the gravitational field lines around an isolated positively charged metal sphere.

similarity ....

....

difference..

....[2]

(f) A positive point charge $+Q$ is positioned at a fixed point X and an identical positive point charge is positioned at a fixed point Y, as shown in Fig. 7.2.
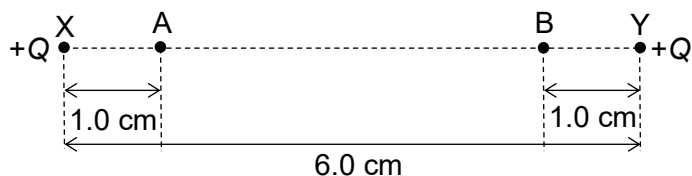

Fig. 7.2

The charges are separated in a vacuum by a distance of 6.0 cm.

Points A and B are on the line XY. Point A is at a distance of 1.0 cm from X and   point B is a distance of 1.0 cm from Y. The electric field strength at point A is 4.1×10^{-5} V m^{-1}.

(i) Calculate charge of $+Q$.

charge of $+Q$ = ... C   [3]

(ii) On Fig. 7.3, sketch the variation of the electric field strength E with distance d from A to B, along the line AB.
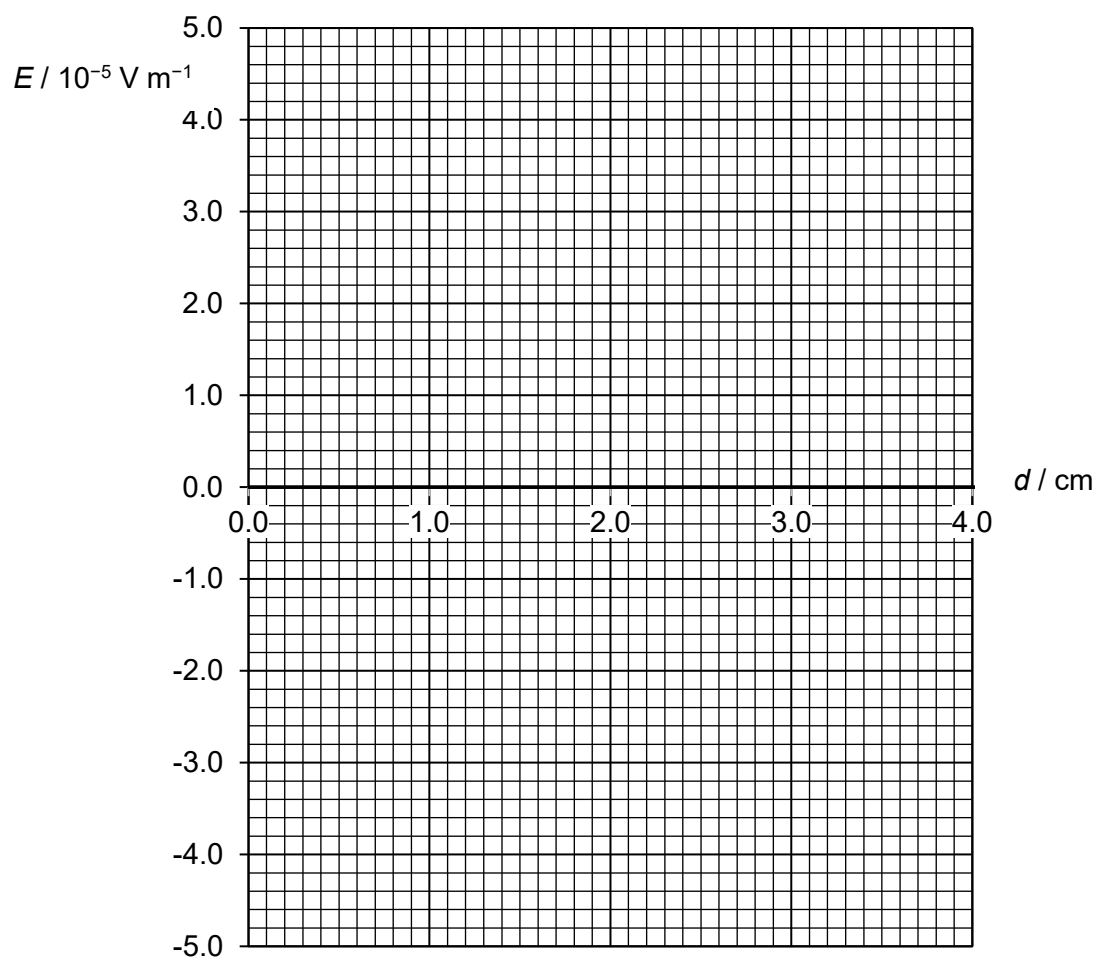
E / 10^{-5} V m^{-1}

Fig. 7.3

[2]

(iii) A small positive charge is placed at A. The electric field causes this charge to move from rest along the line AB.

Describe the acceleration of the charge as it moves from A to B.

...…….………………………………………………….………………….

...…….…………………………………………………………….…………………

...…….…………………………………………………………….…………………

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