9 **(a)** State one similarity and one difference between the fields of force produced by an isolated point charge and by an isolated point mass.

similarity: …..……..…..

…..…….……...……

difference: …..……..…..

…..…….……...…… [2]

(b) Two horizontal metal plates are separated by a distance of 1.8 cm in a vacuum.
A potential difference of 270 V is maintained between the plates, as shown in Fig. 9.1.

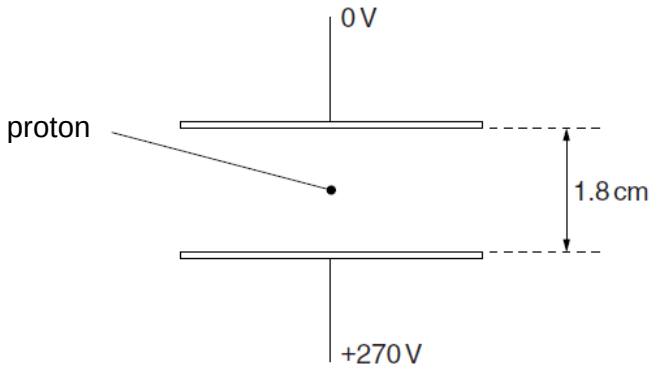

Fig. 9.1

A proton is in the space between the plates.

Explain quantitatively why, when predicting the motion of the proton between the plates, the gravitational field is not taken into consideration.

[4]

(c) Two point charges P and Q are placed 0.120 m apart as shown in Fig. 9.2.

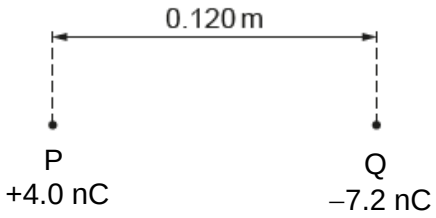

Fig. 9.2

(i) The charge at P is +4.0 nC and the charge at Q is −7.2 nC.

Determine the distance from P of the point on the line joining the two charges where the electric potential is zero.

distance = …… m [2]

(ii) State and explain, without calculation, whether the electric field strength is zero at the same point at which the electric potential is zero.

……

……

…… [2]

(iii) An electron is positioned at point X, equidistant from both P and Q, as shown in Fig. 9.3.

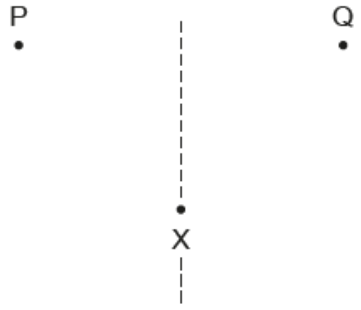

Fig. 9.3

On Fig. 9.3, draw an arrow to represent the direction of the resultant force acting on the electron. [1]

(d) State the relationship between *gravitational potential* and *gravitational field strength*.

……

…… [1]

(e) A moon of mass *M* and radius *R* orbits a planet of mass 3*M* and radius 2*R*. At a particular time, the distance between their centres is *D*, as shown in Fig. 9.4.

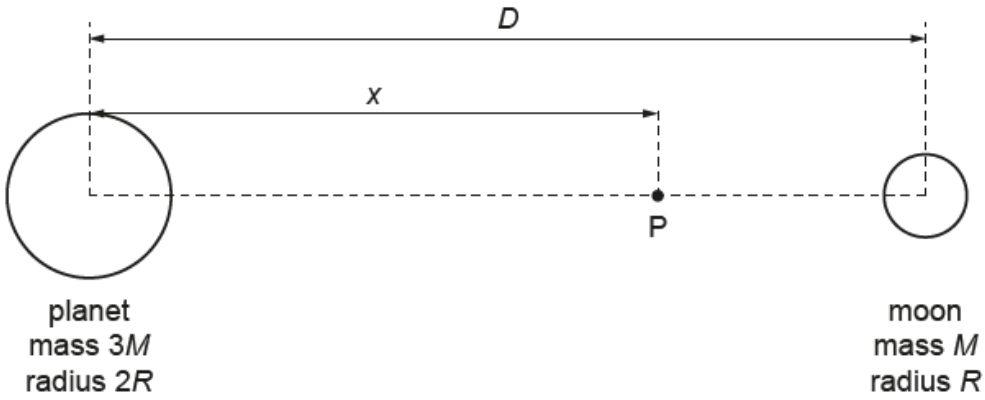

Fig. 9.4

Point P is a point along the line between the centres of the planet and the moon, at a variable distance *x* from the centre of the planet.

The variation with *x* of the gravitational potential ϕ at point P, for points between the planet and the moon, is shown in Fig. 9.5.

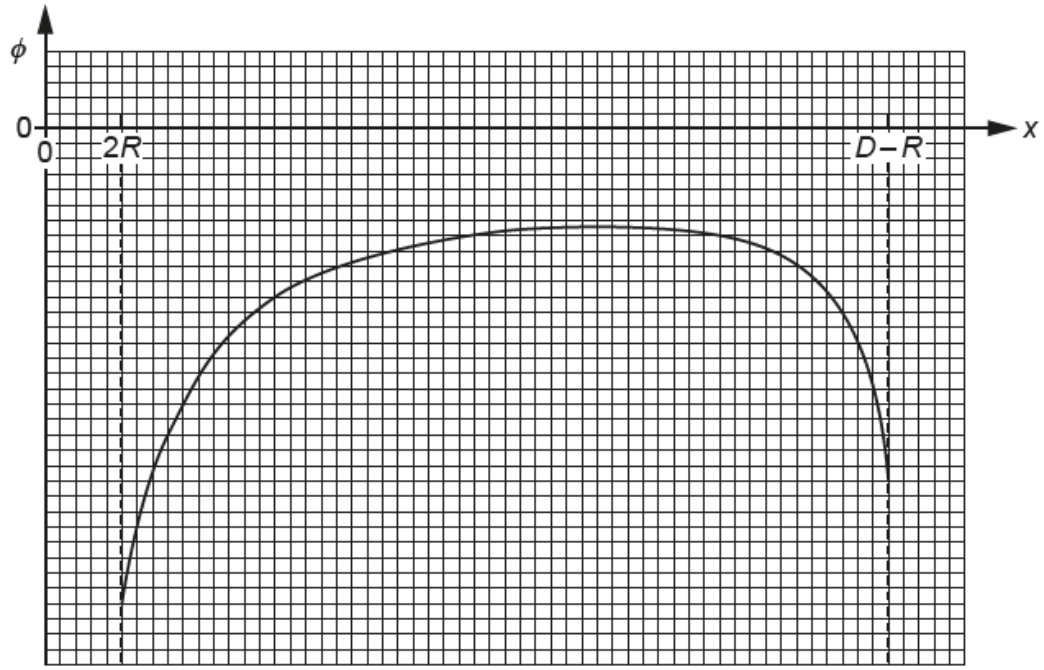

Fig. 9.5

(i) Explain why ϕ is negative throughout the entire range $x = 2R$ to $x = D - R$.

……

……

……

…… [3]

(ii) One of the features of Fig. 9.5 is that ϕ is negative throughout.
Describe two other features of Fig. 9.5.

1. ……..

……

2. ……..

…… [2]

(iii) On Fig. 9.6, sketch the variation with x of the gravitational field strength g at point P between $x = 2R$ and $x = D - R$.

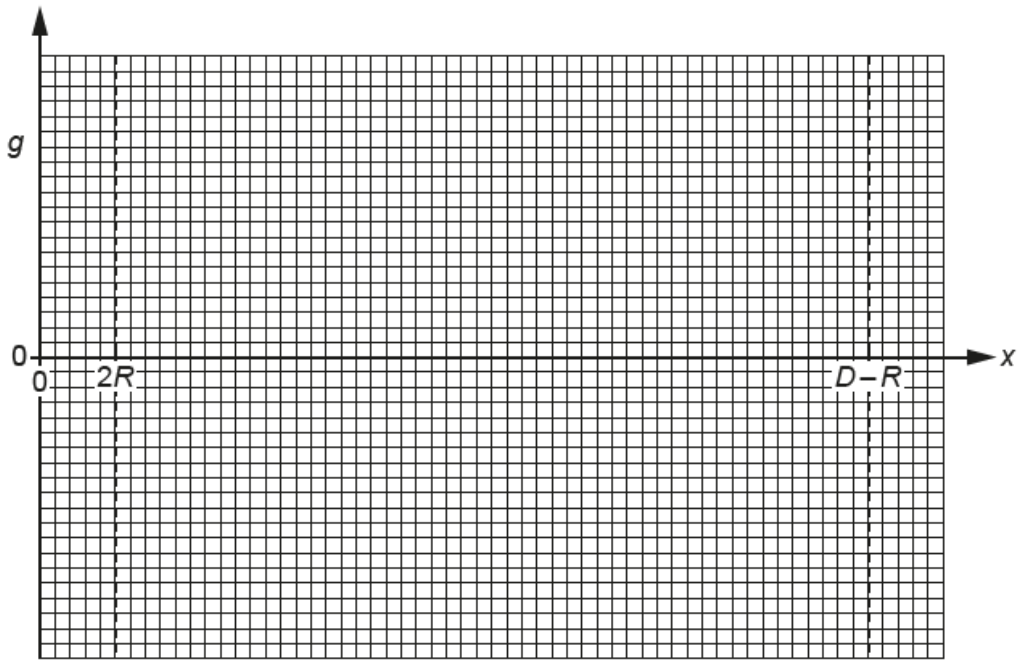

Fig. 9.6

[3]

[Total: 20]

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