GCE PHYSICS

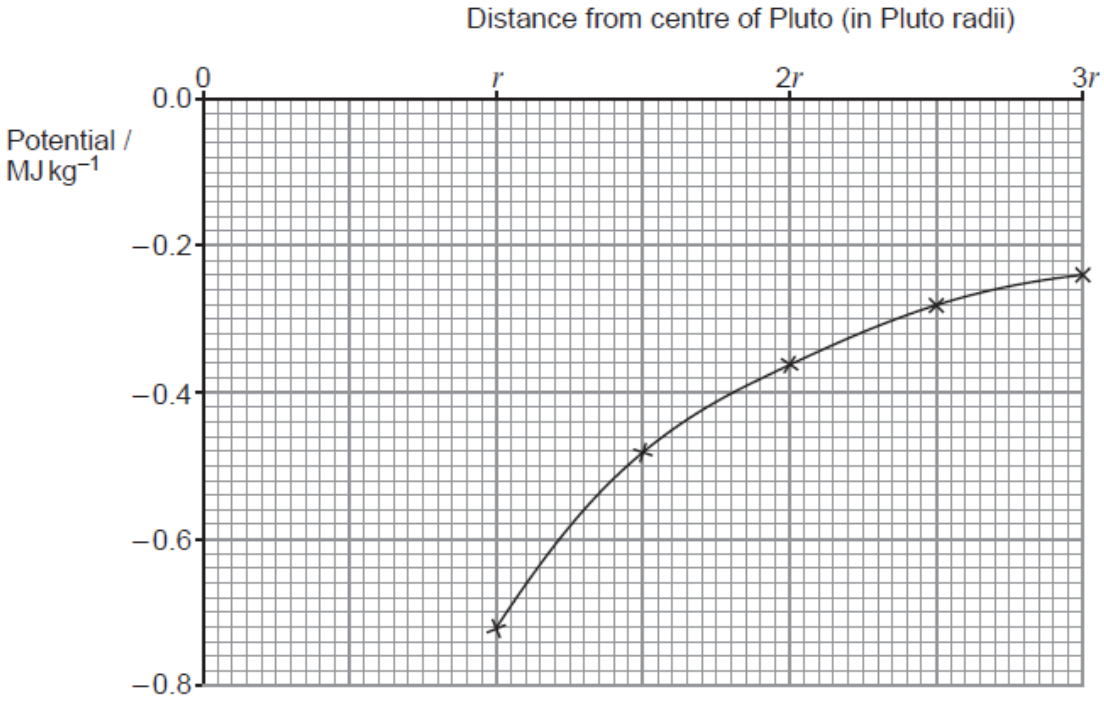
S21-A420QS

Assessment Resource number 15

Electricity and the Universe Resource F

1

The variation in gravitational potential near Pluto is shown by the graph.



(a) Assuming that the potential at the surface is correct, confirm that the potential at $3r$ is plotted correctly. [2]

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(b) (i) Calculate the gravitational potential energy of a spacecraft of mass 600 kg at rest on the surface. [2]

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(ii) 'Escape velocity' is defined as the minimum velocity required for a body to escape from the gravitational influence of a massive body. Calculate the 'escape velocity' of the spacecraft. [3]

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(c) The radius of Pluto is 1.18×10^6 m and the gravitational field strength at the surface is $0.62\,\text{N kg}^{-1}$. Using this information and by **drawing a suitable tangent** show that the gravitational field strength at $2r$ agrees with the theoretical value given by:

$$g \propto \frac{1}{r^2}$$ [4]

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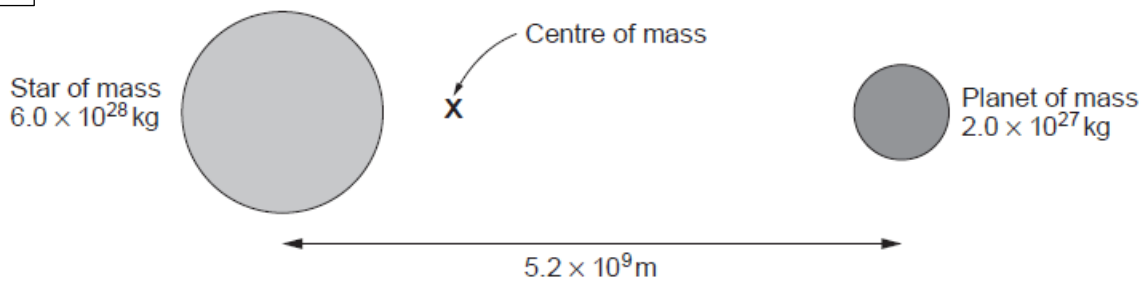
2 A star and a planet orbit their mutual centre of mass as shown. The diagram is not to scale.



(a) (i) Calculate the period of orbit. [2]

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(ii) Calculate the distance of the centre of mass from the centre of the star. [2]

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(b) The centre of mass of this star-planet system is at rest relative to the Earth and the system is viewed 'edge-on'. When analysing light of wavelength 656.3 nm from the star, astronomers measure a maximum red shift of 2.0 pm. Determine whether this shift is (approximately) consistent with your answers to *(a)*(i) and (ii). [4]

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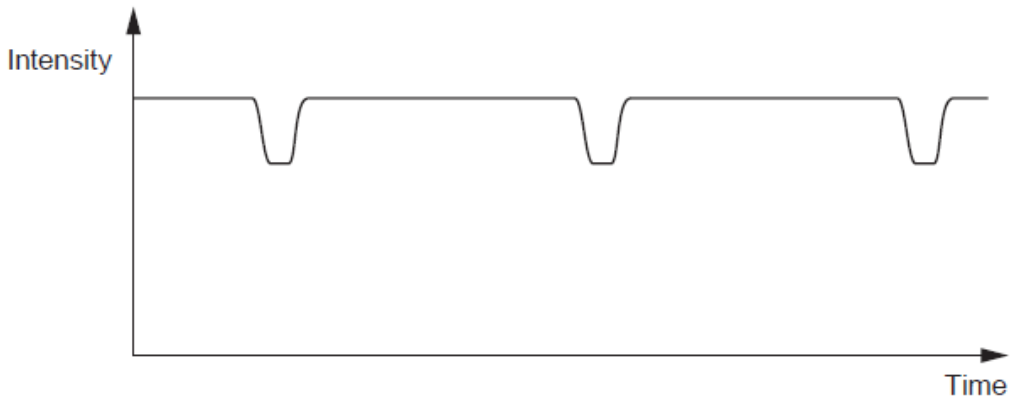
(c) Astronomers note a periodic dip in the brightness of the star as shown in the sketch graph.



Explain this observation. [1]

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(a) State **one** similarity and **one** difference between gravitational and electric fields. [2]

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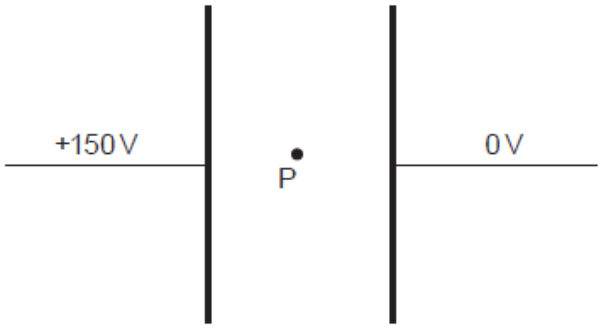
(b) Two parallel vertical metal plates are placed 5.0 cm apart in a vacuum as shown. A pd of 150 V is placed across the plates and a small sphere of mass 9.6×10^{-15} kg carrying a charge of -2.4×10^{-17} C is placed at point P. A side-on view of the arrangement is shown.



(i) Show that the two forces acting on the sphere are approximately 9×10^{-14} N vertically and 7×10^{-14} N horizontally. [3]

(ii) Draw, in the space below, a free body diagram for the sphere, showing the magnitude and direction of the two forces acting on it. Determine the direction with which the sphere will move away from P and include this on your diagram. [3]

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(c) Calculate the time taken for the sphere to travel a distance of 2.0 cm. [4]

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