EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

Time allowed
60 Minutes

Score /50

Percentage %

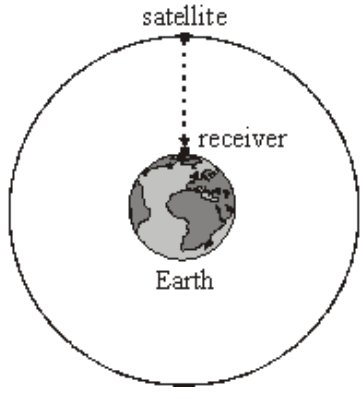
Physics

Topic Questions

AQA
AS & A LEVEL

3.7 Fields and their consequences (A-level only)

1 The Global Positioning System (GPS) is a system of satellites that transmit radio signals which can be used to locate the position of a receiver anywhere on Earth.



(a) A receiver at sea level detects a signal from a satellite in a circular orbit when it is passing directly overhead a hown in the diagram above

(i) The microwave signal is received 68 ms after it was transmitted from the satellite. Calculate the height of the satellite.

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(ii) Show that the gravitational field strength of the Earth at the position of the satellite is 0.56 N kg^{-1}.

mass of the Earth = 6.0×10^{24} kg
mean radius of the Earth = 6400 km

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(4)

(b) For the satellite in this orbit, calculate

(i) its speed,

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(ii) its time period.

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(5)
(Total 9 marks)

2 (a) Artificial satellites are used to monitor weather conditions on Earth, for surveillance and for communications. Such satellites may be placed in a *geo-synchronous* orbit or in a low polar orbit.

Describe the properties of the geo-synchronous orbit and the advantages it offers when a satellite is used for communications.

You may be awarded marks for the quality of written communication in your answer.

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(3)

(b) A satellite of mass m travels at angular speed ω in a circular orbit at a height h above the surface of a planet of mass M and radius R.

(i) Using these symbols, give an equation that relates the gravitational force on the satellite to the centripetal force.

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(ii) Use your equation from part (b)(i) to show that the orbital period, *T*, of the satellite is given by

$$T^2 = \frac{4\pi^2 (R+h)^3}{GM}$$

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(iii) Explain why the period of a satellite in orbit around the Earth cannot be less than 85 minutes. Your answer should include a calculation to justify this value.

mass of the Earth = 6.00×10^{24} kg

kg radius of the Earth = 6.40×10^{6} m

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(6)

(c) Describe and explain what happens to the speed of a satellite when it moves to an orbit that is closer to the Earth.

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(2)

(Total 11 marks)

3 Communications satellites are usually placed in a *geo-synchronous* orbit.

(a) State two features of a geo-synchronous orbit.

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(2)

(b) The mass of the Earth 6.00×10^{24} kg and its mean radius is 6.40×10^{6} m.

(i) Show that the radius of a geo-synchronous orbit must be 4.23×10^{7} m,

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(ii) Calculate the increase in potential energy of a satellite of 750 kg when it is raised from the Earth's surface into a geo-synchronous orbit.

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(6)

(c) Satellites in orbits nearer the Earth than geo-synchronous satellites may be used in the future to track road vehicles.

(i) State and explain **one** reason why geo-synchronous satellites would not be suitable for such a purpose.

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(ii) Give **two** points you would make in arguing for or against tracking road vehicles. Explain your answers.

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(Total 12 marks)

4 (a) State Newton's law of gravitation.

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(b) In 1798 Cavendish investigated Newton's law by measuring the gravitational force between two unequal uniform lead spheres. The radius of the larger sphere was 100 mm and that of the smaller sphere was 25 mm.

(i) The mass of the smaller sphere was 0.74 kg. Show that the mass of the larger sphere was about 47 kg.

density of lead = 11.3×10^{3} kg m^{-3}

(2)

(ii) Calculate the gravitational force between the spheres when their surfaces were in contact.

answer = ... N

(2)

(c) Modifications, such as increasing the size of each sphere to produce a greater force between them, were considered in order to improve the accuracy of Cavendish's experiment. Describe and explain the effect on the calculations in part (b) of doubling the radius of both spheres.

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(4)
(Total 10 marks)

5 (a) Explain what is meant by the *gravitational potential* at a point in a gravitational field.

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(b) Use the following data to calculate the gravitational potential at the surface of the Moon.

mass of Earth = 81 × mass of Moon
radius of Earth = 3.7 × radius of Moon
gravitational potential at surface of the Earth = –63 MJ kg^{-1}

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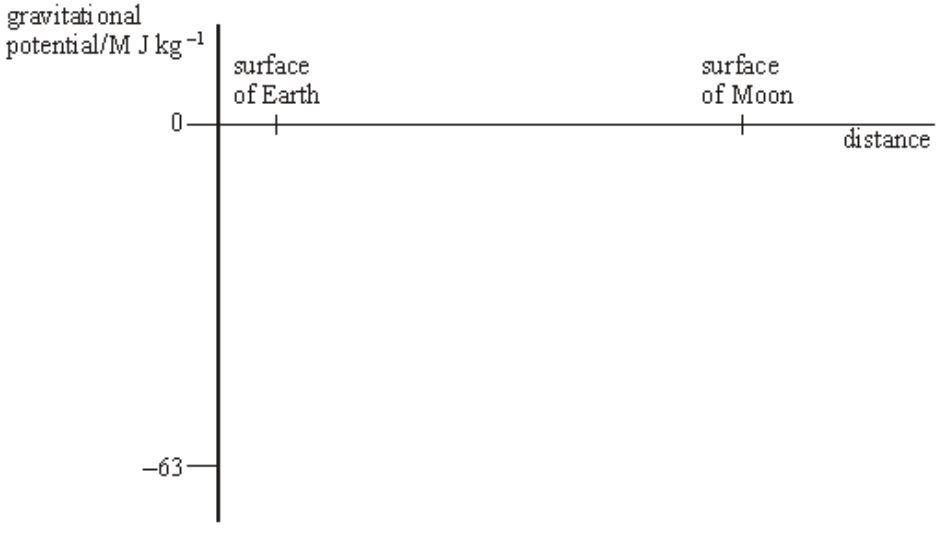
(c) Sketch a graph on the axes below to indicate how the gravitational potential varies with distance along a line outwards from the surface of the Earth to the surface of the Moon.



(3)
(Total 8 marks)