Visit http://www.mathsmadeeasy.co.uk/ for more fantastic resources.

AQA, Edexcel, OCR

A Level

A Level Physics

Gravitational Fields 1 (Answers)

Name:

M M E

Mathsmadeeasy.co.uk

Total Marks: /30

Maths Made Easy © Complete Tuition Ltd 2017

1. Total for Question 1: 13

(a) Which two of the following statements are false? [2]

i. Any object with mass will generate a gravitational field.

ii. Gravitational fields require two masses.

iii. A gravitational field is one of numerous fields that give rise to forces.

iv. The strength of a planet's gravitational field is inversely proportional to the square of the distance from the surface.

Solution: 2 and 4.

(b) Describe what happens to the gravitational force between two objects A and B when:

i. Their separation doubles. [1]

Solution: $\times\frac{1}{4}$

ii. The mass of A halves. [1]

Solution: $\times\frac{1}{2}$

iii. The mass of A doubles and that of B halves. [1]

Solution: Nothing.

iv. The mass of B triples and the separation halves. [2]

Solution: $\times 12$

(c) Sketch, for each of the following, the pattern of field lines. For the first three, by distributing your field lines accordingly, make the relative field strengths clear. [6]

i. A sphere of mass m.

ii. A sphere of mass M, where $m < M$.

iii. A point source of mass M.

iv. A small section of a planet's surface.

Solution:
i: radial from the outside of the sphere; equally distributed.
ii: radial from the outside of the sphere; equally distributed; more lines than for i.
iii: as per ii, but from the point.
iv: straight lines perpendicular to the surface.

2. Zog is the only planet in its solar system. It has a radius of 150 km and is perfectly spherical.

Total for Question 2: 13

(a) By considering Newton's Second Law and his Law of Gravitation, derive an expression for the gravitational field strength, g, of an object in terms of its mass, m, the distance from its centre of mass, r, and the gravitational constant, G. [2]

Solution: $mg = -GmM/r^2 \rightarrow g = -Gm/r^2$

(b) Kyle measures a gravitational acceleration of 0.5 ms^{-2} when his spaceship is 1.0 km from Zog's surface. Calculate the average density of Zog. [4]

Solution: 12000 kgm^{-3}

Though Zog is small, it has an even smaller moon, whose radius is 5 km. The separation of their centres of masses is 200 km. The resultant gravitational field is zero at a distance of 40 km from Zog's surface.

(c) By equating the gravitational field strengths, calculate the mass of the moon. [4]

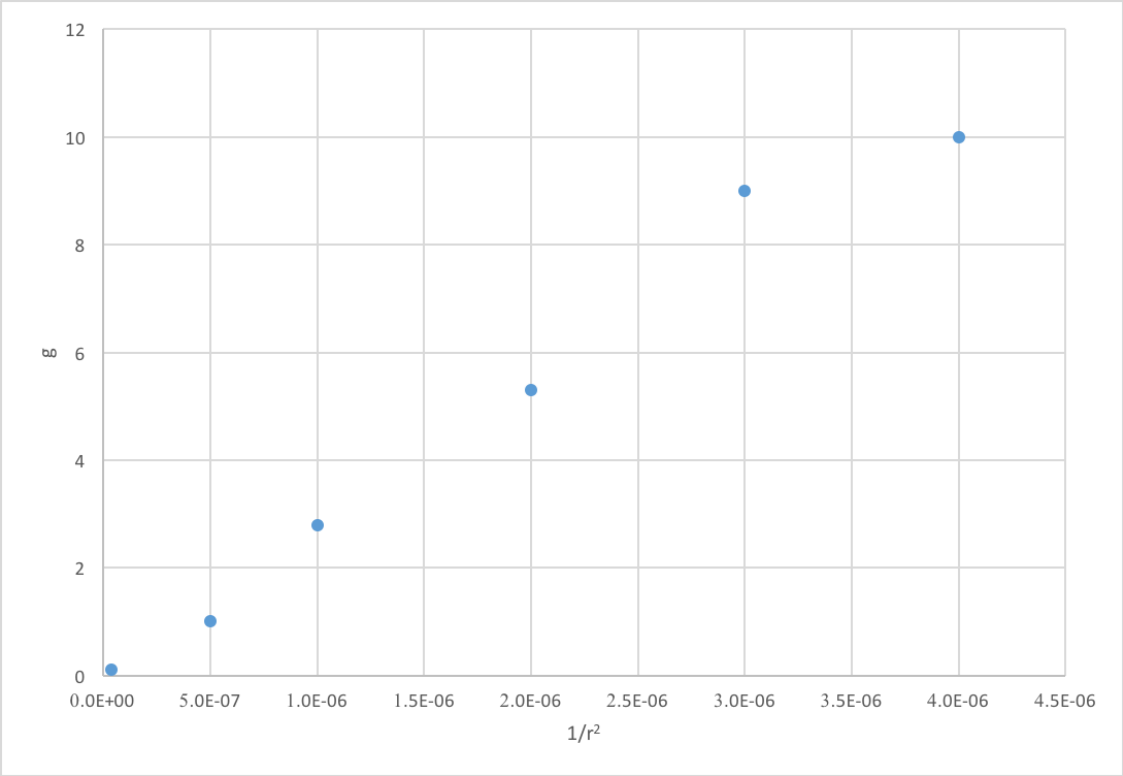
Solution: 4.7×10^{17} kg

(d) Calculate the resultant field halfway between their surfaces, specifying in which direction the resultant force of attraction acts. [3]

Solution: 0.34 ms^{-2}; towards Zog.

3. The graph below shows how the measured gravitational field strength (ms^{-2}) varied with $1/r^2$ (r in m) in an experiment carried out by Zoe

Total for Question 3: 4



(a) Use the graph to calculate the mass of the object used. [4]

Solution: $\approx 4 \times 10^1 6$ kg