6.2 Newton's Law of Gravitation

Question Paper

Course	DP IB Physics
Section	6. Circular Motion & Gravitation
Topic	6.2 Newton's Law of Gravitation
Difficulty	Hard

Time allowed: 20

Score: /10

Percentage: /100

Question 1

The weight of a body on the surface of a planet orbiting a star is 80 N. The star has twice the density of the planet and its diameter is 500 times greater.

What is the weight of the body on the surface of the star?

A. 40 kN

B. 80 kN

C. 120 kN

D. 160 kN

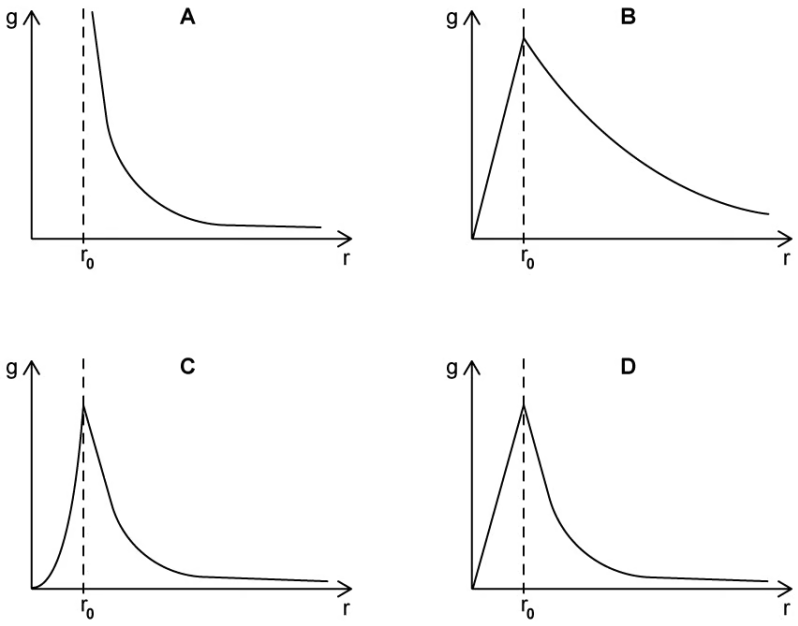
[1 mark]

Question 2

Let r_0 represent the radius of Earth.

Which of the following shows the variation of the magnitude of the Earth's gravitational field strength g with radial distance r from its centre of mass, $r = 0$?

You may assume that mass is uniformly distributed beneath the Earth's surface.



[1 mark]

Question 3

At a point above a moon's surface and a distance x from its centre, the gravitational field strength is 5 N kg^{-1}. At the moon's surface itself, the field strength is 9 N kg^{-1}.

Which of the following gives the value for the radius of the planet?

A. $5x$

B. $\frac{5}{3}x$

C. $\frac{\sqrt{5}}{3}x$

D. $\sqrt{\frac{5}{3}}x$

[1 mark]

Question 4

A binary system consisting of a star of mass *M* and 5*M* orbit each other at a distance *r* between their centre of mass. The resultant gravitational field strength is zero along the line between their centres at a distance x from the centre of the star of mass *M*. What is the value of the ratio $\frac{r}{x}$?

You may wish to use the quadratic formula:

$$p = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For solutions to the equation:

$$ap^2 + bp + c = 0$$

A. $\frac{\sqrt{5}}{5}$

B. $\sqrt{\frac{1}{5}}$

C. $1 - \sqrt{5}$

D. $1 + \sqrt{5}$

[1 mark]

Question 5

Which single condition enables Newton's universal law of gravitation to be used to predict the force between two masses m_1 and m_2?

A. m_1 and m_2 both have large radii

B. The radial distance between m_1 and m_2 is constant

C. m_1 and m_2 are very massive

D. m_1 and m_2 behave as point masses

[1 mark]

Question 6

A planet of mass m and radius r rotates so rapidly that material at its equator only just remains on its surface. What is the period of its rotation?

A. $2\pi\sqrt{\frac{r}{G}}$

B. $2\pi\sqrt{\frac{G}{r}}$

C. $2\pi\sqrt{\frac{r}{Gm}}$

D. $2\pi\sqrt{\frac{r^3}{Gm}}$

[1 mark]

Question 7

Two planetary systems, very far apart from each other, have suns with masses S_1 and S_2. They each have exoplanets P_1 and P_2 of mass m_1 and m_2 respectively, which are observed to have circular orbits of equal radii. If P_1 completes an orbit in $\frac{1}{3}$ the time taken by P_2, which of the following may be deduced?

A. $S_1 = S_2$ and $m_1 = 3m_2$

B. $S_1 = 3S_2$

C. $S_1 = 3S_2$ and $m_1 = m_2$

D. $S_1 = 9S_2$ only

[1 mark]

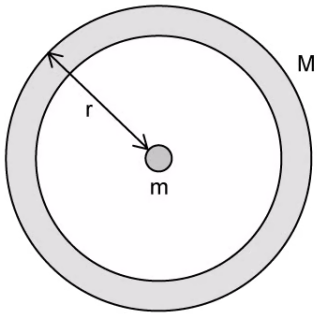
Question 8

Two spherical bodies have the same radius, but one has thrice the mass of the other. At which point, A-D on the diagram below, could the resultant gravitational field of the two masses have the greatest magnitude?

[1 mark]

Question 9

A mass *m* is placed at the centre of a thin, hollow, spherical shell of mass *M* and radius *r*.



What is the magnitude of the resultant gravitational force on *m* and *M*?

	Magnitude of resultant gravitational force on *m*	Magnitude of resultant gravitational force on *M*
A.	0	$\frac{GMm}{r^2}$
B.	$\frac{GMm}{r^2}$	$\frac{GMm}{r^2}$
C.	0	0
D.	$\frac{GMm}{r^2}$	0

[1 mark]

Question 10

Two stationary bodies of mass m_1 and m_2 are a distance d apart. A third body, situated on the line joining m_1 and m_2, experiences no resultant gravitational force. Which of the following is a possible distance between the third body and m_1?

A. $x = \dfrac{\sqrt{m_1}}{\sqrt{m_1} - \sqrt{m_2}}$

B. $x = d\left(\dfrac{\sqrt{m_1}}{\sqrt{m_1} - \sqrt{m_2}}\right)$

C. $x = \dfrac{\sqrt{m_2}}{\sqrt{m_1} - \sqrt{m_2}}$

D. $x = d\left(\dfrac{\sqrt{m_2}}{\sqrt{m_1} - \sqrt{m_2}}\right)$

[1 mark]