Q1. Two identical uniform spheres each of radius R are placed in contact. The gravitational force between them is F.

The spheres are now separated until the force of attraction is $\frac{F}{9}$.

What is the distance between the **surfaces** of the spheres after they have been separated?

A $2R$

B $4R$

C $8R$

D $12R$

(Total 1 mark)

Q2. A satellite of mass m is in a circular orbit at height R above the surface of a uniform spherical planet of radius R and density ρ.

What is the force of gravitational attraction between the satellite and the planet?

A $\frac{\pi\rho GmR}{3}$

B $\frac{2\pi\rho GmR}{3}$

C $\frac{\pi\rho GmR^2}{3}$

D $\frac{2\pi\rho GmR^2}{3}$

(Total 1 mark)

Q3. The following data refers to two planets, P and Q.

Radius / km	Density / kg m^{-3}

planet P	8000	6000
planet Q	16 000	3000

The gravitational field strength at the surface of P is 13.4 N kg^{-1}.
What is the gravitational field strength at the surface of Q?

A 3.4 N kg^{-1}

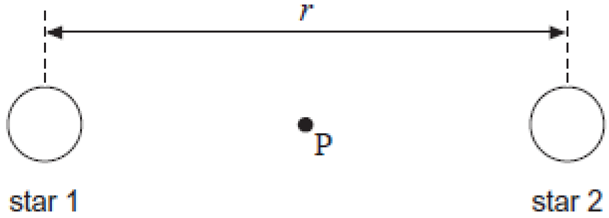
B 13.4 N kg^{-1}

C 53.6 N kg^{-1}

D 80.4 N kg^{-1}

(Total 1 mark)

Q4. The diagram shows an isolated binary star system. The two stars have equal masses, M, and the distance between their centres is r.



The point P is half-way between the two stars.
What is the gravitational field strength at P?

A zero

B $-\frac{GM}{r^2}$

C $-\frac{2GM}{r^2}$

D $-\frac{4GM}{r^2}$

(Total 1 mark)

Q5. In the equation $X = \frac{ab}{r^n}$, X represents a physical variable in an electric or a gravitational field, a is a constant, b is either mass or charge and n is a number.

Which line, **A** to **D**, in the table provides a consistent representation of X, a and b according to the value of n?

The symbols E, g, V and r have their usual meanings.

	n	X	a	b
A	1	E	$\frac{1}{4\pi\varepsilon_0}$	charge
B	1	V	$\frac{1}{4\pi\varepsilon_0}$	mass
C	2	g	G	mass
D	2	V	G	charge

(Total 1 mark)

Q6. A planet has a radius half the Earth's radius and a mass a quarter of the Earth's mass. What is the approximate gravitational field strength on the surface of the planet?

A 1.6 N kg^{-1} ☐

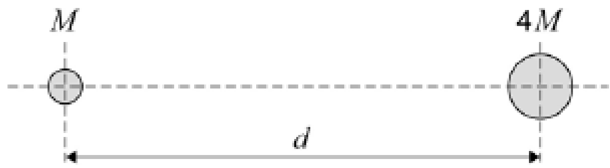
B 5.0 N kg^{-1} ☐

C 10 N kg^{-1} ☐

D 20 N kg^{-1} ☐

(Total 1 mark)

Q7. Two stars of mass M and 4M are at a distance d between their centres.



The resultant gravitational field strength is zero along the line between their centres at a distance y from the centre of the star of mass M.

What is the value of the ratio $\frac{y}{d}$?

A $\frac{1}{2}$

B $\frac{1}{3}$

C $\frac{2}{3}$

D $\frac{3}{4}$

(Total 1 mark)

Q8. The gravitational field strengths at the surfaces of the Earth and the Moon are 9.8 N kg^{-1} and 1.7 N kg^{-1} respectively. If the mass of the Earth is 81 × the mass of the Moon, what is the ratio of the radius of the Earth to the radius of the Moon?

A 3.7

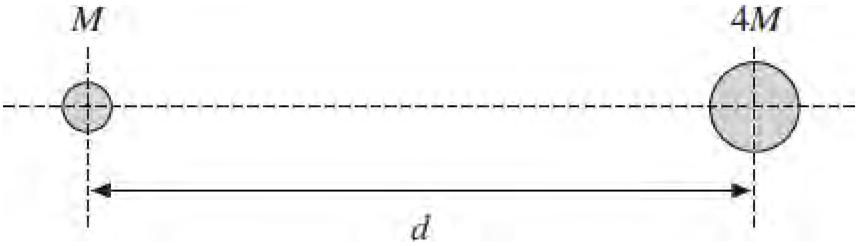
B 5.8

C 14

D 22

(Total 1 mark)

Q9. Two stars of mass *M* and 4*M* are at a distance *d* between their centres.



The resultant gravitational field strength is zero along the line between their centres at a distance y from the centre of the star of mass *M*.

What is the value of the ratio $\frac{y}{d}$?

A $\frac{1}{2}$

B $\frac{1}{3}$

C $\frac{2}{3}$

D $\frac{3}{4}$

(Total 1 mark)

Q10.A small mass is situated at a point on a line joining two large masses m_1 and m_2 such that it experiences no resultant gravitational force. Its distance from the centre of mass of m_1 is r_1 and its distance from the centre of mass of m_2 is r_2.

What is the value of the ratio $\frac{r_1}{r_2}$?

A $\frac{m_1^2}{m_2^2}$

B $\frac{m_2^2}{m_1^2}$

C $\sqrt{\frac{m_1}{m_2}}$

D $\sqrt{\frac{m_2}{m_1}}$

(Total 1 mark)

Q11. Which one of the following gives a correct unit for $\left(\frac{g^2}{G}\right)$?

A N m^{-2}

B N kg^{-1}

C N m

D N

(Total 1 mark)

Q12. The gravitational field strength at the surface of the Earth is 6 times its value at the surface of the Moon. The mean density of the Moon is 0.6 times the mean density of the Earth.

What is the value of the ratio $\left(\frac{\text{radius of Earth}}{\text{radius of Moon}}\right)$?

A 1.8

B 3.6

C 6.0

D 10

(Total 1 mark)

Q13. Which one of the following statements about gravitational fields is **incorrect**?

A Moving a mass in the direction of the field lines reduces its potential energy.

B A stronger field is represented by a greater density of field lines.

C Moving a mass perpendicularly across the field lines does not alter its potential energy.

D At a distance *r* from a mass the field strength is inversely proportional to *r*.

(Total 1 mark)

Q14. The gravitational field strength on the surface of a planet orbiting a star is 8.0 N kg^{-1}. If the planet and star have a similar density but the diameter of the star is 100 times greater than the planet, what would be the gravitational field strength at the surface of the star?

A 0.0008 N kg^{-1}

B 0.08 N kg^{-1}

C 800 N kg^{-1}

D 8000 N kg^{-1}

(Total 1 mark)

Q15. A spherical planet of uniform density ρ has radius R.

Which line, **A** to **D**, in the table gives correct expressions for the mass of the planet and the gravitational field strength at its surface?

	mass of planet	**gravitational field strength at surface**
A	$\dfrac{4\pi R^2 p}{3}$	$\dfrac{4\pi GRp}{3}$
B	$\dfrac{4\pi R^3 p}{3}$	$\dfrac{4\pi GRp}{3}$
C	$\dfrac{4\pi R^2 p}{3}$	$\dfrac{4\pi Gp}{3}$
D	$\dfrac{4\pi R^3 p}{3}$	$\dfrac{4\pi Gp}{3}$

(Total 1 mark)

Q16. A planet has a radius half the Earth's radius and a mass a quarter of the Earth's mass. What is the approximate gravitational field strength on the surface of the planet?

A 1.6 N kg^{-1}

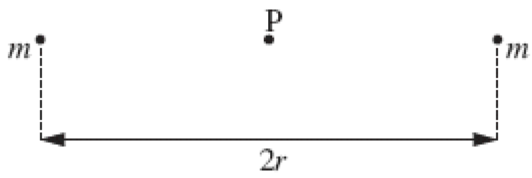
B 5.0 N kg^{-1}

C 10 N kg^{-1}

D 20 N kg^{-1}

(Total 1 mark)

Q17. The diagram shows two point masses each of mass *m* separated by a distance 2*r.*



What is the value of the gravitational field strength at the mid-point, P, between the two masses?

A $\frac{4Gm}{r^2}$

B $\frac{2Gm}{r^2}$

C $\frac{Gm}{2r^2}$

D zero

(Total 1 mark)

Q18. What would the period of rotation of the Earth need to be if objects at the equator were to appear weightless?

radius of Earth = 6.4×10^6 m

A 4.5×10^{-2} hours

B 1.4 hours

C 24 hours

D 160 hours

(Total 1 mark)

Q19. The gravitational potential difference between the surface of a planet and a point P, 10 m above the surface, is 8.0 J kg^{-1}. Assuming a uniform field, what is the value of the gravitational field strength in the region between the planet's surface and P?

A 0.80 N kg^{-1}

B 1.25 N kg^{-1}

C 8.0 N kg^{-1}

D 80 N kg^{-1}

(Total 1 mark)

Q20. The radius of a certain planet is x times the radius of the Earth and its surface gravitational field strength is y times that of the Earth.

Which one of the following gives the ratio $\left(\frac{\text{mass of the planet}}{\text{mass of the Earth}}\right)$?

A xy

B x^2y

C xy^2

D x^2y^2

(Total 1 mark)

Q21. When at the surface of the Earth, a satellite has weight *W* and gravitational potential energy $-U$. It is projected into a circular orbit whose radius is equal to twice the radius of the Earth. Which line, **A** to **D**, in the table shows correctly what happens to the weight of the satellite and to its gravitational potential energy?

	weight	**gravitational potential energy**
A	becomes $\frac{W}{2}$	increases by $\frac{U}{2}$
B	becomes $\frac{W}{4}$	increases by $\frac{U}{2}$
C	remains W	increases by U
D	becomes $\frac{W}{4}$	increases by U

(Total 1 mark)

Q22. A projectile moves in a gravitational field. Which one of the following is a correct statement for the gravitational force acting on the projectile?

A The force is in the direction of the field.

B The force is in the opposite direction to that of the field.

C The force is at right angles to the field.

D The force is at an angle between 0° and 90° to the field.

(Total 1 mark)

Q23. The Earth has density ρ and radius R. The gravitational field strength at the surface is g. What is the gravitational field strength at the surface of a planet of density 2ρ and radius $2R$?

A g

B $2g$

C $4g$

D $16g$

(Total 1 mark)

Q24. The following data refer to two planets.

	radius/km	density/kg m^{-3}
planet P	8 000	6 000
planet Q	16 000	3 000

The gravitational field strength at the surface of P is 13.4 N kg^{-1}. What is the gravitational field strength at the surface of Q?

A 3.4 N kg^{-1}

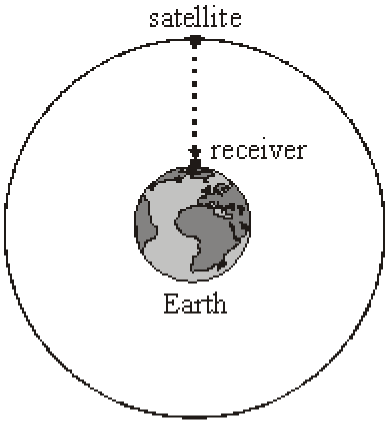
B 13.4 N kg^{-1}

C 53.6 N kg^{-1}

D 80.4 N kg^{-1}

(Total 1 mark)

Q25. 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 as shown 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)

Q26. A planet has a radius half of the Earth's radius and a mass a quarter of the Earth's mass. What is the approximate gravitational field strength on the surface of the planet?

A 1.6 N kg^{-1}

B 5.0 N kg^{-1}

C 10 N kg^{-1}

D 20 N kg^{-1}

(Total 1 mark)

Q27. At a distance R from a fixed charge, the electric field strength is E and the electric potential is V. Which line, **A** to **D**, gives the electric field strength and electric potential at a distance $2R$ from the charge?

	electric field strength	electric potential
A	$\frac{E}{2}$	$\frac{V}{4}$
B	$\frac{E}{2}$	$\frac{V}{2}$
C	$\frac{E}{4}$	$\frac{V}{2}$
D	$\frac{E}{4}$	$\frac{V}{4}$

(Total 1 mark)

Q28. A small mass is situated at a point on a line joining two large masses m_1 and m_2 such that it experiences no resultant gravitational force. If its distance from the mass m_1 is r_1 and

its distance from the mass m_2 is r_2, what is the value of the ratio $\frac{r_1}{r_2}$?

A $\frac{m_1^2}{m_2^2}$

B $\frac{m_2^2}{m_1^2}$

C $\sqrt{\frac{m_1}{m_2}}$

D $\sqrt{\frac{m_2}{m_1}}$

(Total 1 mark)

Q29. A planet of mass M and radius R rotates so rapidly that loose material at the equator just remains on the surface. What is the period of rotation of the planet?

G is the universal gravitational constant.

A $2\pi\sqrt{\frac{R}{GM}}$

B $2\pi\sqrt{\frac{R^2}{GM}}$

C $2\pi\sqrt{\frac{GM}{R^3}}$

D $2\pi\sqrt{\frac{R^3}{GM}}$

(Total 1 mark)