Q1. A planet of mass *M* and radius *R* rotates so rapidly that loose material at the equator only 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)

Q2. 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)

Q3. Which one of the following could be a unit of gravitational potential?

A N

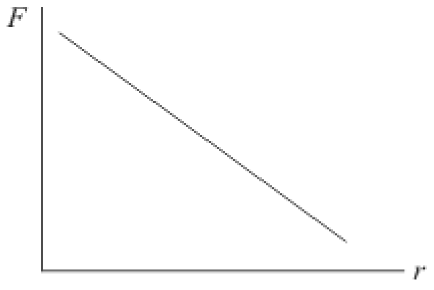
B J

C N kg^{-1}

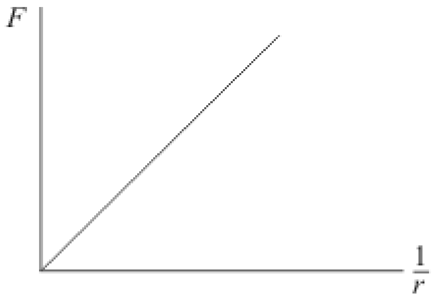
D J kg^{-1}

(Total 1 mark)

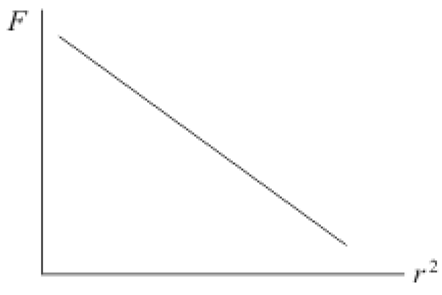
Q4. Which one of the following graphs correctly shows the relationship between the gravitational force, *F*, between two masses and their separation *r*.



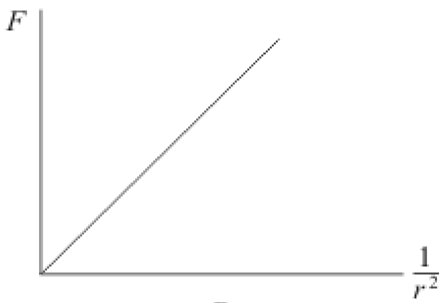
A



B



C



D

(Total 1 mark)

Q5. 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)

Q6. Two protons are 1.0×10^{-14} m apart. Approximately how many times is the electrostatic force between them greater than the gravitational force between them?

A 10^{23}

B 10^{30}

C 10^{36}

D 10^{42}

(Total 1 mark)

Q7. The diagram shows two positions, **X** and **Y**, at different heights on the surface of the Earth.

Which line, **A** to **D**, in the table gives correct comparisons at **X** and **Y** for gravitational potential and angular velocity?

	gravitational potential at X compared with Y	**angular velocity at X compared with Y**
A	greater	greater
B	greater	same
C	greater	smaller
D	same	same

(Total 1 mark)

Q8. 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)

Q9. 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)

Q10. Two protons, each of mass m and charge e, are a distance d apart. Which one of the following expressions correctly gives the ratio $\left(\frac{\text{electrostatic force}}{\text{gravitational force}}\right)$ for the forces acting between them?

A $\frac{4\pi\varepsilon_0 e^2}{Gm^2}$

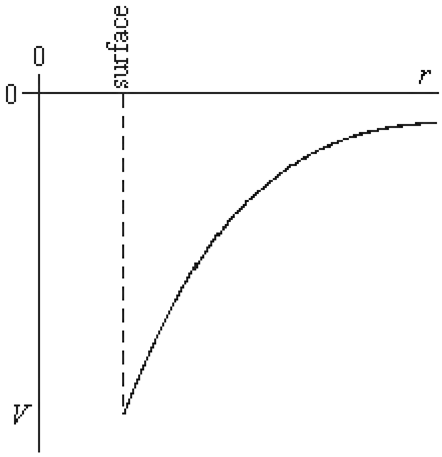
B $\frac{Ge^2}{4\pi\varepsilon_0 m^2}$

C $\frac{e^2 m^2}{4\pi\varepsilon_0 G}$

D $\frac{e^2}{4\pi\varepsilon_0 Gm^2}$

(Total 1 mark)

Q11. The graph shows how the gravitational potential, *V*, varies with the distance, *r* , from the centre of the Earth.



What does the gradient of the graph at any point represent?

A the magnitude of the gravitational field strength at that point

B the magnitude of the gravitational constant

C the mass of the Earth

D the potential energy at the point where the gradient is measured

(Total 1 mark)

Q12. 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)

Q13. Near the surface of a planet the gravitational field is uniform and for two points, 10 m apart vertically, the gravitational potential difference is 3 J kg^{-1}. How much work must be done in raising a mass of 4 kg vertically through 5 m?

A 3 J

B 6 J

C 12 J

D 15 J

(Total 1 mark)

Q14. What is the angular speed of a satellite in a geo-synchronous orbit around the Earth?

A 7.3×10^{-5} rad s^{-1}

B 2.6×10^{-1} rad s^{-1}

C 24 rad s^{-1}

D 5.0×10^{6} rad s^{-1}

(Total 1 mark)

Q15. 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)

Q16. 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 2*R* 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)

Q17. 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)

Q18. 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 $2\pi\sqrt{\dfrac{R}{GM}}$

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

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

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

(Total 1 mark)

Q19. Which one of the following has different units to the other three?

A gravitational potential

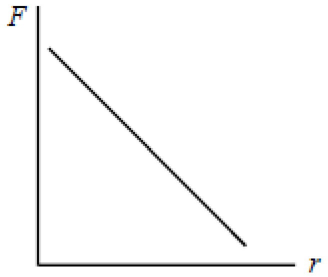
B gravitational field strength

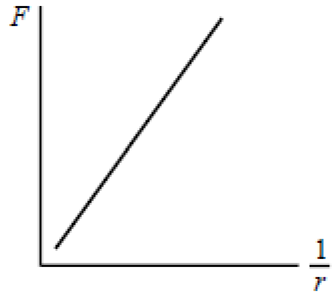
C force per unit mass

D gravitational potential gradient

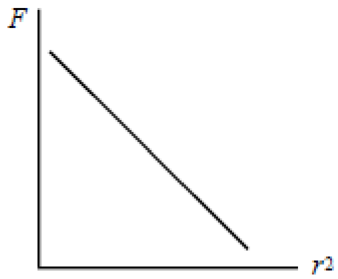
(Total 1 mark)

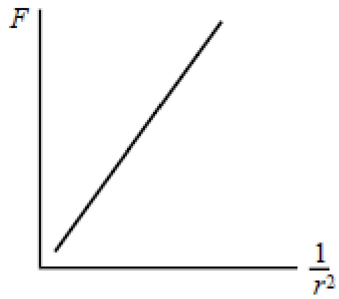
Q20. Which one of the following graphs correctly shows the relationship between the gravitational force, *F*, between two masses and the distance, *r*, between them?





A **B**





C **D**

(Total 1 mark)

Q21. A satellite is in orbit at a height h above the surface of a planet of mass M and radius R. What is the velocity of the satellite?

A $\sqrt{\frac{GM(R+h)}{R}}$

B $\frac{\sqrt{GM(R+h)}}{R}$

C $\sqrt{\frac{GM}{(R+h)}}$

D $\frac{\sqrt{GM}}{(R+h)}$

(Total 1 mark)

Q22. 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)

Q23. The following data refer to two planets.

	radius / km	density / kg m^{-3}
planet P	8000	6000
planet Q	16000	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)

Q24. Satellites N and F have the same mass and move in circular orbits about the same planet. N is the nearer satellite and F is the more distant. Which one of the following is smaller for N than for F?

A gravitational force on the satellite

B speed

C kinetic energy

D time for one orbit

(Total 1 mark)

Q25. Two identical conducting spheres on insulating supports carry charges of magnitude Q and $2Q$ respectively. When separated by distance d, the electrostatic repulsive force is F. The spheres are made to touch and then restored to their original separation d. If there is no loss of charge what is the new force of repulsion?

A $\frac{F}{2}$

B $\frac{3F}{4}$

C $\frac{9F}{8}$

D $\frac{4F}{3}$

(Total 1 mark)

Q26. A mass of 5 kg is moved in a gravitational field from a point **X** at which the gravitational potential is –20 J kg^{-1} to a point **Y** where it is –10 J kg^{-1}. The change in potential energy of the mass, in J, between **X** and **Y** is

A –50

B –10

C +10

D +50

(Total 1 mark)

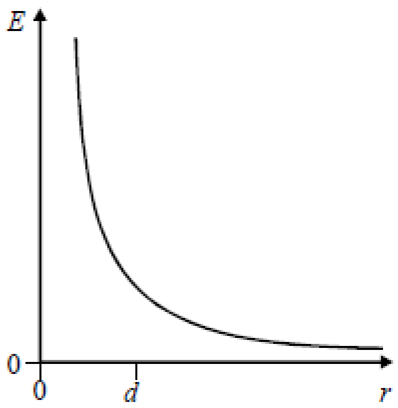
Q27. For which of the following relationships is the quantity *y* related to the quantity *x* by the relationship $x \propto \frac{1}{y}$?

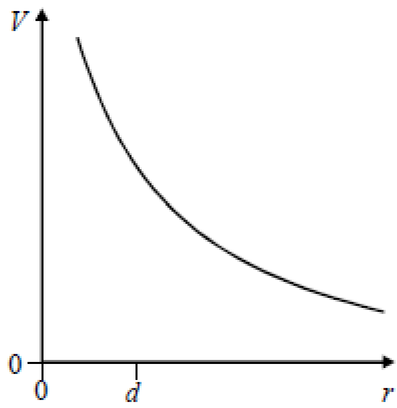
	x	*y*
A	energy stored in a spring	extension of the spring
B	gravitational field strength	distance from a point mass
C	de Broglie wavelength of an electron	momentum of the electron
D	period of a mass-spring system	spring constant (stiffness) of the spring

(Total 1 mark)

Q28.Graph 1 shows the variation of electric field strength E with separation r for two point charges.

Graph 2 shows the corresponding variation of electric potential V with separation.





Which line in the table correctly relates data for the two graphs?

	Magnitude of electric field strength at separation *d*	**Magnitude of electric potential at separation *d***
A	Gradient of **graph** 2 at separation d	Area under **graph 1** from separation d to ∞
B	Area under **graph 2** from separation d to ∞	Area under **graph 1** from separation d to ∞
C	Gradient of **graph 2** at separation d	Gradient of **graph 1** at separation d
D	Area under **graph 2** from separation d to ∞	Gradient of **graph 1** at separation d

(Total 1 mark)

Q29. When two similar spherical objects of radius R are touching, the gravitational force of attraction between them is F. When the gravitational force between them is $F/4$, the distance between the surfaces of the spheres is

A R

B $2R$

C $4R$

D $6R$

(Total 1 mark)

Q30. g is the strength of the gravitational field at the surface of the Earth; R is the radius of the Earth. The potential energy lost by a satellite of mass m falling to the Earth's surface from a height R above the surface is

A $4mgR$

B $2mgR$

C $\frac{mgR}{2}$

D $\frac{mgR}{4}$

(Total 1 mark)