

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

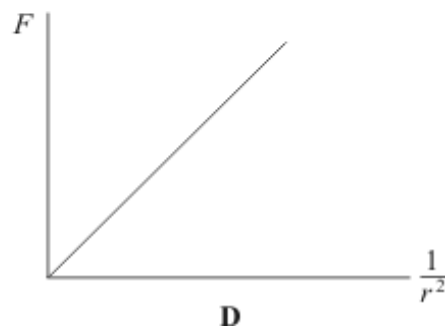
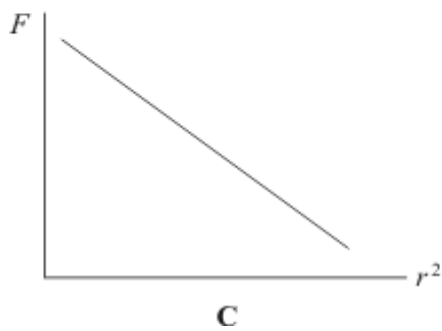
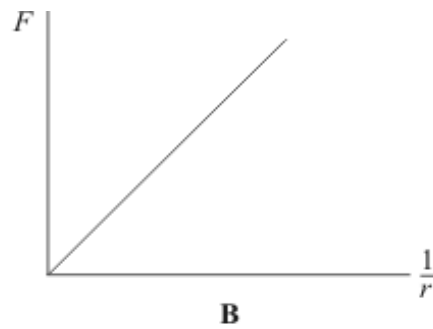
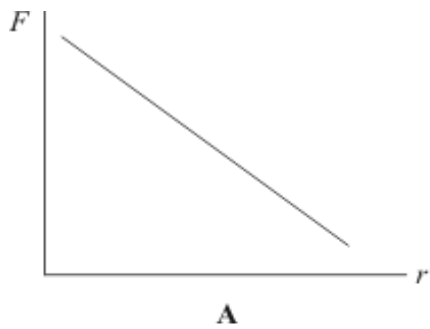
(Total 1 mark)

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 .



(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 $16g$

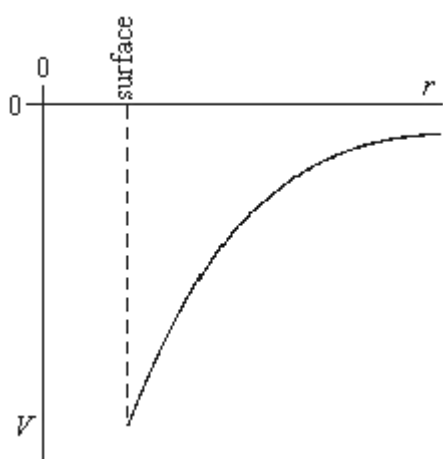
(Total 1 mark)

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 $\frac{4\pi\epsilon_0 e^2}{Gm^2}$
- B $\frac{Ge^2}{4\pi\epsilon_0 m^2}$
- C $\frac{e^2 m^2}{4\pi\epsilon_0 G}$
- D $\frac{e^2}{4\pi\epsilon_0 Gm^2}$

(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** $7.3 \times 10^{-5} \text{ rad s}^{-1}$
- B** $2.6 \times 10^{-1} \text{ rad s}^{-1}$
- C** 24 rad s^{-1}
- D** $5.0 \times 10^6 \text{ rad s}^{-1}$

(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 $2R$ 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)

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

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

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

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

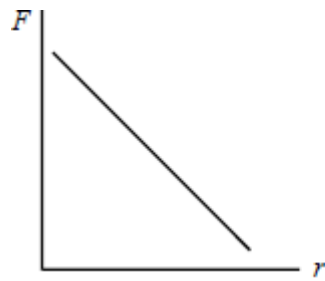
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Q19. Which one of the following has different units to the other three?

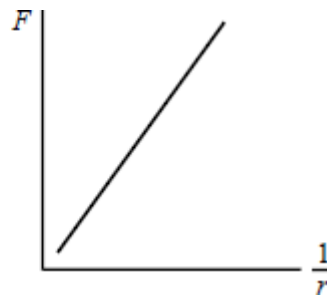
- A gravitational potential
- B gravitational field strength
- C force per unit mass
- D gravitational potential gradient

(Total 1 mark)

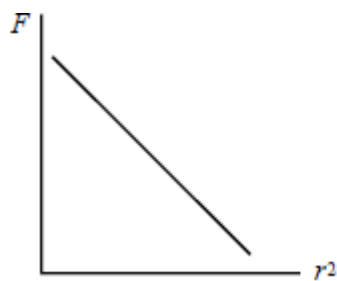
Q20. Which one of the following graphs correctly shows the relationship between the gravitational force, F , between two masses and the distance, r , between them?



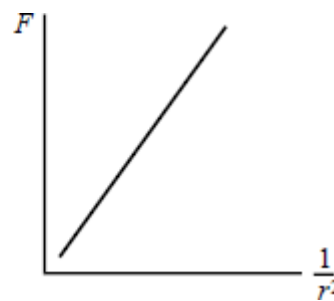
A



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

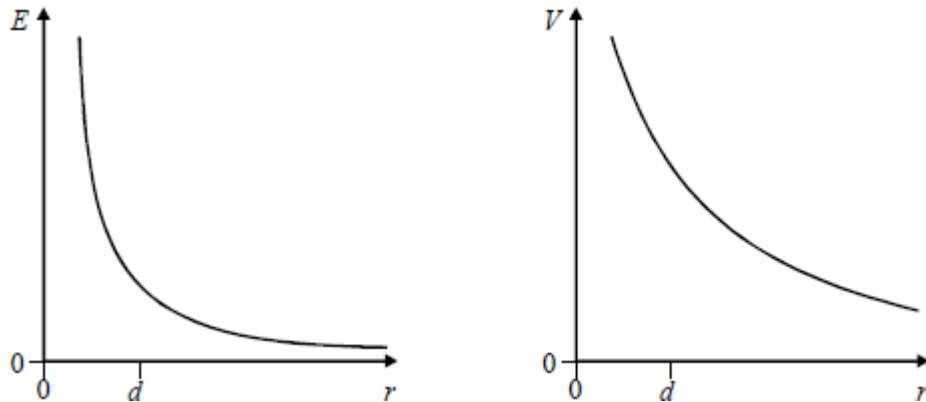
relationship $x \propto \frac{1}{y}$?

	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)