

Gravitational Field

TOPIC QUESTIONS

Level	AS Level
Subject	Physics
Exam Board	AQA
Paper Type	Multiple Choice

Time Allowed : 30min

EXAM PAPERS PRACTICE

1. Which of the following statements about Newton's law of gravitation is correct?

Newton's gravitational law explains

A the origin of gravitational forces.

B why a falling satellite burns up when it enters the Earth's atmosphere.

C why projectiles maintain a uniform horizontal speed.

D how various factors affect the gravitational force between two particles



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2. A spacecraft of mass m is at the mid-point between the centres of a planet of mass M_1 and its moon of mass M_2 . If the distance between the spacecraft and the centre of the planet is d , what is the magnitude of the resultant gravitational force on the spacecraft?

A

$$\frac{Gm(M_1 - M_2)}{d}$$

B

$$\frac{Gm(M_1 + M_2)}{d^2}$$

C $\frac{Gm(M_1 - M_2)}{d^2}$

D $\frac{Gm(M_1 + M_2)}{d}$

3. Which one of the following statements about gravitational potential is correct?

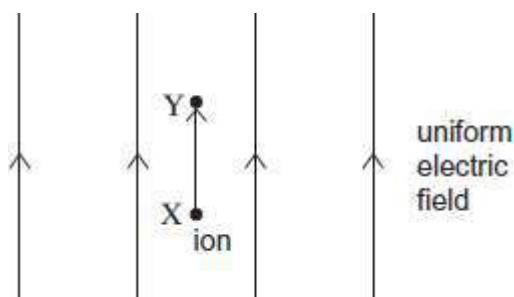
A gravitational potential can have a positive value

B the gravitational potential at the surface of the Earth is zero

C the gravitational potential gradient at a point has the same numerical value as the gravitational field strength at that point

D the unit of gravitational potential is N kg^{-1}

4. A uniform electric field of electric field strength E is aligned so it is vertical. An ion moves vertically through a small distance Δd from point X to point Y in the field. There is a uniform gravitational field of field strength g throughout the region.



Which line, A to D, in the table correctly gives the gravitational potential difference, and the electric potential difference, between X and Y?

	Gravitational potential difference	Electric potential difference
A	$g\Delta d$	$\frac{E\Delta d}{d}$
B	$g\Delta d$	$\frac{E}{\Delta d}$
C	$\frac{g}{\Delta d}$	$\frac{E\Delta d}{d}$
D	$\frac{g}{\Delta d}$	$\frac{E}{\Delta d}$

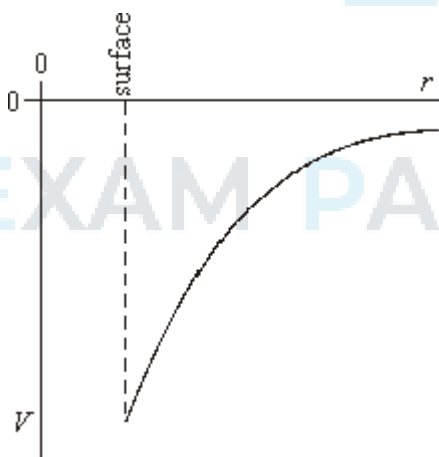
5. When a space shuttle is in a low orbit around the Earth it experiences gravitational forces F_E due to the Earth, F_M due to the Moon and F_S due to the Sun. Which one of the following correctly shows how the magnitudes of these forces are related to each other?

mass of Sun = 1.99×10^{30}

kg mass of Moon = 7.35×10^{22} kg

mean distance from Earth to Sun = 1.50×10^{11} m
 mean distance from Earth to Moon = 3.84×10^8 m

- A $F_E > F_S > F_M$
 B $F_S > F_E > F_M$
 C $F_E > F_M > F_S$
 D $F_M > F_E > F_S$
6. 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

7. 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}

8. 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

9. 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 $5.0 \times 10^6 \text{ rad s}^{-1}$

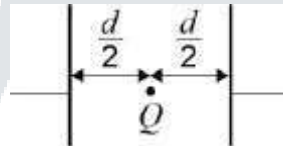


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10. A planet has a radius half of the Earth's radius and a mass a quarter of the Earth's mass. What is the approximate gravitational field strength on the surface of the planet?

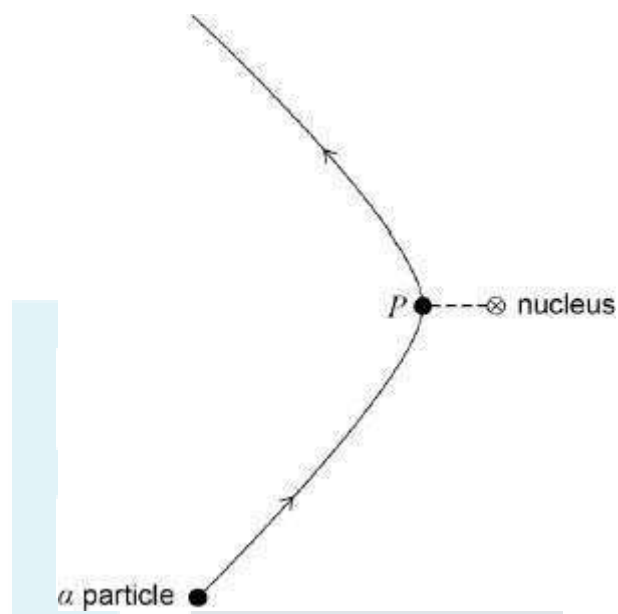
- A 1.6 N kg^{-1}
- B 5.0 N kg^{-1}
- C 10 N kg^{-1}
- D 20 N kg^{-1}

11. Two parallel metal plates are separated by a distance d and have a potential difference V across them. Which expression gives the magnitude of the electrostatic force acting on a charge Q placed midway between the plates?



- A $\frac{2VQ}{d}$
- B $\frac{VQ}{d}$
- C $\frac{VQ}{2d}$
- D $\frac{Qd}{v}$

12. The diagram shows the path of an α particle deflected by the nucleus of an atom. Point P on the path is the point of closest approach of the α particle to the nucleus.



Which of the following statements about the α particle on this path is correct?

- A** Its acceleration is zero at P.
- B** Its kinetic energy is greatest at P.
- C** Its potential energy is least at P.
- D** Its speed is least at P.

13. The electric potential at a distance r from a positive point charge is 45 V. The potential increases to 50 V when the distance from the point charge decreases by 1.5 m. What is the value of r ?

- A 1.3 m
- B 1.5 m
- C 7.9 m
- D 15m



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14. The diagram shows two particles at distance d apart. One particle has charge $+Q$ and the other $-2Q$. The two particles exert an electrostatic force of attraction, F , on each other. Each particle is then given an additional charge $+Q$ and their separation is increased to distance $2d$.



Which of the following gives the force that now acts between the two particles?

- A an attractive force of $\frac{F}{4}$
- B a repulsive force of $\frac{F}{4}$
- C an attractive force of $\frac{F}{2}$
- D a repulsive force of $\frac{F}{2}$

15. Which of the following statements about a parallel plate capacitor is **incorrect**?

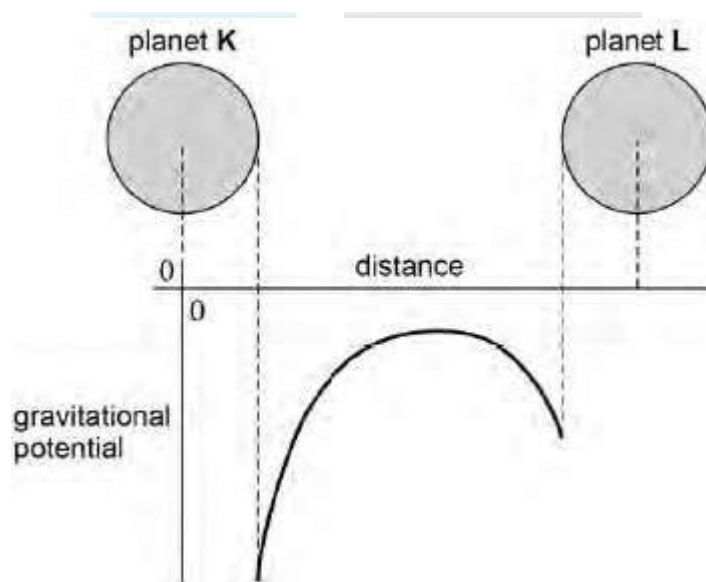
- A The capacitance of the capacitor is the amount of charge stored by the capacitor when the pd across the plates is 1 V.
- B A uniform electric field exists between the plates of the capacitor.
- C The charge stored on the capacitor is inversely proportional to the pd across the plates.
- D The energy stored when the capacitor is fully charged is proportional to the square of the pd across the plates.

16. What is the angular speed of a satellite in a geostationary orbit around the Earth?

- A $1.2 \times 10^{-5} \text{ rad s}^{-1}$
- B $7.3 \times 10^{-5} \text{ rad s}^{-1}$
- C $4.4 \times 10^{-3} \text{ rad s}^{-1}$

D $2.6 \times 10^{-1} \text{ rad s}^{-1}$

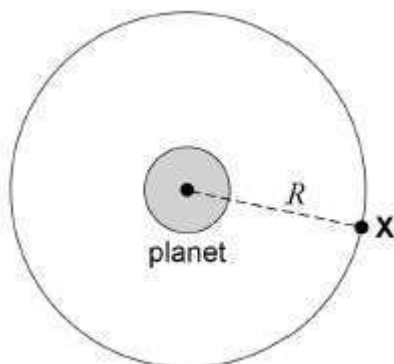
17. The graph shows how the gravitational potential varies with distance between two planets, **K** and **L**, that have the same radius.



Which statement is correct?

- A The mass of **L** is greater than the mass of **K**.
- B The gravitational field strength at the surface of **L** is greater than that at the surface of **K**.
- C The escape velocity from planet **L** is greater than that from planet **K**.
- D More work must be done to move a mass of 1 kg from the surface of **K** to a distant point, than 1 kg from the surface of **L**.

18. A satellite **X** of mass m is in a concentric circular orbit of radius R about a planet of mass M .



What is the kinetic energy of **X**?

A $\frac{GMm}{2R}$

B $\frac{GMm}{R}$

C $\frac{2GMm}{R}$

D $\frac{4GMm}{R}$

19. The distance between the Sun and Mars varies from 2.1×10^{11} m to 2.5×10^{11} m. When Mars is closest to the Sun, the force of gravitational attraction between them is F .

What is the force of gravitational attraction between them when they are furthest apart?

A $0.71F$

B $0.84F$

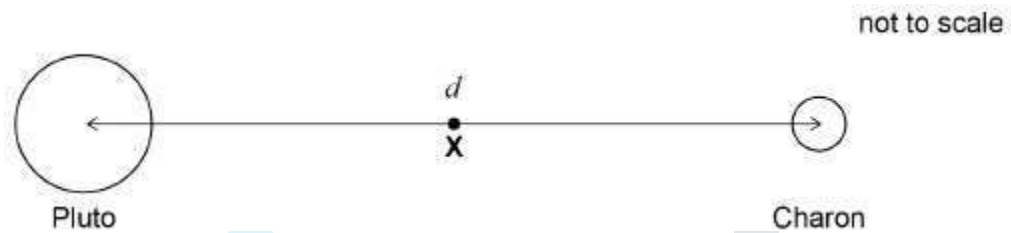
C $1.2F$

D $1.4F$

20. Charon is a moon of Pluto that has a mass equal to $\frac{1}{9}$ that of Pluto.

The distance between the centre of Pluto and the centre of Charon is d .

X is the point at which the resultant gravitational field due to Pluto and Charon is zero.



What is the distance of **X** from the centre of Pluto?

- A $\frac{2}{9}d$
- B $\frac{2}{3}d$
- C $\frac{3}{4}d$
- D $\frac{8}{9}d$