H2 Physics Revision Topic : Gravitation

Multiple Choice Questions Name: _____

1 A small mass m is placed in the gravitational field of a large mass M. Both masses experience a force F.

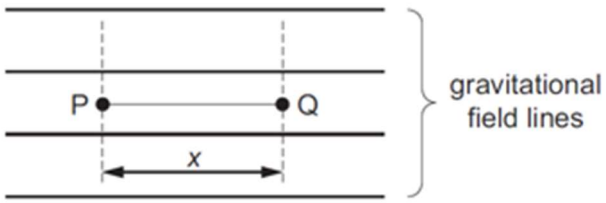
What is the gravitational field strength due to M at the position of m?

A $\frac{F}{Mm}$ **B** $\frac{F}{M}$ **C** FMm **D** $\frac{F}{m}$

2 Which of the following satellites must be a geostationary satellite orbiting about Earth?

A Satellite A has a period of 12 hours.
B Satellite B orbits directly above the equator.
C Satellite C orbits from east to west.
D Satellite D always remains above the same point on the Earth.

3 A mass m is situated in a uniform gravitational field.



When the mass moves through a displacement x, from P to Q, it loses an amount of potential energy E.

Which row correctly specifies the magnitude and the direction of the acceleration due to gravity in this field?

	magnitude	direction
A	$\frac{E}{mx}$	→
B	$\frac{E}{mx}$	←
C	$\frac{E}{x}$	→
D	$\frac{E}{x}$	←

4 An Earth satellite is moved from one stable circular orbit to another stable circular orbit at a greater distance from the Earth.

Which one of the following quantities increases for the satellite as a result of the change?

A gravitational force

B gravitational potential energy

C angular velocity

D centripetal acceleration

5 Two stationary particles of masses M_1 and M_2 are a distance d apart. A third particle, lying on the line joining the particles, experiences no resultant gravitational force.

What is the distance of this particle from M_1?

A $d\left(\frac{M_1}{M_2}\right)$ **B** $d\sqrt{\frac{M_1}{M_2}}$

C $d\sqrt{\frac{M_1}{M_1+M_2}}$ **D** $d\left(\frac{\sqrt{M_1}}{\sqrt{M_1}+\sqrt{M_2}}\right)$

6 Two isolated planets A and B have masses M_A and M_B respectively. Their centres are a distance D apart and they rotate with a uniform angular velocity ω about an axis which is perpendicular to the line joining their centres.

If the distance of planet A from the axis of rotation is R, which of the following does not give the expression for the centripetal force on planet B?

A $\frac{GM_AM_B}{D^2}$ **B** $\frac{GM_AM_B}{(D-R)^2}$ **C** $M_AR\omega^2$ **D** $M_B(D-R)\omega^2$

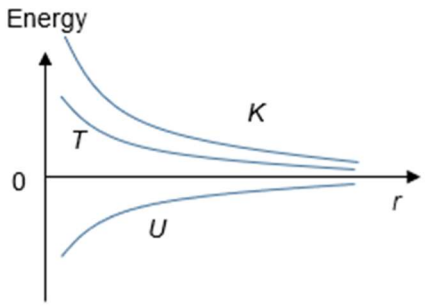
7 The Earth may be assumed to be an isolated uniform sphere of radius 6400 km.

At what height above the Earth's pole will the acceleration of free fall decrease by 1%?

A 32 km **B** 65 km **C** 80 km **D** 1253 km

8 Which of the following sets of graphs best represents the variation of the total energy (T), the kinetic energy (K) and the gravitational potential energy (U) of an orbiting satellite with distance r from the centre of Earth?

A



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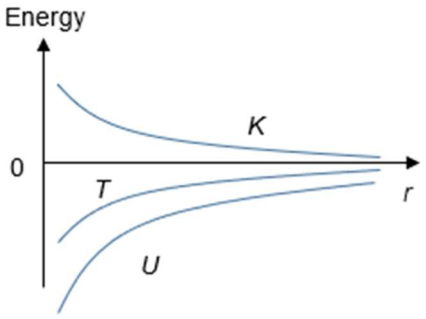

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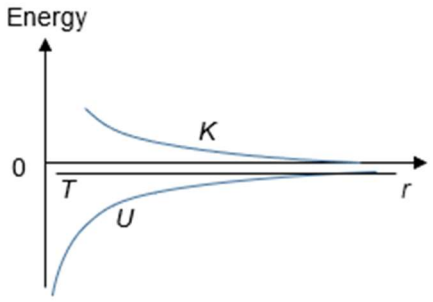

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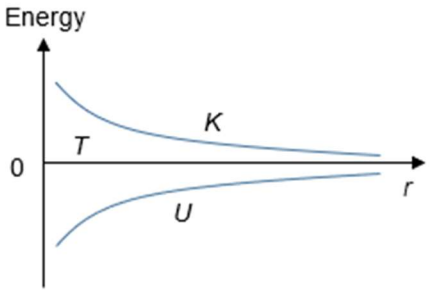


9 Two stationary particles of masses M_1 and M_2 are a distance d apart. A third particle, lying on the line joining the particles, experiences no resultant gravitational force.

What is the distance of this particle from M_1?

A $\left(\frac{M_1}{M_1+M_2}\right)d$

B $\left(\frac{M_2}{M_1+M_2}\right)d$

C $\left(\sqrt{\frac{M_1}{M_1+M_2}}\right)d$

D $\left(\frac{\sqrt{M_1}}{\sqrt{M_1}+\sqrt{M_2}}\right)d$

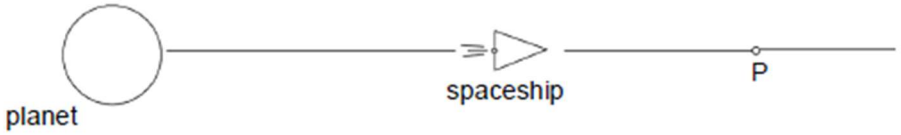
10 A satellite orbits a planet at a distance $2R$ from its centre. Its gravitational potential energy is –2.1 MJ.

Another identical satellite orbits the planet at a distance $3R$ from its centre.

What is the sum of the kinetic energy and the gravitational potential energy of this second satellite?

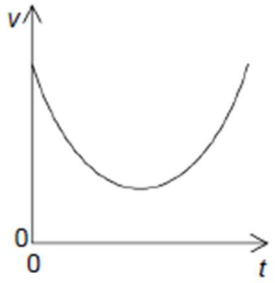
A –0.70 MJ **B** –1.4 MJ **C** –2.1 MJ **D** –3.2 MJ

11 A powered spaceship is moving directly away from a planet as shown below.

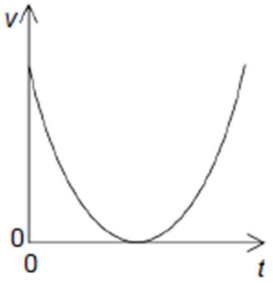


The spaceship passes point P at $t = 0$. At point P, the thrusters of the spaceship are switched off but the spaceship remains under the influence of the planet. Which one of the following graphs best represents the subsequent variation with time t of the velocity v of the spaceship?

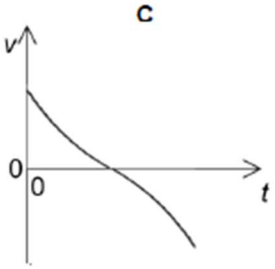
A



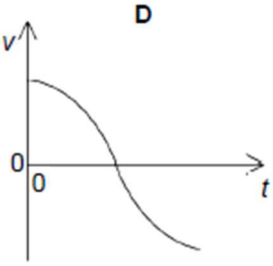
B



C



D



12 A satellite of mass 200 kg is moved from an orbit where the gravitational potential is –80 MJ kg^{-1} to another orbit where the gravitational potential is –40 MJ kg^{-1}.

What is the increase in its **total** energy?

A 0 MJ **B** 2000 MJ **C** 4000 MJ **D** 8000 MJ

13 The Earth may be considered to be a uniform sphere of mass M and radius R. An apple of mass m falls from rest from a height h to the ground, where $h << R$ such that the gravitational field strength g experienced by the apple during its fall may be assumed to be constant.

What is the gain in kinetic energy of the apple?

A mgR

B $\frac{GMmh}{R^2}$

C $\frac{GM}{R} - \frac{GM}{R+h}$

D $m\left(\frac{GM}{R+h} - \frac{GM}{R}\right)$

14 An object has weight W on the surface of the Earth.

The radius of Mars is 0.50 times that of the Earth.
The density of Mars is 0.70 times that of the Earth.

What is the weight of the object on the surface of Mars?

A 0.35 W **B** 0.50 W **C** 0.70 W **D** 2.8 W

15 The table shows three geostationary satellites, **P**, **Q** and **R**, and their masses

satellite	mass of satellite / kg
P	1200
Q	1500
R	3500

Which satellite has the largest centripetal force?

A P

B Q

C R

D They have the same magnitude of centripetal force

16 The planet Jupiter has satellites called Io and Europa which have different orbital radii and different orbital time periods. The table shows the orbital radii for Io and Europa and the orbital time period of Io.

	orbital radius / km	orbital time period / days
Io	4.22×10^5	1.77
Europa	6.71×10^5	T_E

What is the orbital time period T_E of Europa?

A 0.88 days **B** 2.4 days **C** 2.8 days **D** 3.5 days

17 The gravitational potentials on the surface of a planet P and on the surface of its moon Q are -120 MJ kg^{-1} and -20 MJ kg^{-1} respectively.

The minimum amount of energy required to project a 1 kg mass from the surface of Q to the surface of P is E.

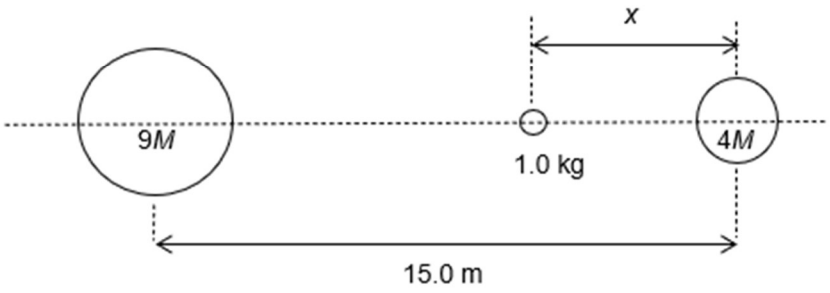
Which of the following correctly describes the value of E?

A $E < 20$ MJ
B $E = 20$ MJ
C 20 MJ $< E <$ 100 MJ
D 100 MJ $< E <$ 120 MJ

18 A 1.0 kg mass is placed between two masses of mass $9M$ and $4M$ respectively. The distance between the two masses is 15.0 m.

If the net gravitational force due to the two masses on the 1.0 kg mass is zero, what is the distance x?

(Diagram is not to scale)



A 3.0 m **B** 4.0 m **C** 5.0 m **D** 6.0 m

19 Many galaxies have a supermassive black hole at its core. Studies of stars that orbit close to the centre of our Milky Way galaxy's central black hole, Sagittarius A* can yield the approximate mass of the black hole. One star, S4714, is as of 2020, the record holder of closest approach. Given that it orbits with a period of 12 years and at a radius of 1.3×10^{14} m, what is the approximate mass of Sagittarius A*?

A 5.0×10^{8} kg **B** 9.1×10^{36} kg **C** 2.7×10^{45} kg **D** 8.3×10^{51} kg