Q1. An astronaut takes a ball of mass m from earth to space. He throws the ball into a circular orbit about earth at an altitude of 318.5 km. From earth's surface to the orbit, the change in total mechanical energy of the ball is $x\frac{\mathrm{GM_e m}}{21\mathrm{R_e}}$. The value of x is (take $\mathrm{R_e} = 6370\ \mathrm{km}$) : ***09 Apr 2024 (M)***

(1) 10 (2) 12

(3) 9 (4) 11

Q2. A satellite of 10^3 kg mass is revolving in circular orbit of radius $2R$. If $\frac{10^4 R}{6} J$ energy is supplied to the satellite, it would revolve in a new circular orbit of radius

(use $g = 10\ \mathrm{m/s^2}, R =$ radius of earth) ***09 Apr 2024 (E)***

(1) $2.5R$ (2) $3R$

(3) $4R$ (4) $6R$

Q3. Two satellite A and B go round a planet in circular orbits having radii $4R$ and R respectively. If the speed of A is $3v$, the speed of B will be : ***08 Apr 2024 (E)***

(1) $3v$ (2) $6v$

(3) $\frac{4}{3}v$ (4) $12v$

Q4. Two planets A and B having masses m_1 and m_2 move around the sun in circular orbits of r_1 and r_2 radii respectively. If angular momentum of A is L and that of B is 3 L, the ratio of time period $\left(\frac{T_A}{T_B}\right)$ is: ***08 Apr 2024 (M)***

(1) $\left(\frac{r_2}{r_1}\right)^{\frac{3}{2}}$ (2) $\frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$

(3) $27\left(\frac{m_1}{m_2}\right)^3$ (4) $\left(\frac{r_1}{r_2}\right)^3$

Q5. Assuming the earth to be a sphere of uniform mass density, a body weighed 300 N on the surface of earth. How much it would weigh at R/4 depth under surface of earth ? ***06 Apr 2024 (E)***

(1) 75 N (2) 300 N

(3) 375 N (4) 225 N

Q6. To project a body of mass m from earth's surface to infinity, the required kinetic energy is (assume, the radius of earth is $R_E, g =$ acceleration due to gravity on the surface of earth): ***06 Apr 2024 (M)***

(1) $2mgR_E$ (2) $4mgR_E$

(3) mgR_E (4) $1/2mgR_E$

Q7. A satellite revolving around a planet in stationary orbit has time period 6 hours. The mass of planet is one-fourth the mass of earth. The radius orbit of planet is :

(Given $=$ Radius of geo-stationary orbit for earth is 4.2×10^4 km) ***05 Apr 2024 (E)***

(1) 1.4×10^4 km (2) 1.05×10^4 km

(3) 8.4×10^4 km (4) 1.68×10^5 km

Q8. In hydrogen like system the ratio of coulombic force and gravitational force between an electron and a proton is in the order of : ***05 Apr 2024 (M)***

(1) 10^{39} (2) 10^{29}

(3) 10^{19} (4) 10^{36}

Q9. A simple pendulum doing small oscillations at a place R height above earth surface has time period of $T_1 = 4$ s. T_2 would be it's time period if it is brought to a point which is at a height 2R from earth surface. Choose the correct relation $[R = \text{radius of earth}]$: ***05 Apr 2024 (M)***

(1) $2\,\mathrm{T}_1 = \mathrm{T}_2$ (2) $2\,\mathrm{T}_1 = 3\,\mathrm{T}_2$

(3) $\mathrm{T}_1 = \mathrm{T}_2$ (4) $3\,\mathrm{T}_1 = 2\,\mathrm{T}_2$

Q10. Match List I with List II :

	List I		List II
(A)	Kinetic energy of planet	(I)	$-\mathrm{GMm}/\mathrm{a}$
(B)	Gravitation Potential energy of sun-planet system	(II)	$\mathrm{GMm}/2\mathrm{a}$
(C)	Total mechanical energy of planet	(III)	$\frac{\mathrm{Gm}}{\mathrm{r}}$
(D)	Escape energy at the surface of planet for unit mass object	(IV)	$-\mathrm{GMm}/2\mathrm{a}$

(Where a = radius of planet orbit, r = radius of planet, M = mass of Sun, m = mass of planet)

Choose the **correct** answer from the options given below :

05 Apr 2024 (M)

(1) (A)-(III), (B)-(IV), (C)-(I), (D)-(II) (2) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(3) (A)-(I), (B)-(II), (C)-(III), (D)-(IV) (4) (A)-(I), (B)-(IV), (C)-(II), (D)-(III)

Q11. A metal wire of uniform mass density having length L and mass M is bent to form a semicircular arc and a particle of mass m is placed at the centre of the arc. The gravitational force on the particle by the wire is :

04 Apr 2024 (M)

(1) $\frac{\mathrm{GmM}\pi^2}{\mathrm{L}^2}$ (2) $\frac{\mathrm{GMm}\pi}{2\,\mathrm{L}^2}$

(3) 0 (4) $\frac{2\mathrm{GmM}\pi}{\mathrm{L}^2}$

Q12. A 90 kg body placed at 2R distance from surface of earth experiences gravitational pull of :

$(\mathrm{R} = \text{ Radius of earth, } \mathrm{g} = 10\ \mathrm{m\,s}^{-2})$ ***04 Apr 2024 (E)***

(1) 100 N (2) 300 N

(3) 225 N (4) 120 N

Q13. Correct formula for height of a satellite from earths surface is: ***04 Apr 2024 (E)***

(1) $\left(\frac{T^2R^2}{4\pi^2 g}\right)^{1/3} - R$ (2) $\left(\frac{T^2R^2 g}{4\pi^2}\right)^{1/3} - R$

(3) $\left(\frac{T^2R^2 g}{4\pi^2}\right)^{-1/3} + R$ (4) $\left(\frac{T^2R^2 g}{4\pi}\right)^{1/2} - R$

Q14. If R is the radius of the earth and the acceleration due to gravity on the surface of earth is $g = \pi^2\ \mathrm{m\,s}^{-2}$, then the length of the second's pendulum at a height $h = 2R$ from the surface of earth will be: ***01 Feb 2024 (M)***

(1) $\frac{2}{9}$ m (2) $\frac{1}{9}$ m

(3) $\frac{4}{9}$ m (4) $\frac{8}{9}$ m

Q15. A light planet is revolving around a massive star in a circular orbit of radius R with a period of revolution T. If the force of attraction between planet and star is proportional to $R^{-3/2}$ then choose the correct option :

01 Feb 2024 (E)

(1) $T^2 \propto R^{5/2}$
(2) $T^2 \propto R^{7/2}$
(3) $T^2 \propto R^{3/2}$
(4) $T^2 \propto R^3$

Q16. Four identical particles of mass m are kept at the four corners of a square. If the gravitational force exerted on one of the masses by the other masses is $\left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2}$, the length of the sides of the square is

31 Jan 2024 (M)

(1) $\frac{L}{2}$
(2) $4L$
(3) $3L$
(4) $2L$

Q17. The mass of the moon is $\frac{1}{144}$ times the mass of a planet and its diameter $\frac{1}{16}$ times the diameter of a planet. If the escape velocity on the planet is v, the escape velocity on the moon will be: ***31 Jan 2024 (E)***

(1) $\frac{v}{3}$
(2) $\frac{v}{4}$
(3) $\frac{v}{12}$
(4) $\frac{v}{6}$

Q18. The gravitational potential at a point above the surface of earth is $-5.12 \times 10^7 \text{ J kg}^{-1}$ and the acceleration due to gravity at that point is 6.4 m s^{-2}. Assume that the mean radius of earth to be 6400 km. The height of this point above the earth's surface is: ***30 Jan 2024 (M)***

(1) 1600 km
(2) 540 km
(3) 1200 km
(4) 1000 km

Q19. Escape velocity of a body from earth is 11.2 km s^{-1}. If the radius of a planet be one-third the radius of earth and mass be one-sixth that of earth, the escape velocity from the plate is: ***30 Jan 2024 (E)***

(1) 11.2 km s^{-1}
(2) 8.4 km s^{-1}
(3) 4.2 km s^{-1}
(4) 7.9 km s^{-1}

Q20. At what distance above and below the surface of the earth a body will have same weight? (Take radius of earth as R)

29 Jan 2024 (M)

(1) $\sqrt{5}\mathrm{R}-\mathrm{R}$
(2) $\frac{\sqrt{3}R-R}{2}$
(3) $\frac{R}{2}$
(4) $\frac{\sqrt{5}R-R}{2}$

Q21. A planet takes 200 days to complete one revolution around the Sun. If the distance of the planet from Sun is reduced to one fourth of the original distance, how many days will it take to complete one revolution?

29 Jan 2024 (E)

(1) 25
(2) 50
(3) 100
(4) 20

Q22. The acceleration due to gravity on the surface of earth is g. If the diameter of earth reduces to half of its original value and mass remains constant, then acceleration due to gravity on the surface of earth would be :

27 Jan 2024 (M)

(1) $\frac{g}{4}$
(2) $2g$
(3) $\frac{g}{2}$
(4) $4g$

Q23. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.
Assertion (A) : The angular speed of the moon in its orbit about the earth is more than the angular speed of the

earth in its orbit about the sun.

Reason (R): The moon takes less time to move around the earth than the time taken by the earth to move around the sun.

In the light of the above statements, choose the most appropriate answer from the options given below :

27 Jan 2024 (E)

(1) (A) is correct but (R) is not correct

(2) Both (A) and (R) are correct and (R) is the correct explanation of A.

(3) Both (A) and (R) are correct but (R) is not the correct explanation of A.

(4) (A) is not correct but (R) is correct

Q24. Two identical particles each of mass m go round a circle of radius a under the action of their mutual gravitational attraction. The angular speed of each particle will be : ***15 Apr 2023 (M)***

(1) $\sqrt{\frac{Gm}{a^3}}$ (2) $\sqrt{\frac{Gm}{8a^3}}$

(3) $\sqrt{\frac{Gm}{4a^3}}$ (4) $\sqrt{\frac{Gm}{2a^3}}$

Q25. A planet having mass $9\ \mathrm{M_e}$ and radius $4\mathrm{R_e}$, where $\mathrm{M_e}$ and $\mathrm{R_e}$ are mass and radius of earth respectively, has escape velocity in $\mathrm{km\ s^{-1}}$ given by: (Given escape velocity on earth $V_\mathrm{e} = 11.2 \times 10^3\ \mathrm{m\ s^{-1}}$)

13 Apr 2023 (M)

(1) 67.2 (2) 16.8

(3) 11.2 (4) 33.6

Q26. Given below are two statements:

Statement I : For a planet, if the ratio of mass of the planet to its radius increase, the escape velocity from the planet also increase.

Statement II : Escape velocity is independent of the radius of the planet.

In the light of above statements, choose the **most appropriate** answer from the options given below

13 Apr 2023 (E)

(1) Statement I is incorrect but Statement II is correct

(2) Statement I is correct but statement II is incorrect

(3) Both Statement I and Statement II are incorrect

(4) Both Statement I and Statement II are correct

Q27. Two planets A and B of radii R and $1.5\ R$ have densities ρ and $\frac{\rho}{2}$ respectively. The ratio of acceleration due to gravity at the surface of B to A is: ***13 Apr 2023 (E)***

(1) $2 : 3$ (2) $2 : 1$

(3) $3 : 4$ (4) $4 : 3$

Q28. Two satellites A and B move round the earth in the same orbit. The mass of A is twice the mass of B. The quantity which is same for the two satellites will be ***12 Apr 2023 (M)***

(1) Speed (2) Kinetic energy

(3) Total energy (4) Potential energy

Q29. The ratio of escape velocity of a planet to the escape velocity of earth will be:-

Given: Mass of the planet is 16 times mass of earth and radius of the planet is 4 times the radius of earth.

12 Apr 2023 (M)

(1) $4 : 1$ (2) $1 : 4$
(3) $1 : \sqrt{2}$ (4) $2 : 1$

Q30. The radii of two planets A and B are R and $4R$ and their densities are ρ and $\frac{\rho}{3}$ respectively. The ratio of acceleration due to gravity at their surfaces $(g_A : g_B)$ will be

11 Apr 2023 (M)

(1) 4 : 3 (2) 1 : 16
(3) 3 : 16 (4) 3 : 4

Q31. A space ship of mass 2×10^4 kg is launched into a circular orbit close to the earth surface. The additional velocity to be imparted to the space ship in the orbit to overcome the gravitational pull will be (if $g = 10 \mathrm{~m~s}^{-2}$ and radius of earth $= 6400$ km): ***11 Apr 2023 (E)***

(1) $11.2(\sqrt{2}-1) \mathrm{~km~s}^{-1}$ (2) $8(\sqrt{2}-1) \mathrm{~km~s}^{-1}$
(3) $7.9(\sqrt{2}-1) \mathrm{~km~s}^{-1}$ (4) $7.4(\sqrt{2}-1) \mathrm{~km~s}^{-1}$

Q32. The time period of a satellite, revolving above earth's surface at a height equal to R will be (Given $g = \pi^2 \mathrm{~m~s}^{-2}$, $R =$ radius of earth) ***10 Apr 2023 (E)***

(1) $\sqrt{2R}$ (2) $\sqrt{8R}$
(3) $\sqrt{32R}$ (4) $\sqrt{4R}$

Q33. Assuming the earth to be a sphere of uniform mass density, the weight of a body at a depth $d = \frac{R}{2}$ from the surface of earth, if its weight on the surface of earth is 200 N, will be : (Given $R =$ radius of earth)

10 Apr 2023 (M)

(1) 300 N (2) 100 N
(3) 400 N (4) 500 N

Q34. Given below are two statements:

Statement I : Rotation of the earth shows effect on the value of acceleration due to gravity (g).

Statement II : The effect of rotation of the earth on the value of g at the equator is minimum and that at the pole is maximum.

In the light of the above statements, choose the correct answer from the options given below

10 Apr 2023 (E)

(1) Statement I is false but statement II is true (2) Both Statement I and Statement II are true
(3) Both Statement I and Statement II are false (4) Statement I is true but statement II is false

Q35. Two satellites of masses m and 3 m revolve around the earth in circular orbits of radii r & 3r respectively. The ratio of orbital speeds of the satellites respectively is ***10 Apr 2023 (M)***

(1) $\sqrt{3} : 1$ (2) $3 : 1$
(3) $9 : 1$ (4) $1 : 1$

Q36. If the earth suddenly shrinks to $\frac{1}{64}$th of its original volume with its mass remaining the same, the period of rotation of earth becomes $\frac{24}{x} h$. The value of x is ________ ***10 Apr 2023 (M)***

Q37. The acceleration due to gravity at height h above the earth if $h \ll R$ (Radius of earth) is given by

08 Apr 2023 (E)

(1) $g' = g\left(1 - \frac{h^2}{2R^2}\right)$
(2) $g' = \mathrm{g}\left(1 - \frac{\mathrm{h}}{2\mathrm{R}}\right)$
(3) $g' = \mathrm{g}\left(1 - \frac{2\mathrm{h}}{\mathrm{R}}\right)$
(4) $g' = g\left(1 - \frac{2h^2}{R^2}\right)$

Q38. Given below are two statements:
Statement I: If E be the total energy of a satellite moving around the earth, then its potential energy will be $\frac{E}{2}$.
Statement II: The kinetic energy of a satellite revolving in an orbit is equal to the half the magnitude of total energy E.
In the light of the above statements, choose the most appropriate answer from the options given below.

08 Apr 2023 (M)

(1) Statement I is correct but Statement II is incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

Q39. The weight of a body on the earth is 400 N. Then weight of the body when taken to a depth half of the radius of the earth will be: ***08 Apr 2023 (M)***
(1) 200 N
(2) Zero
(3) 100 N
(4) 300 N

Q40. The orbital angular momentum of a satellite is L, when it is revolving in a circular orbit at height h from earth surface. If the distance of satellite from the earth centre is increased by eight times to its initial value, then the new angular momentum will be ***08 Apr 2023 (E)***
(1) 8 L
(2) 9 L
(3) 4 L
(4) 3 L

Q41. A planet has double the mass of the earth. Its average density is equal to that of the earth. An object weighing W on earth will weigh on that planet:

06 Apr 2023 (M)

(1) $2^{\frac{1}{4}}\mathrm{W}$
(2) $2^{\frac{1}{3}}\mathrm{W}$
(3) 2W
(4) $2^{\frac{2}{3}}\mathrm{W}$

Q42. The weight of a body on the surface of the earth is 100 N. The gravitational force on it when taken at a height, from the surface of earth, equal to one-fourth the radius of the earth is: ***06 Apr 2023 (E)***
(1) 64 N
(2) 25 N
(3) 50 N
(4) 100 N

Q43. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**.
Assertion A: Earth has atmosphere whereas moon doesn't have any atmosphere.
Reason R: The escape velocity on moon is very small as compared to that on earth.
In the light of the above statements, choose the correct answer from the options given below:

06 Apr 2023 (M)

(1) Both A and R are correct but R is NOT the correct explanation of A
(2) A is false but R is true
(3) Both A and R are correct and R is the correct explanation of A
(4) A is true but R is false

Q44. Choose the incorrect statement from the following: ***06 Apr 2023 (E)***

(1) The speed of satellite in a given circular orbit remains constant
(2) For a planet revolving around the sun in an elliptical orbit, the total energy of the planet remains constant
(3) The linear speed of a planet revolving around the sun remains constant
(4) When a body falls towards earth, the displacement of earth towards the body is negligible

Q45. Given below are two statements :
Statement-I: Acceleration due to gravity is different at different places on the surface of earth.
Statement-II: Acceleration due to gravity increases as we go down below the earth's surface.
In the light of the above statements, choose the correct answer from the options given below ***01 Feb 2023 (M)***

(1) Both Statement I and Statement II are true
(2) Both Statement I and Statement II are false
(3) Statement I is true but Statement II is false
(4) Statement I is false but Statement II is true

Q46. For a body projected at an angle with the horizontal from the ground, choose the correct statement ***01 Feb 2023 (E)***

(1) Gravitational potential energy is maximum at the highest point.
(2) The horizontal component of velocity is zero at highest point.
(3) The vertical component of momentum is maximum at the highest point.
(4) The kinetic energy (K.E.) is zero at the highest point of projectile motion.

Q47. The escape velocities of two planets $A \ and \ B$ are in the ratio $1 : 2$. If the ratio of their radii respectively is $1 : 3$, then the ratio of acceleration due to gravity of planet A to the acceleration of gravity of planet B will be: ***01 Feb 2023 (E)***

(1) $\frac{4}{3}$
(2) $\frac{3}{2}$
(3) $\frac{2}{3}$
(4) $\frac{3}{4}$

Q48. If earth has a mass nine times and radius twice to the of a planet P. Then $\frac{v_e}{3}\sqrt{x} ms^{-1}$ will be the minimum velocity required by a rocket to pull out of gravitational force of P, where ve is escape velocity on earth. The value of x is ***01 Feb 2023 (M)***

(1) 2
(2) 3
(3) 18
(4) 1

Q49. At a certain depth d below surface of earth, value of acceleration due to gravity becomes four times that of its value at a height $3R$ above earth surface. Where R is Radius of earth (Take $R = 6400 \text{ km}$). The depth d is equal to ***31 Jan 2023 (M)***

(1) 5260 km
(2) 640 km
(3) 2560 km
(4) 4800 km

Q50. A body weight W, is projected vertically upwards from earth's surface to reach a height above the earth which is equal to nine times the radius of earth. The weight of the body at that height will be: ***31 Jan 2023 (E)***

(1) $\frac{W}{91}$ (2) $\frac{W}{100}$

(3) $\frac{W}{9}$ (4) $\frac{W}{3}$

Q51. An object is allowed to fall from a height R above the earth, where R is the radius of earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be : ***30 Jan 2023 (E)***

(1) $2\sqrt{gR}$ (2) $\sqrt{gR}$

(3) $\sqrt{\frac{gR}{2}}$ (4) $\sqrt{2gR}$

Q52. If the gravitational field in the space is given as $\left(-\frac{K}{r^2}\right)$. Taking the reference point to be at $r = 2$ cm with gravitational potential $V = 10\ \mathrm{J\ kg^{-1}}$. Find the gravitational potentials at $r = 3$ cm in SI unit (Given, that $K = 6\ \mathrm{J\ cm\ kg^{-1}}$) ***30 Jan 2023 (M)***

(1) 9 (2) 11

(3) 12 (4) 10

Q53. The time period of a satellite of earth is 24 hours. If the separation between the earth and the satellite is decreased to one fourth of the previous value, then its new time period will become. ***29 Jan 2023 (E)***

(1) 4 hours (2) 6 hours

(3) 12 hours (4) 3 hours

Q54. Two particles of equal mass m move in a circle of radius r under the action of their mutual gravitational attraction. The speed of each particle will be : ***29 Jan 2023 (M)***

(1) $\sqrt{\frac{Gm}{2r}}$ (2) $\sqrt{\frac{4Gm}{r}}$

(3) $\sqrt{\frac{Gm}{r}}$ (4) $\sqrt{\frac{Gm}{4r}}$

Q55. Every planet revolves around the sun in an elliptical orbit :

A. The force acting on a planet is inversely proportional to square of distance from sun.

B. Force acting on planet is inversely proportional to product of the masses of the planet and the sun.

C. The centripetal force acting on the planet is directed away from the sun.

D. The square of time period of revolution of planet around sun is directly proportional to cube of semi-major axis of elliptical orbit.

Choose the correct answer from the options given below :

25 Jan 2023 (E)

(1) A and D only (2) C and D only

(3) B and C only (4) A and C only

Q56. T is the time period of simple pendulum on the earth's surface. Its time period becomes xT when taken to a height R (equal to earth's radius) above the earth's surface. Then, the value of x will be: ***25 Jan 2023 (M)***

(1) 4 (2) 2

(3) $\frac{1}{2}$ (4) $\frac{1}{4}$

Q57. A body of mass is taken from earth surface to the height h equal to twice the radius of earth (R_e), the increase in potential energy will be : (g = acceleration due to gravity on the surface of earth) ***25 Jan 2023 (E)***

(1) $3mgR_e$
(2) $\frac{1}{3}mgR_e$
(3) $\frac{2}{3}mgR_e$
(4) $\frac{1}{2}mgR_e$

Q58. Assume that the earth is a solid sphere of uniform density and a tunnel is dug along its diameter throughout the earth. It is found that when a particle is released in this tunnel, it executes a simple harmonic motion. The mass of the particle is 100 g. The time period of the motion of the particle will be (approximately) (take $g = 10 \text{ ms}^{-2}$, radius of earth $= 6400 \text{ km}$)

25 Jan 2023 (M)

(1) 24 hours
(2) 1 hour 24 minutes
(3) 1 hour 40 minutes
(4) 12 hours

Q59. The weight of a body at the surface of earth is 18 N. The weight of the body at an altitude of 3200 km above the earth's surface is (given, radius of earth $R_e = 6400 \text{ km}$) ***24 Jan 2023 (M)***

(1) 9.8 N
(2) 4.9 N
(3) 19.6 N
(4) 8 N

Q60. Given below are two statements:

Statement I: Acceleration due to earth's gravity decreases as you go 'up' or 'down' from earth's surface.

Statement II: Acceleration due to earth's gravity is same at a height 'h' and depth 'd' from earth's surface, if $h = d$.

In the light of above statements, choose the most appropriate answer form the options given below

24 Jan 2023 (E)

(1) Statement I is incorrect but statement II is correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but statement II is incorrect
(4) Both Statement I and II are correct

Q61. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**

Assertion A: A pendulum clock when taken to Mount Everest becomes fast.

Reason R: The value of g (acceleration due to gravity) is less at Mount Everest than its value on the surface of earth.

In the light of the above statements, choose the most appropriate answer from the options given below

24 Jan 2023 (E)

(1) Both A and R are correct and R is the correct explanation of A
(2) Both A and R are correct but R is not the correct explanation of A
(3) A is correct but R is not correct
(4) A is not correct but R is correct

Q62. If the distance of the earth from Sun is $1.5 \times 10^6 \text{ km}$, then the distance of an imaginary planet from Sun, if its period of revolution is 2.83 years is: ***24 Jan 2023 (E)***

(1) $6 \times 10^7 \text{ km}$
(2) $6 \times 10^6 \text{ km}$
(3) $3 \times 10^6 \text{ km}$
(4) $3 \times 10^7 \text{ km}$

Q63. If the acceleration due to gravity experienced by a point mass at a height h above the surface of earth is same as that of the acceleration due to gravity at a depth $\alpha h(h \ll R_e)$) from the earth surface. The value of α will be _____. (use $R_e = 6400 \text{ km}$)

29 Jul 2022 (M)

Q64. An object of mass 1 kg is taken to a height from the surface of earth which is equal to three times the radius of earth. The gain in potential energy of the object will be
[If, $g = 10 \text{ m s}^{-2}$ and radius of earth $= 6400 \text{ km}$] ***29 Jul 2022 (E)***

(1) $48\,\text{MJ}$ (2) $24\,\text{MJ}$
(3) $36\,\text{MJ}$ (4) $12\,\text{MJ}$

Q65. Assume there are two identical simple pendulum Clocks-1 is placed on the earth and Clock-2 is placed on a space station located at a height h above the earth surface. Clock-1 and Clock-2 operate at time periods 4 s and 6 s respectively. Then the value of h is -
(consider radius of earth $R_E = 6400 \text{ km}$ and g on earth 10 m s^{-2}) ***28 Jul 2022 (E)***

(1) 1200 km (2) 1600 km
(3) 3200 km (4) 4800 km

Q66. If the radius of earth shrinks by 2% while its mass remains same. The acceleration due to gravity on the earth's surface will approximately ***28 Jul 2022 (M)***

(1) decrease by 2% (2) decrease by 4%
(3) increase by 2% (4) increase by 4%

Q67. A body of mass m is projected with velocity λv_e in vertically upward direction from the surface of the earth into space. It is given that v_e is escape velocity and $\lambda < 1$. If air resistance is considered to the negligible, then the maximum height from the centre of earth, to which the body can go, will be (R : radius of earth)

27 Jul 2022 (E)

(1) $\frac{R}{1+\lambda^2}$ (2) $\frac{R}{1-\lambda^2}$
(3) $\frac{R}{1-\lambda}$ (4) $\frac{\lambda^2 R}{1-\lambda^2}$

Q68. Two satellites A and B having masses in the ratio 4 : 3 are revolving in circular orbits of radii $3r$ and $4r$ respectively around the earth. The ratio of total mechanical energy of A to B is ***27 Jul 2022 (M)***

(1) 9 : 16 (2) 16 : 9
(3) 1 : 1 (4) 4 : 3

Q69. The percentage decrease in the weight of a rocket, when taken to a height of 32 km above the surface of earth will, be
(Radius of earth $= 6400 \text{ km}$) ***26 Jul 2022 (M)***

(1) 1% (2) 3%
(3) 4% (4) 0.5%

Q70. A body is projected vertically upwards from the surface of earth with a velocity equal to one third of escape velocity. The maximum height attained by the body will be
(Take radius of earth $= 6400 \text{ km}$ and $g = 10 \text{ ms}^{-2}$) ***26 Jul 2022 (E)***

(1) 800 km (2) 1600 km
(3) 2133 km (4) 4800 km

Q71. Three identical particle A, B and C of mass 100 kg each are placed in a straight line with $AB = BC = 13 \text{ m}$. The gravitational force on a fourth particle P of the same mass is F, when placed at a distance 13 m from the particle B on the perpendicular bisector of the line AC. The value of F will be approximately ***25 Jul 2022 (M)***

(1) 21G (2) 100G
(3) 59G (4) 42G

Q72. The length of a seconds pendulum at a height $h = 2R$ from earth surface will be:
(Given: $R =$ Radius of earth and acceleration due to gravity at the surface of earth $g = \pi^2 \text{ m s}^{-2}$) ***25 Jul 2022 (E)***

(1) $\frac{2}{9}\text{m}$ (2) $\frac{4}{9}\text{m}$
(3) $\frac{8}{9}\text{m}$ (4) $\frac{1}{9}\text{m}$

Q73. An object is taken to a height above the surface of earth at a distance $\frac{5}{4}R$ from the centre of the earth. Where radius of earth, $R = 6400 \text{ km}$. The percentage decrease in the weight of the object will be ***25 Jul 2022 (E)***

(1) 36% (2) 50%
(3) 64% (4) 25%

Q74. The escape velocity of a body on a planet A is 12 km s^{-1}. The escape velocity of the body on another planet B, whose density is four times and radius is half of the planet A, is ***29 Jun 2022 (M)***

(1) 12 km s^{-1} (2) 24 km s^{-1}
(3) 36 km s^{-1} (4) 6 km s^{-1}

Q75. The time period of a satellite revolving around earth in a given orbit is 7 hours. If the radius of orbit is increased to three times its previous value, then approximate new time period of the satellite will be ***29 Jun 2022 (E)***

(1) 36 hours (2) 40 hours
(3) 30 hours (4) 25 hours

Q76. Two objects of equal masses placed at certain distance from each other attracts each other with a force of F. If one-third mass of one object is transferred to the other object, then the new force will be ***28 Jun 2022 (E)***

(1) $\frac{2}{9}F$ (2) $\frac{16}{9}F$
(3) $\frac{8}{9}F$ (4) F

Q77. Two planets A and B of equal mass are having their period of revolutions T_A and T_B such that $T_A = 2T_B$. These planets are revolving in the circular orbits of radii r_A and r_B respectively. Which out of the following would be the correct relationship of their orbits? ***28 Jun 2022 (M)***

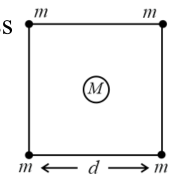
(1) $2r_A^2 = r_B^3$ (2) $r_A^3 = 2r_B^3$
(3) $r_A^3 = 4r_B^3$ (4) $T_A^2 - T_B^2 = \frac{\pi^2}{GM}\left(r_B^3 - 4r_A^3\right)$

Q78. **Statement I:** The law of gravitation holds good for any pair of bodies in the universe.
Statement II: The weight of any person becomes zero when the person is at the centre of the earth.
In the light of the above statements, choose the correct answer from the options given below.

27 Jun 2022 (M)

(1) Statement 1 and statement 2 both are true.
(2) Statement 1 is true and statement 2 is false.
(3) Statement 1 and statement 2 both are false.
(4) Statement 1 is false and statement 2 is true.

Q79. Four spheres each of mass m form a square of side d (as shown in figure). A fifth sphere of mass M is situated at the centre of square. The total gravitational potential energy of the system is

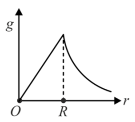


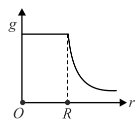
27 Jun 2022 (E)

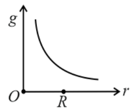
(1) $-\frac{Gm}{d}\left[\left(4+\sqrt{2}\right)m+4\sqrt{2}M\right]$
(2) $-\frac{Gm}{d}\left[\left(4+\sqrt{2}\right)M+4\sqrt{2}m\right]$
(3) $-\frac{Gm}{d}\left[3m^2+4\sqrt{2}M\right]$
(4) $-\frac{Gm}{d}\left[6m^2+4\sqrt{2}M\right]$

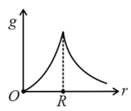
Q80. The variation of acceleration due to gravity (g) with distance (r) from the center of the earth is correctly represented by (Given $R=$ radius of earth)

26 Jun 2022 (M)

(1) 

(2) 

(3) 

(4) 

Q81. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A: If we move from poles to equator, the direction of acceleration due to gravity of earth always points towards the center of earth without any variation in its magnitude.
Reason R: At equator, the direction of acceleration due to the gravity is towards the center of earth.
In the light of above statements, choose the correct answer from the options given below

26 Jun 2022 (E)

(1) Assertion and reason both are correct and reason is correct explanation of assertion.
(2) Assertion and reason both are correct but reason is not correct explanation of assertion.
(3) Assertion is true but reason is false
(4) Assertion is false but reason is true

Q82. The height of any point P above the surface of earth is equal to diameter of earth. The value of acceleration due to gravity at point P will be : (Given $g=$acceleration due to gravity at the surface of earth).

25 Jun 2022 (M)

(1) $\frac{g}{2}$
(2) $\frac{g}{4}$
(3) $\frac{g}{3}$
(4) $\frac{g}{9}$

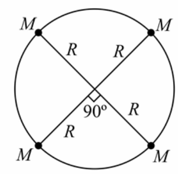
Q83. Two satellites S_1 and S_2 are revolving in circular orbits around a planet with radius $R_I=3200$ km and $R_2=800$ km respectively. The ratio of speed of satellite S_1 to the speed of satellite S_2 in their respective orbits would be $\frac{1}{x}$ where $x=$

25 Jun 2022 (E)

Q84. The approximate height from the surface of earth at which the weight of the body becomes $\frac{1}{3}$ of its weight on the surface of earth is :
[Radius of earth $\mathrm{R}=6400\ \mathrm{km}$ and $\sqrt{3}=1.732$] ***24 Jun 2022 (M)***
(1) $3840\ \mathrm{km}$
(2) $4685\ \mathrm{km}$
(3) $2133\ \mathrm{km}$
(4) $4267\ \mathrm{km}$

Q85. The distance between Sun and Earth is R. The duration of year if the distance between Sun and Earth becomes $3R$ will be : ***24 Jun 2022 (E)***
(1) $\sqrt{3}\ \mathrm{yr}$
(2) $3\sqrt{3}\ \mathrm{yr}$
(3) $3\ \mathrm{yr}$
(4) $9\ \mathrm{yr}$

Q86. Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction as shown in figure. The speed of each particle is:



01 Sep 2021 (E)
(1) $\frac{1}{2}\sqrt{\frac{GM}{R}\left(2\sqrt{2}+1\right)}$
(2) $\frac{1}{2}\sqrt{\frac{GM}{R\left(2\sqrt{2}+1\right)}}$
(3) $\frac{1}{2}\sqrt{\frac{GM}{R}\left(2\sqrt{2}-1\right)}$
(4) $\sqrt{\frac{GM}{R}}$

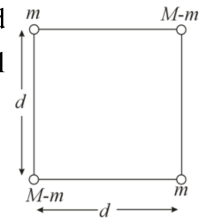
Q87. Two satellites revolve around a planet in coplanar circular orbits in anticlockwise direction. Their period of revolutions are 1 hour and 8 hours respectively. The radius of the orbit of nearer satellite is $2\times10^{3}\ \mathrm{km}$. The angular speed of the farther satellite as observed from the nearer satellite at the instant when both the satellites are closest is $\frac{\pi}{x}$ rad h^{-1}, where x is _______. ***01 Sep 2021 (E)***

Q88. The masses and radii of the earth and moon are $(M_1,\ R_1)$ and $(M_2,\ R_2)$ respectively. Their centres are at a distance r apart. Find the minimum escape velocity for a particle of mass m to be projected from the middle of these two masses : ***31 Aug 2021 (M)***
(1) $v_e=\sqrt{\frac{4G(M_1+M_2)}{r}}$
(2) $v_e=\frac{1}{2}\sqrt{\frac{2G(M_1+M_2)}{r}}$
(3) $v_e=\frac{1}{2}\sqrt{\frac{4G(M_1+M_2)}{r}}$
(4) $v_e=\frac{\sqrt{2G}(M_1+M_2)}{r}$

Q89. If R_E be the radius of Earth, then the ratio between the acceleration due to gravity at a depth r below and a height r above the earth surface is: (Given: $r<R_E$) ***31 Aug 2021 (E)***
(1) $1+\frac{r}{R_E}-\frac{r^2}{R_E^2}-\frac{r^3}{R_E^3}$
(2) $1+\frac{r}{R_E}+\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$
(3) $1-\frac{r}{R_E}-\frac{r^2}{R_E^2}-\frac{r^3}{R_E^3}$
(4) $1+\frac{r}{R_E}-\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$

Q90. A mass of $50\ \mathrm{kg}$ is placed at the center of a uniform spherical shell of mass $100\ \mathrm{kg}$ and radius $50\ \mathrm{m}$. If the gravitational potential at a point, $25\ \mathrm{m}$ from the center is $V\ \mathrm{kg\ m}^{-1}$. The value of V is: ***27 Aug 2021 (E)***
(1) $+2G$
(2) $-20G$
(3) $-4G$
(4) $-60G$

Q91. A body of mass $(2M)$ splits into four masses $\{m, M-m, m, M-m\}$, which are rearranged to form a square as shown in the figure. The ratio of $\frac{M}{m}$ for which, the gravitational potential energy of the system becomes maximum is $x : 1$. The value of x is ________.



27 Aug 2021 (M)

Q92. Inside a uniform spherical shell:

(a) The gravitational field is zero. (b) The gravitational potential is zero. (c) The gravitational field is the same everywhere. (d) The gravitation potential is the same everywhere. (e) All the above.

Choose the most appropriate answer from the options given below:

26 Aug 2021 (M)

(1) (a), (c) and (d) only
(2) (a), (b) and (c) only
(3) (b), (c) and (d) only
(4) (e) only

Q93. Two identical particles of mass $1\ \text{kg}$ each go round a circle of radius R, under the action of their mutual gravitational attraction. The angular speed of each particle is: ***27 Jul 2021 (E)***

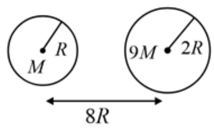
(1) $\sqrt{\frac{G}{2R^3}}$
(2) $\frac{1}{2}\sqrt{\frac{G}{R^3}}$
(3) $\frac{1}{2R}\sqrt{\frac{1}{G}}$
(4) $\sqrt{\frac{2G}{R^3}}$

Q94. The planet Mars has two moons, if one of them has a period 7 hours, 30 minutes and an orbital radius of $9.0 \times 10^3\ \text{km}$. Find the mass of Mars.

$\left\{\text{Given } \frac{4\pi^2}{G} = 6 \times 10^{11}\ \text{N}^{-1}\ \text{m}^{-2}\ \text{kg}^2\right\}$ ***27 Jul 2021 (E)***

(1) $5.96 \times 10^{19}\ \text{kg}$
(2) $3.25 \times 10^{21}\ \text{kg}$
(3) $7.02 \times 10^{25}\ \text{kg}$
(4) $6.00 \times 10^{23}\ \text{kg}$

Q95. Suppose two planets (spherical in shape) of radii R and $2R$, but mass M and $9M$ respectively have a centre to centre separation $8R$ as shown in the figure. A satellite of mass m is projected from the surface of the planet of mass M directly towards the centre of the second planet. The minimum speed v required for the satellite to reach the surface of the second planet is $\sqrt{\frac{a}{7}\frac{GM}{R}}$, then the value of a is [Given: The two planets are fixed in their position]



27 Jul 2021 (M)

Q96. Consider a planet in some solar system that has a mass double the mass of earth and density equal to the average density of the earth. If the weight of an object on earth is W, the weight of the same object on that planet will be: ***25 Jul 2021 (E)***

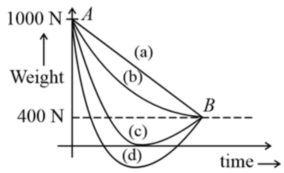
(1) $2W$
(2) W
(3) $2^{\frac{1}{3}}W$
(4) $\sqrt{2}\,W$

Q97. A body is projected vertically upwards from the surface of earth with a velocity sufficient enough to carry it to infinity. The time taken by it to reach height h is _____ S.

22 Jul 2021 (M)

(1) $\sqrt{\frac{R_e}{2\,g}}\left[\left(1+\frac{h}{R_e}\right)^{\frac{3}{2}}-1\right]$
(2) $\sqrt{\frac{2R_e}{g}}\left[\left(1+\frac{h}{R_e}\right)^{\frac{3}{2}}-1\right]$
(3) $\frac{1}{3}\sqrt{\frac{R_e}{2\,g}}\left[\left(1+\frac{h}{R_c}\right)^{\frac{3}{2}}-1\right]$
(4) $\frac{1}{3}\sqrt{\frac{2R_c}{g}}\left[\left(1+\frac{h}{R_e}\right)^{\frac{3}{2}}-1\right]$

Q98. A person whose mass is $100\ \text{kg}$ travels from Earth to Mars in a spaceship. Neglect all other objects in sky and take acceleration due to gravity on the surface of the Earth and Mars as $10\ \text{m s}^{-2}$ and $4\ \text{m s}^{-2}$, respectively. Identify from the below figures, the curve that fits best for the weight of the passenger as a function of time.



20 Jul 2021 (M)

(1) (c)
(2) (a)
(3) (d)
(4) (b)

Q99. Consider a binary star system of star A and star B with masses m_{A} and m_{B} revolving in a circular orbit of radii r_{A} and r_{B}, respectively. If T_{A} and T_{B} are the time period of star A and star B, respectively, then:

20 Jul 2021 (E)

(1) $\frac{T_{\mathrm{A}}}{T_{\mathrm{B}}}=\left(\frac{r_{\mathrm{A}}}{r_{\mathrm{B}}}\right)^{\frac{3}{2}}$
(2) $T_{\mathrm{A}}=T_{\mathrm{B}}$
(3) $T_A>T_B$ (if $m_A>m_B$)
(4) $T_{\mathrm{A}}>T_{\mathrm{B}}$ (if $r_{\mathrm{A}}>r_{\mathrm{B}}$)

Q100. A satellite is launched into a circular orbit of radius R around earth, while a second satellite is launched into a circular orbit of radius $1.02\ R$. The percentage difference in the time periods of the two satellites is:

20 Jul 2021 (E)

(1) 1.5
(2) 2.0
(3) 0.7
(4) 3.0

Q101. The time period of a satellite in a circular orbit of the radius R is T. The period of another satellite in a circular orbit of the radius $9R$ is: ***18 Mar 2021 (M)***

(1) $9T$
(2) $27T$
(3) $12T$
(4) $3T$

Q102. The angular momentum of a planet of mass M moving around the sun in an elliptical orbit is $\vec{L}$. The magnitude of the areal velocity of the planet is : ***18 Mar 2021 (E)***

(1) $\frac{4L}{M}$
(2) $\frac{L}{M}$
(3) $\frac{2L}{M}$
(4) $\frac{L}{2M}$

Q103. The radius in kilometer to which the present radius of earth $(R=6400\ \text{km})$ to be compressed so that the escape velocity is increased 10 time is _______. ***17 Mar 2021 (M)***

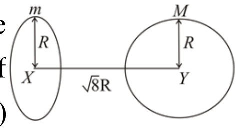
Q104. A geostationary satellite is orbiting around an arbitrary planet P at a height of $11R$ above the surface of P, R being the radius of P. The time period of another satellite in hours at a height of $2R$ from the surface of P is ________ has the time period of 24 hours. ***17 Mar 2021 (E)***

(1) $6\sqrt{2}$
(2) $\frac{6}{\sqrt{2}}$
(3) 3
(4) 5

Q105. If one wants to remove all the mass of the earth to infinity in order to break it up completely. The amount of energy that needs to be supplied will be $\frac{x}{5} \frac{GM^2}{R}$ where x is _____. (Round off to the Nearest Integer) (M is the mass of earth, R is the radius of earth, G is the gravitational constant)

16 Mar 2021 (E)

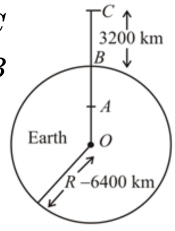
Q106. Find the gravitational force of attraction between the ring and sphere as shown in the diagram, where the plane of the ring is perpendicular to the line joining the centres. If $\sqrt{8}R$ is the distance between the centres of a ring (of mass m) and a sphere (mass M) where both have equal radius R



26 Feb 2021 (M)

(1) $\frac{2\sqrt{2}}{3} \frac{GMm}{R^2}$
(2) $\frac{\sqrt{8}}{9} \frac{GmM}{R}$
(3) $\frac{1}{3\sqrt{8}} \frac{GMm}{R^2}$
(4) $\frac{\sqrt{8}}{27} \frac{GmM}{R^2}$

Q107. In the reported figure of earth, the value of acceleration due to gravity is same at point A and C but it is smaller than that of its value at point B (surface of the earth). The value of $OA : AB$ will be $x : 5$. The value of x is



26 Feb 2021 (E)

Q108. A planet revolving in elliptical orbit has:

A. a constant velocity of revolution. B. has the least velocity when it is nearest to the sun. C. its areal velocity is directly proportional to its velocity. D. areal velocity is inversely proportional to its velocity. E. to follow a trajectory such that the areal velocity is constant.

Choose the correct answer from the options given below:

26 Feb 2021 (M)

(1) A only
(2) C only
(3) E only
(4) D only

Q109. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

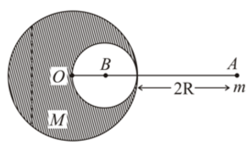
Assertion A : The escape velocities of planet A and B are same. But A and B are of unequal mass.

Reason R: The product of their mass and radius must be same. $M_1R_1 = M_2R_2$ In the light of the above statements, choose the most appropriate answer from the options given below :

25 Feb 2021 (M)

(1) Both A and R are correct and R is the correct explanation of A
(2) Both A and R are correct but R is NOT the correct explanation of A
(3) A is not correct but R is correct
(4) A is correct but R is not correct

Q110. A solid sphere of radius R gravitationally attracts a particle placed at $3R$ from its centre with a force F_1. Now a spherical cavity of radius $\left(\frac{R}{2}\right)$ is made in the sphere (as shown in figure) and the force becomes F_2. The value of $F_1 : F_2$ is:

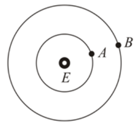


25 Feb 2021 (M)

(1) 41 : 50 (2) 50 : 41
(3) 25 : 36 (4) 36 : 25

Q111. The initial velocity v_i required to project a body vertically upward from the surface of the earth to reach a height of $10R$, where R is the radius of the earth, may be described in terms of escape velocity v_{e} such that $v_i = \sqrt{\frac{x}{y}} \times v_{\mathrm{e}}$. The value of x will be ***25 Feb 2021 (E)***

Q112. $AB 200\ \mathrm{kg} 400\ \mathrm{kg} 600\ \mathrm{km} 1600\ \mathrm{km} T_A T_B A B T_B - T_A = 6400\ \mathrm{km}, = 6 \times 10^{24}\ \mathrm{kg}$



25 Feb 2021 (M)

(1) 4.24×10^3 s (2) 3.33×10^2 s (3) 1.33×10^3 s (4) 4.24×10^2 s

Q113. Consider two satellites S_1 and S_2 with periods of revolution 1 hr and 8 hr respectively revolving around a planet in circular orbits. The ratio of angular velocity of satellite S_1 to the angular velocity of satellite S_2 is: ***24 Feb 2021 (M)***

(1) 8 : 1 (2) 2 : 1
(3) 1 : 4 (4) 1 : 8

Q114. Four identical particles of equal masses 1 kg made to move along the circumference of a circle of radius 1 m under the action of their own mutual gravitational attraction. The speed of each particle will be: ***24 Feb 2021 (M)***

(1) $\sqrt{G\left(1+2\sqrt{2}\right)}$ (2) $\sqrt{\frac{G}{2}\left(1+2\sqrt{2}\right)}$
(3) $\sqrt{\frac{G}{2}\left(2\sqrt{2}-1\right)}$ (4) $\frac{\sqrt{\left(1+2\sqrt{2}\right)G}}{2}$

Q115. A body weighs 49 N on a spring balance at the north pole. What will be its weight recorded on the same weighing machine, if it is shifted to the equator?
[Use $g = \frac{GM}{R^2} = 9.8\ \mathrm{m\,s^{-2}}$ and radius of earth, $R = 6400\ \mathrm{km}$.]

24 Feb 2021 (E)

(1) 49.17 N (2) 48.83 N
(3) 49.83 N (4) 49 N

Q116. Two stars of masses m and $2m$ at a distance d rotate about their common centre of mass in free space. The period of revolution is ***24 Feb 2021 (M)***

(1) $2\pi\sqrt{\frac{d^3}{3Gm}}$ (2) $2\pi\sqrt{\frac{3Gm}{d^3}}$
(3) $\frac{1}{2\pi}\sqrt{\frac{3Gm}{d^3}}$ (4) $\frac{1}{2\pi}\sqrt{\frac{d^3}{3Gm}}$

Q117. Two planets have masses M and 16 M and their radii are a and 2a, respectively. The separation between the centres of the planets is 10a. A body of mass m is fired from the surface of the larger planet towards the smaller planet along the line joining their centres. For the body to be able to reach at the surface of smaller planet, the minimum firing speed needed is : ***06 Sep 2020 (E)***

(1) $2\sqrt{\frac{\mathrm{GM}}{\mathrm{a}}}$
(2) $4\sqrt{\frac{\mathrm{GM}}{\mathrm{a}}}$
(3) $\sqrt{\frac{\mathrm{GM}^2}{\mathrm{ma}}}$
(4) $\frac{3}{2}\sqrt{\frac{5\,\mathrm{GM}}{\mathrm{a}}}$

Q118. The acceleration due to gravity on the earth's surface at the poles is g and angular velocity of the earth about the axis passing through the pole is ω. An object is weighed at the equator and at a height h above the poles by using a spring balance. If the weights are found to be same, then h is: ($h \ll R$, where R is the radius of the earth) ***05 Sep 2020 (E)***

(1) $\frac{R^2\omega^2}{2g}$
(2) $\frac{R^2\omega^2}{g}$
(3) $\frac{R^2\omega^2}{4g}$
(4) $\frac{R^2\omega^2}{8g}$

Q119. The value of the acceleration due to gravity is g_1 at a height $h = \frac{R}{2}$ ($R =$ radius of the earth) from the surface of the earth. It is again equal to g_1 at a depth d below the surface the earth. The ratio $\left(\frac{d}{R}\right)$ equals: ***05 Sep 2020 (M)***

(1) $\frac{4}{9}$
(2) $\frac{5}{9}$
(3) $\frac{1}{3}$
(4) $\frac{7}{9}$

Q120. On the x-axis and at a distance x from the origin, the gravitational field due to a mass distribution is given by $\frac{Ax}{(x^2+a^2)^{3/2}}$ in the x-direction. The magnitude of the gravitational potential on the x-axis at a distance x, taking its value to be zero at infinity is: ***04 Sep 2020 (M)***

(1) $\frac{A}{(x^2+a^2)^{1/2}}$
(2) $\frac{A}{(x^2+a^2)^{3/2}}$
(3) $A\left(x^2+a^2\right)^{1/2}$
(4) $A\left(x^2+a^2\right)^{3/2}$

Q121. A body is moving in a low circular orbit about a planet of mass M and radius R. The radius of the orbit can be taken to be R itself. Then the ratio of the speed of this body in the orbit to the escape velocity from the planet is: ***04 Sep 2020 (E)***

(1) $\frac{1}{\sqrt{2}}$
(2) 2
(3) 1
(4) $\sqrt{2}$

Q122. A satellite is moving in a low nearly circular orbit around the earth. Its radius is roughly equal to that of the earth's radius $\mathrm{R_e}$. By firing rockets attached to it, its speed is instantaneously increased in the direction of its motion so that it become $\sqrt{\frac{3}{2}}$ times larger. Due to this the farthest distance from the centre of the earth that the satellite reaches is R. Value of R is : ***03 Sep 2020 (M)***

(1) $4\mathrm{R_e}$
(2) $2.5\mathrm{R_e}$
(3) $3\mathrm{R_e}$
(4) $2\mathrm{R_e}$

Q123. The mass density of a planet of radius R varies with the distance r from its centre as $\rho\left(r\right) = \rho_0\left(1 - \frac{r^2}{R^2}\right)$ Then the gravitational field is maximum at: ***03 Sep 2020 (E)***

(1) $r = \sqrt{\frac{3}{4}}R$
(2) $r = R$
(3) $r = \frac{1}{\sqrt{3}}R$
(4) $r = \sqrt{\frac{5}{9}}R$

Q124. The mass density of a spherical galaxy varies as $\frac{K}{r}$ over a large distance r from its center. In that region, a small star is in a circular orbit of radius R. Then the period of revolution,T depends on R as:

02 Sep 2020 (M)

(1) $T^2 \propto R$ (2) $T^2 \propto R^3$

(3) $T^2 \propto \frac{1}{R^3}$ (4) $T \propto R$

Q125. The height 'h' at which the weight of a body will be the same as that at the same depth 'h' from the surface of the earth is (Radius of the earth is R and effect of the rotation of the earth is neglected) ***02 Sep 2020 (E)***

(1) $\frac{\sqrt{5}}{2}\mathrm{R}-\mathrm{R}$ (2) $\frac{R}{2}$

(3) $\frac{\sqrt{5}\mathrm{R}-\mathrm{R}}{2}$ (4) $\frac{\sqrt{3}\mathrm{R}-\mathrm{R}}{2}$

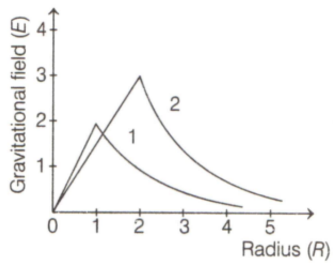
Q126. Planet A has mass M and radius R. Planet B has half the mass and half the radius of Planet A. If the escape velocities from the Planets A and B are v_A and v_B, respectively, then $\frac{v_A}{v_B}=\frac{n}{4}$. The value of n is:

09 Jan 2020 (E)

(1) 4 (2) 1

(3) 2 (4) 3

Q127. Consider two solid spheres of radii $R_1=1$ m, $R_2=2$ m and masses M_1 and M_2, respectively. The gravitational field due to sphere (1) and (2) are shown. The value of $\frac{M_1}{M_2}$ is:



08 Jan 2020 (M)

(1) $\frac{2}{3}$ (2) $\frac{1}{6}$

(3) $\frac{1}{2}$ (4) $\frac{1}{3}$

Q128. An asteroid is moving directly towards the centre of the earth. When at a distance of $10R$ (R is the radius of the earth) from the centre of the earth, it has a speed of $12\ \mathrm{km\ s^{-1}}$. Neglecting the effect of earth's atmosphere, what will be the speed of the asteroid when it hits the surface of the earth (escape velocity from the earth is $11.2\ \mathrm{km\ s^{-1}}$) ? Give your answer to the nearest integer in $\mathrm{km\ s^{-1}}$__________. ***08 Jan 2020 (E)***

Q129. A box weighs 196N on a spring balance at the north pole. Its weight recorded on the same balance if it is shifted to the equator is close to (Take $\mathrm{g}=10\mathrm{ms}^{-2}$ at the north pole and the radius of the earth $=6400\mathrm{km}$):

07 Jan 2020 (E)

(1) 195.66N (2) 194.32N

(3) 194.66N (4) 195.32N

Q130. A satellite of mass M is launched vertically upwards with an initial speed u from the surface of the earth. After it reaches height R ($R=$ radius of the earth), it ejects a rocket of mass $\frac{M}{10}$ so that subsequently the satellite moves in a circular orbit. The kinetic energy of the rocket is (G is the gravitational constant; M_e is the mass of the earth): ***07 Jan 2020 (M)***

(1) $\frac{M}{20}\left(u^2+\frac{113}{200}\frac{GM_e}{R}\right)$ (2) $5M\left(u^2-\frac{119}{200}\frac{GM_e}{R}\right)$

(3) $\frac{3M}{8}\left(u+\sqrt{\frac{5GM_e}{6R}}\right)^2$ (4) $\frac{M}{20}\left(u-\sqrt{\frac{2GM_e}{3R}}\right)^2$

Q131. The ratio of the weights of a body on Earth's surface to that on the surface of a planet is 9 : 4 The mass of the planet is $\frac{1}{9}th$ of that of the Earth. If R is the radius of the Earth, what is the radius of the planet? (Take the planets to have the same mass density) ***12 Apr 2019 (E)***

(1) $\frac{R}{4}$ (2) $\frac{R}{2}$
(3) $\frac{R}{3}$ (4) $\frac{R}{9}$

Q132. The value of acceleration due to gravity at Earth's surface is $9.8 \mathrm{~m~s}^{-2}$. The altitude above its surface at which the acceleration due to gravity decreases to $4.9 \mathrm{~m~s}^{-2}$, is close to: (Radius of earth $=6.4 \times 10^6 \mathrm{~m}$) ***10 Apr 2019 (M)***

(1) $1.6 \times 10^6 \mathrm{~m}$ (2) $2.6 \times 10^6 \mathrm{~m}$
(3) $6.4 \times 10^6 \mathrm{~m}$ (4) $9.0 \times 10^6 \mathrm{~m}$

Q133. A spaceship orbits around a planet at a height of 20 km from its surface. Assuming that only gravitational field of the planet acts on the spaceship, what will be the number of complete revolutions made by the spaceship in 24 hours around the planet?
[Given: Mass of planet $=8 \times 10^{22} \mathrm{~kg}$,
Radius of planet $=2 \times 10^6 \mathrm{~m}$,
Gravitational constant $\mathrm{G}=6.67 \times 10^{-11} \mathrm{~Nm}^2/\mathrm{kg}^2$] ***10 Apr 2019 (E)***

(1) 17 (2) 9
(3) 13 (4) 11

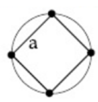
Q134. A solid sphere of mass M and radius a is surrounded by a uniform concentric spherical shell of thickness 2a and mass 2M. The gravitational field at distance 3a from the centre will be: ***09 Apr 2019 (M)***

(1) $\frac{\mathrm{GM}}{9\mathrm{a}^2}$ (2) $\frac{\mathrm{GM}}{3\mathrm{a}^2}$
(3) $\frac{2\mathrm{GM}}{3\mathrm{a}^2}$ (4) $\frac{2\mathrm{GM}}{9\mathrm{a}^2}$

Q135. A test particle is moving in a circular orbit in the gravitational field produced by a mass density $\rho(r)=\frac{K}{r^2}$. Identify the current relation between the radius R of the particle's orbit and its period T : ***09 Apr 2019 (E)***

(1) TR is a constant (2) ${T^2}/{R^3}$ is a constant
(3) ${T}/{R}$ is a constant (4) ${T}/{R^2}$ is a constant

Q136. Four identical particles of mass M are located at the corners of a square of side 'a'. What should be their speed if each of them revolves under the influence of other's gravitational field in a circular orbit circumscribing the square?



08 Apr 2019 (M)

(1) $1.35\sqrt{\frac{\mathrm{GM}}{\mathrm{a}}}$ (2) $1.21\sqrt{\frac{\mathrm{GM}}{\mathrm{a}}}$
(3) $1.41\sqrt{\frac{\mathrm{GM}}{\mathrm{a}}}$ (4) $1.16\sqrt{\frac{\mathrm{GM}}{\mathrm{a}}}$

Q137. A rocket has to be launched from earth in such a way that it never returns. If E is the minimum energy delivered by the rocket launcher, what should be the minimum energy that the launcher should have, if the same rocket is to be launched from the surface of the moon? Assume that the density of the earth and the moon are equal and that the earth's volume is 64 times the volume of the moon. ***08 Apr 2019 (E)***

(1) $\frac{\mathrm{E}}{64}$
(2) $\frac{\mathrm{E}}{4}$
(3) $\frac{\mathrm{E}}{32}$
(4) $\frac{\mathrm{E}}{16}$

Q138. Two satellites, A and B, have masses m and $2m$ respectively. A is in a circular orbit of radius R and B is in a circular orbit of radius $2R$ around the earth. The ratio of their kinetic energies, $\frac{K_{\mathrm{A}}}{K_{\mathrm{B}}}$ is: ***12 Jan 2019 (E)***

(1) 2
(2) $\frac{1}{2}$
(3) 1
(4) $\sqrt{\frac{1}{2}}$

Q139. A straight rod of length L extends from $x=a$ to $x=L+a$. The gravitational force it exerts on a point mass 'm' at $x=0$, if the mass per unit length of the rod is $A+Bx^2$, is given by: ***12 Jan 2019 (M)***

(1) $Gm\left[A\left(\frac{1}{a+L}-\frac{1}{a}\right)+BL\right]$
(2) $Gm\left[A\left(\frac{1}{a+L}-\frac{1}{a}\right)-BL\right]$
(3) $Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)-BL\right]$
(4) $Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)+BL\right]$

Q140. A satellite of mass M is in a circular orbit of radius R about the center of the earth. A meteorite of the same mass, falling towards the earth, collides with the satellite completely inelastic. The speeds of the satellite and the meteorite are the same, just before the collision. The subsequent motion of the combined body will be: ***12 Jan 2019 (M)***

(1) In an elliptical orbit
(2) Such that it escapes to infinity
(3) In a circular orbit of a different radius
(4) In the same circular orbit of radius R

Q141. A satellite is revolving in a circular orbit at a height h from the carth surface, such that h $<<$ R where R is the radius of the earth. Assuming that the effect of earth"s atmosphere can be neglected the minimum increase in the speed required so that the satellite could escape from the gravitational field of earth is ***11 Jan 2019 (M)***

(1) $\sqrt{2gR}$
(2) $\sqrt{gR}$
(3) $\sqrt{\frac{gR}{2}}$
(4) $\sqrt{gR}(\sqrt{2}-1)$

Q142. The mass and the diameter of a planet are three times the respective values for the Earth. The period of oscillation of a simple pendulum on the Earth is 2 s. The period of oscillation of the same pendulum on the planet would be: ***11 Jan 2019 (E)***

(1) $\frac{\sqrt{3}}{2}$ s
(2) $\frac{2}{\sqrt{3}}$ s
(3) $\frac{3}{2}s$
(4) $2\sqrt{3}$ s

Q143. Two stars of masses 3×10^{31} kg each, and at distance 2×10^{11} m rotate in a plane about their common centre of mass O. A meteorite passes through O moving perpendicular to the stars's rotation plane. In order to escape from the gravitational field of this double star, the minimum speed that meteorite should have at O is (Take Gravitational constant $G=6.67\times10^{-11}\ \mathrm{N\ m^2\ kg^{-2}}$) ***10 Jan 2019 (E)***

(1) $2.4\times10^4\ \mathrm{m\ s^{-1}}$
(2) $3.8\times10^4\ \mathrm{m\ s^{-1}}$
(3) $2.8\times10^5\ \mathrm{m\ s^{-1}}$
(4) $1.4\times10^5\ \mathrm{m\ s^{-1}}$

Q144. A satellite is moving with a constant speed v in circular orbit around the earth. An object of mass 'm' is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of ejection, the kinetic energy of the object is: ***10 Jan 2019 (M)***

(1) $\frac{3}{2}m\,v^2$
(2) $m\,v^2$
(3) $\frac{1}{2}m\,v^2$
(4) $2\,m\,v^2$

Q145. The energy required to take a satellite to a height h above the Earth surface (radius of Earth $= 6.4 \times 10^3 \mathrm{~km}$) is E_1, and the kinetic energy required for the satellite to be in a circular orbit at this height is E_2. The value of h for which E_1 and E_2 are equal, is ***09 Jan 2019 (E)***

(1) $1.28 \times 10^4 km$ (2) $6.4 \times 10^3 km$

(3) $3.2 \times 10^3 km$ (4) $1.6 \times 10^3 km$

Q146. If the angular momentum of a planet of mass m, moving around the Sun in a circular orbit is L, about the center of the Sun, its areal velocity is: ***09 Jan 2019 (M)***

(1) $\frac{L}{m}$ (2) $\frac{4L}{m}$

(3) $\frac{L}{2m}$ (4) $\frac{2L}{m}$

ANSWER KEYS

1. (4)	**2.** (4)	**3.** (2)	**4.** (2)	**5.** (4)	**6.** (3)	**7.** (2)	**8.** (1)
9. (4)	**10.** (2)	**11.** (4)	**12.** (1)	**13.** (2)	**14.** (2)	**15.** (1)	**16.** (2)
17. (1)	**18.** (1)	**19.** (4)	**20.** (4)	**21.** (1)	**22.** (4)	**23.** (2)	**24.** (3)
25. (2)	**26.** (2)	**27.** (3)	**28.** (1)	**29.** (4)	**30.** (4)	**31.** (2)	**32.** (3)
33. (2)	**34.** (4)	**35.** (1)	**36.** (16)	**37.** (3)	**38.** (4)	**39.** (1)	**40.** (4)
41. (2)	**42.** (1)	**43.** (3)	**44.** (3)	**45.** (3)	**46.** (1)	**47.** (4)	**48.** (1)
49. (4)	**50.** (2)	**51.** (2)	**52.** (2)	**53.** (4)	**54.** (4)	**55.** (1)	**56.** (2)
57. (3)	**58.** (2)	**59.** (4)	**60.** (3)	**61.** (4)	**62.** (3)	**63.** (2)	**64.** (1)
65. (3)	**66.** (4)	**67.** (2)	**68.** (2)	**69.** (1)	**70.** (1)	**71.** (2)	**72.** (4)
73. (1)	**74.** (1)	**75.** (1)	**76.** (3)	**77.** (3)	**78.** (1)	**79.** (1)	**80.** (1)
81. (4)	**82.** (4)	**83.** (2)	**84.** (2)	**85.** (2)	**86.** (1)	**87.** (3)	**88.** (1)
89. (1)	**90.** (3)	**91.** (2)	**92.** (1)	**93.** (2)	**94.** (4)	**95.** (4)	**96.** (3)
97. (4)	**98.** (1)	**99.** (2)	**100.** (4)	**101.** (2)	**102.** (4)	**103.** (64)	**104.** (3)
105. (3)	**106.** (4)	**107.** (4)	**108.** (3)	**109.** (4)	**110.** (2)	**111.** (10)	**112.** (3)
113. (1)	**114.** (4)	**115.** (2)	**116.** (1)	**117.** (4)	**118.** (1)	**119.** (2)	**120.** (1)
121. (1)	**122.** (3)	**123.** (4)	**124.** (1)	**125.** (3)	**126.** (1)	**127.** (2)	**128.** (16)
129. (4)	**130.** (2)	**131.** (2)	**132.** (2)	**133.** (4)	**134.** (2)	**135.** (3)	**136.** (4)
137. (4)	**138.** (3)	**139.** (4)	**140.** (1)	**141.** (4)	**142.** (4)	**143.** (3)	**144.** (2)
145. (3)	**146.** (3)						