7 - GRAVITATION

(Answers at the end of all questions)

1) The change in the value of 'g' at a height 'h' above the surface of the earth is the same as at a depth 'd' below the surface of earth. When both 'd' and 'h' are much smaller than the radius of the earth, then which one of the following is correct ?

(a) d = 3h / 2 (b) d = h / 2 (c) d = h (d) d = 2h [AIEEE 2005, 2003]

2) A particle of mass 10 g is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to be done against the gravitational force between them to take the particle far away from the surface. ($G = 6.67 \times 10^{-11}\ Nm^2/kg^2$)

(a) 3.33×10^{-10} J (b) 13.34×10^{-10} J

(c) 6.67×10^{-10} J (d) 6.67×10^{-9} J [AIEEE 2005]

3) Average density of the earth

(a) is a complex function of g (b) does not depend on g

(c) is inversely proportional to g (d) is directly proportional to g [AIEEE 2005]

4) A satellite of mass m revolves around the earth of radius R at a height x from its surface. If g is the acceleration due to gravity on the surface of the earth, the orbital speed of the satellite is

(a) gx (b) gR /(R - x) (c) $gR^2 /(R + x)$ (d) $[gR^2/(R + x)]^{1/2}$ [AIEEE 2004]

5) The time-period of an earth satellite in circular orbit is independent of

(a) the mass of the satellite (b) radius of its orbit

(c) both the mass and radius of the orbit

(d) neither the mass of the satellite nor the radius of its orbit [AIEEE 2004]

6) If g is the acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass m raised from the surface of the earth to a height equal to the radius R of the earth is

(a) 2 mgR (b) (1 / 2) mgR (c) (1 / 4) mgR (d) mgR [AIEEE 2004, IIT 1983]

7) Suppose the gravitational force varies inversely as the nth power of the distance. Then the time-period of a planet in circular orbit of radius R around the sun will be proportional to

(a) $R^{(n+1)/2}$ (b) $R^{(n-1)/2}$ (c) R^n (d) $R^{(n-2)/2}$ [AIEEE 2004]

8) The time-period of a satellite of earth is 5 hours. If the separation between the earth and the satellite is increased to 4 times the previous value, the new time-period will become

(a) 10 hours (b) 20 hours (c) 40 hours (d) 80 hours [AIEEE 2003]

9) The escape velocity for a body projected vertically upwards from the surface of the earth is 11 km/s. If the body is projected at an angle of 45° with the vertical, the escape velocity will be

(a) $11 / \sqrt{2}$ km/s (b) $11\sqrt{2}$ km/s (c) 2 km/s (d) 11 km/s [AIEEE 2003]

10) A body weighs 500 N on the surface of the earth. How much would it weigh half way below the surface of the earth ?

(a) 1000 N (b) 500 N (c) 250 N (d) 125 N [AIEEE 2002]

(Answers at the end of all questions)

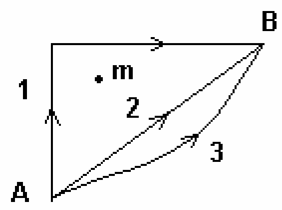
11) The time-period of revolution of planet A around the sun is 8 times that of B. The distance of A from the sun is how many times greater than that of B from the sun ?
(a) 2 (b) 3 (c) 4 (d) 5 [AIEEE 2002]

12) The angular velocity of rotation of a star (of mass M and radius R) at which the matter will start escaping from its equator is
(a) $\sqrt{(2GR/M)}$ (b) $\sqrt{(2GM/R^3)}$ (c) $\sqrt{(2GM/R)}$ (d) $\sqrt{(2GM^2/R)}$ [AIEEE 2002]

13) Energy required to move a body of mass m from an orbit of radius 2R to 3R is
(a) $GMm/(12R^2)$ (b) $GMm/(3R^2)$ (c) $GMm/(8R)$ (d) $GMm/(6R)$ [AIEEE 2002]

14) An infinite number of identical point masses each equal to m are placed at points x = 1, x = 2, x = 4, x = 8m, … … The total gravitational potential at point at x = 0 is
(a) - Gm (b) - 2Gm (c) + 2Gm (d) infinite
[AIEEE 2002]

15) If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths 1, 2 and 3 respectively in the gravitational field of a point mass m as shown in the figure, find the correct relation between W_1, W_2 and W_3.
(a) $W_1 > W_2 > W_3$ (b) $W_1 = W_2 = W_3$
(c) $W_1 < W_2 < W_3$ (d) $W_2 > W_1 > W_3$ [IIT 2003]



16) A geostationary satellite orbits around the earth in a circular orbit of radius 36000 km. Then, the time period of a spy satellite orbiting a few hundred km above the earth's surface (R_{earth} = 6400 km) will approximately be
(a) 1 / 2 hr (b) 1 hr (c) 2 hr (d) 4 hr [IIT 2002]

17) A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth.
(a) The acceleration of S is always directed towards the centre of the earth.
(b) The angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant.
(c) The total mechanical energy of S varies periodically with time.
(d) The linear momentum of S remains constant in magnitude. [IIT 1998]

18) If the distance between the earth and the sun were half its present value, the number of days in a year would have been
(a) 64.5 (b) 129 (c) 182.5 (d) 730 [IIT 1996]

19) The magnitudes of the gravitational field at distances r_1 and r_2 from the centre of uniform sphere of radius R and mass M are F_1 and F_2 respectively. Then

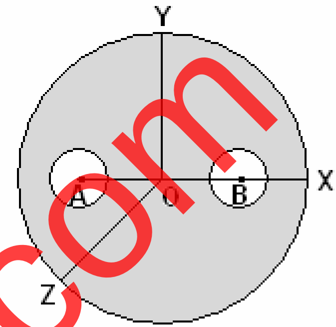
(a) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 < R$ and $r_2 < R$ (b) $\frac{F_1}{F_2} = \frac{r_2^2}{r_1^2}$ if $r_1 > R$ and $r_2 > R$

(c) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 > R$ and $r_2 > R$ (d) $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 < R$ and $r_2 < R$

[IIT 1994]

(Answers at the end of all questions)

20) A solid sphere of uniform density and radius 4 units is located with its centre at the origin O of coordinates. Two spheres of equal radii 1 unit with their centres at A (- 2, 0, 0) and B (2, 0, 0) respectively, are taken out of the solid leaving behind spherical cavities as shown in the figure.



(a) the gravitational force due to this object at the origin is zero
(b) the gravitational force at the point B (2, 0, 0) is zero
(c) the gravitational potential is the same at all points of the circle $y^2 + z^2 = 36$
(d) the gravitational potential is the same at all points on the circle $y^2 + z^2 = 4$

[IIT 1993]

21) Imagine a light planet revolving around a very massive star in a circular orbit of radius R with a period of revolution T. If the gravitational force of attraction between the planet and the star is proportional to $R^{-5/2}$, then

(a) T^2 is proportional to R^2 (b) T^2 is proportional to $R^{7/2}$
(c) T^2 is proportional to $R^{3/2}$ (d) T^2 is proportional to $R^{3.75}$ [IIT 1989]

22) v_e and v_p denote the escape velocities from the earth and another planet having twice the radius and the same mean density as the earth, then

(a) $v_e = v_p$ (b) $v_e = 0.5\, v_p$ (c) $v_e = 2\, v_p$ (d) $v_e = 0.25\, v_p$ [NCERT 1974]

23) The ratio of the kinetic energy required to be given to the satellite to escape earth's gravitational field to the kinetic energy required to be given so that the satellite moves in a circular orbit just above earth's atmosphere is

(a) one (b) two (c) half (d) infinity [NCERT 1975]

24) g_e and g_p denote the acceleration due to gravity on the surface of the earth and another planet whose mass and radius are twice that of the earth, then

(a) $g_p = g_e$ (b) $g_p = 0.5 g_e$ (c) $g_p = 2 g_e$ (d) $g_p = g_e / \sqrt{2}$ [NCERT 1973]

25) The weight of an object in the coal mine, sea level and at the top of the mountain are respectively W_1, W_2 and W_3, then

(a) $W_1 < W_2 > W_3$ (b) $W_1 = W_2 = W_3$
(c) $W_1 < W_2 < W_3$ (d) $W_1 > W_2 > W_3$ [EAMCET 1990]

26) With what angular velocity the earth should spin in order that a body lying at 60° latitude may become weightless

(a) $\sqrt{(g/R)}$ (b) $\sqrt{(2g/R)}$ (c) $2\sqrt{(g/R)}$ (d) $\sqrt{(g/2R)}$

27) A body is projected vertically from the surface of the earth of radius R with velocity equal to half of the escape velocity. The maximum height reached by the body is

(a) R (b) R / 2 (c) R / 3 (d) R / 4

28) The escape velocity from the earth's surface is 11 km/s. A planet has a radius twice that of the earth but its mean density is the same as that of the earth. The value of the escape velocity from this planet would be

(a) 22 km/s (b) 11 km/s (c) 5.5 km/s (d) 16.5 km/s [CPMT 1990]

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(Answers at the end of all questions)

29) If R is the radius of the earth and g the acceleration due to gravity on the earth's surface, the mean density of the earth is

(a) $(4\pi G)/(3gR)$ (b) $(3\pi R)/(4gG)$ (c) $(3g)/(4\pi RG)$ (d) $(\pi Rg)/(12G)$

[CPMT 1990]

30) The radius of the earth is 6400 km and g = 10 m/s^2. In order that a body of 5 kg weighs zero at the equator, the angular speed of the earth is

(a) 1 / 80 rad / s (b) 1 / 400 rad / s

(c) 1 / 800 rad / s (d) 1 / 1600 rad / s [MP, PMT 1985]

31) If the earth were at one-fourth its present distance from the sun, the duration of the year will be (a) half the present year (b) one-eighth the present year (c) one-fourth the present year (d) one-sixth the present year

32) If two stars of masses m_1 and m_2 separated by a distance d rotate about their common centre of mass, then their common angular velocity is

(a) $\sqrt{(G m_1 m_2 / d^2)}$ (b) $\sqrt{(G m_1 m_2 / d)}$

(c) $\sqrt{[G(m_1 + m_2)/d^3]}$ (d) $\sqrt{(G m_1 m_2)}$

33) If the radius of the earth were to decrease by 1 %, its mass remaining the same, the acceleration due to gravity on the surface of the earth will

(a) increase by 1 % (b) decrease by 2 %

(c) decrease by 1 % (d) increase by 2 %

34) Three point masses each of mass m rotate in a circle of radius r with constant angular velocity ω due to their mutual gravitational attraction. If at any instant, the masses are on the vertices of an equilateral triangle of side a, then the value of ω is

(a) $\sqrt{(GM/a^3)}$ (b) $\sqrt{(3GM/a^3)}$ (c) $\sqrt{(GM/3a^3)}$ (d) none

35) Two bodies each of mass 66.7 kg are at a distance of 2 m. The escape velocity of a body midway between them is

(a) 13.34 m / s (b) 6.67 m / s (c) 33.35 m / s (d) zero

36) If a body of mass m is taken out from a point below the surface of earth equal to half the radius of earth, R, to a height R above the earth's surface, then work done on it will be (a) (5 / 6) mgR (b) (6 / 7) mgR (c) (7 / 8) mgR (d) (8 / 9) mgR

37) A satellite is revolving around the earth in a circular orbit with a velocity of 7.07 km / s. What minimum increase in its velocity is needed to make it escape gravitational pull of earth ?

(a) 4.23 km/s in the direction of its velocity

(b) 11.3 km/s in a direction perpendicular to its velocity

(c) 2.93 km/s in the direction of its velocity

(d) 4.23 km/s in a direction perpendicular to its velocity

38) The escape velocity of a body from the surface of the earth is v. It is given a velocity twice this velocity on the surface of the earth. What will be its velocity at infinity ?

(a) v (b) 2 v (c) $\sqrt{2}$ v (d) $\sqrt{3}$ v

7 - GRAVITATION

(Answers at the end of all questions)

39) A satellite is moving on a circular path of radius r around the earth with time-period T. If its radius slightly increases by Δr, the change in its time-period is

(a) $(3T/2r)\, \Delta r$ (b) $(T / r)\, \Delta r$ (c) $(T / r)^2\, \Delta r$ (d) none of these

40) A satellite is orbiting a planet at a constant height in a circular orbit. If the mass of the planet is reduced to half, the satellite would

(a) fall on the planet (b) go to an orbit of higher radius
(c) escape from the planet (d) go to an orbit of smaller radius

41) A satellite of mass m is revolving in a circular orbit around the earth of mass M. If E is its total mechanical energy, then its angular momentum is

(a) $\sqrt{(E / mr^2)}$ (b) $E / (2 mr^2)$ (c) $(2 Emr^2)^{1/2}$ (d) $\sqrt{(2 Emr)}$

42) A body of mass m is projected from the surface of the earth with a speed v (v < escape velocity). Its speed at a height equal to radius R of earth is

(a) $\sqrt{(gR)}$ (b) $\sqrt{(v^2 - 2 gR)}$ (c) $\sqrt{(v^2 - gR)}$ (d) none of these

43) A body of mass m rises to height $h = R / 5$ from the earth's surface, where R is earth's radius. If g is acceleration due to gravity at earth's surface, the increase in potential energy of the body is

(a) mgh (b) (4 / 5) mgh (c) (5 / 6) mgh (d) (6 / 7) mgh

44) Two particles of equal mass m go round a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is

(a) $\sqrt{(Gm / 2R)}$ (b) $\sqrt{(4Gm / R)}$ (c) $(1 / 2R) \sqrt{(1 / Gm)}$ (d) $1 / 2 \sqrt{(Gm / R)}$

45) A body weighs W in a train at rest at equator. If it runs from west to east around the equator with velocity v and earth's angular velocity is ω, then its weight will be

(a) W (b) $W (1 + 2v\omega / g)$ (c) $W (1 - 2v\omega / g)$ (d) $W (1 + v^2 / R)$

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
d	c	b	d	a	b	a	c	d	c	c	b	d	b	d	b	a	b	a,b	a,c,d	b

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
b	b	b	a	c	c	a	c	c	b	c	d	b	a	c	c	d	a	d	c	c	c

44	45															
d	c															