DPP - Daily Practice Problems

Name : ____________ Date : ____________

Start Time : ____________ End Time : ____________

PHYSICS 19

SYLLABUS : Gravitation - 2 (Gravitational potential energy, Gravitational potential, Escape velocity & Orbital velocity of a satellite, Geo-stationary satellites)

Max. Marks : 120 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 A body of mass 100 kg falls on the earth from infinity. What will be its energy on reaching the earth ? Radius of the earth is 6400 km and g = 9.8 m/s^2. Air friction is negligible.

(a) 6.27×10^9 J (b) 6.27×10^{10} J
(c) 6.27×10^{10} J (d) 6.27×10^7 J

Q.2 An artificial satellite of the earth is to be established in the equatorial plane of the earth and to an observer at the equator it is required that the satellite will move eastward, completing one round trip per day. The distance of the satellite from the centre of the earth will be- (The mass of the earth is 6.00×10^{24} kg and its angular velocity = 7.30×10^{-5} rad./sec.)

(a) 2.66×10^3 m. (b) 2.66×10^5 m.
(c) 2.66×10^6 m. (d) 2.66×10^7 m.

Q.3 Two satellites S_1 and S_2 revolve round a planet in the same direction in circular orbits. Their periods of revolutions are 1 hour and 8 hour respectively. The radius of S_1 is 10^4 km. The velocity of S_2 with respect to S_1 will be-

(a) $\pi \times 10^4$ km/hr (b) $\pi/3 \times 10^4$ km/hr
(c) $2\pi \times 10^4$ km/hr (d) $\pi/2 \times 10^4$ km/hr

Q.4 In the above example the angular velocity of S_2 as actually observed by an astronaut in S_1 is -

(a) $\pi/3$ rad/hr (b) $\pi/3$ rad/sec
(c) $\pi/6$ rad/hr (d) $2\pi/7$ rad/hr

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ

Space for Rough Work

Q.5 The moon revolves round the earth 13 times in one year. If the ratio of sun-earth distance to earth-moon distance is 392, then the ratio of masses of sun and earth will be -
(a) 365 (b) 356
(c) 3.56×10^5 (d) 1

Q.6 Two planets of radii in the ratio 2 : 3 are made from the materials of density in the ratio 3 : 2. Then the ratio of acceleration due to gravity g_1/g_2 at the surface of two planets will be
(a) 1 (b) 2.25 (c) $\frac{4}{9}$ (d) 0.12

Q.7 A satellite of mass m is revolving in a circular orbit of radius r. The relation between the angular momentum J of satellite and mass m of earth will be -
(a) $J = \sqrt{G.Mm^2r}$ (b) $J = \sqrt{GMm}$
(c) $J = \sqrt{GMmr}$ (d) $J = \sqrt{\frac{mr}{M}}$

Q.8 A spaceship is launched into a circular orbit close to earth's surface. What additional velocity has now to be imparted to the spaceship in the orbit to overcome the gravitational pull? (Radius of earth = 6400 km, g = 9.8 m/sec^2)
(a) 3.285 km/sec (b) 32.85 m/sec
(c) 11.32 km/sec (d) 7.32 m/sec

Q.9 The ratio of the radius of the Earth to that of the moon is 10. The ratio of g on earth to the moon is 6. The ratio of the escape velocity from the earth's surface to that from the moon is approximately -
(a) 10 (b) 8 (c) 4 (d) 2

Q.10 Acceleration due to gravity on a planet is 10 times the value on the earth. Escape velocity for the planet and the earth are V_p and V_e respectively. Assuming that the radii of the planet and the earth are the same, then -
(a) $V_P = 10\, V_e$ (b) $V_P = \sqrt{10}\, V_e$
(c) $V_p = \frac{V_e}{\sqrt{10}}$ (d) $V_P = \frac{V_e}{10}$

Q.11 The Jupiter's period of revolution round the Sun is 12 times that of the Earth. Assuming the planetary orbits are circular, how many times the distance between the Jupiter and Sun exceeds that between the Earth and the sun.
(a) 5.242 (b) 4.242 (c) 3.242 (d) 2.242

Q.12 The mean distance of mars from sun is 1.524 times the distance of the earth from the sun. The period of revolution of mars around sun will be-
(a) 2.88 earth year (b) 1.88 earth year
(c) 3.88 earth year (d) 4.88 earth year

Q.13 The semi-major axes of the orbits of mercury and mars are respectively 0.387 and 1.524 in astronomical unit. If the period of Mercury is 0.241 year, what is the period of Mars.
(a) 1.2 years (b) 3.2 years
(c) 3.9 years (d) 1.9 years

Q.14 If a graph is plotted between T^2 and r^3 for a planet then its slope will be -
(a) $\frac{4\pi^2}{GM}$ (b) $\frac{GM}{4\pi^2}$
(c) 4π GM (d) 0

Q.15 The mass and radius of earth and moon are M_1, R_1 and M_2, R_2 respectively. Their centres are d distance apart. With what velocity should a particle of mass m be projected from the mid point of their centres so that it may escape out to infinity -
(a) $\sqrt{\frac{G(M_1+M_2)}{d}}$ (b) $\sqrt{\frac{2G(M_1+M_2)}{d}}$
(c) $\sqrt{\frac{4G(M_1+M_2)}{d}}$ (d) $\sqrt{\frac{GM_1M_2}{d}}$

Q.16 A satellite has to revolve round the earth in a circular orbit of radius 8×10^3 km. The velocity of projection of the satellite in this orbit will be -
(a) 16 km/sec (b) 8 km/sec
(c) 3 km/sec (d) 7.08 km/sec

Q.17 If the satellite is stopped suddenly in its orbit which is at a distnace = radius of earth from earth's surface and allowed to fall freely into the earth, the speed with which it hits the surface of earth will be -
(a) 7.919 m/sec (b) 7.919 km/sec
(c) 11.2 m/sec (d) 11.2 km/sec

RESPONSE GRID					
	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ
	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ		

Space for Rough Work

Q.18 A projectile is fired vertically upward from the surface of earth with a velocity K v_e m/s where v_e m/s is the escape velocity and K < 1. Neglecting air resistance, the maximum height to which it will rise measured from the centre of the earth is - (where R = radius of earth)

(a) $\frac{R}{1-K^2}$ (b) $\frac{R}{K^2}$ (c) $\frac{1-K^2}{R}$ (d) $\frac{K^2}{R}$

Q.19 A satellite is revolving in an orbit close to the earth's surface. Taking the radius of the earth as 6.4×10^6 metre, the value of the orbital speed and the period of revolution of the satellite will respectively be (g = 9.8 meter/sec^2)

(a) 7.2 km/sec., 84.6 minutes
(b) 2.7 km/sec., 8.6 minutes
(c) .72 km/sec., 84.6 minutes
(d) 7.2 km/sec., 8.6 minutes

Q.20 If the period of revolution of an artificial satellite just above the earth be T second and the density of earth be ρ, kg/m^3 then
($G = 6.67 \times 10^{-11}$ m^3/kg. second^2)

(a) ρT^2 is a universal constant
(b) ρT^2 varies with time
(c) $\rho T^2 = \frac{3\pi}{G}$
(d) Both (a) and (c)

Q.21 Two satellites P and Q of same mass are revolving near the earth surface in the equitorial plane. The satellite P moves in the direction of rotation of earth whereas Q moves in the opposite direction. The ratio of their kinetic energies with respect to a frame attached to earth will be -

(a) $\left(\frac{8363}{7437}\right)^2$ (b) $\left(\frac{7437}{8363}\right)^2$ (c) $\left(\frac{8363}{7437}\right)$ (d) $\left(\frac{7437}{8363}\right)$

DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :
(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.22 Gas escapes from the surface of a planet because it acquires an escape velocity. The escape velocity will depend on which of the following factors:
(1) Mass of the planet
(2) Radius of the planet
(3) Mass of the particle escaping
(4) Temperature of the planet

Q.23 v_e and v_p denotes the escape velocity from the earth and another planet having twice the radius and the same mean density as the earth. Then which of the following is (are) wrong ?
(1) $v_e = v_p$ (2) $v_e = 2v_p$
(3) $v_e = v_p/4$ (4) $v_e = v_p / 2$

Q.24 Select the wrong statements from the following
(1) The orbital velocity of a satellite increases with the radius of the orbit
(2) Escape velocity of a particle from the surface of the earth depends on the speed with which it is fired
(3) The time period of a satellite does not depend on the radius of the orbit
(4) The orbital velocity is inversely proportional to the square root of the radius of the orbit

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

It can be assumed that orbits of earth and mars are nearly circular around the sun. It is proposed to launch an artificial planet around the sun such that its apogee is at the orbit of mars while its perigee is at the orbit of earth. Let T_e and T_m be periods of revolution of earth and mars. Further the variables are assigned the meanings as follows.

$M_e \rightarrow$ Mass of earth
$M_m \rightarrow$ Mass of mars.
$L_e \rightarrow$ Angular momentum of earth around the sun.
$L_m \rightarrow$ Angular momentum of mars around the sun.
$R_e \rightarrow$ Semi major axis of earth's orbit.
$R_m \rightarrow$ Semi major axis of mars orbit.
$M \rightarrow$ Mass of the artificial planet.
$E_e \rightarrow$ Total energy of earth.
$E_m \rightarrow$ Total energy of mars.

RESPONSE GRID					
	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ
	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ			

Space for Rough Work

Q.25 Time period of revolution of the artificial planet about sun will be (neglect gravitational effects of earth and mars)

(a) $\frac{T_e + T_m}{2}$ (b) $\sqrt{T_e T_m}$

(c) $\frac{2T_e T_m}{T_e + T_m}$ (d) $\left[\frac{T_e^{2/3} + T_m^{2/3}}{2}\right]^{3/2}$

Q.26 The total energy of the artificial planet's orbit will be

(a) $\frac{2M}{M_e}\left(\frac{R_e E_e}{R_e + R_m}\right)$ (b) $\frac{2M}{M_m}\left(\frac{R_e E_e}{R_e + R_m}\right)$

(c) $\frac{2E_e M}{M_m}\left(\frac{R_e + R_m}{R_m}\right)$ (d) $\frac{2E_e M}{M_e}\left(\frac{R_e + R_m}{\sqrt{R_e^2 + R_m^2}}\right)$

Q.27 Areal velocity of the artificial planet around the sun will be

(a) less than that of earth
(b) more than that of mars
(c) more than that of earth
(d) same as that of the earth

DIRECTIONS (Q. 28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement-1 is False, Statement-2 is True.
(d) Statement-1 is True, Statement-2 is False.

Q.28 **Statement-1 :** The speed of revolution of an artificial satellite revolving very near the earth is $8 kms^{-1}$.
Statement-2 : Orbital velocity of a satellite, become independent of height of near satellite.

Q.29 **Statement-1 :** If an earth satellite moves to a lower orbit, there is some dissipation of energy but the speed of gravitational satellite increases.
Statement-2 : The speed of satellite is a constant quantity.

Q.30 **Statement-1 :** Gravitational potential of earth at every place on it is negative.
Statement-2 : Every body on earth is bound by the attraction of earth.

RESPONSE GRID	
	25. ⓐⓑⓒⓓ 26. ⓐⓑⓒⓓ 27. ⓐⓑⓒⓓ 28. ⓐⓑⓒⓓ 29. ⓐⓑⓒⓓ 30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 19 - PHYSICS			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	32	Qualifying Score	50
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

19

(1) (a) A body projected up with the escape velocity v_e will go to infinity. Therefore, the velocity of the body falling on the earth from infinity will be v_e. Now, the escape velocity on the earth is

$$v_e = \sqrt{gR_e} = \sqrt{2\times(9.8\text{m/s}^2)\times(6400\times10^3\text{m})}$$
$$= 1.2 \times 10\ 10^4 \text{ m/s} = 11.2 \text{ km/s}.$$

The kinetic energy acquired by the body is

$$K = \frac{1}{2}m v_e^2 = \frac{1}{2} \times 100\text{ kg} \times (11.2 \times 10^3 \text{ m/s})^2$$
$$= 6.27 \times 10^9 \text{ J}.$$

(2) (d) We know that $\frac{GMm}{r^2} = m\,\omega^2 r$ or $\frac{GM}{r^2} = \omega^2 r.$

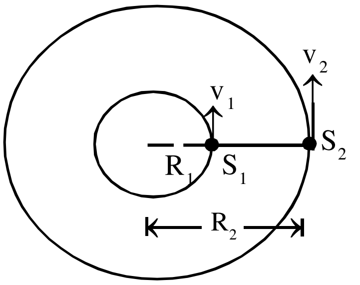
$$\therefore r^3 = \frac{GM}{\omega^2}$$

where ω is the angular velocity of the satellite
In the present case, $\omega = 2\omega_0$,
where ω_0 is the angular velocity of the earth.
$\therefore\ \omega = 2 \times 7.3 \times 10^{-5}$ rad/ sec.
$G = 6.673 \times 10^{-11}$ n-m^2/kg^2
and $M = 6.00 \times 10^{24}$kg.
Substituting these values in equation (A), we get

$$r^3 = \frac{(6.673 \times 10^{-11})(6.00 \times 10^{24})}{(2 \times 7.3 \times 10^{-5})^2}$$

Solving we get $r = 2.66 \times 10^7$m.

(3) (a)



From Kepler's Law, $T^2 \propto r^3$

$$\therefore \left(\frac{T_1}{T_2}\right)^2 = \left(\frac{r_1}{r_2}\right)^3 \Rightarrow \left(\frac{1}{8}\right)^2 = \left(\frac{10^4}{r_2}\right)$$

$\Rightarrow r_2 = 4\text{x } 10^4$ km

$$v = \omega r = \frac{2\pi r}{T}$$

$$\therefore |v_2 - v_1| = 2\pi\left(\frac{r_1}{T_1} - \frac{r_2}{T_2}\right) = \pi \times 10^4 \text{ km/hr}$$

(4) (a) When S_2 is closest to S_1, the speed of S_2 relative to S_1 is $v_2 - v_1 = \pi \times 10^4$ km/hr. The angular speed of S_2 as observed from S_1 (when closest distance between them is $r_2 - r_1 = 3 \times 10^4$ km)

$$\omega = \frac{v_2 - v_1}{r_2 - r_1} = -\frac{\pi \times 10^4}{3 \times 10^4} = -\frac{\pi}{3} \text{ rad/hr},$$

$$|\omega| = \frac{\pi}{3} \text{ rad/hr}$$

(5) (c) Period of revolution of earth around sun

$$T_e^2 = \frac{4\pi^2 R_e^2}{GM_s}$$

Period of revolutions of moon around earth

$$T_n^2 = \frac{4\pi^2 R_m^2}{GM_e}$$

$$\therefore \left(\frac{T_e}{T_m}\right)^2 = \left(\frac{M_e}{M_s}\right)\left(\frac{R_e}{R_m}\right)^3$$

$$\therefore \frac{M_s}{M_e} = \left(\frac{T_m}{T_e}\right)^2\left(\frac{R_e}{R_m}\right)^3 = \frac{(393)^3}{13^2} = 3.56 \times 10^5$$

(6) (a) According to law of conservation of angular momentum, mvr = constant
$\Rightarrow$ vr = constant
$v_{max} \cdot r_{min} = v_{min} \cdot r_{max}$

$$\Rightarrow \frac{V_B}{V_A} = \frac{v_{max}}{v_{min}} = \frac{r_{max}}{r_{min}} = x$$

(7) (a) Angular momentum of satellite, J = mvr. But,

$$\frac{GMm}{r^2} = \frac{mv^2}{r} \Rightarrow v = \sqrt{\frac{GM}{r}}$$

$$\therefore\ J = m\sqrt{GMr}$$

(8) (a) The orbital velocity of space ship, $v_0 = \sqrt{\frac{GM}{r}}$

If space, ship is very near to earth's surface,

r = Radius of earth = R $\therefore\ v_0 = \sqrt{\frac{GM}{R}}$

$$= \sqrt{Rg} = \sqrt{6.4 \times 10^6 \times 9.8}$$

$= 7.9195 \times 10^3$ m/sec $= 7.195$ km/sec
The escape velocity of space-ship
$v_e = \sqrt{2Rg} = 7.9195\sqrt{2} = 11.2$ km/sec
Additional velocity required = 11.2– 7.9195=3.2805 km/sec.

(9) (b) The escape velocity $v_e = \sqrt{2gR}$

Now, $(V_e)_{moon} = \sqrt{2gR}$

$(V_e)_{earth} = \sqrt{2 \times 6g \times 10R}$,

So $\frac{(V_e)_{earth}}{(V_e)_{moon}} = 8$

(10) (b) Escape velocity $= \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$

$$\therefore \frac{V_p}{V_e} = \sqrt{\frac{g_p}{g_e} \times \frac{R_e}{R_p}} = \sqrt{10 \times 1} = \sqrt{10}$$

$V_p = \sqrt{10}\ V_e$

(11) (a) We know that $T^2 \propto a^3$

Given that $(12\ T)^2 \propto a_1{}^3$ and $T^2 \propto a_2{}^3$

$$\therefore \frac{a_1{}^3}{a_2{}^3} = \frac{(12T)^2}{T^2} = 144$$

or $\frac{a_1}{a_2} = (144)^{1/3} = 5.242$

Hence the jupiter's distance is 5.242 times that of the earth from the sun.

(12) (b) We know that $T^2 \propto a^3 \Rightarrow T \propto (a)^{3/2}$

$$\therefore \frac{T_{mars}}{T_{earth}} = \left(\frac{a_{mars}}{a_{earth}}\right)^{\frac{3}{2}} = (1.524)^{3/2} = 1.88$$

As the earth revolves round the sun in one year and hence, $T_{earth} = 1$ year.

$\therefore T_{mars} = T_{earth} \times 1.88 = 1 \times 1.88 = 1.88$ earth-year.

(13) (d) $\frac{T_{mercury}}{T_{mars}} = \left(\frac{a_{mercury}}{a_{mars}}\right)^{3/2} = \left(\frac{0.387}{1.524}\right)^{3/2}$

$$\therefore T_{mars} = T_{mercury} \times \left(\frac{1.524}{0.387}\right)^{3/2}$$

$= (0.241 \text{years}) \times (7.8) = 1.9$ years.

(14) (a) $\frac{T^2}{r^3} = \frac{\left(\frac{2\pi r}{v_0}\right)^2}{r^3} = \frac{(2\pi r)^2}{r^3}\frac{1}{GM}r = \frac{4\pi^2}{GM}$

$[\therefore \frac{mv_0{}^2}{r} = \frac{GMm}{r^2},\ v_0^2 = \frac{GM}{r}]$

Slope of $T^2 - r^3$ curve $= \tan\theta = \frac{T^2}{r^3} = \frac{4\pi^2}{GM}$

(15) (c) Total energy of the particle at P

$$E = E_{kP} + U = \frac{1}{2}mv_e^2 - \frac{GM_1m}{d/2} - \frac{GM_2m}{d/2}$$

$$= \frac{1}{2}mv_e^2 - \frac{2Gm}{d}(M_1 + M_2)$$

At infinite distance from M_1 and M_2, the total energy of the particle is zero.

$$\therefore \frac{1}{2}mv_e^2 = \frac{2Gm}{d}(M_1 + M_2),$$

$$\therefore v_e = \sqrt{\frac{4G}{d}(M_1 + M_2)}$$

(16) (d) $v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{gR^2}{r}} = \sqrt{\frac{9.8 \times 6.4^2 \times 10^{12}}{8 \times 10^6}}$

$= 7.08$ km/sec.

(17) (b) From conservation of energy,

The energy at height h = Total energy at earth's surface

$$0 - \frac{GMm}{R+h} = \frac{1}{2}mv^2 - \frac{GMm}{R},$$

$$\frac{1}{2}mv^2 = \frac{GMm}{R} - \frac{GMm}{R+h} = \frac{GMm}{R} - \frac{GMm}{2R}$$

$$\Rightarrow v = \sqrt{\frac{GM}{R}} = \sqrt{\frac{R^2g}{R}} = \sqrt{Rg}$$

$$= \sqrt{6400 \times 10^3 \times 9.8} = 7.919 \times 10^3 \text{ m/s}$$

$= 7.919$ km/sec

(18) (a) If a body is projected from the surface of earth with a velocity v and reaches a height h, then using law of conservation of energy, $\frac{1}{2}mv^2 = \frac{mgh}{1 + h/R}$.

Given $v = Kv_e = K\sqrt{2gR}$ and $h = r - R$

Hence, $\frac{1}{2}mK^2\,2gR = \frac{mg(r-R)}{1 + \frac{r-R}{R}}$ or $r = \frac{R}{1-K^2}$

(19) (a) Orbital speed,

$v_0 = \sqrt{g\,R_e} = \sqrt{9.8 \times (6.4 \times 10^6)}$

$= 7.2 \times 10^3$ m/s $= 7.2$ km/s.

Period of revolution,

$T = 2\pi\sqrt{R/g}$

$= 2 \times 3.14\sqrt{(6.4 \times 10^6)/9.8} = 5075$ s $= 84.6$ minutes.

(20) (d) If the period of revolution of a satellite about the earth be T, then

$$T^2 = \frac{4\pi^2(R_e+h)^3}{GM_e}$$

where h is the height of the satellite from earth's surface.

$$\therefore M_e = \frac{4\pi^2(R_e+h)^3}{GT^2}$$

The satellite is revolving just above the earth, hence h is negligible compared to R_e.

$$\therefore M_e = \frac{4\pi^2 R_e^3}{GT^2}$$

But $M_e = \frac{4}{3}\pi R_e^3 \rho$ where ρ is the density of the earth.

$$\text{Thus } \frac{4}{3}\pi R_e^3 \rho = \frac{4\pi^2 R_e^3}{GT^2}$$

$$\therefore \rho T^2 = \frac{3\pi}{G}.$$

which is universal constant. To determine its value,

$$\rho T^2 = \frac{3\pi}{G} = \frac{3 \times 3.14}{6.67\times10^{-11}\ m^3/kg\text{-}s^2}$$

(21) (a) $\frac{E_{KQ}}{E_{KP}} = \frac{v_Q^2}{v_P^2}$.

Linear velocity of earth,

$$V_e = \frac{2\pi R_e}{T_e} = \frac{6.28\times6.4\times10^6}{24\times3600} = 463\ m/s$$

Orbital velocity, $V_0 = \sqrt{R_e g} = 7.9\times10^3$ m/s

According to question,

$V_P = V_0 + V_e = 7900 - 463 = 7437$ m/s

$V_Q = V_0 + V_e = 7900 + 463 = 8363$ m/s

$$\therefore \frac{E_{KQ}}{E_{KP}} = \left(\frac{8363}{7437}\right)^2$$

(22) (b) $v_e = \sqrt{\frac{2GM}{R}}$ i.e. escape velocity depends upon the mass and radius of the planet.

(23) (a) $v_e = \sqrt{\frac{2GM}{R}} = R\sqrt{\frac{8}{3}\pi G\rho}$

If mean density is constant then $v_e \propto R$

$$\frac{v_e}{v_p} = \frac{R_e}{R_p} = \frac{1}{2} \Rightarrow v_e = \frac{v_p}{2}$$

(24) (a) $v_0 = \sqrt{\frac{GM}{r}}$

(25) (d) $T^2 \propto R^3$

$$T_e^2 = KR_e^3; T_m^2 = kR_m^3; T^2 = kR^3$$

$$R = \frac{R_e+R_m}{2}$$

$$\Rightarrow T^2 = k\left[\frac{T_e^{2/3}}{k^{1/3}} + \frac{T_m^{2/3}}{k^{1/3}} \times \frac{1}{2}\right]^3$$

$$\Rightarrow T = \left[\frac{T_e^{2/3}+T_m^{2/3}}{2}\right]^{3/2}$$

(26) (a) $E_e = -\frac{GM_sM_e}{2R_e} = -\frac{GM_sM}{2R}$

$$= \frac{2R_eE_e}{M_e} \times \frac{M}{2\left(\frac{R_e+R_m}{2}\right)}$$

$$= \frac{2M}{M_e}\left(\frac{R_e}{R_e+R_m}\right)E_e$$

(27) (c) Areal velocity of the artificial planet around the sun will be more than that of earth.

(28) (a) $v_0 = R_e\sqrt{\frac{g}{R_e+h}}$

For satellite revolving very near to earth $R_e + h = R_e$

As $(h << R)$

$$v_0 = \sqrt{R_e g} \simeq \sqrt{64\times10^5\times10} = 8\times10^3\ m/s = 8\ kms^{-1}$$

Which is independent of height of a satellite.

(29) (d) Due to resistance force of atmosphere, the satellite revolving around the earth losses kinetic energy. Therefore in a particular orbit the gravitational attraction of earth on satellite becomes greater than that required for circular orbit there. Therefore satellite moves down to a lower orbit. In the lower orbit as the potential energy $(U = -GMm/r)$ becomes more negative, Hence kinetic energy $(E_k = GMm/2r)$ increases, and hence speed of satellite increases.

(30) (a) Because gravitational force is always attractive in nature and every body is bound by this gravitational force of attraction of earth.