PSI AP Physics C – Universal Gravity
Multiple Choice Questions

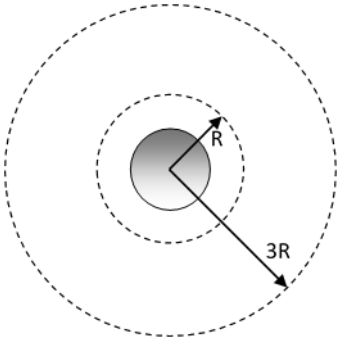
1. Who determined the value of the gravitational constant (G)?
   (A) Newton
   (B) Galileo
   (C) Einstein
   (D) Schrödinger
   (E) Cavendish

2. Who came up with the law for Universal Gravitation?
   (A) Newton
   (B) Galileo
   (C) Einstein
   (D) Schrödinger
   (E) Cavendish

3. Two large objects of equal mass m are separated by a distance r and exert a gravitational pull of magnitude F. If the distance between the two objects is reduced to r/4, what is the new gravitational force acting on each object?
   (A) F/2
   (B) F/4
   (C) F/16
   (D) 4F
   (E) 16F

4. An object of mass m_1 is a distance r away from a mass of m_2. If m_1 is tripled and the distance between the two objects is increased from r to 3r, what is the new gravitational force?
   (A) F/9
   (B) F/3
   (C) F
   (D) 3F
   (E) 9F

5. A satellite is orbiting the Earth a distance R_E above its surface. What is the acceleration due to gravity in this orbit? (R_E is the radius of the earth)
   (A) 2.45 m/s^2
   (B) 4.9 m/s^2
   (C) 9.8 m/s^2
   (D) 19.6 m/s^2
   (E) 39.2 m/s^2



6. A satellite is orbiting a planet a distance R from its center and another satellite is orbiting at a distance 3R from its center. What is the relation between the accelerations due to gravity for each case? (a_1 is the acceleration a distance R away from its center and a_2 is the acceleration due to gravity a distance 3R from its center)
   (A) $a_2 = \frac{a_1}{9}$
   (B) $a_2 = \frac{a_1}{3}$
   (C) $a_2 = a_1$
   (D) $a_2 = 3a_1$
   (E) $a_2 = 9a_1$

7. Planet β has 2 times the mass of the Earth and ½ of the radius. The acceleration due to gravity at the surface is closest to:
   (A) 20 m/s^2
   (B) 40 m/s^2
   (C) 80 m/s^2
   (D) 3 m/s^2
   (E) 5 m/s^2

8. Planet α has 5 times the mass of the Earth and 2 times the radius. The acceleration due to gravity at the surface of planet α is closest to:
   (A) 6.125 m/s^2
   (B) 12.5 m/s^2
   (C) 25 m/s^2
   (D) 10 m/s^2
   (E) 49 m/s^2

9. What is the weight of an object that has a mass of 10 kg on the surface of the Earth?
   (A) 49 N
   (B) 64 N
   (C) 86 N
   (D) 98 N
   (E) 110 N

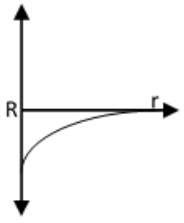
10. A mass of 10 kg is placed on the surface of Mars. What is its mass? (The acceleration due to gravity on Mars is 3.7 m/s^2)
    (A) .37 kg
    (B) 3.7 kg
    (C) 37 kg
    (D) 10 kg
    (E) 100 kg

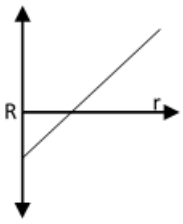
11. A mass of 10 kg is placed on the surface of Mars. What is its weight? (The acceleration due to gravity on Mars is 3.7 m/s^2)
    (A) .37 N
    (B) 3.7 N
    (C) 37 N
    (D) 10 N
    (E) 100 N

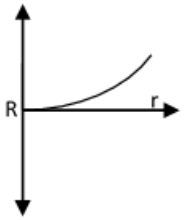
12. How much work is done by the force due to gravity when an object moves from the surface of the Earth to a height above its surface equal to its radius R?
    (A) $w = GMm/R$
    (B) $w = (-GMm)/2R$
    (C) $w = 2GMm/R$
    (D) $w = GM/R$
    (E) $w = (-GMm)/R$

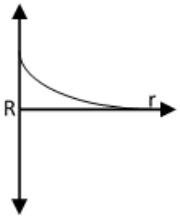
13. What is the gravitational potential energy of an object located 32,000m above the Earth's Surface?
    (A) $U = -GMm/(32km + R_E)$
    (B) $U = -GMm/(32{,}000\ km + R_{E)}$
    (C) $U = -GMm/R_E$
    (D) $U = -GMm/(R_E - 32\ km)$
    (E) $U = -GM/R_E$

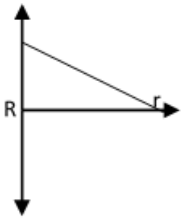
14. As an object moves away from the surface of the Earth, the graph of the gravitational potential energy is:

(A) 

(B) 

(C) 

(D) 

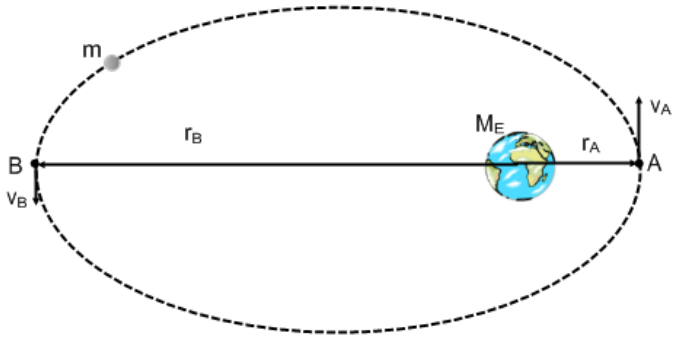
(E) 

15. A rocket ship is sitting on the surface of a planet with a mass of $1x10^{27}$ kg and a radius of $6.67x10^{12}$ m. What is the planet's escape velocity?
    (A) $\sqrt{200}$ m/s
    (B) 100 m/s
    (C) $100\sqrt{2}$ m/s
    (D) 50 m/s
    (E) 10 m/s

16. There are two Planets, each with the same surface gravity, but Planet 1 has a greater radius and is less massive then Planet 2. Which of these planets has a greater escape velocity?
    (A) Planet 1
    (B) Planet 2
    (C) Both have the same escape velocity because surface gravity is equal
    (D) Not enough information is given

17. Satellite A remains in a stable circular orbit of 2 R_E above the earth's center. If satellite B were to maintain a stable circular orbit of $4R_E$ above the Earth's center, what velocity must it maintain with respect to satellite 1?
    (A) $V_B = V_A\sqrt{2}$
    (B) $V_B = 2V_A$
    (C) $V_B = V_A$
    (D) $V_B = V_A/\sqrt{2}$
    (E) $V_B = V_A/2$

18. A meteor follows an elliptical orbit around the sun. When does the meteor swipe through the greatest area in time t?
    (A) When it is the closest to the sun
    (B) When it is the furthest away from the sun
    (C) It is impossible for the meteor to maintain an elliptical orbit therefore the question is not valid
    (D) The meteor sweeps through equal areas in the same amount of time anywhere in the orbit
    (E) None from the above



19. A satellite of mass m is traveling in an elliptical orbit about the Earth. At its furthest distance of r_B its velocity is v_B. What is its velocity at point A, which is a distance r_A from the Earth's center?
    (A) $V_A = \frac{V_B r_B}{r_A}$
    (B) $V_A = \frac{r_B}{r_A}$
    (C) $V_A = \frac{m V_r r_B}{r_A}$
    (D) $V_A = \frac{V_B r_B}{m r_A}$
    (E) $V_A = \frac{V_B}{r_A}$

20. A satellite orbiting around Jupiter at a distance r from its center has a period of T_1. What would the period of an identical satellite orbiting at a distance $\frac{1}{4}r$ from Jupiter's center?
    (A) $T_2=T_1/2$
    (B) $T_2=T_1/4$
    (C) $T_2=T_1/8$
    (D) $T_2=4T_1$
    (E) $T_2=8T_1$

21. A satellite orbiting a planet at a distance of $8\text{x}10^6$ m from its center has a period of 16 hours. What would be the period of a satellite orbiting at a distance of $2\text{x}10^6$ m above the planet's center?
    (A) 2 hr
    (B) 4 hr
    (C) 6 hr
    (D) 8 hr
    (E) 32 hr

22. A satellite is orbiting a planet at distance r above its surface and has a period of T. What would the distance above the surface have to be in order for the period to become eight times greater?
    (A) $R_{new}=R/7$
    (B) $R_{new}=R/4$
    (C) $R_{new}=R$
    (D) $R_{new}=4R$
    (E) $R_{new}=7R$

23. What is the total mechanical energy of a satellite of mass m orbiting the Earth at a distance equal to 2 times the Earth's radius above its surface?
    (A) $E = \frac{-GMm}{6R_E}$
    (B) $E = \frac{-GMm}{4R_E}$
    (C) $E = \frac{-GMm}{2R_E}$
    (D) $E = \frac{-2GMm}{R_E}$
    (E) $E = \frac{-4GMm}{R_E}$

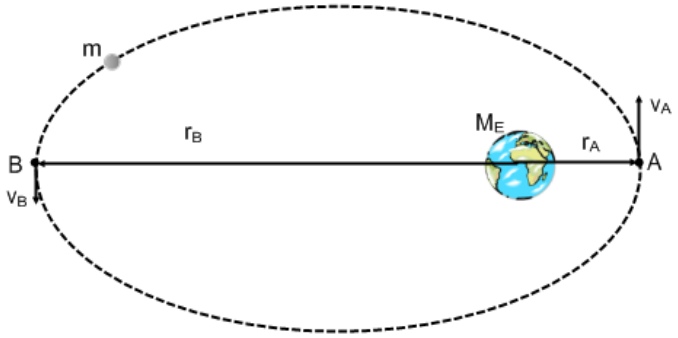
24. Why does an astronaut appear to be weightless in a satellite orbiting the Earth?
    (A) The astronaut is unaffected by the Earth's gravitational pull at this distance
    (B) The Moon is exerting a force equal to and in the opposite direction of the force that the Earth is exerting. Therefore there is no net force acting on the astronaut
    (C) The astronaut is not accelerating
    (D) The astronaut is in a constant state of free fall
    (E) When in space the astronaut has no mass

25. Suppose we drill a hole through the Earth along its diameter and drop a small mass m down the hole. Assume that the Earth is not rotating and has a uniform density throughout its volume. The Earth's mass is M_E and its radius is R_E. Let r be the distance from the falling object to the center of the Earth. Which of the following describes the potential energy of the object as a function of distance r?
    (A) $\frac{-GM_Emr^2}{2R_E^3}$
    (B) $\frac{-GM_Emr^2}{4R_E^3}$
    (C) $\frac{-GM_Emr^2}{8R_E^3}$
    (D) $\frac{-GM_Emr^4}{16R_E^3}$
    (E) $\frac{-GM_Emr^3}{4R_E^3}$

26. For all gravitational problems involving $F=-GMm/r^2$, where do we consider the mass to be concentrated?
    (A) All of the mass is concentrated on the objects surface
    (B) All of the mass is concentrated at the objects center
    (C) The mass is distributed throughout the object
    (D) The mass is considered to be concentrated halfway between the center and the surface
    (E) Its varies depending on the density of the planet

27. If a hole could be cut straight through the earth and a person dropped a ball of mass m what path would the ball follow?
    (A) The ball will fall straight through the hole and come out the other side
    (B) The ball will oscillate
    (C) The ball will stop once it reaches the center
    (D) The ball will never make it to the center
    (E) The ball will rebound as if it hit a floor and bounce back up to the person

Questions 28-29



28. A satellite is orbiting Earth in an elliptical orbit with radii r_A and r_B. If radius r_B is five time of radius r_A, what is the ration v_B/v_A of the speed of the satellite at point B to the speed at point A?
    (A) 5/1 (B) 10/1 (C) 1/5 (D) 1/1 (E) 1/100

29. A satellite is orbiting Earth in an elliptical orbit with radii r_A and r_B. If radius r_B is five time of radius r_A, what is the ration F_B/F_A of the force on the satellite at point B to the force at point A?
    (A) 5/1 (B) 10/1 (C) 1/5 (D) 1/25 (E) 1/100

30. Two small spheres, each with a mass of 1 kg, are separated by a distance of 2 m. Which of the following is the order of magnitude of the gravitational force between the spheres?
    (A) 10^{-20} (B) 10^{-15} (C) 10^{-11} (D) 10^{-7} (E) 10^{-3}

Answer Key

1.E	6.A	11.C	16.B	21.A	26.B
2.A	7.C	12.B	17.D	22.E	27.B
3.E	8.B	13.A	18.D	23.A	28.C
4.B	9.D	14.A	19.A	24.D	29.D
5.A	10.D	15.C	20.C	25.A	30.C