# Quest Chapter 14

| # | Problem | Hint |
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| 1 | Since the moon is gravitationally attracted to the Earth, why doesn't it simply crash into the Earth?<br>1.When the moon moves close to the Earth, the air on the Earth repels it.<br>2. The moon's tangential velocity keeps the moon coasting around the Earth rather than crashing into it.<br>3. The moon does not have enough speed to crash into the Earth.<br>4. The Sun attracts the moon so that the moon cannot move closer the Earth. | Think back to circular motion.<br><br>What keeps something moving around an object instead of to it? |
| 2 | When the space shuttle coasts in a circular orbit at constant speed about the Earth, is it accelerating? If so, in what direction?<br>1. No acceleration<br>2. Yes; in a direction from the moon to the Sun.<br>3. Yes; toward the Earth's center.<br>4. Yes; in a direction from the Earth to the moon. | What are the properties of acceleration?<br><br>Are either of those changing? |
| 3 | Which planets have a period of rotation around the Sun greater than 1 Earth year?<br>1. Additional information is needed.<br>2. Those closer to the sun<br>3. Those farther from the sun<br>4. It depends on the planet's mass. | What would cause a planet to have a higher angular velocity than Earth's (shorter year)?<br><br>What would cause a planet to have a lower angular velocity than Earth's (longer year)? |
| 4 | What is the shape of the orbit when the velocity of the satellite is everywhere perpendicular to the force of gravity?<br>1. ellipse<br>2. rectangle<br>3. hyperbola<br>4. circle<br>5. parabola | Draw the diagram for several positions in the orbit.<br><br>What geometric shape has this characteristic? |

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| 5 | If the Space Shuttle circled the Earth at a distance equal to the Earth-moon distance, how long would it take for it to make a complete orbit?<br>1. 24 hours<br>2. 365 days<br>3. 7 days<br>4. 35 days<br>5. 28 days | If the space shuttle was at the same orbital radius as the moon, what would be the same about the forces acting on them?<br><br>What would be the result of those similarities? |
| 6 | A “geosynchronous” Earth satellite can remain directly overhead in which of the following cities?<br>1. Moscow<br>2. Singapore<br>3. London<br>4. Sidney<br>5. San Francisco | Over what line around the Earth does a geosynchronous orbit occur?<br><br>Which city is closest to that? |
| 7 | If you stopped an Earth satellite dead in its tracks, it would simply crash into the Earth. Why, then, don’t the communications satellites that hover motionless above the same spot on Earth crash into the Earth?<br>1. The moon attracts the satellites at the same time.<br>2. The satellites are not attracted by the Earth.<br>3. The satellites’ orbital period coincides with the daily rotation of the Earth.<br>4. There is no power on the satellites. | What do we call satellites that orbit over the same spot on the Earth?<br><br>What does that word mean? |
| 8 | If our Sun were eight times as massive as it is, how many times faster or slower should the Earth move in order to remain in the same orbit? | Remember: $a_{centripetal} = v^2/r$ and $a_g = Gm/r^2$ .<br><br>In this case, $a_{centripetal} = a_g$ to maintain orbit.<br><br>Solve for v.<br><br>What happens when mass becomes 8m instead of m? |

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| 9 | Two satellites A and B with the same mass orbit the Earth in concentric orbits. The distance of satellite B from the earth's center is four times that of satellite A.<br>What is the ratio of the tangential speed of satellite B to that of satellite A?<br>1. VB/VA = 1/16<br>2. VB/VA = 1/64<br>3. VB/VA = 64<br>4. VB/VA = 4<br>5. VB/VA = 1/2<br>6. VB/VA = 16<br>7. VB/VA = 2<br>8. VB/VA = 1/4 | Use the equation you derived in #8.<br><br>What happens to velocity when radius changes as it does in this problem? |
| 10 | (part 1 of 2)<br>Two satellites A and B orbit the Earth in the same plane. Their masses are m and 6m, respectively, and their radii r and 3 r, respectively.<br>What is the ratio of the orbital speeds?<br>1. VB/VA = 9<br>2. VB/VA = sqrt 2<br>3. VB/VA = 1/(sqrt 2)<br>4. VB/VA = 1/2<br>5. VB/VA = sqrt 3<br>6. VB/VA = 1/9<br>7. VB/VA = 1/(sqrt 3)<br>8. VB/VA = 2<br>9. VB/VA = 1/3<br>10. VB/VA = 3 | Setup the equation from #8 with both sets of data from this problem.<br><br>Then set vb/va in a ratio.<br><br>Simplify the problem. |

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| 11 | (part 2 of 2)<br>Let $10R_E$ be the distance of the satellite A from the center of the Earth, where $R_E$ is the radius of the Earth.<br>What is the gravitational acceleration due to the Earth at satellite A? g is the gravitational acceleration at the surface of the Earth.<br>1. $g_A = g/10$<br>2. $g_A = g/(\text{sqrt } 11)$<br>3. $g_A = g/81$<br>4. $g_A = g/11$<br>5. $g_A = g/9$<br>6. $g_A = g/121$<br>7. $g_A = g/3$<br>8. $g_A = g/(\text{sqrt}10)$<br>9. $g_A = g$<br>10. $g_A = g/100$ | Remember chapters 12 and 13. |
| 12 | How long would our year be if our Sun were three fifths its present mass and the radius of the Earth's orbit were ten times its present value? | Remember:<br>v = d/t and d = 2πr<br>Which means v = 2πr/t.<br><br>Also, v = sqrt(Gm/r).<br><br>Set these equal to each other and solve for t.<br>Write one for $t_{old}$ and one with the new mass and radius for $t_{new}$. Make sure to label the equations.<br><br>Set up a ratio of $t_{new}/t_{old}$<br><br>Now simplify. |

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| 13 | Of all the United States, why is Hawaii the most efficient launching site for non-polar satellites?<br>1. Hawaii is the warmest place in the US; less energy is needed.<br>2. There is not any strong cold wind in Hawaii.<br>3. Hawaii has a greater tangential speed about the polar axis.<br>4. Hawaii is composed of small islands; launch failures can easily go into the sea instead of damaging residential areas. | What characteristic of the Earth are we examining when we consider efficient launching of non-polar satellites?<br><br>How could Hawaii take advantage of that? |
| 14 | If the Earth shrank in size, with all other factors remaining the same, how would the escape velocity from its surface change?<br>1. smaller<br>2. greater<br>3. the same<br>4. Cannot be determined | When the Earth shrinks in size, what is changing?<br><br>How would a change in that affect $v_{escape}$? |
| 15 | Two planets are never seen at midnight. Which two?<br>1. Neptune and Mercury<br>2. Venus and Mercury<br>3. Saturn and Jupiter<br>4. Jupiter and Mars<br>5. Neptune and Pluto | What would keep us from ever seeing a planet at a certain time?<br><br>Where would those planets have to be at midnight?<br><br>Which planets fit that bill? |
| 16 | A rocket of mass m is to be launched from planet X, which has a mass M and a radius R. What is the minimum speed that the rocket must have for it to escape into space? | Which of the selections is the equation for escape velocity? |

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| 17 | Suppose you were hanging in empty space at rest, far from the Earth, but at the same distance from the Sun as the Earth.<br>What minimum speed would you need to have in order to leave the solar system entirely and never fall back toward the Sun? The mass of the Sun is $2\times 10^{30}$ kg and the radius of the Earth's orbit is $1.5 \times 10^{11}$ m.<br>1. About 7 km/s<br>2. About 42.2 km/s<br>3. About 19.4 km/s<br>4. Any speed at all, away from the Sun, since there is no gravity in outer space<br>5. About 1.5 km/s<br>6. About 2100 km/s | $v_{escape}$ = SQRT(2Gm/r)<br><br>Substitute and solve. |
| 18 | Dominating the outer solar system is the dwarf planet Eris (formerly called Xena!) which currently orbits 96.7 times further from the Sun than the Earth. The radius of the Earth's orbit is $1.5 \times 10^{11}$ m. The mass of the Sun is $2 \times 10^{30}$ kg.<br>If you were hanging in empty space at rest at Eris' distance fromthe Sun, what minimum speed would you need to have in order to leave the solar system entirely, and never fall back toward the Sun?<br>1. About 25.2 km/s<br>2. About 7 km/s<br>3. About 11 km/s, same as for the Earth<br>4. About 0.001 km/s<br>5. About 42.3 km/s<br>6. Any speed at all, away from the Sun, since there is no gravity in outer space<br>7. About 1 km/s<br>8. About 0.1 km/s<br>9. About 4.3 km/s<br>10. About 0.01 km/s | $v_{escape}$ = SQRT(2Gm/r)<br><br>Substitute and solve. |

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| 19 | A black hole is an object so heavy that neither matter nor even light can escape the influence of its gravitational field. Since no light can escape from it, it appears black. Suppose a mass approximately the size of the Earth's mass $5.79 \times 10^{24}$ kg is packed into a small uniform sphere of radius r.<br>Use:<br>The speed of light $c = 2.99792 \times 10^{8}$ m/s .<br>The universal gravitational constant<br>$G = 6.67259 \times 10^{-11}$ Nm$^2$/kg$^2$ .<br>Hint: The escape speed must be the speed of light.<br>Based on Newtonian mechanics, determine the limiting radius $r_0$ when this mass (approximately the size of the Earth's mass) becomes a black hole.<br>Answer in units of m | $v_{escape}$ = SQRT(2Gm/r)<br><br>Substitute and solve.<br><br>"Newtonian mechanics" means normal calculations without considering Einstein's theories of relativity. So, just calculate as you usually do. |
| 20 | Calculate the mass of the earth from the period of the moon (27.3 d) and its mean orbital radius of $3.84 \times 10^{8}$ m.<br>The universal gravitational constant is $6.673 \times 10^{-11}$ N · m$^2$/kg$^2$.<br>Answer in units of kg | Remember:<br>$v_{orbit}$ = SQRT (Gm/r)<br><br>So, calculate the angular velocity, $\omega$, from the period. (Note: $\omega$ is in rad/s so you have to convert days to seconds, and one cycle is $2\pi$ radians.)<br><br>Then, $v = \omega r$.<br><br>Lastly, solve for m. |
| 21 | Use the period of the earth (34.86 y), its mean orbital radius ($1.496 \times 10^{11}$ m), and the universal gravitational constant ($6.673 \times 10^{-11}$ N · m$^2$/kg$^2$) to calculate the mass of sun.<br>Answer in units of kg | Same as #20, but you have to convert years to seconds. |

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| 22 | Mechanical energy is associated with<br>1. the nuclei of atoms.<br>2. chemical reactions.<br>3. motion.<br>4. the motion of electric charges. | This is a review question about energy.<br><br>Review your notes or reread the chapter 8. |
| 23 | Heat energy is associated with<br>1. motion.<br>2. the internal motion of particles of matter.<br>3. position or shape.<br>4. holding together the nuclei of atoms. | This is a review question about energy.<br><br>Review your notes or reread the chapter 8. |