Assess Quizzes from the o-book – Explanations for the answers.

Chapter Review – Support

Q	Reason
1	This is Kepler's 1st law. See NCPQ text page 138. (A) and (C) are both true but irrelevant. (D) is untrue.
2	Kepler's ratio $\frac{T^2}{r^3}$ is a constant for objects orbiting the Sun, so as r decreases then T must decrease. A shorter time period means it must be going faster when closer. Alternatively, when it is closer to the Sun it must cover a bigger distance in the same time as it does when farthest from the Sun)Kepler's 2nd law) so it must speed up when close.
3	Kepler's ratio $\frac{T^2}{r^3}$ is a constant for objects orbiting the Sun, so as r increases then T (period of revolution) must also increase, meaning it slows down.
4	$F_g = \frac{Gm_E m}{r^2}$ $F_c = \frac{mv^2}{r}$ $\frac{Gm_E m}{r^2} = \frac{mv^2}{r}$ $\frac{Gm_E}{r} = v^2$ $v = \sqrt{\frac{Gm_E}{r}}$
5	$v = \sqrt{\frac{GM}{r}}\ (satellite\ X)$ $v_Y = \sqrt{\frac{GM}{r}}\ (satellite\ Y)$ $v_Y = v$ The mass of the satellite has no effect on the velocity, only the mass of the central star and the radius have an effect.
6	Kepler's ratio $\frac{T^2}{r^3}$ is a constant for objects orbiting a central star (eg Sun), so if you know that ratio for one planet you can work out the mass of another planet if you know it's period (T)

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7	$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$ $M = \frac{4\pi^2}{G} \times \frac{r^3}{T^2}$ If you know its orbital period (T) and distance from Jupiter (r) you can calculate M
8	$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$ $M = \frac{4\pi^2}{G} \times \frac{r^3}{T^2}$ You can calculate the mass of the Sun M if you know the orbital period (T) of Earth and Earth's distance to the Sun (r).
9	$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$ $T = \sqrt{\frac{4\pi^2 r^3}{GM}}$ T is dependent on the radius of orbit, its velocity and the mass of the Earth. It is not dependent on the mass of the satellite.
10	$v = \sqrt{\frac{GM}{r}}$ Velocity depends on the mass of the Sun and the planet's orbital radius. It is not dependent on the mass of the planet, or the planet's period of rotation.

Chapter 5 Review – Consolidate

Q	Reason
1	We know that T^2/r^3 is a constant for a particular system, so all planets obey this law in their orbit of the Sun. So as the (orbital) distance r from the Sun increases, the period T must also increase. That is, if one changes the other changes (varies) too. As for the other incorrect options: "The closer a planet is to the Sun, the ~~slower~~ *faster* it moves in its orbit". The path a planet takes around the Sun is ~~circular~~ *an ellipse*". The square of the period *divided by the cube of the orbital radius* is the same for all planets in our solar system.

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2	$r_J = 5.2 r_E$ $\frac{T_E^2}{r_E^3} = \frac{T_J^2}{r_J^3}$ [Kepler's 3rd Law] $\frac{1^2}{r_E^3} = \frac{T_J^2}{(5.2 r_E)^3}$ $\frac{1^2}{1} = \frac{T_J^2}{(5.2)^3}$ $T_J = \sqrt{(5.2)^3}$ $= 11.9\, y$ $\approx 12\, y$
3	$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$ $M = \frac{4\pi^2 r^3}{GT^2}$ $M_E = \frac{4\pi^2 r_E{}^3}{GT_M{}^2}$ [E=Earth, M=Moon] $= \frac{4\pi^2 r_M{}^3}{G(1)^2}$ [$T_M = 1$ month] $M_P = \frac{4\pi^2 r_P{}^3}{GT_S{}^2}$ [P = planet, S = satellite of planet] $M_P = \frac{4\pi^2 r_M{}^3}{G(2)^2}$ [*given* $r_P = r_M, T_S$=1month] $M_P = \frac{1}{4} \times \frac{4\pi^2 r_M{}^3}{G(1)^2}$ $M_P = \frac{1}{4} \times M_E$ Thus, the mass of the planet is less than the mass of the Earth.

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4	$\frac{T_J^2}{r_J^3} = \frac{T_E^2}{r_E^3}$ [Kepler's 3rd Law] $\frac{(12T_E)^2}{r_J^3} = \frac{T_E^2}{r_E^3}$ $\frac{12^2 T_E^2}{r_J^3} = \frac{T_E^2}{r_E^3}$ $\frac{12^2}{r_J^3} = \frac{1^2}{r_E^3}$ $\frac{r_J^3}{r_E^3} = \frac{12^2}{1^2}$ $\frac{r_J}{r_E} = \sqrt[3]{144}$ $\frac{r_J}{r_E} = 5.24$ $r_J = 5.24 r_E$
5	The mass of the orbiting body makes no difference. We can apply Kepler's 3rd law: $\frac{T_X^2}{r_X^3} = \frac{T_Y^2}{r_Y^3}$ [Kepler's 3rd Law] $as\ r_X = r_Y$ $then\ T_X = T_Y$ Alternatively, we can apply the law Newton derived from equating gravitational and centripetal force (see NCPQ U3&4 page 142): $\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$ You can see that the mass of the orbiting body, m, doesn't come into the formula. The orbital period of an Earth satellite (T_X, or T_Y) depends only on the mass of the central body, *M*, the Earth.

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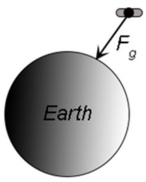
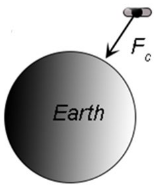
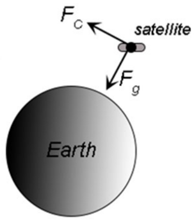
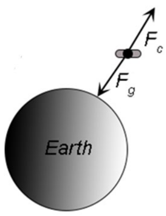
Chapter 5 Review – Extend

Q	Reason	
1		This is correct. The only force acting on the satellite is the gravitational force F_g between Earth and the satellite. It is directed from the satellite towards Earth.
		This is incorrect. It is true that the gravitational force F_g provides the centripetal force F_c but this diagram doesn't show the gravitational force.
		Wrong. F_c is directed towards the centre of rotation but is also not needed in the diagram as the underling force is F_g. Students often think that there must be a force in the direction of motion to keep the object moving in a circle, but this is not true. Gravity causes the object to accelerate towards the centre of motion which makes it travel in a circle. You can't show both F_c and F_g anyway as that would double the forces.
		This is wrong. The F_g is correct and is responsible for providing F_c but F_c is directed towards the centre ('centri-petal' is Latin for *centre seeking*. You can't show both F_c and F_g anyway as that would double the forces.
2	$\frac{T_P^2}{r_P^3} = \frac{T_E^2}{r_E^3}$ [Kepler's 3rd Law] $\frac{T_P^2}{(4r_E)^3} = \frac{T_E^2}{r_E^3}$ $\frac{T_P^2}{4^3} = \frac{T_E^2}{1^3}$ $T_P^2 = \frac{T_E^2 \times 4^3}{1^3}$ $= (1\,y)^2 \times 64$ $T_P = \sqrt{(1\,y)^2 \times 64}$ $= 8\,y$	

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3	$\frac{T_1^2}{r_1^3}=\frac{T_2^2}{r_2^3}$ [Kepler's 3rd Law] $\frac{6^2}{(2r_E)^3}=\frac{T_2^2}{(4r_E)^3}$ $\frac{36}{(2)^3}=\frac{T_2^2}{(4)^3}$ $\frac{36}{8}=\frac{T_2^2}{64}$ $T_2=\sqrt{\frac{36\times 64}{8}}$ $=17\,h$
4	$\frac{T_M^2}{r_{MO}{}^3}=\frac{4\pi^2}{GM}$ [MO = moon orbit] $M=\frac{4\pi^2 r_{MO}{}^3}{GT_M{}^2}$ $M_E=\frac{4\pi^2(385000\times 10^3)^3}{6.67\times 10^{-11}\times(27.4\times 24\times 69\times 60)^2}$ $=\frac{2.25\times 10^{27}}{3.74\times 10^2}kg$ $=6.0\times 10^{24}kg$
5	$\frac{T_U^2}{r_U{}^3}=\frac{T_S^2}{r_S{}^3}$ [Kepler's 3rd Law] $\frac{T_U^2}{(2.5)^3}=\frac{29^2}{(1.2)^3}$ $T_U=\sqrt{\frac{29^2\times 2.5^3}{1.2^2}}$ $=87.2\,y$ $\approx 87\,y$

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