Question Number	Answer	Mark
18(a)	Use of $V = \frac{4}{3}\pi r^3$ **(1)** Use of $\rho = \frac{m}{V}$ **(1)** Use of $F = \frac{Gm_1m_2}{r^2}$ **(1)** $F = 7.4 \times 10^5$ N **(1)** <u>Example of calculation</u> $V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(\frac{5.65\text{ m}}{2}\right)^3 = 94.437\text{ m}^3$ $m = \rho V = 1950\text{ kg m}^{-3} \times 94.437\text{ m}^3 = 1.842 \times 10^5\text{ kg}$ $F = \frac{Gm_1m_2}{r^2}$ $= \frac{6.67 \times 10^{-1}\text{ N m}^2\text{ kg}^{-3} \times 5.98 \times 10^{24}\text{ kg} \times 1.842 \times 10^5\text{ kg}}{(6.38 \times 10^6\text{ m} + 3.59 \times 10^6\text{ m})^2}$ $\therefore F = 7.39 \times 10^5$ N	**4**
18(b)	Use of $V_{grav} = (-)\frac{GM}{r}$ **(1)** Use of $E_{grav} = m \times V_{grav}$ **(1)** $\therefore \Delta E_{grav} = (-)\ 4.1 \times 10^{12}$ J (Allow ecf for mass from (a)) **(1)** [Either mass can be used for *M* in the potential equation, but to award MP2 the multiplier *m*. must not be the mass used in the potential equation.] <u>Example of calculation</u> $\Delta E_{grav} = -6.67 \times 10^{-11}\text{ N m}^2\text{ kg}^{-2} \times 1.842 \times 10^5\text{ kg} \times 5.98 \times 10^{\ 24}\text{ kg}$ $\times\left(\frac{1}{6.38 \times 10^6\text{ m}} - \frac{1}{(6.38 \times 10^6 + 3.59 \times 10^6)\text{ m}}\right)$ $\therefore \Delta E_{grav} = -4.14 \times 10^{12}$ J [Note the following values, but different degrees of rounding may change these slightly: $V_{final} = (-)\ 6.252 \times 10^7\text{ J kg}^{-1}$ $V_{initiall} = (-)\ 4.001 \times 10^7\text{ J kg}^{-1}$ $E_{final} = (-)1.152 \times 10^{13}$ J $E_{initial} = (-)\ 7.296 \times 10^{12}$ J]	**3**
18(c)	Work would be done on the asteroid by frictional forces **Or** Drag/friction causes heating (of the asteroid) **(1)** Asteroid burns up **(1)**	**2**
	Total for question 18	**9**