Question Number	Answer		Mark
20(a)	**EITHER**		
	Use of $r = R_1 + R_2$ [0.165 m]	**(1)**	
	Use of $F = \frac{Gm_1m_2}{r^2}$	**(1)**	
	Maximum force = 2.83×10^{-7} N [Allow 7.1×10^{-8} N if diameters added]	**(1)**	
	Conclusion consistent with calculated values	**(1)**	
	[e.g. 2.83×10^{-7} (N) < 50×10^{-6} (N) so it can't be measured]		
	OR		
	Use of $r = R_1 + R_2$ [0.165 m]	**(1)**	
	Use of $F = \frac{Gm_1m_2}{r^2}$	**(1)**	
	(Maximum) separation (to give minimum measurable force) = 0.012 m	**(1)**	**4**
	Conclusion consistent with calculated values	**(1)**	
	[e.g. 0.012 (m) < 0.165 (m), so it can't be measured]		
	<u>Example of calculation</u>		
	$r = \sqrt{\frac{6.67 \times 10^{-11}\ \text{N m}^2\text{kg}^{-2} \times 158\ \text{kg} \times 0.73\ \text{kg}}{5.0 \times 10^{-5}\ \text{N}}} = 0.012\ \text{m}$		
	$r = \left(\frac{0.305\ \text{m}}{2} + \frac{0.025\ \text{m}}{2}\right) = 0.165\ \text{m}$		
20(b)(i)	**EITHER**	**(1)**	
	Correct equation re-arranged to make G the subject		
	Base units substituted to obtain required units	**(1)**	
	OR		
	Units of G = N m^2 kg^{-2} and N = kg m s^{-2}	**(1)**	
	So units of G = kg m s^{-2} m^2 kg^{-2} = m^3 kg^{-1} s^{-2}	**(1)**	**2**
	<u>Example of derivation</u>		
	$F = G\frac{m_1m_2}{r^2} \therefore G = \frac{Fr^2}{m_1m_2}$		
	Units of $G = \frac{\text{N m}^2}{\text{kg}^2} = \frac{\text{kg m s}^{-2}\ \text{m}^2}{\text{kg}^2} = \text{m}^3\ \text{kg}^{-1}\ \text{s}^{-2}$		
20(b)(ii)	% difference calculated [9.4%]	**(1)**	
	Appropriate comment based on their calculated % difference	**(1)**	**2**
	[One value expressed as a ratio/percentage of the other with an appropriate comment can score MAX 1mark]		
	<u>Example of calculation</u>		
	% difference $= \frac{(6.67 \times 10^{-11} - 6.04 \times 10^{-11})\ \text{N m}^2\ \text{kg}^{-2}}{6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}} \times 100\% = 9.4\ \%$		
	Total for question 20		**8**