

Question	Answer	Marks
1(a)	force per unit mass	B1
1(b)(i)	lines drawn are radial from the surface	B1
	arrows show pointing towards planet	B1
1(b)(ii)	field lines show force (on satellite) is towards centre of planet or velocity of satellite is perpendicular to field lines	B1
	(gravitational) force perpendicular to velocity causes centripetal <u>acceleration</u>	B1
1(c)(i)	$T = 24$ hours	C1
	$a = r\omega^2$ and $\omega = 2\pi / T$ or $a = v^2 / r$ and $v = 2\pi r / T$ or $a = 4\pi^2 r / T^2$	C1
	$a = (4\pi^2 \times 6.4 \times 10^6) / (24 \times 60 \times 60)^2$ $= 0.034 \text{ m s}^{-2}$	A1
1(c)(ii)	identification of the two forces acting on the object as gravitational force and (normal) contact force	M1
	gravitational force and normal contact force are in opposite directions, and their resultant causes the (centripetal) acceleration	A1

Question	Answer	Marks
1(a)	at least 4 straight radial lines to P 	B1
	all arrows pointing along the lines towards P	B1
1(b)	Any 2 from: gravitational force provides the centripetal force (centripetal or gravitational) force has constant magnitude (centripetal or gravitational) force is perpendicular to velocity (of moon) / direction of motion (of moon)	B2
1(c)(i)	$\frac{GMm}{r^2} = m\omega^2$	M1
	$M = \frac{r^3 \omega^2}{G}$ and gradient = $r^3 \omega^2$ hence $M = \frac{\text{gradient}}{G}$ or $r^3 = GM \times 1/\omega^2$ so gradient = GM hence $M = \frac{\text{gradient}}{G}$	A1
1(c)(ii)	$M = 4.1 \times 10^{23} / (6.0 \times 10^7 \times 6.67 \times 10^{-11}) = 1.0 \times 10^{26} \text{ kg}$	B1

Question	Answer	Marks
1(c)(iii)	$\frac{GMm}{r^2} = \frac{mv^2}{r}$	C1
	$\frac{GM}{r} = v^2$	
	$v^2 = \frac{6.67 \times 10^{-11} \times 1.0 \times 10^{26}}{1.2 \times 10^8}$	C1
	$v^2 = 5.6 \times 10^7 \text{ m s}^{-1}$	
	$v = 7500 \text{ m s}^{-1}$	A1