

| Question | Answer                                                                                                                                                                                                                                                 | Marks |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 1(a)     | at least 4 straight radial lines to P<br>                                                                                                                             | B1    |
|          | all arrows pointing along the lines towards P                                                                                                                                                                                                          | B1    |
| 1(b)     | <b>Any 2 from:</b><br>gravitational force provides the centripetal force<br>(centripetal or gravitational) force has constant magnitude<br>(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 $M = \frac{\text{gradient}}{G}$<br>or<br>$r^3 = GM \times 1/\omega^2$ 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    |

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|-----------|--------------------------------------------------------------------------------|-------|
| 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    |