<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>15(a)</td><td>One pair of readings taken from graph (1)

2 pairs of readings taken from graph (1)

Attempt to show that gr^2 is constant (1)

OR
Use of $F = \frac{GMm}{r^2}$ with $F = mg$ (1)

Algebra to show that $g = \frac{GM}{r^2}$ (1)

Statement that GM is constant (1)

<u>Example of calculation</u>
<table><tr><th>g / N kg^{-1}</th><th>r / R_E</th><th>$g r^2$ / N kg^{-1} R_E^2</th></tr><tr><td>8.0</td><td>1.1</td><td>9.7</td></tr><tr><td>5.0</td><td>1.4</td><td>9.8</td></tr><tr><td>2.0</td><td>2.2</td><td>9.7</td></tr><tr><td colspan="3"></td></tr><tr><td>9.8</td><td>1.0</td><td>9.8</td></tr><tr><td>2.4</td><td>2.0</td><td>9.6</td></tr><tr><td>0.6</td><td>4.0</td><td>9.6</td></tr></table></td><td>3</td></tr>
<tr><td>15(b)(i)</td><td>(The graph shows) g is not constant (from the surface of the Earth to height of $5R_E$)
Or the gravitational field is not uniform over this distance (1)</td><td>1</td></tr>
<tr><td>15(b)(ii)</td><td>Use of $V_{grav} = -\frac{GM}{r}$ (1)

Use of $\Delta E_{grav} = m\,\Delta V_{grav}$ (1)

$\therefore \Delta E_{grav} = 1.8 \times 10^{11}$ J (1)

<u>Example of calculation</u>

$\Delta V_{grav} = \frac{GM}{R_E} - \frac{GM}{6R_E}$

$\therefore \Delta V_{grav} = \frac{6.67 \times 10^{-11}\text{N m}^2\text{ kg}^{-2} \times 6.0 \times 10^{24}\text{kg}}{6.4 \times 10^{6}\text{m}}\left(1 - \frac{1}{6}\right) = 5.2 \times 10^{7}\text{ J kg}^{-1}$

$\therefore \Delta E_{grav} = 3.5 \times 10^{3}\text{kg} \times 5.2 \times 10^{7}\text{ J kg}^{-1} = 1.82 \times 10^{11}$ J</td><td>3</td></tr>
<tr><td></td><td>Total for question 15</td><td>7</td></tr>
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