

Question Number	Answer	Mark
<b>12(a)(i)</b>	<p>Use of <math>v = H_0 d</math> (1)</p> <p><math>H_0 = 2.33 \times 10^{-1} \text{ (s}^{-1}\text{)}</math> (1)</p> <p><u>Example of calculation</u></p> $H_0 = \frac{72 \times 10^3 \text{ m s}^{-1}}{3.09 \times 10^{22} \text{ m}} = 2.33 \times 10^{-18} \text{ s}^{-1}$	<b>2</b>
<b>12(a)(ii)</b>	<p>Use of <math>t = \frac{1}{H_0}</math> (1)</p> <p><math>t = 1.36 \times 10^{10} \text{ (years)}</math> ecf from (i) (1)</p> <p><u>Example of calculation</u></p> $t = \frac{1}{2.33 \times 10^{-1} \text{ s}^{-1}} = 4.29 \times 10^{17} \text{ s}$ $t = \frac{4.29 \times 10^{17} \text{ s}}{3.16 \times 10^7 \text{ s year}^{-1}} = 1.36 \times 10^{10} \text{ years}$	<b>2</b>
<b>12(b)</b>	<p><math>H_0</math> is halved (for the same recessional velocity) (1)</p> <p>So the (calculated) age of the universe doubles (dependent upon MP1) (1)</p> <p><b>OR</b></p> <p>The universe would have taken twice as long to expand to its current size (assuming it expanded at the same rate) (1)</p> <p>So the age of the universe is double what was previously thought (dependent upon MP1) (1)</p> <p>Allow 1 mark max for <math>H_0</math> is lower so universe is older than previously thought  <b>Or</b> universe would have taken longer to expand to current size so it is older than previously thought.</p>	<b>2</b>
<b>Total for question 12</b>		<b>6</b>