12 The 'escape velocity' is the minimum speed needed for an object to escape from the gravitational field of a planet.

An object travelling at the escape velocity has a kinetic energy equal to the magnitude of its gravitational potential energy at the surface of the planet.

(a) Show that the escape velocity v for a planet of mass M and radius r is given by the expression

$$v = \sqrt{\frac{2GM}{r}}$$

(2)

(b) (i) Show that the escape velocity for a mass at the Earth's surface is about $1.1 \times 10^4\,\text{m s}^{-1}$.

mass of Earth = 5.98×10^{24} kg
radius of Earth = 6.36×10^6 m

(2)

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(ii) When the Earth formed, a large proportion of the gas in the Earth's atmosphere was hydrogen.

Explain why hydrogen gas is no longer a large proportion of the gas in the Earth's atmosphere. No further calculation is necessary.

at 20 °C, $\sqrt{\langle c^2 \rangle} = 1900\,\text{m s}^{-1}$ for hydrogen

(2)

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(Total for Question 12 = 6 marks)