[2]

(d) Suggest a method to reduce the percentage uncertainty of R calculated in **(a)**.

……..

…… [1]

2 The planet Mars has a radius of 3390 km. **Fig. 2.1** below shows the variation with the distance r from the centre of this planet, of the gravitational potential ϕ near it.

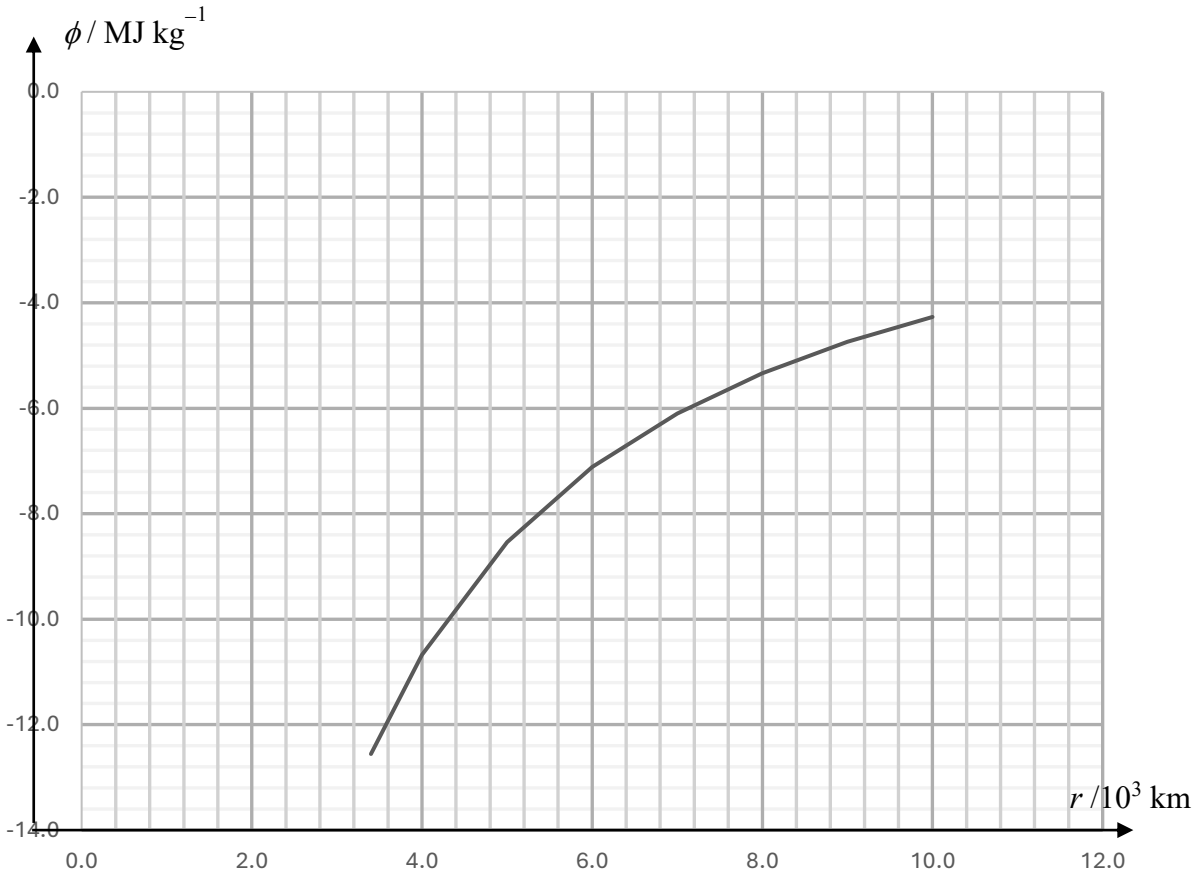

Fig 2.1

(a) Explain why gravitational potential has a negative value.

……..

……..

……..

…… [2]

(b) **(i)** On **Fig. 2.1** draw a tangent to the graph at r = 6000 km.

The gradient of this tangent is the magnitude of a vector quantity. State what this physical quantity is.

…… [1]

(ii) Calculate the gradient of this tangent and hence state the magnitude of the physical quantity that you have identified in **(b)(i)**, together with its S.I. unit.

Magnitude and unit =…… ……[3]

(c) The Perseverance rover is a car sized Mars rover designed to explore the Jezero crater on Mars as part of NASA's Mars 2020 mission. The landing craft, initially at rest 6000 km from the centre of the planet, is released and accelerates towards the surface. Use **Fig. 2.1** to estimate the magnitude of the velocity of the landing just as it impacts the surface. Disregard atmospheric friction.

Magnitude of velocity = …… m s^{-1} [3]

(d) In order to safely land the rover without damage, suggest a mechanism/method that the landing craft can use to reduce the damage of impact.

……..

…… [1]