**2** This question pertains to objects moving in the Earth's gravitational field. Take radius of Earth to be $6.38 \times 10^6$ m and mass of Earth to be $6.0 \times 10^{24}$ kg.

**(a)** A small craft P is sent to space, fired from a giant cannon from Florida.

**(i)** Calculate the minimum speed needed for the craft to be projected vertically up to a height above the surface of Earth that is equal to the Earth's radius.

minimum speed = ……m $s^{-1}$ [2]

**(ii)** Another craft Q is launched with the *escape speed*, i.e., minimum speed needed to escape the Earth's gravitational field.

The variation with distance from surface of Earth, $x$, of the gravitational potential energy, $U$, of this craft as it approaches infinity is shown in Fig. 2.1.

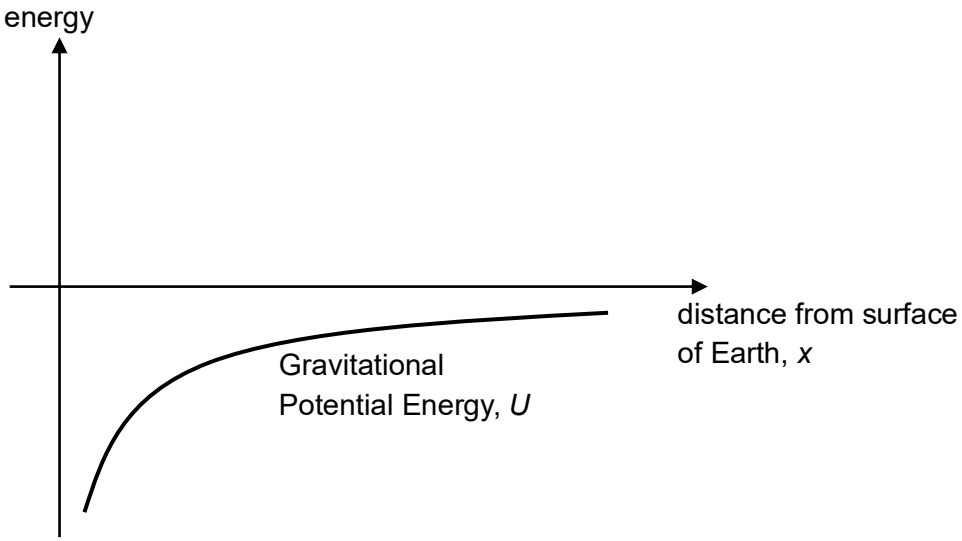


**Fig. 2.1**

**1.** By considering the total energy of the craft at infinity, state the value of total energy *T*, of craft Q at any part of its path towards infinity.

*T* = …… J [1]

**2.** Hence, on the axis of Fig. 2.1, sketch a graph to show how the kinetic energy *K* of craft Q varies with the distance from the surface of the Earth. Label this graph clearly as *K*.

[2]

**(b)** The ChinaSat 9 is a geostationary satellite of Earth that was launched to do relay broadcast of the 2008 Olympic Games.

**(i)** Taking the Earth to be a uniform sphere, determine the height *h* of the *geostationary* satellite from the Earth's surface.

height *h* = …….. m [3]

**(ii)** Calculate the velocity of the geostationary satellite.

velocity = …….. m $s^{-1}$ [2]

**(iii)** Calculate the total energy of the satellite given that its mass is 1000 kg.

total energy = …….. J [2]

**(iv)** Assuming that this satellite experiences friction in the outer space, state what would happen to the satellite's different types of energy.

……..……...

……..……... [1]

[Total: 13]