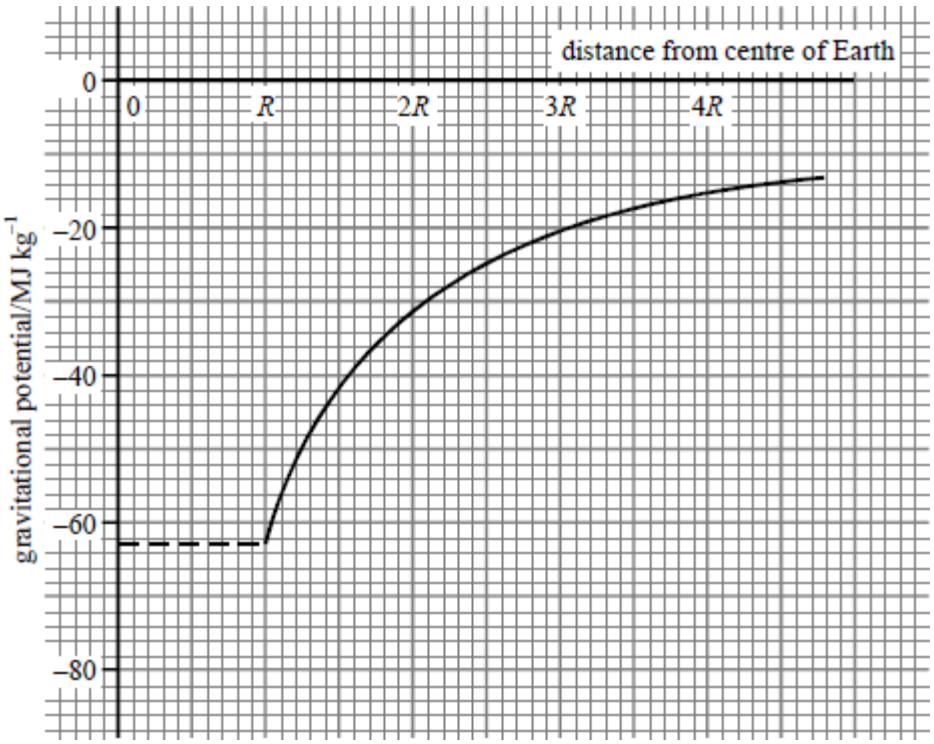
Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Q1.

(a) The graph shows how the gravitational potential varies with distance in the region above the surface of the Earth. R is the radius of the Earth, which is 6400 km. At the surface of the Earth, the gravitational potential is −62.5 MJ kg^{-1}.



Use the graph to calculate

(i) the gravitational potential at a distance $2R$ from the centre of the Earth,

_____

(ii) the increase in the potential energy of a 1200 kg satellite when it is raised from the surface of the Earth into a circular orbit of radius $3R$.

_____

_____

_____

(4)

(b) (i) Write down an equation which relates gravitational field strength and gravitational potential.

(ii) **By use of the graph** in part (a), calculate the gravitational field strength at a distance $2R$ from the centre of the Earth.

(iii) Show that your result for part (b)(ii) is consistent with the fact that the surface gravitational field strength is about 10 N kg^{-1}.

(5)

(Total 9 marks)

Q2.

The gravitational field strength at the surface of a planet, X, is 19 N kg^{-1}.

(a) (i) Calculate the gravitational potential difference between the surface of X and a point 10 m above the surface, if the gravitational field can be considered to be uniform over such a small distance.

(ii) Calculate the minimum amount of energy required to lift a 9.0 kg rock a vertical distance of 10 m from the surface of X.

(iii) State whether the minimum amount of energy you have found in part (ii) would be different if the 9.0 kg mass were lifted a vertical distance of 10 m from a point near the top of the highest mountain of planet X. Explain your answer.

(3)

(b) Calculate the gravitational field strength at the surface of another planet, Y, that has the same mass as planet X, but twice the diameter of X.

(2)
(Total 5 marks)

Q3.

(a) State, in words, Newton's law of gravitation.

(2)

(b) Some of the earliest attempts to determine the gravitational constant, G, were regarded as experiments to "weigh" the Earth. By considering the gravitational force acting on a mass at the surface of the Earth, regarded as a sphere of radius R, show that the mass of the Earth is given by

$$M = \frac{gR^2}{G},$$

where g is the value of the gravitational field strength at the Earth's surface.

(2)

(c) In the following calculation use these data.

radius of the Moon	$= 1.74 \times 10^6$ m
gravitational field strength at Moon's surface	$= 1.62$ N kg^{-1}
mass of the Earth M	$= 6.00 \times 10^{24}$ kg
gravitational constant G	$= 6.67 \times 10^{-11}$ N m^2 kg^{-2}

Calculate the mass of the Moon and express its mass as a percentage of the mass of the Earth.

_____

_____

_____

(3)

(Total 7 marks)