Name of the Student:_____
Max. Marks : 25 Marks **Time : 25 Minutes**

Q1.

Figure 1 shows (not to scale) three students, each of mass 50.0 kg, standing at different points on the Earth's surface. Student **A** is standing at the North Pole and student **B** is standing at the equator.

Figure 1

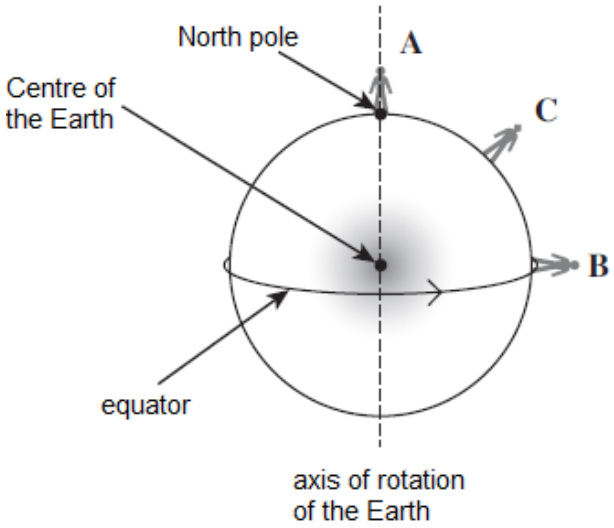
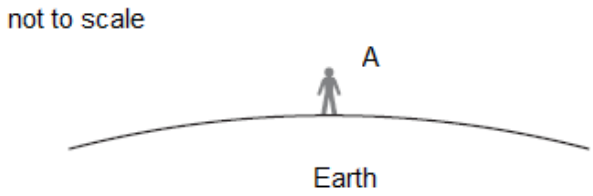


Figure 2



The radius of the Earth is 6370 km.
The mass of the Earth is 5.98×10^{24} kg.

In this question assume that the Earth is a perfect sphere.

(a) (i) Use Newton's gravitational law to calculate the gravitational force exerted by the Earth on a student.

force _____ N

(3)

(ii) **Figure 2** shows a closer view of student **A**.

Draw, on **Figure 2**, vector arrows that represent the forces acting on student **A**.

(2)

(b) (i) Show that the linear speed of student **B** due to the rotation of the Earth is about 460 m s^{-1}.

(3)

(ii) Calculate the magnitude of the centripetal force required so that student **B** moves with the Earth at the rotational speed of 460 m s^{-1}.

magnitude of the force _____ N

(2)

(iii) Show, on **Figure 1**, an arrow showing the direction of the centripetal force acting on student **C**.

(1)

(c) Student **B** stands on a bathroom scale calibrated to measure weight in newton (N). If the Earth were not rotating, the weight recorded would be equal to the force calculated in part (a)(i).

State and explain how the rotation of the Earth affects the reading on the bathroom scale for student **B**.

_____

_____

_____

_____

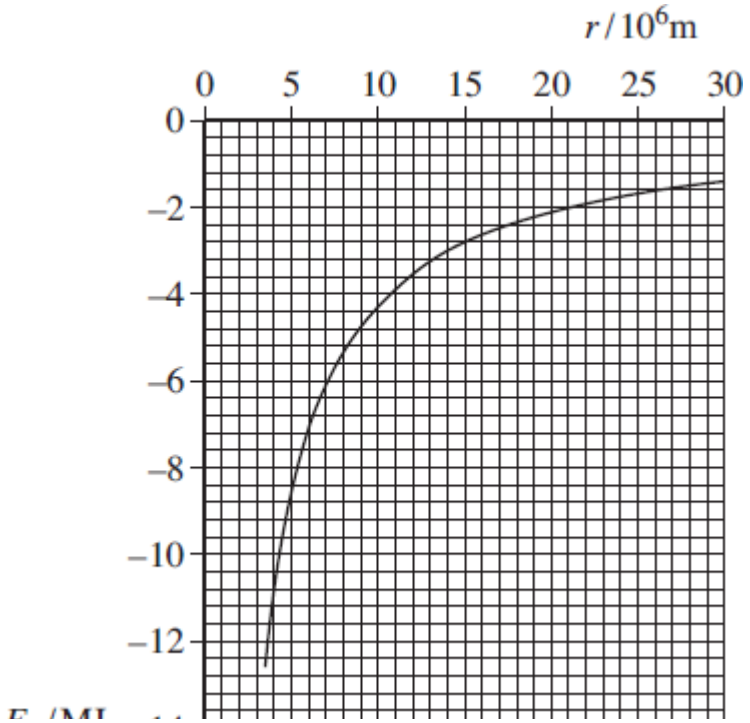
_____

(3)

(Total 14 marks)

Q2.

The graph below shows how the gravitational potential energy, E_p, of a 1.0 kg mass varies with distance, r, from the centre of Mars. The graph is plotted for positions above the surface of Mars.



(a) Explain why the values of E_p are negative.

_____

_____

_____

_____

_____

(2)

(b) Use data from the graph to determine the mass of Mars.

mass of Mars _____ kg

(3)

(c) Calculate the escape velocity for an object on the surface of Mars.

escape velocity _____ m s^{-1}

(3)

(d) Show that the graph data agree with $E_p \propto \frac{1}{r}$

(3)
(Total 11 marks)