

Name of the Student: _____

Max. Marks : 24 Marks

Time : 24 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

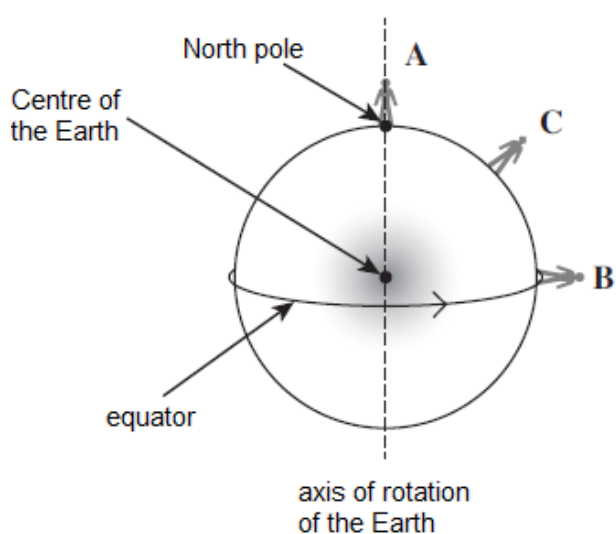
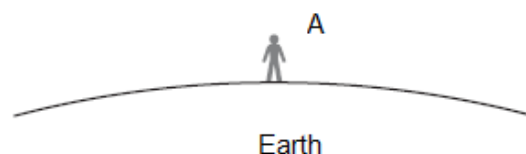


Figure 2

not to scale



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.

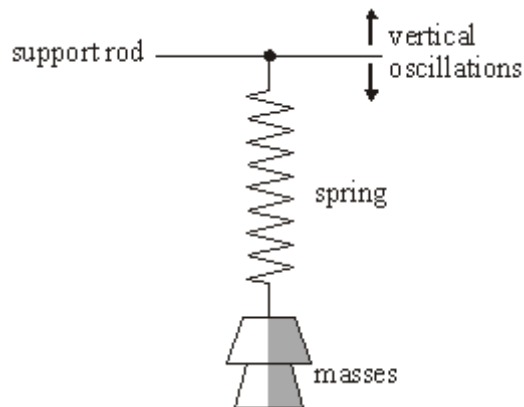
- (a) A spring, which hangs from a fixed support, extends by 40 mm when a mass of 0.25 kg is suspended from it.

- (i) Calculate the spring constant of the spring.

- (ii) An additional mass of 0.44 kg is then placed on the spring and the system is set into vertical oscillation. Show that the oscillation frequency is 1.5 Hz.

(4)

- (b) With both masses still in place, the spring is now suspended from a horizontal support rod that can be made to oscillate vertically, as shown in the figure below, with amplitude 30 mm at several different frequencies.



Describe fully, with reference to amplitude, frequency and phase, the motion of the masses suspended from the spring in each of the following cases.

- (i) The support rod oscillates at a frequency of 0.2 Hz.

- (ii) The support rod oscillates at a frequency of 1.5 Hz.

(iii) The support rod oscillates at a frequency of 10 Hz.

(6)

(Total 10 marks)