8 **(a)** The Earth may be assumed to be a uniform sphere of radius of 6370 km and mass of 5.98×10^{24} kg. An object of mass 1.00 kg is placed on the Equator.

Calculate

(i) the centripetal acceleration of the object,

centripetal acceleration = ... m s^{-2} [2]

(ii) the gravitational force exerted on the object by the Earth.

gravitational force = ... N [2]

(b) The object in **(a)** is suspended from a spring balance fixed to the ceiling of a laboratory, as shown in Fig. 8.1. There are two forces acting on the object, namely the gravitational force $\boldsymbol{F_G}$ by the Earth and the support force $\boldsymbol{F_s}$ by the spring.

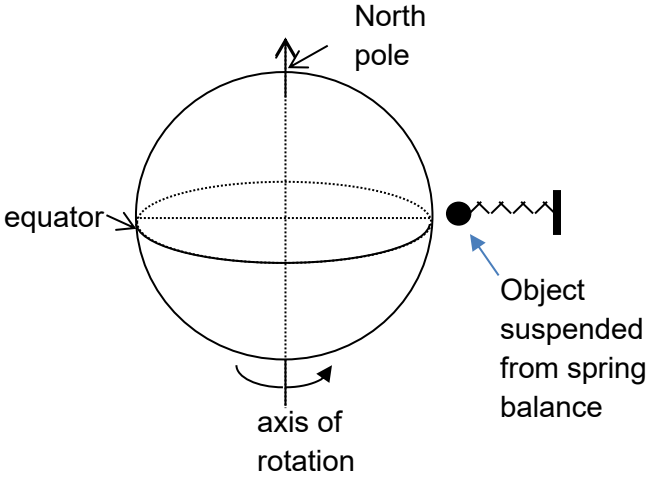


Fig. 8.1

(i) Draw a labelled force diagram to show the forces on the object.

[2]

(ii) Using your answers to **(a)(i)** and **(a)(ii)**, calculate the magnitude of F_s.

F_s = ... N [2]

(iii) A student, situated at the Equator, releases a ball from rest in a vacuum and measures its acceleration towards the Earth's surface. He then states that this acceleration is 'the acceleration due to gravity'.

Comment on his statement.

.....

.....

.....

..... [2]

(c) An elastic rope is attached to a man on one end and to a bridge on the other end. The man has a mass of 80.0 kg while the rope has a natural length of 25.0 m and an elastic constant of 120 N m^{-1}. The man steps off the bridge and falls vertically downwards from rest. Assume that air resistance acting on the man is negligible.

(i) Explain why the person has maximum speed when the tension in the elastic rope is equal to his weight.

……

……

……

……

……

…… [2]

(ii) Determine the maximum speed of the man after he steps off the bridge.

maximum speed = …… m s^{-1} [3]

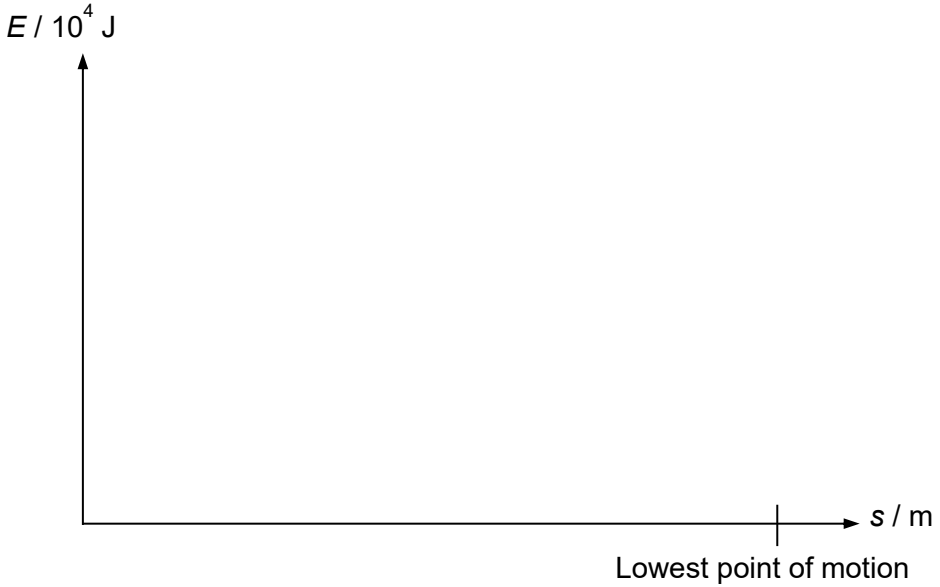
(iii) Calculate the extension of the elastic rope when the man is at the lowest point of his motion.

extension = …… m [2]

(iv) Sketch on Fig. 8.2 three well-labelled graphs for the variation with downward displacement *s* of

1. the gravitational potential energy of the man, (Label as **G**)
2. the elastic potential energy stored in the rope and (Label as **E**)
3. the kinetic energy of the man. (Label as **K**)

Assume that gravitational potential energy of the man is zero at the lowest point of the man's motion. Take *s* = 0 m as the start point of motion.



[3]

Fig. 8.2

[Total: 20]