16 The photograph shows an example of a Foucault pendulum.

This is a pendulum that consists of a massive sphere, suspended by a long wire from a high ceiling. Over time the vertical plane through which the pendulum swings appears to rotate because of the rotation of the Earth.

mass of sphere = 28.0 kg

(a) The pendulum makes 8 complete oscillations in 52.2 s.

Show that the length of the wire supporting the sphere is about 10 m.

diameter of sphere = 60.0 cm

(4)

(b) During refurbishment, the pendulum is taken down and the wire is replaced.

Steel wires of the following diameters are available:

0.71 mm 0.91 mm 1.22 mm 1.63 mm 2.03 mm

(i) Explain which of these wires is the thinnest that could be used to support the sphere safely.

breaking stress of steel = 3.10×10^8 N m^{-2}

(3)

(ii) The wire identified in part (i) is used for the pendulum, the unstretched length of the new wire is 11.2 m.

Calculate the extension of the new wire when the sphere is attached.

Young Modulus for steel = 200 GPa

(3)

Extension = ...

(c) To show the rotation of the Earth, the pendulum needs to oscillate for several hours.

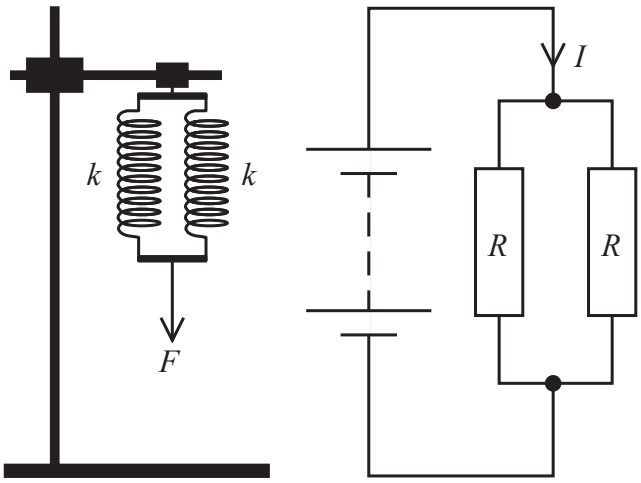
Explain how using a heavy sphere is better than using a light sphere of the same diameter.

(3)

(Total for Question 16 = 13 marks)

6 A student is experimenting with different combinations of springs and recalls that in physics it is often possible to model different physical situations in similar ways.

The student suggests that a parallel combination of springs could be a model for a parallel combination of resistors in a circuit.



(a) Derive an expression for the effective resistance R_{eff} of two resistors R_1 and R_2 connected in parallel in a circuit.

(3)

(b) Assess the validity of the student's suggestion by considering the effective stiffness of two identical springs in parallel.

(6)

(Total for Question 6 = 9 marks)