

**1** A student wants to carry out an experiment to determine the input power to a small electric motor without using electrical meters. The motor is used to lift light loads. The efficiency of the motor is 15%. Describe how this student can determine the input power to the motor. Your description should include:

- the measurements taken
- the instruments used to take the measurements
- how the measurements are used to determine the input power to the



motor. *In your answer, you should use appropriate technical terms, spelled*

..... *correctly.*

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**(b)** The global positioning system (GPS) is used to locate accurately the position of cars on the Earth's surface.

**(i)** Name the electromagnetic waves used by GPS.

..... **[1]**

**(ii)** Explain how GPS determines the distance between the car and satellite.

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..... **[2]**

**(iii)** Briefly describe how the distances from two or more satellites are used to locate the position of a car.

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..... **[2]**

**[Total: 12]**

**3** You are provided with a small bottle of cooking oil and standard physics laboratory equipment. With the help of a **labelled** diagram, describe an electrical experiment to determine the specific heat capacity  $c$  of the oil.

State **two** sources of uncertainty in your measurements and discuss how these could be reduced.



*In your answer, you should use appropriate technical terms spelled correctly.*

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[Total: 6]

- 4 (a) Fig. 2.1 shows a mass attached to the end of a spring. The mass is pulled down and then released. The mass performs vertical simple harmonic motion.

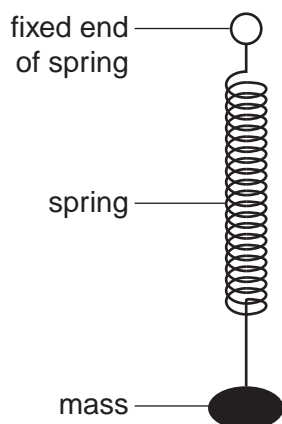


Fig. 2.1

- (i) Define *simple harmonic motion*.

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- (ii) Mark the following statements about the oscillating mass-spring system as *true* or *false*. [2]

statement	true/false
The period of oscillation is constant.	
The net force on the mass is equal to its weight.	
The acceleration of the mass is a maximum at the mid-point of the oscillations.	
The velocity of the mass is proportional to the displacement.	







(c) The radius of a  ${}_{92}^{235}\text{U}$  nucleus is  $8.8 \times 10^{-15}\text{m}$ . The average mass of a nucleon is  $1.7 \times 10^{-27}\text{kg}$ .

(i) Estimate the average density of this nucleus.

density = .....  $\text{kgm}^{-3}$  [3]

(ii) State one assumption made in your calculation.

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[Total: 14]

- 6 Fig. 4.1 shows slotted masses suspended from a spring. The spring is attached to a fixed support at its upper end.

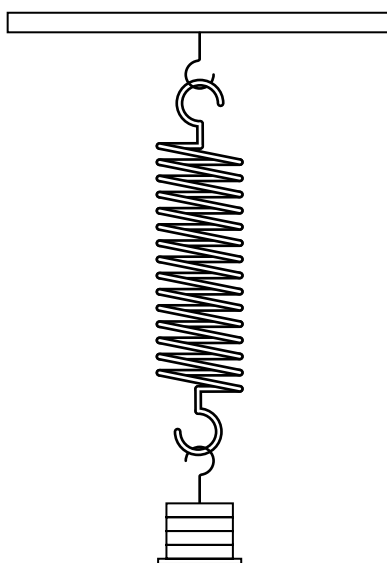


Fig. 4.1

When the masses are pulled down a short distance from the equilibrium position and released they oscillate vertically with simple harmonic motion. The frequency  $f$  of these oscillations depends on the mass  $m$  of the masses.

Two students make different predictions about the relationship between  $f$  and  $m$ .

One suggests  $f$  is proportional to  $1/m$  and the other believes  $f$  is proportional to  $1/\sqrt{m}$ .

- (a) Describe how you would test experimentally which prediction is correct.

Include in your answer:

- the measurements you would take, and
- how you would use these measurements to test each prediction.

You should also discuss ways of making the test as reliable as possible.

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**(b)** When the masses hanging on the spring are 400 g in total, they oscillate with an amplitude of 36 mm and a period of 1.2 s. Calculate

**(i)** the maximum kinetic energy of the masses

maximum kinetic energy = ..... J [3]

**(ii)** the maximum acceleration of the masses.

maximum acceleration = .....  $\text{ms}^{-2}$  [2]

- (c) List the different types of energy involved in the oscillations of this mass-spring system. Describe the energy changes when the masses move from the lowest point of the oscillation to the highest point.



*In your answer you should use appropriate technical terms spelled correctly.*

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**[Total: 13]**