SMART EXAM RESOURCES
0654 COORDINATED SCIENCES
PHYSICS
FORCES-SET-4-QP-MS

1 A student uses two different methods to measure the spring constant k of a spring.

The spring constant k of a spring is a measure of the stiffness of the spring.

(a) Method 1

- She measures the unstretched length of the spring.

Fig. 5.1 shows a full-scale diagram of the unstretched spring.

unstretched spring

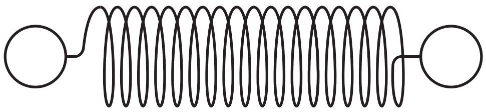

Fig. 5.1

Measure the unstretched length l_0 of the spring to the nearest 0.1 cm.

Do **not** include the loops at the end of the spring in your measurement.

l_0 = ... cm [1]

(b)
- She attaches the spring to a clamp.
- She suspends a 200 g mass on the spring as shown in Fig. 5.2.

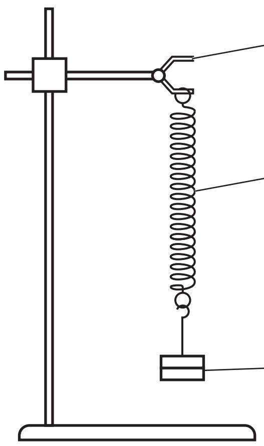

Fig. 5.2 (not to scale)

Fig. 5.3 shows a full-scale diagram of the stretched spring.

spring stretched by 200 g mass

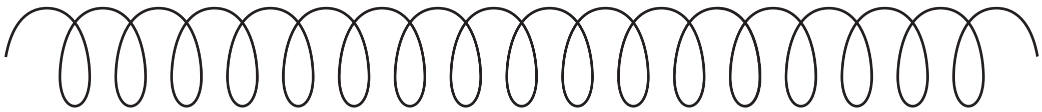

Fig. 5.3

Measure the new length l_1 of the spring to the nearest 0.1 cm.

l_1 = ... cm

Calculate the extension *e* of the spring produced by the mass. Use the equation shown.

$$e = l_1 - l_0$$

e = ... cm [1]

(c) Calculate the spring constant *k* of the spring. Use the equation shown.

$$k = \frac{2}{e}$$

k = ... N / cm [1]

(d) **Method 2**

- She pulls the mass down a small distance and releases it.

The mass oscillates up and down.

The period *T* of the oscillations is the time taken for **one** oscillation.

- She measures the time *t* taken for 20 oscillations.
- She records this time in Table 5.1.

Fig. 5.4 shows the reading of the stop-watch.

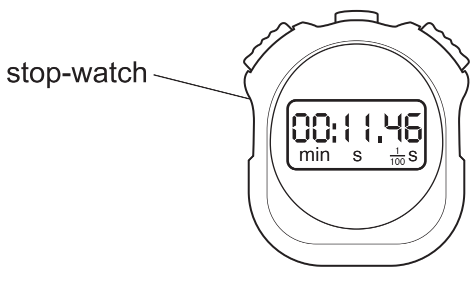

Fig. 5.4

Record the time t for 20 oscillations in Table 5.1 to one decimal place. [1]

Table 5.1

mass m / g	time t for 20 oscillations / s	period T / s	T^2 / s^2
200			

(e) **(i)** Calculate the period T, the time for **one** oscillation.

Record your answer in Table 5.1. [1]

(ii) Calculate the value of T^2.

Record your answer in Table 5.1. [1]

(f) Use the results in Table 5.1 to calculate the spring constant k of the spring.

Use the equation shown.

$$k = \frac{0.08}{T^2}$$

k = ... N/cm [1]

(g) Compare your values of k from **(c)** and **(f)**. State whether they agree within the limits of experimental error.

Explain your answer.

....

.... [1]

(h) It is important to avoid line-of-sight (parallax) errors when measuring the length of the spring.

Describe how the student avoids this error.

....

.... [1]

(i) Explain why timing 20 oscillations gives a more accurate value for the period T than timing a smaller number of oscillations.

....

.... [1]

[Total: 10]

MARKSCHEME:

Question	Answer	Marks
(a)	4.7 (cm) ;	**1**
(b)	13.7 **AND** 9(.0) (cm) ;	**1**
(c)	0.22 (N / cm) ;	**1**
5(d)	11.5 (s) ;	**1**
(e)(i)	0.575 (s) ;	**1**
(e)(ii)	0.33 (s^2) ;	**1**
(f)	0.24(2) (N / m) ;	**1**
(g)	expect YES and values are the same / very close / not too far apart / <10% difference etc. ;	**1**
(h)	view perpendicular **to scale** / rule close to spring / use a fiducial aid;	**1**
(i)	reduces the effect of reaction time errors **ora** ;	**1**

2 A student investigates how the extension of a spring depends upon the original length of the spring.

Plan an experiment to investigate how the extension of a spring depends upon its original length.

The apparatus available is listed:
- 30 cm rule graduated in millimetres
- boss, clamp and stand
- set of four 100 g masses and a 100 g mass hanger
- selection of springs of different lengths.

  The selection includes springs of different diameters and made of different materials.

You **must** select apparatus for your experiment from the list above. You may **not** use any other apparatus.

You should:
- explain briefly how you would carry out the experiment
- state the key variables you would control
- draw a table with column headings to show how you would present your results (you are **not** required to enter any readings in the table)
- explain how you would use your readings to reach a conclusion.

....

....

....

....

....

....

....

....

....

....

[7]

MARKSCHEME:

One mark from each section and any other 2 marks. **If one section missed max 6 etc.** **method**: measure initial length of spring ; (suspend) spring and hang load ; measure new length ; repeat with a spring of different length ; **key variables** diameter / width of spring ; same material ; same mass ; **accuracy and processing** check length doesn't change after taking off the mass ; calculate extension = new length – original length ; repeat for each and average for each spring ; plot length / extension graphs ; **table**: headings: (mass) length of spring at start, length after mass added ; (extension) cm / mm ; **conclusion**: (compare extensions for different lengths) look to see if longer springs give longer / shorter extensions look for relationship / trend **on graph** ;	

3 A student investigates the force needed to make objects move.

When the force **P** pulling an object is greater than the force **F** resisting the pull, the block moves as shown in Fig. 6.1.

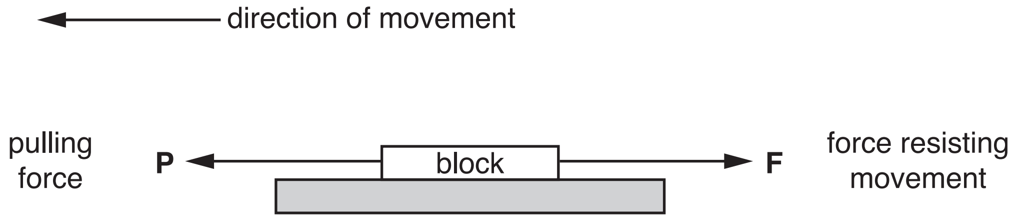

Fig. 6.1

(a) The student places a block onto a surface, attaches a newton meter and measures the force needed to make the block just move, as shown in Fig. 6.2.

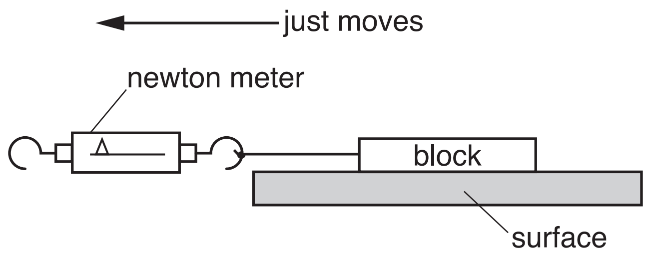

Fig. 6.2

She uses blocks of the same size.

She varies the material of the block and the surface that it sits on.

She records her results in Table 6.1.

Table 6.1

test number	block	surface	pulling force / N
1	brick	carpet	20.8
2	aluminium	glass	3.8
3	wood	wood	5.8
4	brick	glass	
5	aluminium	sand	
6	brick	wood	17.5
7	wood	sand	15.6
8	brick	sand	21.6

(i) The newton meter readings for two of her tests are shown in Fig. 6.3.

Read the values and record them in Table 6.1.

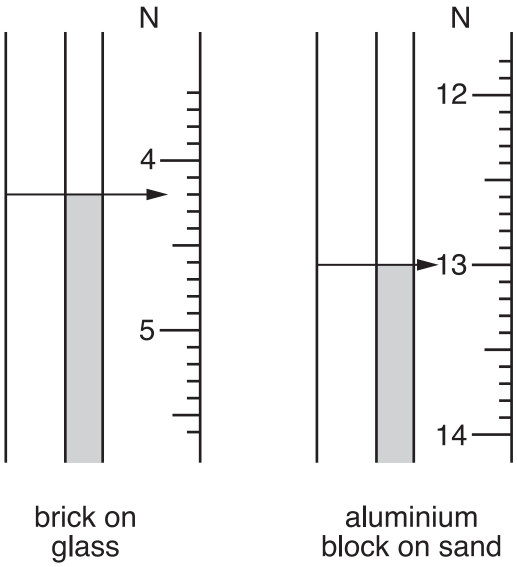

Fig. 6.3

[2]

(ii) The student wants to place all the surfaces she used in order of resistance to movement (friction).

Suggest which test results she should use and explain your choice.

test numbers ....

explanation ....

....
[3]

(iii) Place the surfaces in order of resistance to movement (friction).

most resistant to movement ....

....

....

least resistant to movement ....

[1]

(b) Explain why each test should have been repeated three times **and** the average pulling force calculated.

....

....[1]

(c) The student says that a road surface should be made of a material with a small resistance to movement so that a car uses less petrol.

The teacher says that this would be unsafe.

Explain the teacher's answer.

....

....[1]

(d) On some steep hills there are safety tracks (called escape lanes) at the side of the road, as shown in Fig. 6.4.

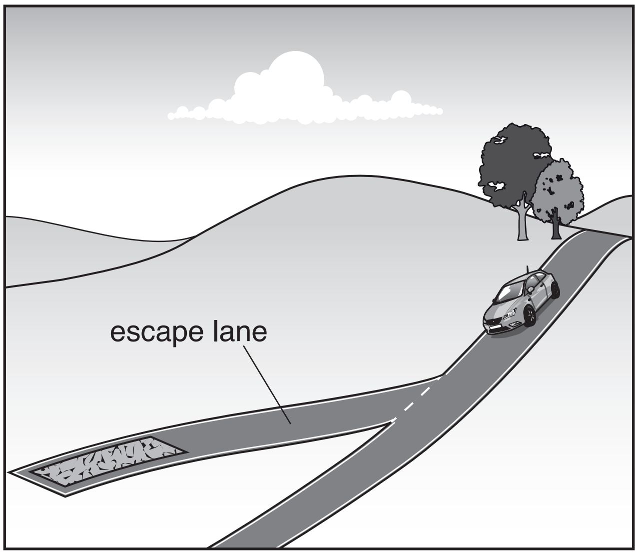

Fig. 6.4

If a car is going too fast and the driver cannot brake strongly enough to stop the car, then he can drive onto the escape lane. The escape lane slows down the car quickly and brings it to a stop.

Suggest a suitable material for the surface of the escape lane and explain your answer.

surface ....

explanation ....

....
[2]

(a)(i)	4.2 ; 13.0 ;	2
(a)(ii)	1,4,6,8 ; all use brick / same block ; all have different surfaces / all surfaces ;	3
(a)(iii)	sand carpet wood glass ;	1
(b)	difficult to judge the first pull / accuracy / minimise errors / lessens effects of anomalies AVP ;	1
(c)	would be difficult to stop / slip / slide etc. ;	1
(d)	sand / gravel / very rough tarmac ; high resistance to movement / would slow / stop car quickest / big(gest) resisting force / large(st) friction ;	2