Oxford Cambridge and RSA

Wednesday 18 May 2022 – Morning

AS Level Physics B (Advancing Physics)

H157/01 Foundations of physics

Time allowed: 1 hour 30 minutes

You must have:
- the Data, Formulae and Relationships Booklet

You can use:
- a scientific or graphical calculator
- a ruler (cm/mm)

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

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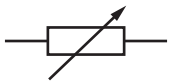
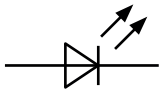
SECTION A

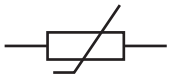
You should spend a maximum of 25 minutes on this section.

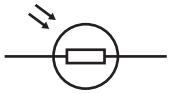
Answer **all** the questions.

1 Which is the correct circuit symbol for an LDR?

A 

B 

C 

D 

Your answer ☐

[1]

2 A rubber band is made from a polymer. At room temperature the polymer is:

A Flexible and tough

B Stiff and strong

C Strong and flexible

D Tough and stiff

Your answer ☐

[1]

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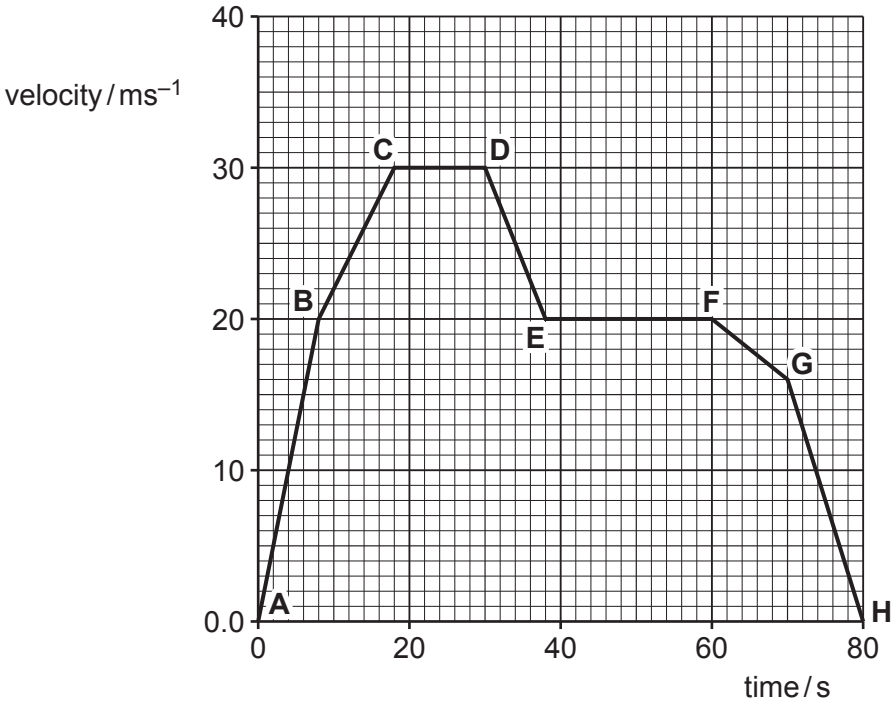
3 The graph below shows the journey of a car.

The points A to H represent the times when the car changes its speed.



Between which of the following points does the car accelerate at the greatest rate?

A A to B

B B to C

C D to E

D G to H

Your answer ☐

[1]

4 Which of the following is a unit of electrical power, equivalent to the watt?

A joule per second, J s^{-1}

B joule-second, J s

C volt-ampere-second, V A s

D volt per ampere, V A^{-1}

Your answer ☐

[1]

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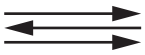
5 A diffraction grating has three slits. An intensity maximum is produced on a distant screen where the phase difference between light from successive slits is 2π radians.

Which phasor diagram correctly represents the constructive interference seen on the screen?

A 

B

C

D

Your answer ☐

[1]

6 Three identical resistors, each of resistance R, are connected in parallel.

The resistance of the combination is:

A $3R$

B $\frac{3}{R}$

C R^3

D $\frac{R}{3}$

Your answer ☐

[1]

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7 An appropriate unit for measuring temperature difference is the:

A ampere

B coulomb

C joule

D kelvin

Your answer ☐

[1]

8 The best estimate of the height of a two-storey house similar to the one shown in the diagram is:

A 2 m

B 5 m

C 10 m

D 20 m

Your answer ☐

[1]

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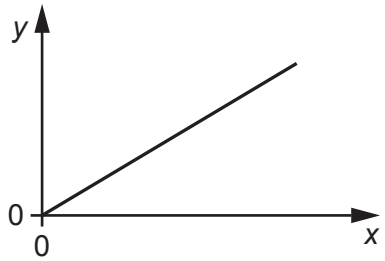
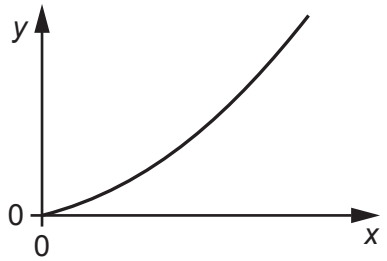
9 A large object falls vertically through the atmosphere. Which graph would be obtained by plotting:

- velocity of the object on the y-axis
- time on the x-axis?



A



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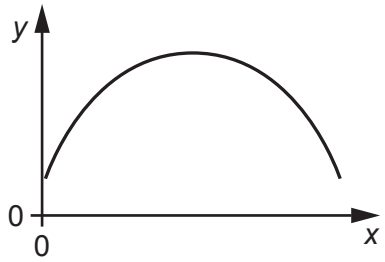
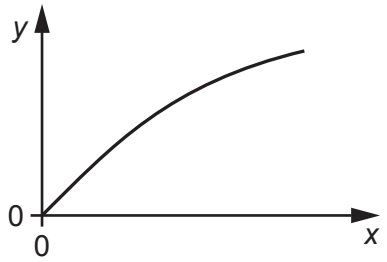


C



D

Your answer ☐

[1]

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10 From which of these can you determine the power of a thin converging lens?

A diameter

B focal length

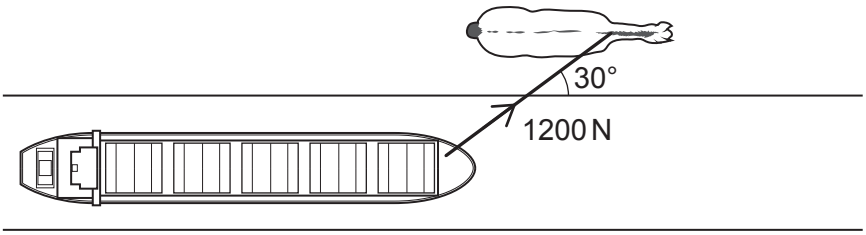
C image distance

D magnification

Your answer ☐

[1]

11 A horse is towing a barge along a straight canal.



What is the work done by the pulling force when the horse walks 5.0 m parallel to the canal?

A 120 J

B 210 J

C 3000 J

D 5200 J

Your answer ☐

[1]

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12 "The sum of the currents entering and leaving a junction are equal."

This statement results from the conservation of:

A charge

B current

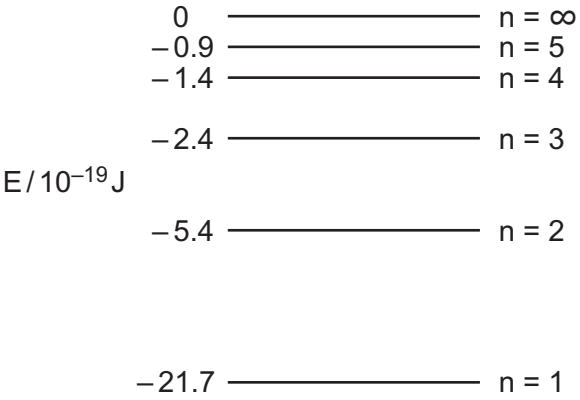
C energy

D momentum

Your answer ☐

[1]

13 The diagram shows the energy levels in an atom.



An electron absorbs a photon with energy 3.0×10^{-19} J.

Which transition could occur as a result?

A From n=2 to n=3

B From n=3 to n=2

C From n=3 to n=5

D From n=5 to n=3

Your answer ☐

[1]

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14 Which statement about the number density of mobile charge carriers in a material is correct?

A It depends on the amount of material.

B It depends on the current through the material.

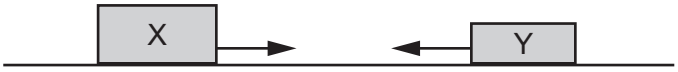
C It is higher in insulators than in metals.

D It is higher in metals than in semiconductors.

Your answer ☐

[1]

15 Two bodies, moving as represented in the diagram, collide and move off together.



mass of X = 2.0 kg
velocity of X = 3.0 m s^{-1}

mass of Y = 1.0 kg
velocity of Y = –3.0 m s^{-1}

What is the final velocity of X and Y as they move off together?

A –3 m s^{-1}

B –1 m s^{-1}

C 1 m s^{-1}

D 3 m s^{-1}

Your answer ☐

[1]

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16 Which of the statements about metals below is **not** correct?

A Metals contain more free electrons than insulators.

B Metals have a high breaking stress due to strong, directional bonds between metal ions.

C Some metals are ductile due to the presence of mobile dislocations.

D The resistance of metals increases with temperature, because the vibration of the ionic lattice increases.

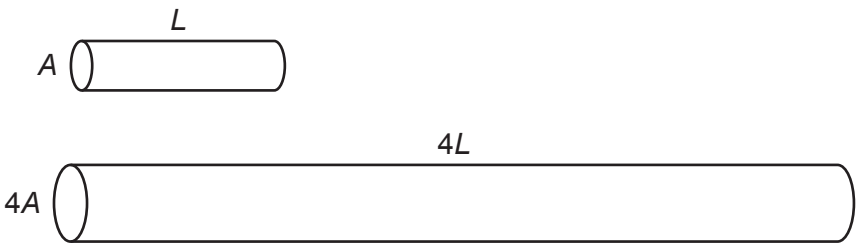
Your answer ☐

[1]

17 A metal wire has cross-sectional area A, and length L.

Another wire is made from the same material with cross-sectional area $4A$, and length $4L$.

Both wires are loaded with the same force applied to the ends.



The ratio $\frac{\text{strain on first wire}}{\text{strain on second wire}}$ is:

A $\frac{1}{4}$

B 1

C 4

D 16

Your answer ☐

[1]

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18 A signal is received with a signal-to-noise ratio of 7.5.

Which is the best choice of the number of bits used to sample this signal?

A 2

B 3

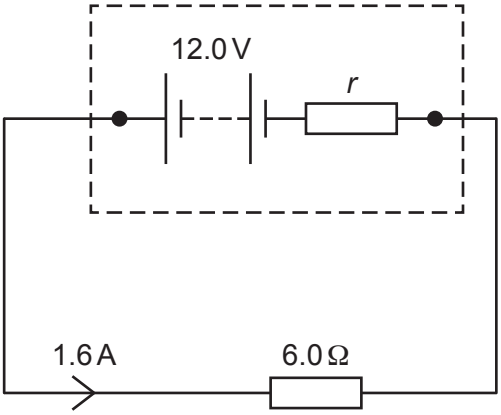
C 7

D 8

Your answer ☐

[1]

19 The diagram shows a circuit with a battery that has internal resistance *r* and EMF of 12.0 V.



The value of the internal resistance *r* is:

A 1.25 Ω

B 1.50 Ω

C 2.40 Ω

D 21.6 Ω

Your answer ☐

[1]

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20 A student makes two measurements to determine the speed of a trolley rolling down a ramp.

Measurement	**Measuring device**	**Value**	**Uncertainty**
Length of ramp	metre ruler	2.42 m	± 0.01 m
Time taken	stopwatch	7.48 s	± 0.25 s

The best estimate of the percentage uncertainty in the average speed of the trolley is:

A 3.76%

B 4%

C 24.0%

D 26%

Your answer ☐

[1]

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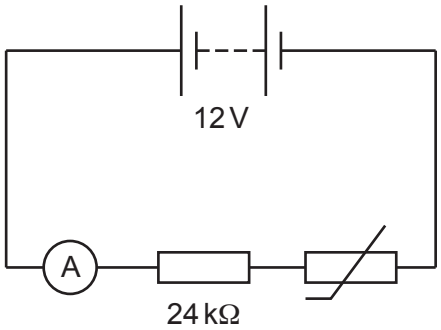
SECTION B

Answer **all** the questions.

21 A thermistor is used as a temperature sensor in the circuit shown below.



(a) Name the SI unit of electric current.

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

(b) At the start, the resistance of the thermistor is 36 kΩ.

Calculate the reading on the meter.

reading = ... mA **[2]**

(c) For the thermistor used in this circuit, the resistance increases as the temperature decreases.

Explain what happens to the reading on the ammeter if the temperature of the thermistor increases.

.....

.....

.....

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

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22 **Fig. 22a** shows a kite being flown in the wind. **Fig. 22b** shows a free-body diagram for the kite.

The kite is in equilibrium.

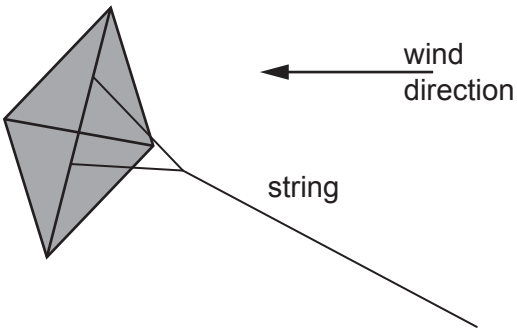

Fig. 22a

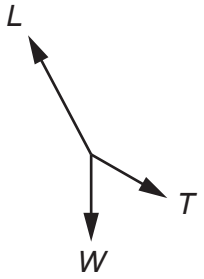

Fig. 22b

The weight of the kite, *W*, is 5.0 N.

The tension in the string, *T*, has a vertical component of 1.5 N.

(a) What is the magnitude of the vertical component of the lift force, *L*?

magnitude of *L* = ... N **[1]**

(b) The horizontal component of the tension is 5.8 N.

Calculate the magnitude of the tension.

tension *T* = ... N **[2]**

The wind changes such that the direction of force *L* becomes closer to vertical and its magnitude increases.

(c) Describe the changes in tension needed to keep the kite in equilibrium.

.....

.....

.....

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

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23 **Fig. 23** shows an experiment to estimate the size of an oil molecule.

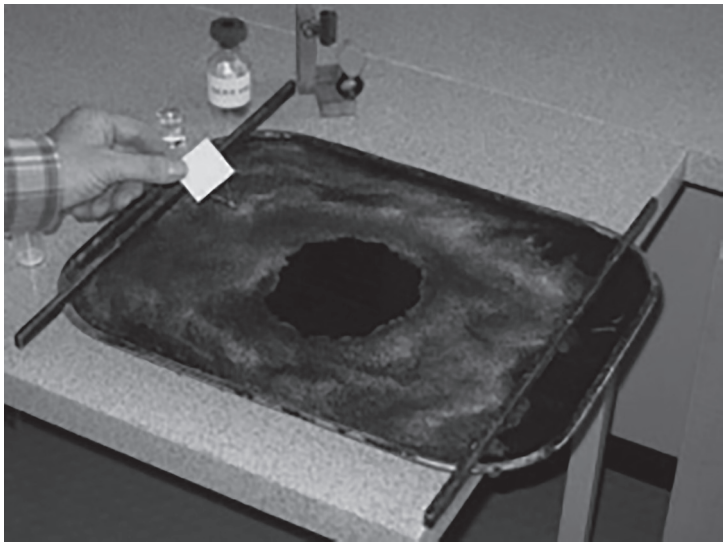

Fig. 23

One drop of oil is placed onto water dusted with powder.

The oil spreads out into a circular patch of uniform thickness.

(a) Sketch the relationship between the radius of the patch and its thickness as it spreads.

[2]

The patch spreads out until its thickness can be assumed to be the size of one molecule.

(b) Calculate an approximate size of an oil molecule in metres.

oil drop volume = 0.05 mm^3

patch radius = 20 cm

size of molecule = ... m **[3]**

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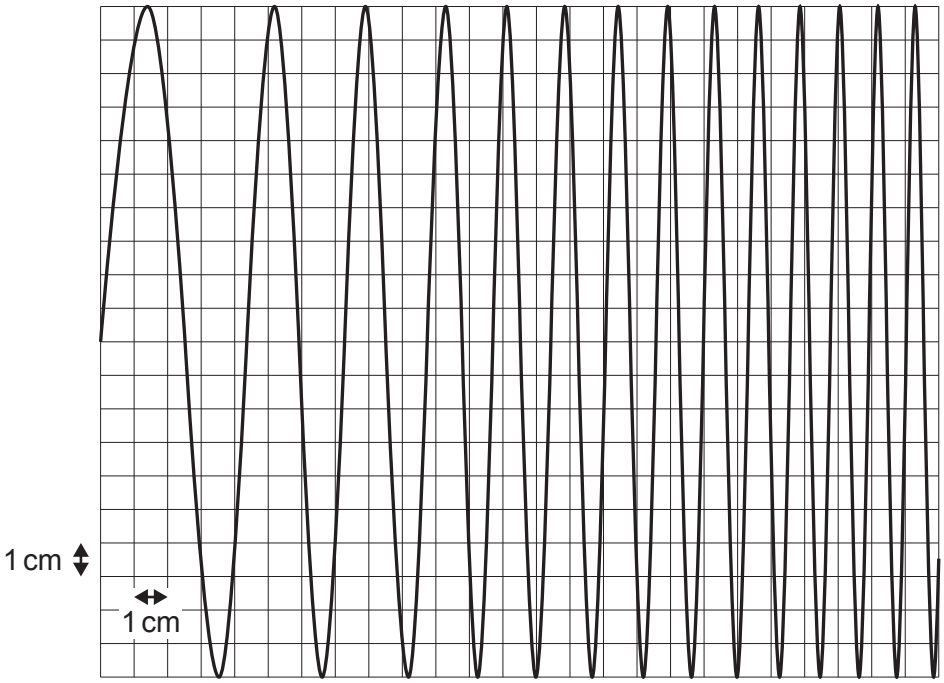
24 The diagram shows an oscilloscope trace of the output p.d. from a signal receiver.



(a) What is meant by the term **frequency**?

.....

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

(b) The voltage (y-) sensitivity of the oscilloscope is set to 25 mV cm^{-1}.

Calculate the amplitude of the signal.

amplitude = ... mV **[1]**

(c) The time base of the oscilloscope is set to 100 ms cm^{-1}.

(i) Estimate the frequency of the **first** cycle of the signal.

frequency = ... Hz **[2]**

(ii) Describe how the frequency of the signal changes over time.

.....

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

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Section C starts on page 18

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SECTION C

Answer **all** the questions.

25 **Fig. 25a** shows an electron microscope image of flu virus particles. **Fig. 25b** is a drawing of one of these virus particles.

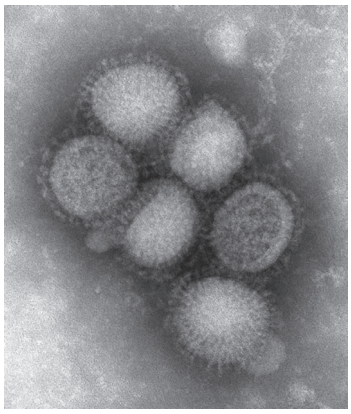

Fig. 25a

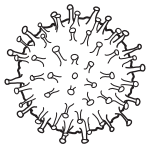

Fig. 25b

The image size is 1798 × 2117 pixels. Each pixel is a shade of grey represented by 8 bits of digital information.

(a) Determine the number of different shades of grey that can be represented by 8 bits.

number of shades = ... **[1]**

(b) Calculate the time taken to transmit this image at a rate of 54 megabits per second.

time taken = ... s **[2]**

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(c) The virus particles are approximately 100 nm in diameter.

Determine the approximate resolution of the image in metres per pixel.

Give your answer to **2** significant figures.

resolution = ... m pixel^{-1} **[4]**

(d) The original image was enhanced before publication on the internet.

Suggest **two** ways in which this image might have been enhanced.

1 .....

.....

2 .....

.....
[2]

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26 The photoelectric effect demonstrates that light exchanges energy in quanta.

(a) Describe **one** other demonstration or effect that shows the quantum behaviour of light. Include a description of the evidence in your answer.

.....

.....

.....

.....

.....

..... **[3]**

In a demonstration of the photoelectric effect using a zinc plate, electrons were just released when the wavelength of incident light was 270 nm.

(b) Calculate the Planck constant from these data.

Work function of zinc = 6.9×10^{-19} J.

Planck constant, h = ... J s **[3]**

(c) A diffraction pattern can be produced when a beam of electrons is passed through a crystal.

Explain how the diffraction pattern provides evidence for the quantum behaviour of electrons.

.....

.....

.....

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

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Section C continues on page 22

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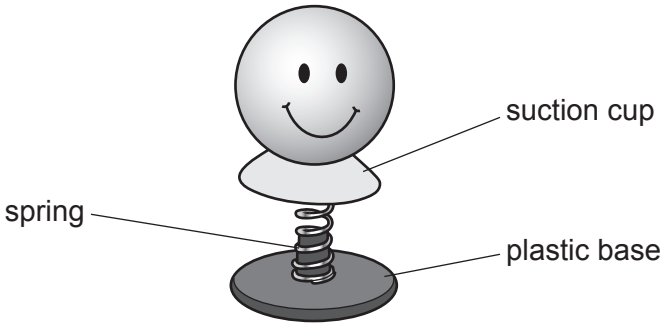
27 Some students are investigating the physics of a child's spring-up toy.



When the toy is pressed down, the spring is compressed.

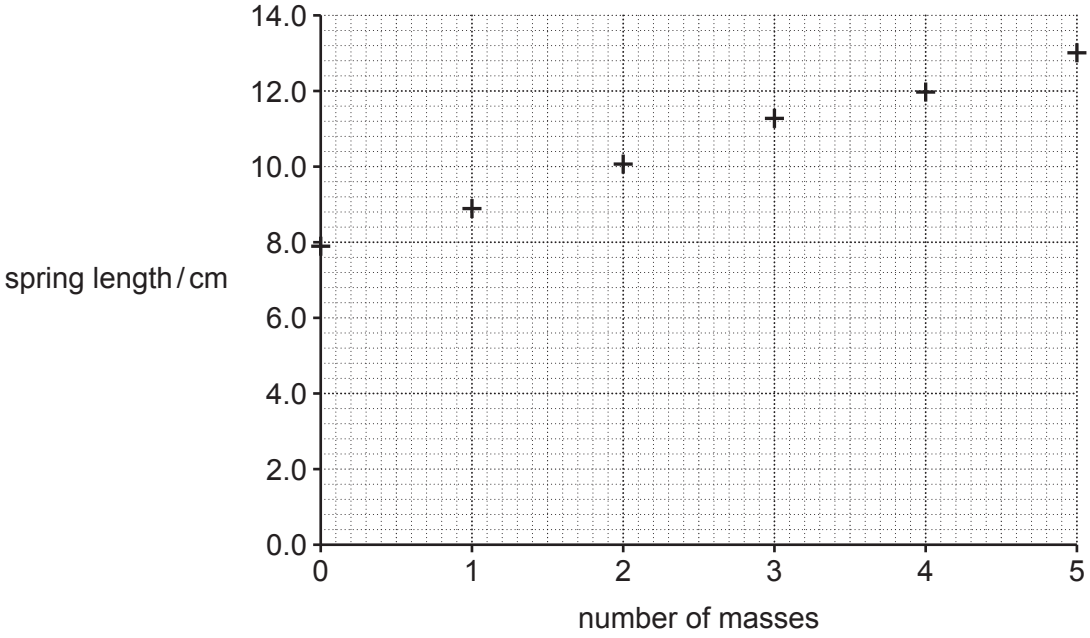
The suction cup holds the toy to the plastic base for a short time.

When air leaks under the suction cup, the spring suddenly decompresses and the toy jumps into the air.

The students removed the spring from the toy and suspended it from a stand.

They hung 100 g masses on the spring and recorded the spring length.

They plotted a graph of their results.



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(a) Use the graph to determine the spring constant of the spring.

spring constant = ... $N\,m^{-1}$ **[3]**

(b) State **one** improvement the students can make to their graph.

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

(c) The students replace the spring and make some different measurements using the toy.

Trial	**Delay before jump / s**	**Maximum height / cm**
1	18	60
2	16	55
3	20	60
4	18	55
5	20	65

Mass of toy = 51.6 g

Compression of spring = 5.0 cm

(i) Use the measurements of maximum height to estimate the energy stored in the spring.

energy stored = ... J **[3]**

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(ii) State and explain whether your estimate is likely to be too high or too low.

.....

.....

.....

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

(iii) Explain why the students did **not** need to use a sensitive balance to find the mass of the toy.

.....

.....

.....

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

(iv) Explain why it is **not** reasonable to conclude that the longer the delay before the toy jumps, the greater the maximum height.

.....

.....

.....

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

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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