Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5961540018

PHYSICS **5054/41**

Paper 4 Alternative to Practical **May/June 2023**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

DC (CJ/SG) 316510/3

[Turn over

1 A student investigates specific heat capacity.

(a) He puts 25 cm^3 of water in a beaker.

The thermometer in Fig. 1.1 shows the temperature θ_1 of the water.

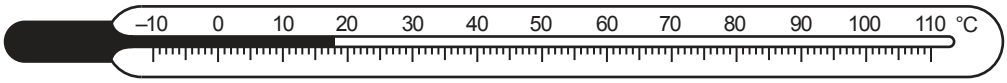


Fig. 1.1

Record θ_1.

θ_1 = ... °C [1]

(b) The teacher has placed some 50 g masses in boiling water. Each mass has been tied to a length of string.

The student takes the beaker of water to where the masses are in boiling water. He uses the string to remove one mass from the boiling water and places it carefully into the beaker as shown in Fig. 1.2.

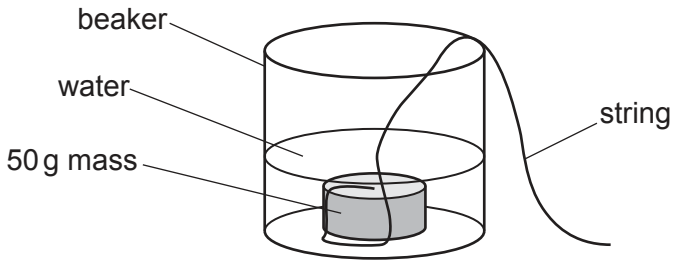


Fig. 1.2

He then returns to his workstation and replaces the thermometer in the beaker.

(i) The thermometer in Fig. 1.3 shows the maximum temperature θ_2 of the water.

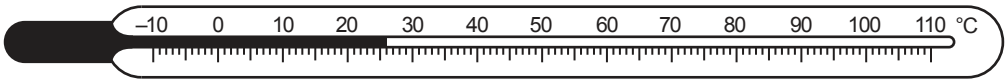


Fig. 1.3

Calculate the temperature change $\theta_2 - \theta_1$.

$\theta_2 - \theta_1$ = ... [1]

(ii) Describe how to ensure that θ_2 is measured as accurately as possible.

.....

.....

..... [2]

(iii) The beaker is made from a special type of glass. Suggest why it is suitable for this experiment.

.....

..... [1]

(iv) Calculate the specific heat capacity c_m of the 50 g mass using the equation:

$$c_m = \frac{4.2\ (\theta_2 - \theta_1)}{2\ (100 - \theta_2)}$$

c_m = ... J/(g °C) [1]

(c) (i) Describe **two** sources of error in the method used to determine c_m.

1 .....

.....

2 .....

.....

[2]

(ii) Suggest **two** improvements to the method.

1 .....

.....

2 .....

.....

[2]

[Total: 10]

2 A student investigates a thermistor using the circuit in **Fig. 2.1**.

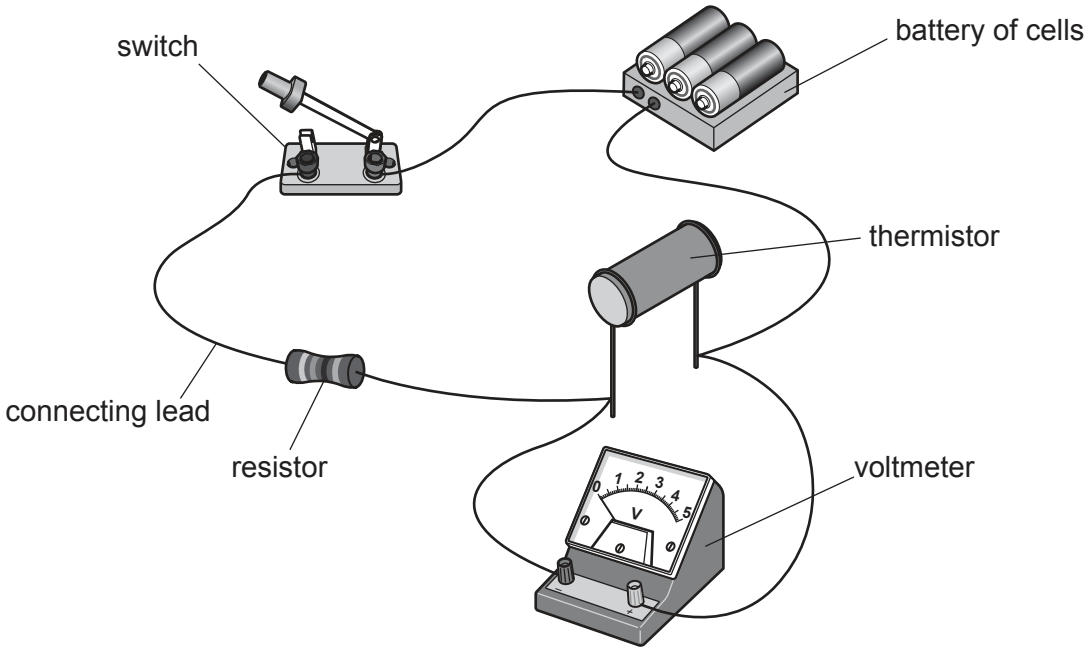


Fig. 2.1

(a) Draw a circuit diagram of the circuit.

[3]

(b) The student measures the temperature of the room and records it.

The recorded result is shown in Fig. 2.2.

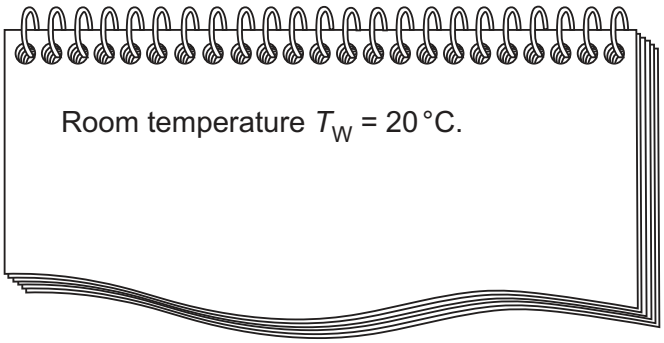


Fig. 2.2

Fig. 2.3 shows the reading V_W on the voltmeter when the switch is closed.

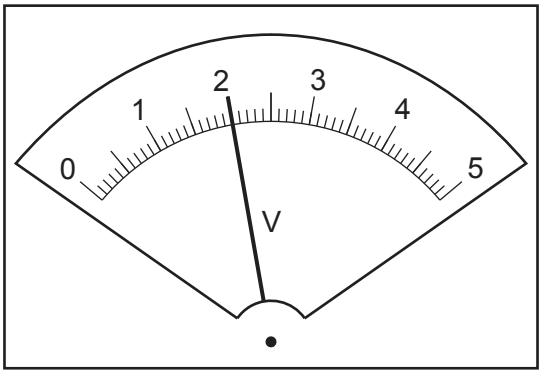


Fig. 2.3

Record the reading V_W.

V_W = ... V [1]

(c) There is a beaker containing ice and water near the thermistor.

The student measures the temperature T_C of the ice and water and records it. The recorded result is shown in Fig. 2.4.

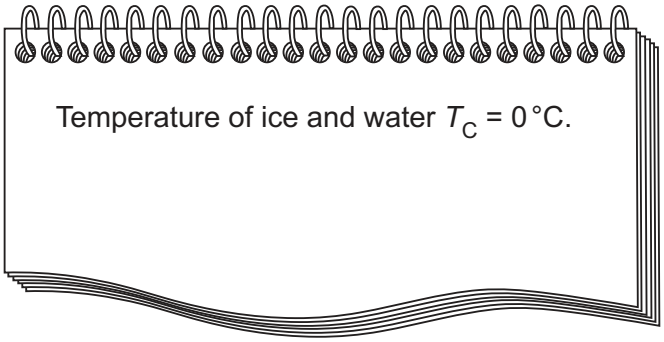


Fig. 2.4

The thermistor is placed in the beaker of ice and water and after a minute, the voltmeter is read again.

Fig. 2.5 shows the reading on the voltmeter when the thermistor is in the beaker of ice and water.

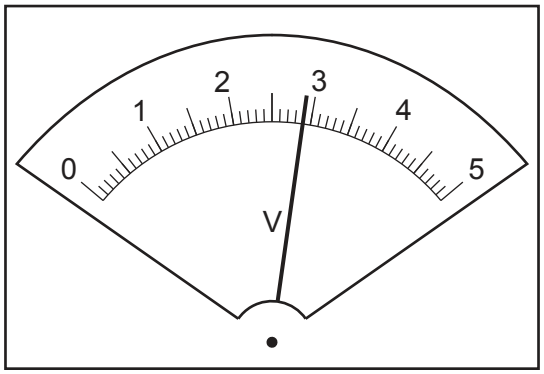


Fig. 2.5

Record the reading V_C.

V_C = ... V [1]

(d) **(i)** Calculate the average change in voltage for one degree temperature change ΔV_{AV} using the equation:

$$\Delta V_{AV} = \frac{(V_C - V_W)}{(T_W - T_C)}$$

State the unit of your answer

ΔV_{AV} = ... unit ..... [2]

(ii) Use your answer to **(d)(i)** to predict the voltage V_{PB} across the thermistor when the thermistor is at body temperature.

Body temperature is 37 °C.

You may assume that the average change in voltage for one degree temperature change ΔV_{AV} is constant.

V_{PB} = ... V [1]

(iii) The student is told that if the thermistor is held between a thumb and forefinger for two minutes, the reading on the voltmeter V_{AB} will be the same as the predicted voltage V_{PB} in **(d)(ii)**.

Two quantities are considered to be equal, within the limits of experimental accuracy, if their values are within 10% of each other.

The thermistor is held between the student's thumb and forefinger for two minutes and the student reads and records the voltage V_{AB}. The recorded result is shown in Fig. 2.6.

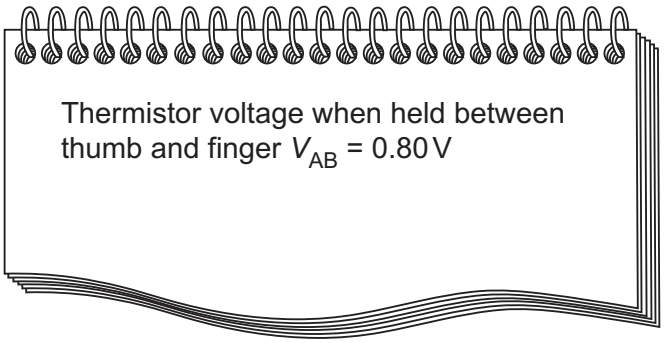


Fig. 2.6

State whether the student's results indicate that V_{PB} and V_{AB} are equal within the limits of experimental accuracy.

Support your statement with a calculation.

calculation

statement .....

..... [2]

[Total: 10]

3 A student investigates a falling mass.

The student uses the apparatus shown in Fig. 3.1.

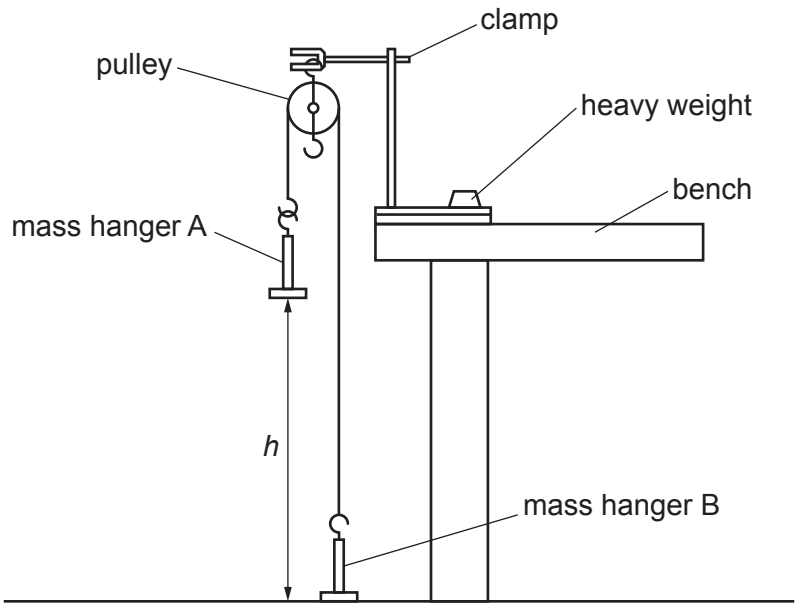


Fig. 3.1

(a) The bottom of mass hanger A is at a height *h* above the floor as shown in Fig. 3.1.

(i) The student places one end of a metre rule on the floor and the other end near to the mass hanger. The top of the metre rule is shown in Fig. 3.2.

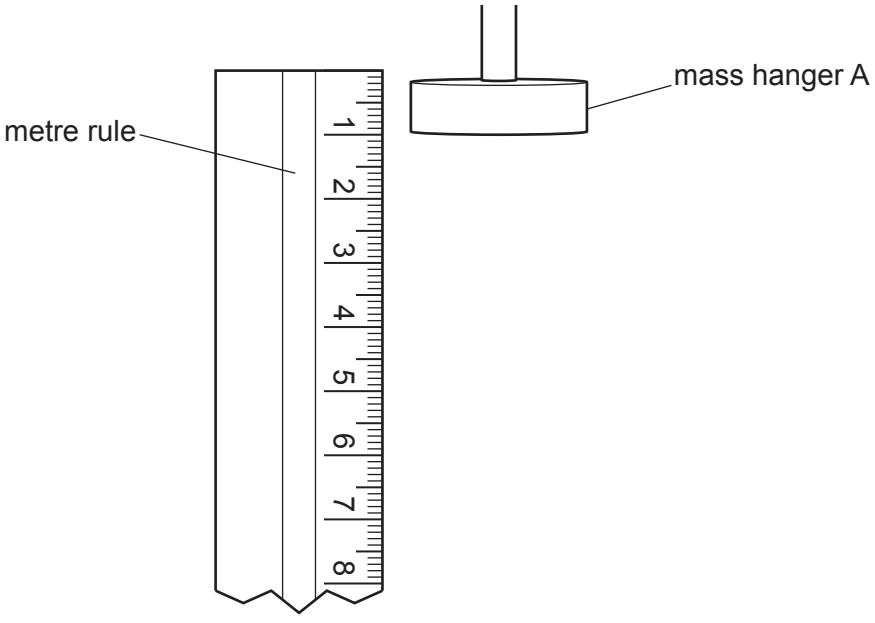


Fig. 3.2

Record *h*.

h = ... cm [1]

(ii) Describe **one** source of error when measuring h and suggest **one** improvement to the procedure to reduce this error.

source of error .....

.....

improvement .....

.....
[2]

(b) (i) The student places a mass m = 5.0 g on mass hanger A.

The additional mass causes the mass hanger to descend slowly.

The student uses a stop-watch to take three readings of the time taken for mass hanger A to fall to the floor.

Using the stop-watch readings in Fig. 3.3, determine an accurate average time t_{av} for the mass hanger to descend the height h.

Fig. 3.3

Show your working.

t_{av} = ... s [2]

(ii) The student repeats the time measurements with different masses placed on hanger A.

Record the measurements from **(b)(i)**, in Table 3.1. Complete the headings and give units.

Table 3.1

mass *m* on hanger				average time t_{av} .....
5.0				
7.0	4.03	4.40	4.09	4.2
9.0	3.06	2.93	3.09	3.0
11.0	2.50	2.59	2.56	2.6
13.0	2.13	2.28	2.28	2.2

[3]

(c) On the grid provided on page 11, plot a graph of average time t_{av} on the *y*-axis against the mass *m* on the *x*-axis.

Draw the best-fit curve. [4]

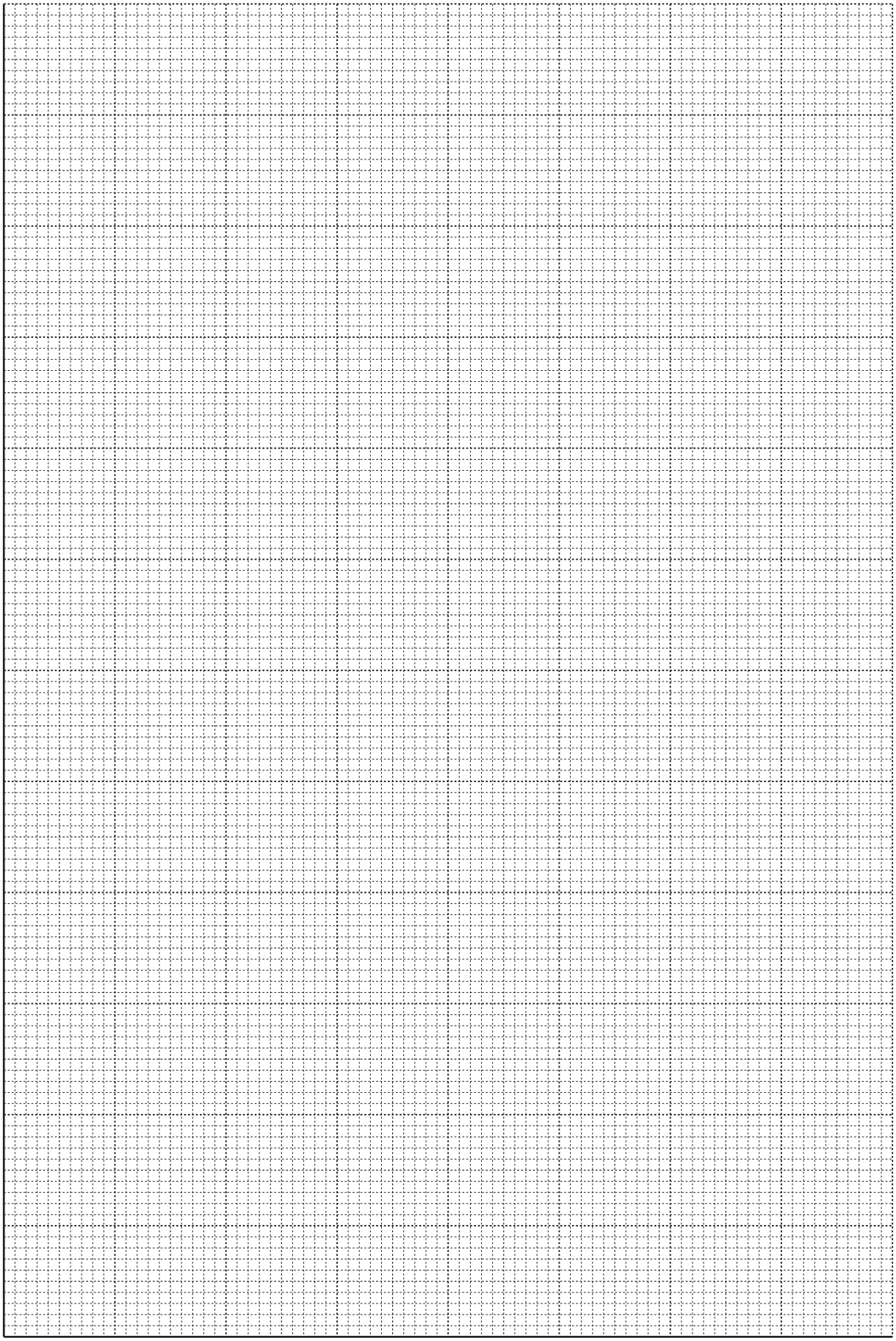
(d) Describe the relationship between t_{av} and *m* shown by the graph.

.....

.....

..... [2]

[Total: 14]



4 A student attaches a propeller to an electric motor driven by a 0 to 12 V d.c. power supply as shown in Fig. 4.1.

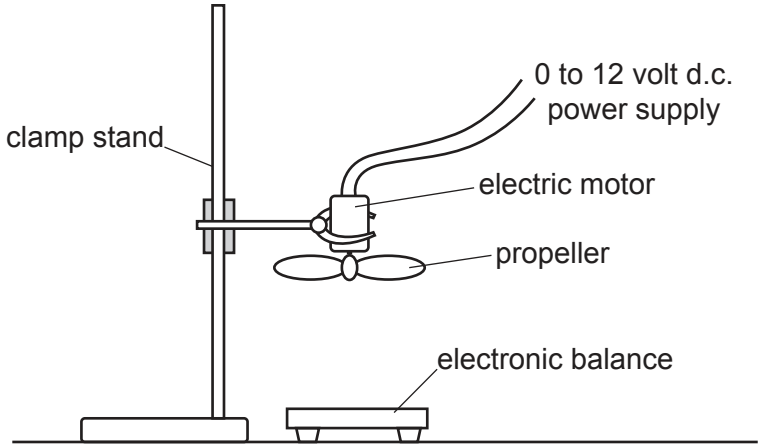


Fig. 4.1

Moving air from the propeller exerts a force on the balance.

Plan an experiment to investigate how this force varies with the voltage of the power supply.

The following apparatus is available:

an electric motor
an electronic balance
a power supply
a propeller
a voltmeter.

You can also use other apparatus and materials that are usually available in a school laboratory.

In your plan, you should:

- explain briefly how to carry out the investigation
- state the key variables to control
- draw a table, with column headings, to show how to display your readings (you are **not** required to enter any readings in the table)
- explain how to use your readings to reach a conclusion.

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[6]

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