# Matter – models and explanations – 2021/20 GCSE 21st Physics Combined Science B

**1.** Nov 2021/Paper_J260/03/No.3

Mia stretches a spring using a forcemeter, as shown in **Fig. 3.1**.

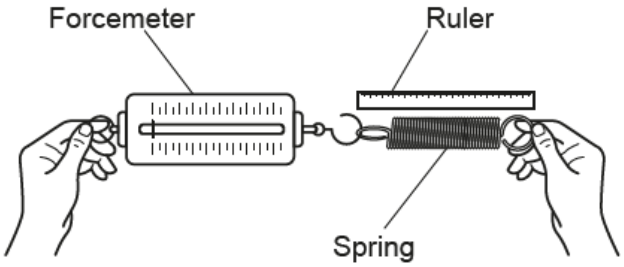


**Fig. 3.1**

**(a)** The spring stretches from 5.0 cm long to 8.5 cm long when a force of 7.7 N is used.

**(i)** Calculate the extension of the spring in **metres**.

Extension = ..... m **[2]**

**(ii)** Calculate the spring constant of the spring.

Use the equation: spring constant = force ÷ extension

Spring constant = ..... N/m **[2]**

**(iii)** Calculate the energy stored in the spring.

Give your answer to **2** decimal places.

Use the Data Sheet.

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

**(b)** Mia investigates the work done when another spring is stretched.

She uses the equipment shown in **Fig. 3.2** and plots the graph shown in **Fig. 3.3**.

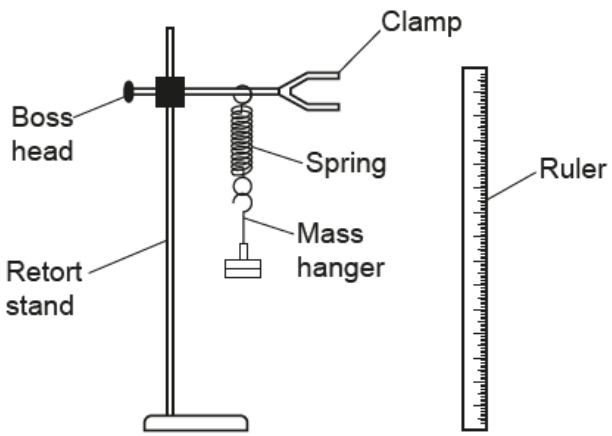


**Fig. 3.2**

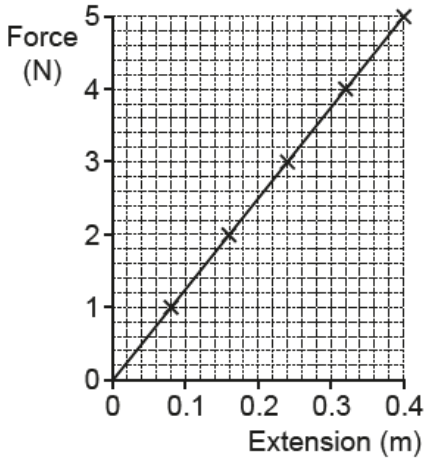


**Fig. 3.3**

**(i)** Suggest how Mia could make the experiment safer.

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

**(ii)** Complete the sentences to describe how Mia could collect the data she needs to plot the graph in **Fig. 3.3**.

Use the words.

You can use each word once, more than once, or not at all.

**energy** **extension** **final** **initial** **mass** **weight**

Measure the ..... length of the spring. Hang a mass on the spring.

Measure the new length of the spring. Subtract the measurements to calculate the

..... . Calculate the force by multiplying the .....

by the gravitational field strength. Repeat for five different masses.

**[3]**

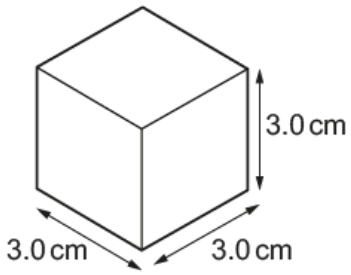
**(iii)** Calculate the work done when the spring is stretched by a force of 5 N.

The area under the graph in **Fig. 3.3** is equal to the work done when the spring is stretched.

Work done = ..... J **[3]**

**2.** Nov 2021/Paper_J260/03/No.6

**(a)** Alex has a cube of tungsten metal.




**(i)** Calculate the volume of the cube.

Volume = ..... $cm^3$ **[1]**

**(ii)** The mass of the cube is 513 g.

Calculate the density of the cube.

Use the equation: density = mass ÷ volume

Density = ..... $g/cm^3$ **[2]**

**(b)** This table shows the density of some solids, liquids and gases.

| | State | Density ($kg/m^3$) |
|---|---|---|
| **Methane** | Gas | 0.67 |
| **Air** | Gas | 1.2 |
| **Ethanol** | Liquid | 790 |
| **Water** | Liquid | 1000 |
| **Limestone** | Solid | 2700 |
| **Iron** | Solid | 7900 |

**(i)** What does the table show about the relationship between state and density?

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

**(ii)*** Explain the difference in density between air, water and iron.

Use data from the table to support your answer.

Include diagrams in your answer.

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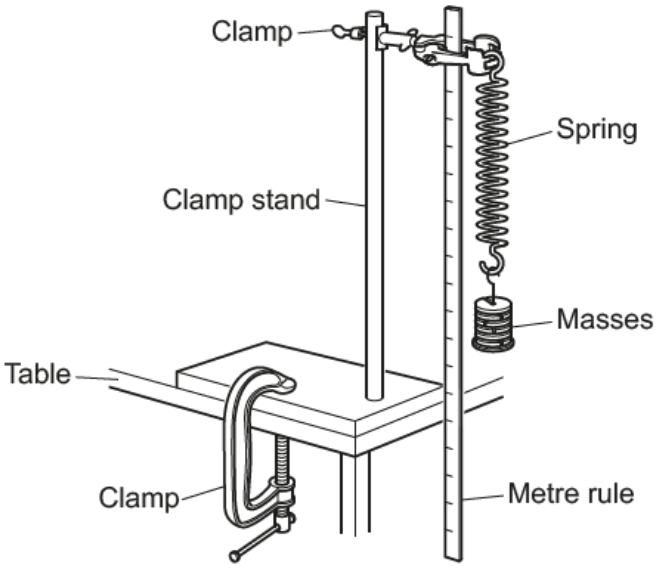
..... **[6]**

**3.** Nov 2021/Paper_J260/04/No.5

**(a)** Ling is investigating the extension of a spring, using the equipment shown in the diagram.




**(i)** Describe how Ling can use this equipment to observe the effect of forces on the extension of the spring.

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

**(ii)** Ling suggests five ways of improving the accuracy of her results.

Which **two** suggestions will increase the accuracy of her results?

Tick (✓) **two** boxes.

Attach a pointer to the bottom of the spring to help read the measurement on the metre rule. ☐

Ask another student to complete the same experiment. ☐

Take the reading as soon as the mass is placed on the spring. ☐

Use a balance to check the exact mass applied to the spring. ☐

Repeat the experiment three times. ☐

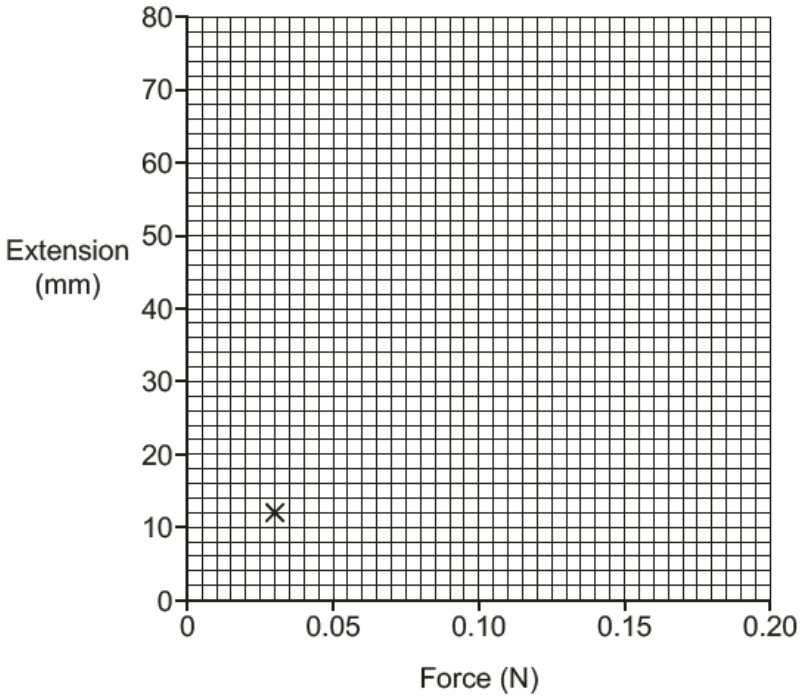
**[2]**

**(b)** The table shows Ling's results.

| Force (N) | Extension (mm) |
|---|---|
| 0.03 | 12 |
| 0.06 | 24 |
| 0.09 | 38 |
| 0.12 | 52 |
| 0.15 | 64 |
| 0.18 | 76 |

**(i)** Plot a graph, using the data in the table. One point has been done for you.

Draw a line of best fit. **[2]**




**(ii)** Which statement describes the relationship between the force on the spring and the extension of the spring?

Tick (✓) **one** box.

As the force increases, the extension decreases. ☐

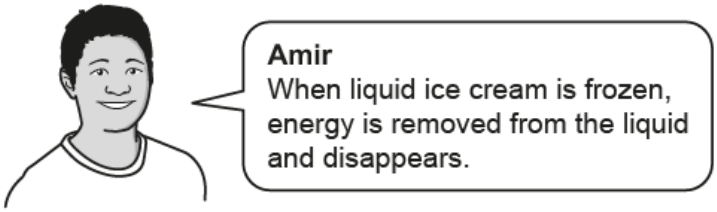
As the force increases, the extension increases. ☐

There is no relationship between extension and force. ☐

**[1]**

**4.** Nov 2020/Paper_J260/04/No.10

Amir thinks about what happens, in terms of energy, when ice cream freezes.




**(a)** Explain what is **incorrect** about Amir's statement.

1. .....

.....

2. .....

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

**(b)** **(i)** What is the correct equation to calculate density?

Put a (ring) around the correct answer.

**density = mass × volume** **density = $\frac{\text{mass}}{\text{volume}}$** **density = $\frac{\text{volume}}{\text{mass}}$** **[1]**

**(ii)** A 90 $cm^3$ scoop of ice cream has a mass of 66 g.

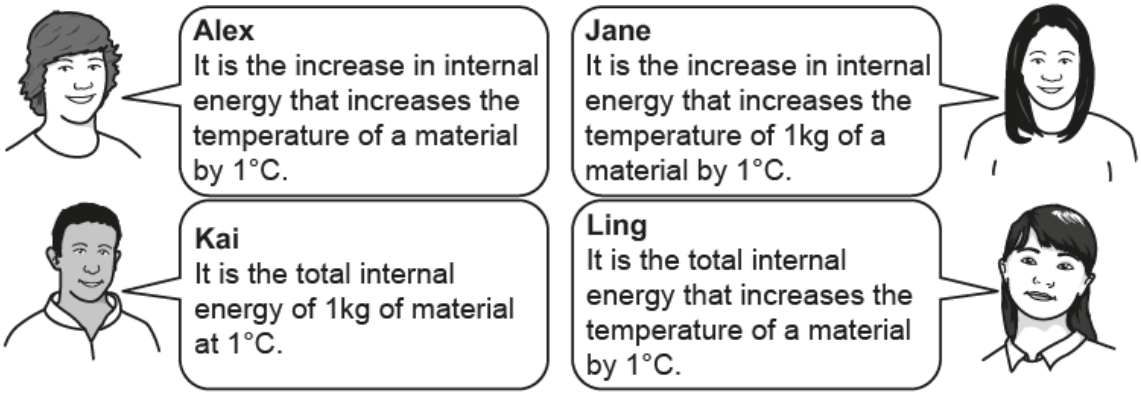
Calculate the density of the ice cream.

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

Density = ..... $g/cm^3$ **[3]**

**(c)** The specific heat capacity of ice cream is 2740 J/kg °C.

Four students are trying to define specific heat capacity.




Which student has given the correct definition of specific heat capacity?

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

**(d)** Amir wants to calculate the energy transferred to a 0.4 kg tub of melted ice cream as it warms up from 4 °C to room temperature, 20 °C.

He uses data from the table.

| | **Ice cream** |
|---|---|
| **Specific heat capacity** | 2740 J/kg °C |
| **Specific latent heat of melting** | 204 kJ/kg |
| **Melting point** | –6 °C |

What is the correct method to calculate the energy transferred?

Tick (✓) **one** box

0.4 × 204 × (20 – 4) ☐

0.4 × 204 × 20 ☐

0.4 × 2740 × (20 – 4) ☐

0.4 × 2740 × 20 ☐

**[1]**

**(e)** Calculate the energy needed to change 0.4 kg of solid, frozen ice cream at –6 °C into 0.4 kg of liquid, melted ice cream at –6 °C.

Use data from the table.

Use the Data Sheet.

Give your answer in **joules**.

Energy = ..... J **[3]**

**5.** Nov 2021/Paper_J260/07/No.10

A sealed, insulated aluminium tank has a mass of 13 kg and contains 2.4 kg of air. Both the air and the aluminium tank have an initial temperature of 8.0 °C.

The tank of air is heated to 22.0 °C by a heater inside the tank.

**(a)** The heater transfers 189 000 J to heat the tank and the air.

Calculate the specific heat capacity of the air.

Specific heat capacity of aluminium = 900 J/kg °C

Use the equation:
change in internal energy = mass × specific heat capacity × change in temperature

Specific heat capacity of **air** = ..... J/kg °C **[4]**

**(b) (i)** Explain how the motion of the air molecules in the tank changes as the temperature increases.

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

**(ii)** Explain how this change in motion affects the pressure of the gas.

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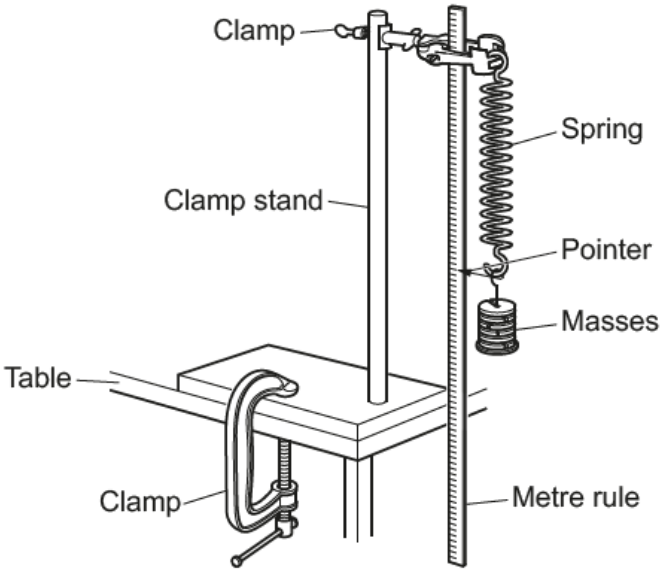
..... **[3]**

**6.** Nov 2021/Paper_J260/07/No.6

Ling is investigating the extension of a spring with different forces, using the equipment shown in the diagram.




**(a)** Describe how Ling can use the equipment in the diagram to produce **accurate** results.

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..... **[4]**

**(b)** When a 0.02 kg mass is attached to the spring, the spring extends by 50 mm.

Calculate the spring constant.

Use the equation: weight = mass × gravitational field strength

Gravitational field strength = 10 N / kg.

Give your answer in **N / m**.

Spring constant = ..... N / m **[4]**

**(c)** When a 20 g mass is removed, the spring returns to its original length.

Suggest why the spring does **not** return to its original length when a mass of 30 g is used.

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

**7.** Nov 2020/Paper_J260/08/No.4

Amaya looks up the relative atomic mass and the density of some metals.

**(a)** Complete the statement about density.

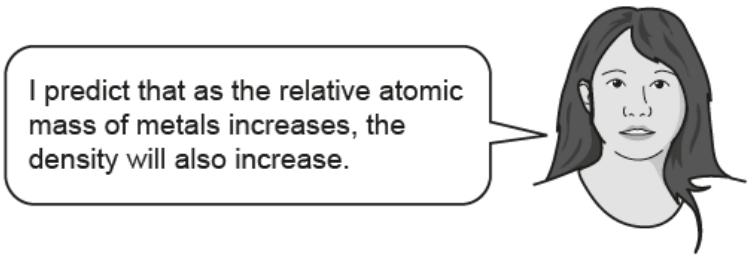
Tick (✓) one box.

The density of a material is equivalent to:

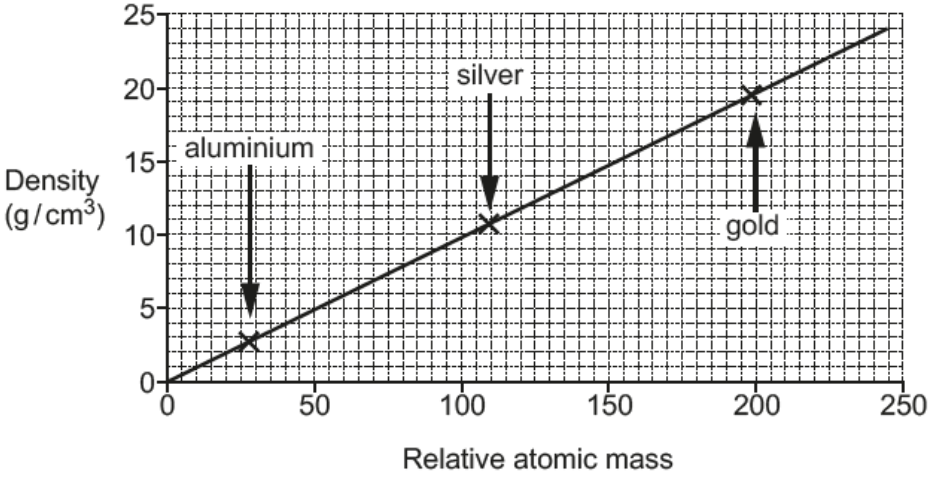
| | |
|---|---|
| the mass per 1 kg of the material. | ☐ |
| the mass per 1 $m^3$ of the material. | ☐ |
| the volume per 1 $m^3$ of the material. | ☐ |
| the volume per 1 kg of the material. | ☐ |

**[1]**

**(b)** Amaya makes a prediction.




She plots a graph of density against relative atomic mass for three metals.




Predict the density of tin from Amaya's graph.

Show your working on Amaya's graph.

Relative atomic mass of tin = 119

Predicted density of tin = ..... g/$cm^3$ **[1]**

**(c)** Amaya concludes from her graph that the density of metals increases as the relative atomic mass of the metals increases.

The table shows the relative atomic mass and the density for two other metals.

| Metal | Relative atomic mass | Density ($g/cm^3$) |
|---|---|---|
| Zinc | 65 | 7.14 |
| Platinum | 195 | 21.5 |

Does the data in the table increase or decrease your confidence in Amaya's conclusion?

Explain your answer.

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

**8.** Nov 2020/Paper_J260/08/No.10

**(a)** Jack puts 560 g of milk in a pan and heats it, taking care not to let it boil by using a thermometer. Energy is transferred from the pan to the milk.

**(i)** Describe the effect on the milk.

Use ideas about energy stores in your answer.

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

**(ii)** Nina heats 560 g of water, using the same method that Jack uses for heating the milk.

Why does the temperature of the milk increase more quickly than the temperature of the water?

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

**(b)** Nina heats the 560 g of water until it is boiling.

**(i)** Calculate the energy needed to turn all the water to steam once it is boiling.

Specific latent heat of water = $2.23 \times 10^6\,J\,kg^{-1}$

Give your answer to **3** significant figures.

Energy needed = ..... J **[3]**

**(ii)** The time taken for all the water to turn to steam is 7 minutes.

Calculate the power of the heater used.

Use the equation: energy transferred = power × time

Power = ..... W **[3]**