1(a). A space mission in 1969 placed an object called a retroreflector on the surface of the Moon.

Fig. 18.1 shows the retroreflector.

Fig. 18.1

Laser light from the Earth is aimed at the retroreflector and reflects back to the Earth.

A student draws a simple model of a retroreflector using two plane mirrors at right angles to each other.

Fig. 18.2 shows the student's model.

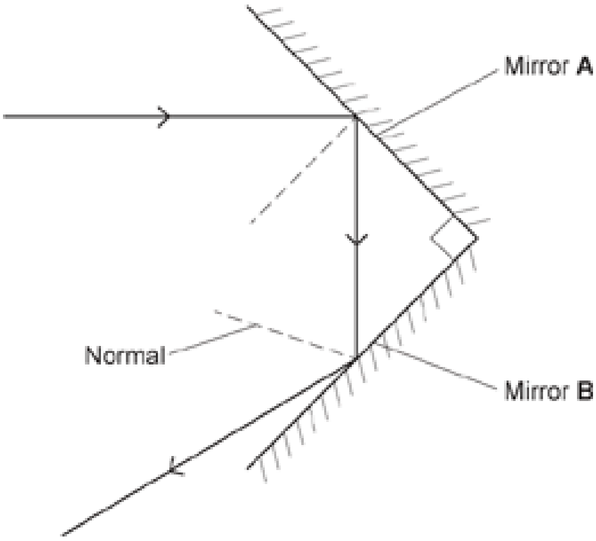


Fig. 18.2

Identify the **two** mistakes the student has made in **Fig. 18.2**.

Mistake 1

____

Mistake 2

____

____ **[2]**

(b). The retroreflector was placed on a layer of dust on the surface of the Moon.

Since 1969, the efficiency of the retroreflector has decreased and it reflects less light back to the Earth.

Suggest why the retroreflector reflects less light.

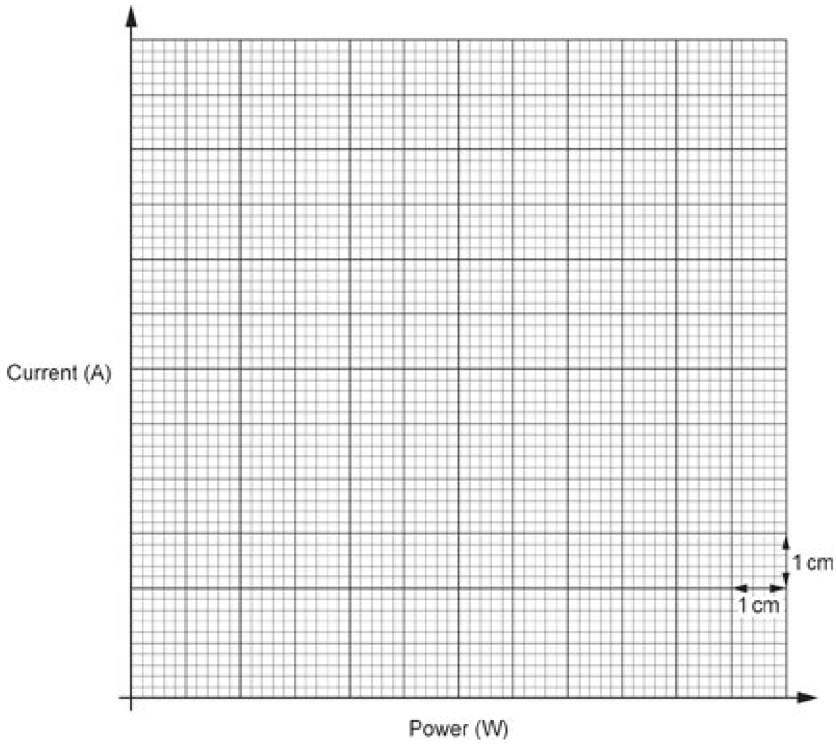
____

____ **[1]**

2. A student investigates how the power of an appliance changes the current in the live wire.

Power (W)	Current (A)
70	0.3
160	0.7
600	2.6
900	3.9
1200	5.2

The student plots a graph of the results using this graph paper.



Which scales should the student use for each axis?

	Power (W)	Current (A)
A	1 cm = 100 W	1 cm = 0.5A
B	1 cm = 100 W	1 cm = 1.0A
C	1 cm = 200 W	1 cm = 0.5A
D	1 cm = 200 W	1 cm = 1.0A

Your answer [ ] **[1]**

3. In one month a wind turbine on a house generates 300 kW h of useful energy.

The efficiency of the wind turbine is 0.60.

What is the wasted energy in one month?

Use the equation: $\text{efficiency} = \dfrac{\text{useful output energy transfer}}{\text{input energy transfer}}$

A 120 kW h
B 180 kW h
C 200 kW h
D 450 kW h

Your answer [ ] **[1]**

4(a).

Fig. 22.1 shows a sealed cardboard tube containing a ball.

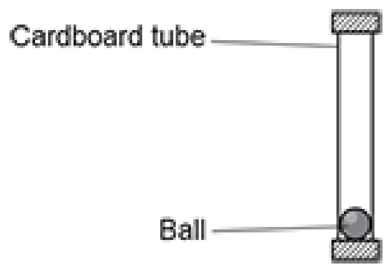
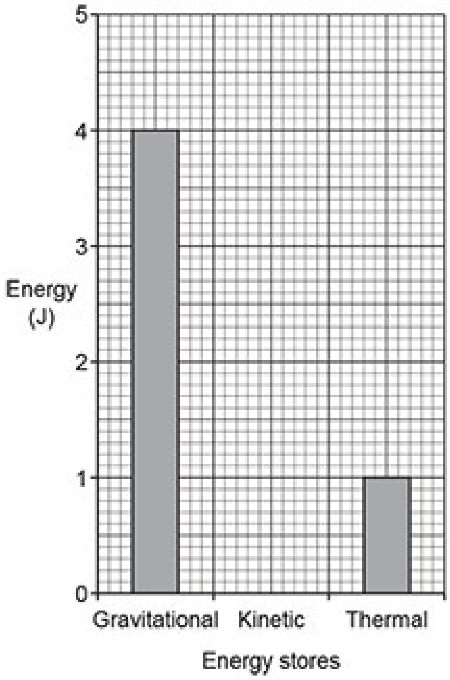


Fig. 22.1

The cardboard tube is quickly turned upside down so that the ball falls the whole length of the tube.
Fig. 22.2 shows the energy stores of the ball at the **top** of the tube.

Complete **Fig. 22.3** to show the energy stores of the ball before it hits the **bottom** of the tube.

[3]



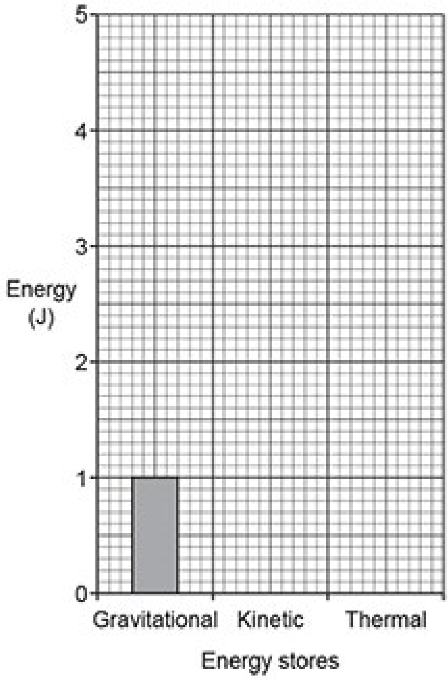


Fig. 22.2 **Fig. 22.3**

(b).

Student **A** and student **B** determine the specific heat capacity of lead using this method.

- Measure the mass and initial temperature of small lead pellets.
- Place the pellets in a sealed cardboard tube.
- Quickly turn the tube upside down 40 times.
- Measure the final temperature of the lead pellets.

Fig. 22.4 shows a diagram of the equipment:

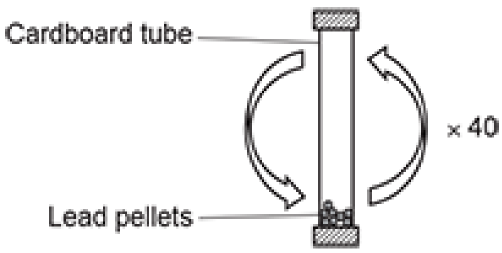


Fig. 22.4

i. State **one** way to improve the experiment.

____ **[1]**

ii. Explain why the cardboard tube is turned upside down very quickly.

____ **[1]**

iii. **Student A** uses 0.030 kg of lead pellets and a 1.5 m long cardboard tube.

Calculate the change in potential energy of the pellets when the tube is turned upside down **once**.

Use the equation: potential energy = mass × height × gravitational field strength

Potential energy = ... J **[2]**

iv. **Student B** repeats the experiment using a different tube.

The total change in potential energy of 0.030 kg of lead pellets for this tube is 21 J.
The temperature change of the lead pellets is 5 °C.

Calculate the specific heat capacity of lead. Include the correct unit.

Use the Equation Sheet June 23 J249-01-02-03-04.

Specific heat capacity = ... Unit .... **[4]**

v. Student **A** says, 'I think we should use a metal with a higher specific heat capacity. This will give us more accurate results.'

Student **B** says, 'I think we should turn the tube upside down 100 times. This will give us more accurate results.'

Explain why both student **A** and student **B** are not correct.

Student **A** ____

____

____

____

Student **B** ______________________________

____

____

____

[3]

5. A teacher plugs an electric kettle into the domestic electricity supply.

The kettle has a power rating of 2300 W.

What is the current in the kettle?

Use the Equation Sheet June 23 J249-01-02-03-04.

A 0.10 A
B 3 A
C 10 A
D 13 A

Your answer ☐ **[1]**

6. A coal fired power station has an efficiency of 0.4.

What is the input energy needed to obtain a useful output energy of 500 MJ?

Use the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{input energy transfer}}$

A 200 MJ
B 500 MJ
C 540 MJ
D 1250 MJ

Your answer ☐ **[1]**

7. A student does an experiment to measure the specific heat capacity of a metal block.

Fig. 20.1 shows the student's equipment.

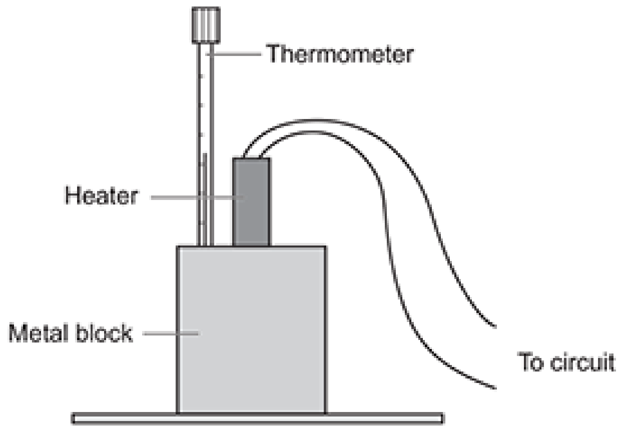


Fig. 20.1

i. The table shows the student's results.

Energy supplied to heater	24 kJ
Starting temperature	20 °C
Final temperature	45 °C
Change in temperature	25 °C
Mass of block	2.0 kg

Use the data in the table to calculate the specific heat capacity of the metal block.

Use the Data sheet_J249 01/02/03/04, June 2022.

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

ii. The value calculated in **(b)(i)** is higher than the actual value.
The student recorded all data correctly.

Suggest why the value calculated is higher than the actual value.

Use **Fig. 20.1**.

____ **[1]**

iii. Suggest how the experiment could be improved.

Use **Fig. 20.1**.

____ **[1]**

8.

Fig. 21.1 shows how the energy output per second of a wind turbine depends on the wind speed.

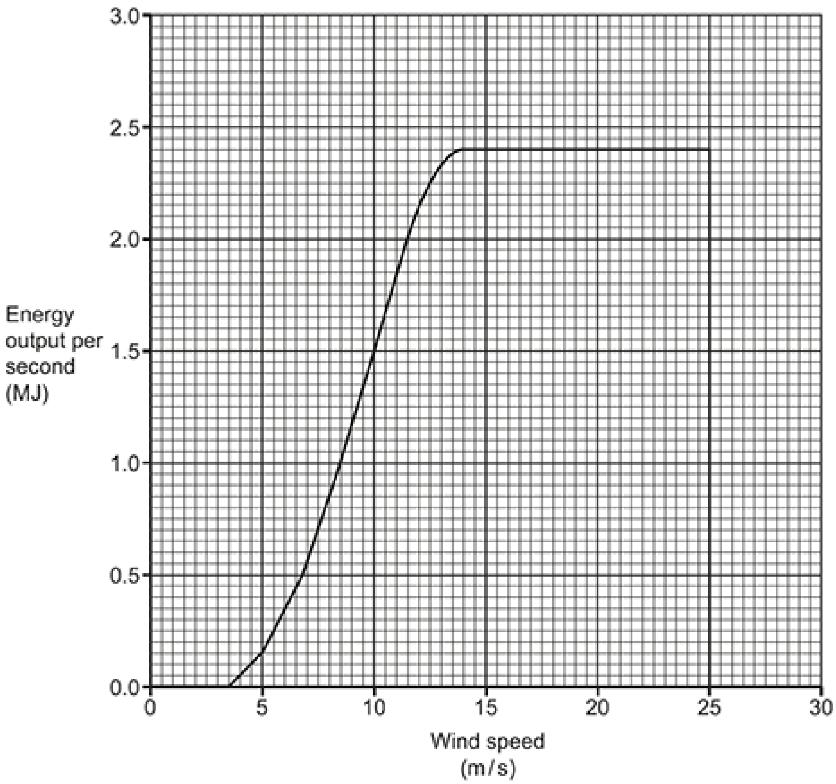


Fig. 21.1

i. Suggest a reason why energy output per second is zero when the wind speed is:

1 Less than 3.5 m / s.

2 Greater than 25 m / s.

[2]

ii. The wind turbine has an efficiency of 0.35.

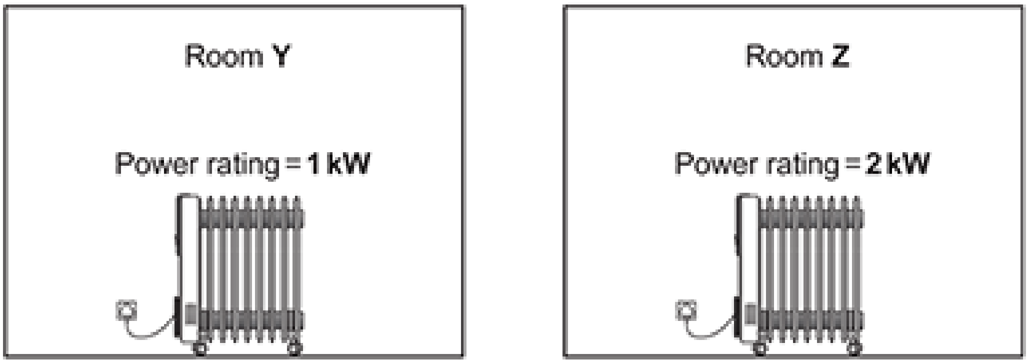
Calculate the input energy per second when the wind speed is 10 m / s.

Use **Fig. 21.1** and the Data sheet_J249 01/02/03/04, June 2022.

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

Input energy per second = ... MJ **[5]**

9. Room **Y** and Room **Z** are identical rooms. No energy can escape from the rooms.
The temperature of each room is increased by using a different heater.



The heater in each is turned on for **30 minutes**.

E_Y is the increase in the thermal energy store of Room **Y**.
E_Z is the increase in the thermal energy store of Room **Z**.

Which row of the table is correct?

	Change in thermal energy stores
A	$E_Z = E_Y/2$
B	$E_Z = E_Y$
C	$E_Z = 2E_Y$
D	$2E_Z = E_Y$

Your answer ☐ **[1]**

10. Power can be measured in watts (W) or milliwatts (mW).

What is 1.5 mW converted into W?

A 1.5×10^{-6} W
B 1.5×10^{-3} W
C 1.5×10^{3} W
D 1.5×10^{6} W

Your answer ☐ **[1]**

END OF QUESTION PAPER