1. 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.

The mass of the retroreflector is 77 kg.

An astronaut lifted the retroreflector a vertical distance of 0.50 m on the Moon.

Calculate the gravitational potential energy gained by the retroreflector.

The gravitational field strength on the Moon is 1.6 N / kg.

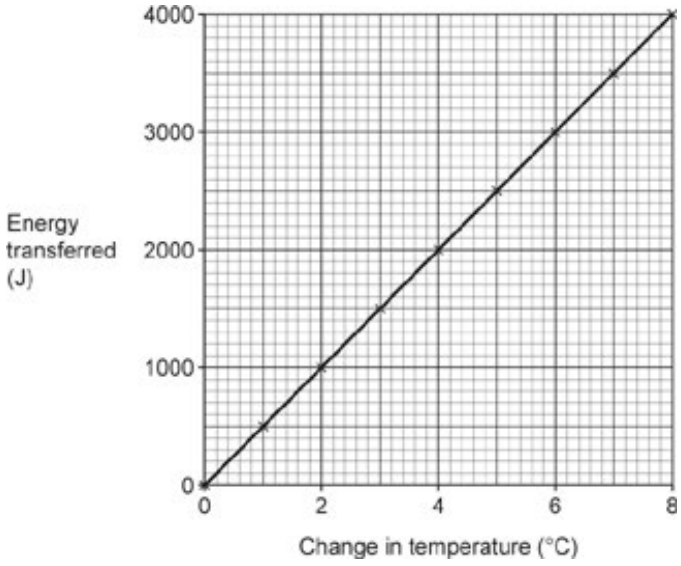
Use the Equation Sheet June 2024, J249-01-02-03-04

Gravitational potential energy =..... J **[3]**

2. A student uses an immersion heater to increase the temperature of 0.25 kg of oil.

The student calculates the energy transferred to the oil.

This is a graph of the student's results.



What is the specific heat capacity of the oil?

Use the graph and the Equation Sheet June 2024, J249-01-02-03-04

A 500 J / kg °C
B 2000 J / kg °C
C 4200 J / kg °C
D 16 000 J / kg °C

Your answer ☐ **[1]**

3. A motorcyclist has a mass of 80 kg and rides his motorcycle at 25 m / s.

The motorcycle has a mass of 160 kg.

What is the total kinetic energy of the motorcyclist **and** motorcycle?

Use the equation: $\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times (\text{speed})^2$

A 3000 J
B 25 000 J
C 75 000 J
D 150 000 J

Your answer ☐ **[1]**

4. 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: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{input energy transfer}}$

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

Your answer ☐ **[1]**

5(a).

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

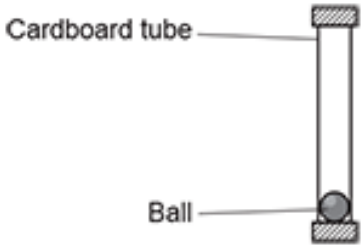


Fig. 22.1

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]

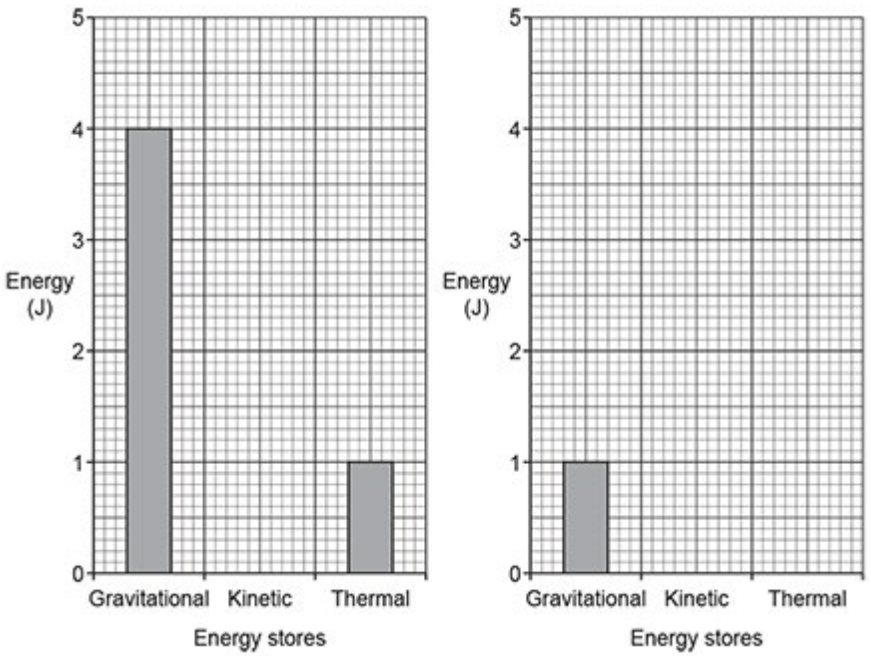


Fig. 22.2 **Fig. 22.3**

(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:

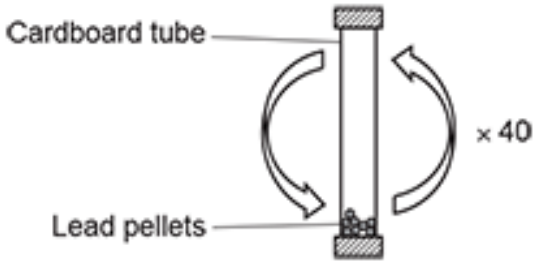


Fig. 22.4

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]

6. The kinetic energy of a car is 180 kJ when its speed is 20 m / s.

What is the mass of the car?

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

A 225 kg
B 450 kg
C 900 kg
D 18 000 kg

Your answer ☐ **[1]**

7. 0.090 J of energy is transferred when stretching a spring.

The spring constant of the spring is 50 N / m.

What is the extension of the spring?

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

A 0.0036 m
B 0.030 m
C 0.060 m
D 0.084 m

Your answer ☐ **[1]**

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

Fig. 20.1 shows the student's equipment.

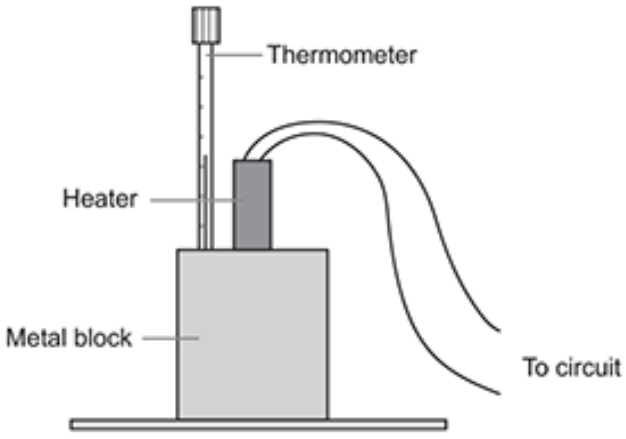


Fig. 20.1

The student measures current and potential difference to calculate the power of the heater.

Complete the circuit diagram in **Fig. 20.2** to show how the student measures current and potential difference.

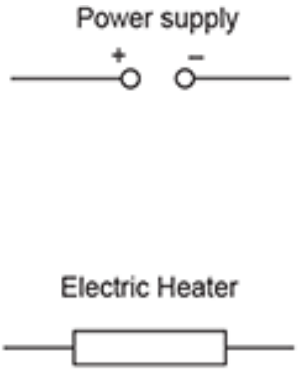


Fig. 20.2

[2]

(b).

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.

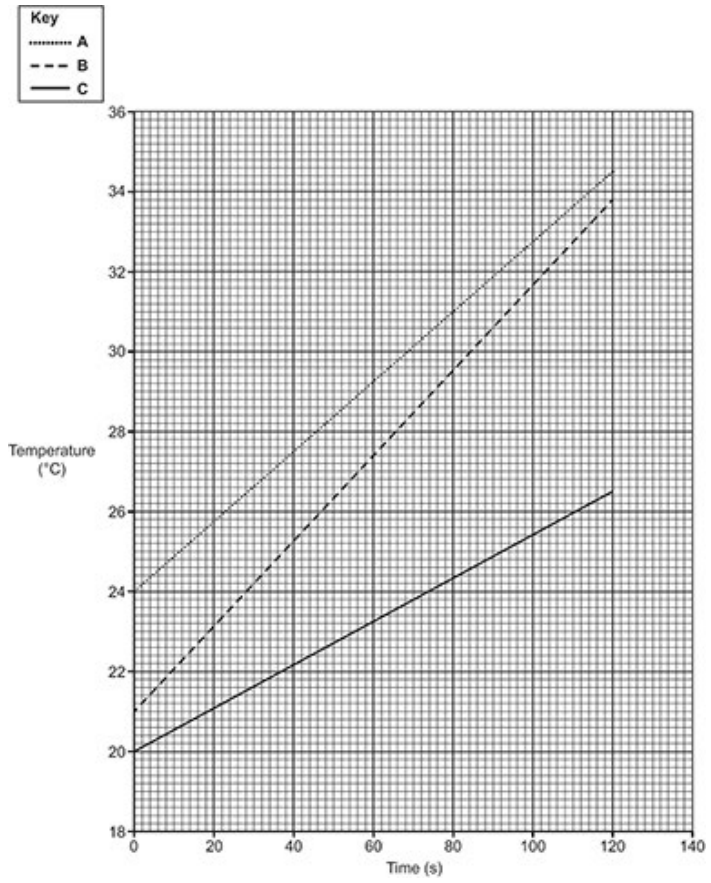
Use **Fig. 20.1**.

[1]

(c). The student repeats the same experiment using 3 different blocks, **A**, **B** and **C**.

- Each block is made of a different metal but has the same mass.
- The power of the heater stays the same.

The graph shows how the temperature of blocks **A**, **B** and **C** change with time.



Which metal has the **highest** specific heat capacity?

Tick (✓) **one** box.

A ☐
B ☐
C ☐

State a reason for your answer.

---

[2]

9. The energy stored in a stretched spring is 5 J.

What is the energy stored in the spring when the extension doubles?
Use the Data sheet_J249 01/02/03/04, June 2022.

A 5 J
B 10 J
C 20 J
D 25 J

Your answer ☐ **[1]**

END OF QUESTION PAPER