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This assessment is based on a now-expired version of the achievement standard and may not accurately reflect the content and practice of external assessments developed for 2024 onwards.

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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Physics, Earth and Space Science RAS 2023

92047 Demonstrate understanding of energy in a physical system

Credits: Five

PILOT ASSESSMENT

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of energy in a physical system.	Explain energy in a physical system.	Analyse energy in a physical system.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Show ALL working.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

You may find the following formulae useful.

$$E_k = \frac{1}{2}mv^2 \qquad \Delta E_p = mg\Delta h \qquad g = 10 \text{ N kg}^{-1} \qquad W = Fd$$

$$E(\text{thermal}) = mc\Delta T \qquad E(\text{thermal}) = mL$$

$$P = VI \qquad V = RI \qquad \Delta E = P\Delta t$$

QUESTION ONE

Jamie plays with his football while he waits for his bus. He throws the ball vertically up. The ball has a mass of 0.150 kg and reaches a height of 3.4 m. As it falls back down, its speed just before it hits the ground is 7.8 m s^{-1}.

(a) In the box below, write an equation to show the energy changes taking place when the ball falls back down from its highest point.

_____ → _____ + _____

(b) Calculate the size of the average force of friction between ball and air.

Begin your answer by showing that, on its way down from the highest point, 0.537 J of mechanical energy are changed into other forms of energy.

(c) While falling, 80% of the 0.537 J converted to other types of energy is absorbed by the ball. The specific heat capacity of the ball is 8200 J kg^{-1} $°C^{-1}$.

Calculate the rise in temperature of the ball as it falls.

(d) After some time, Jamie's bus did not arrive. Jamie shoulders his backpack and walks to the train station. On his way to the platform, he climbs a flight of stairs.

In terms of work and / or energy, explain why each of the following three statements given below is true.

No calculations are needed.

(i) (ii) (iii)

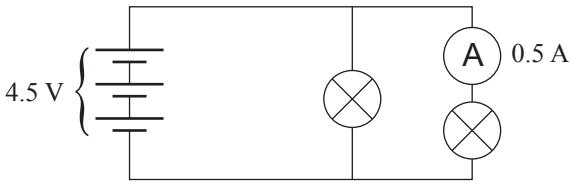
(i) No work is done on Jamie's backpack when Jamie is standing at the bus stop.

(ii) No work is done on Jamie's backpack when Jamie walks at constant speed on horizontal ground.

(iii) Work is done on Jamie's backpack when Jamie climbs up a flight of stairs.

QUESTION TWO

Jake has a torch that uses three 1.5 V batteries in series. The torch has two lamps, each rated at 4.5 V, connected as shown in the circuit diagram below. The current through each lamp is 0.50 A.



(a) Calculate the resistance of each lamp.

(b) The batteries power both lamps simultaneously.

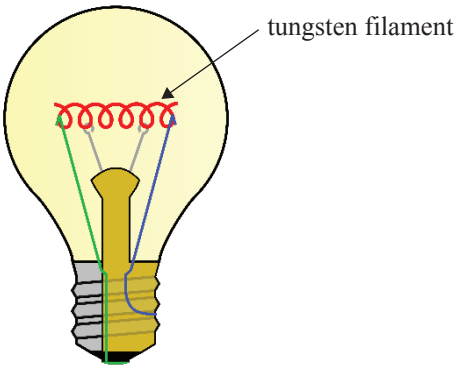
Explain why both lamps glow with their rated brightness if connected as shown above.

Begin your answer by identifying what type of connection the above diagram shows.

(c) Calculate the amount of electrical energy used by both lamps in two hours.

Begin your answer by calculating the power output of each lamp.

(d) Jake's torch uses incandescent lamps. These lamps have a very thin tungsten wire called a 'filament'. When a current passes through such a filament, it heats up and glows.



Tungsten is a metal with a very high melting point and a relatively small specific heat capacity. The very small diameter of the filament means that the filament has a large resistance.

Explain why the high melting point, small specific heat capacity, and large resistance of the filament are important for the incandescent lamps to work well in a circuit.

Begin your answer by describing the energy changes that occur in the filament when a current passes through it.

QUESTION THREE

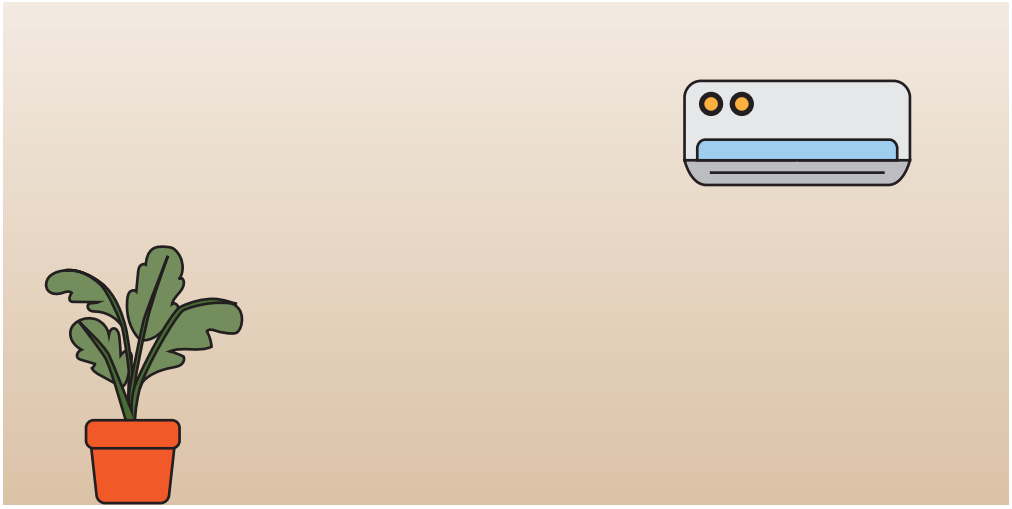
Pearl has had an air conditioning (AC) unit installed in her room. The AC unit uses electricity to cool down air and blow cooled-down air into her room. This way, Pearl's room is comfortably cool although it is hot outside.

AC units are typically mounted high up on a wall.

https://flitemechanical.com/mini-split/

(a) In the diagram below, draw labelled arrows to show the movement of warm air and cool air in the room.

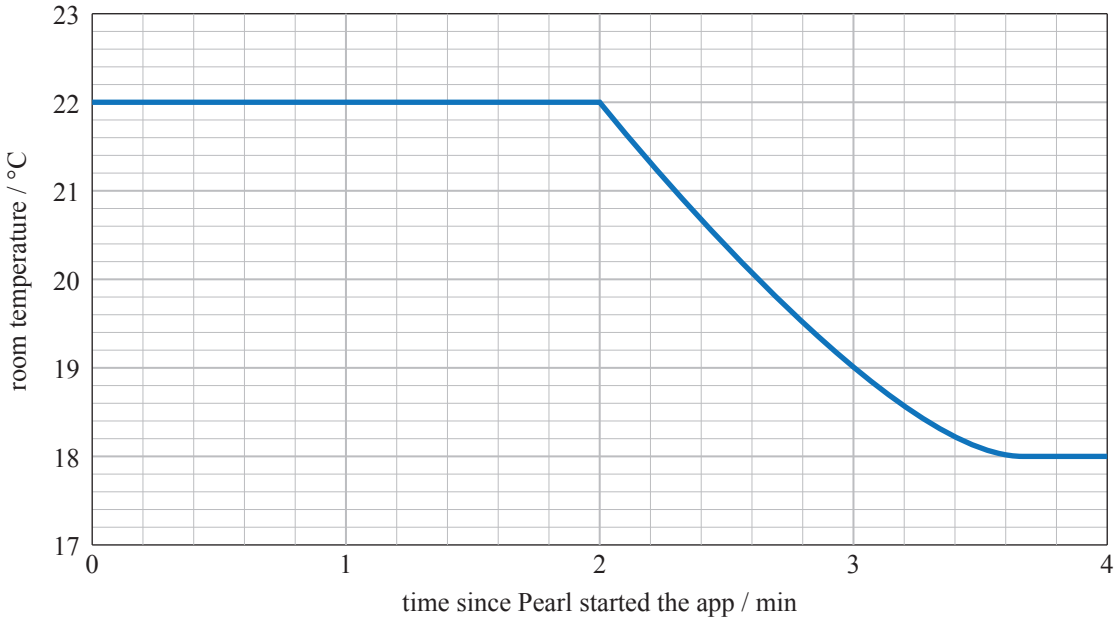
Disregard effects of air being pushed out of the AC unit.



(b) The volume of space occupied by a given amount of air depends on the temperature of the air. This is the reason for the movement of warmer and cooler air around the room.

Explain, in terms of particle theory of matter, why a given amount of cooler air occupies a slightly smaller volume of space than the same mass of warmer air.

(c) One summer morning, Pearl checks the room temperature on her phone. Two minutes after she starts the app, she sets the AC unit to 18 °C and switches it on. The temperature in her room drops as shown in the graph below.



Pearl's room contains 41.4 kg of dry air; the specific heat capacity of dry air is 718 J kg^{-1} $°C^{-1}$.

Using information from the graph above, **calculate the average power** of the AC unit in the two minutes after Pearl sets it to 18 °C.

Begin your answer by calculating the amount of thermal energy drawn from the air in Pearl's room.

Question Three continues on the following page.

(d) At night, when it gets cold outside, Pearl closes the curtains on the window in her room. Pearl's curtains reach down to the floor and are close to the wall.

Explain why the layer of air between the curtain and the window reduces heat transfer by conduction through the glass of the window pane.

In your answer, you should:

- explain, in terms of particle theory of matter, how heat transfer by conduction works
- compare and contrast conduction through air and glass.

Extra space if required.
Write the question number(s) if applicable.

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