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90184

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 1 Physics, 2004

90184 Demonstrate understanding of heat transfer and nuclear physics

Credits: Three
9.30 am Thursday 18 November 2004

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 answer ALL the questions in this booklet.

For all numerical answers, full working must be shown. The answer should be given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences.

Formulae you may find useful are given on page 2.

If you need more space for any answer, use the pages provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

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

Achievement Criteria *For Assessor's use only*		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles. ☐	Give descriptions or explanations in terms of phenomena, concepts, principles and/or relationships. ☐	Give concise explanations that show clear understanding in terms of phenomena, concepts, principles and/or relationships. ☐
Solve straightforward problems. ☐	Solve problems. ☐	Solve complex problems. ☐
Overall Level of Performance (all criteria within a column are met) ☐		

You are advised to spend 40 minutes answering the questions in this booklet.

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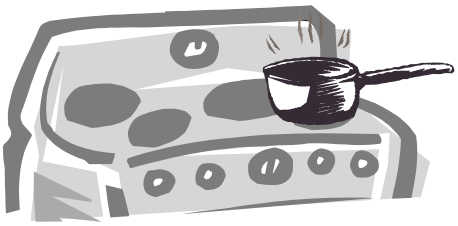
You may find the following formulae useful.

$$Q = mc\Delta T \qquad Q = mL \qquad P = \frac{E}{t}$$

QUESTION ONE: COOKING PASTA



Tama uses a pot with a thick steel base to heat some water to cook pasta. He places the pot on a flat electric hot plate without its lid and turns on the power.

(a) Name and explain the process by which heat energy is **transferred** from the hot plate to the water.

Process _____

Explanation _____

_____

_____

_____

_____

_____

(b) Name and explain the process by which heat energy is **spread** through the water.

Process _____

Explanation _____

_____

_____

_____

_____

_____

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(c) Explain why the water would reach boiling point **more rapidly** if Tama places a lid on the pot.

(d) The sides of cooking pots are often polished. Explain why a cooking pot with a polished surface stays hotter than one with a dull black surface.

(e) Explain why the handle of the pot is made from **plastic.**

(f) The pot contains **1.5 kg** of water and the specific heat capacity of water is **4200 J kg^{-1} (°C)$^{-1}$**. Show that the amount of heat energy required to raise the temperature of water by **85°C** is 535 500 joules.

The mass of the pot (excluding the plastic handle) is **0.5 kg.** The specific heat capacity of the steel is **447 J kg^{-1} (°C)$^{-1}$**. It took **5.0 minutes** to raise the temperature of water by 85°C. During this time the temperature of the pot increases by 95°C.

(g) Calculate the power output of the hot plate. Ignore the heat loss to the air and to the plastic handle.

power = _____

QUESTION TWO: MAKING CAPPUCCINO

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For this question you may use the following data:

> Latent heat of vaporisation of water is 2 260 000 J kg^{-1}.
> Specific heat capacity of water is 4200 J kg^{-1} $(°C)^{-1}$

Sue makes a cappuccino using her new coffee maker. She mixes coffee with milk in a cup, then bubbles steam from the coffee maker through the mixture. When steam is added to the mixture, it first condenses and then it cools down from **100°C** to the final drinking temperature of **85°C.**

(a) Show that the amount of energy released when **0.015 kg** of steam condenses to water at 100°C is 33 900 J.

(b) Calculate the **total** amount of energy released when **0.015 kg** of steam condenses to water at **85°C.**

Total energy = _____

(c) The power output of the coffee maker is **600 W**. Calculate the time taken, **in minutes**, to convert **0.04 kg** of water at 100°C to steam.

Time = _____

QUESTION THREE: NUCLEAR ENERGY

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Natural uranium is mainly $^{238}_{92}U$. About 0.7% of natural uranium is $^{235}_{92}U$. These two atoms are known as isotopes.

(a) Explain what is meant by the term **isotope**.

(b) Complete the following table for U-238.

Symbol	Number of protons	Number of neutrons
$^{238}_{92}U$		

Plutonium is a fuel sometimes used in nuclear reactors. One possible nuclear fission reaction for plutonium is:

$$^{239}_{x}Pu + {}^{1}_{0}n \rightarrow {}^{147}_{56}Ba + {}^{90}_{38}Sr + y\,{}^{1}_{0}n + \text{energy}$$

(c) Calculate the value of x and state the conservation law used to calculate its value.

Value of x

Law

(d) Calculate the value of y and state the conservation law used to calculate its value.

Value of y

Law

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Stars produce their energy by nuclear fusion. In stars larger than our sun this is achieved by the Carbon–Nitrogen–Oxygen cycle. One possible reaction for this cycle is:

$$^{15}_{7}\text{N} + \text{proton} \rightarrow {}^{m}_{6}\text{C} + {}^{4}_{n}\text{X} + \text{energy}$$

(e) Complete the following equation by writing the correct symbols for **proton** and **X;** and the correct numbers for **m** and **n** in the given square brackets.

$$^{15}_{7}\text{N} + {}^{[\ ]}_{[\ ]}[\quad] \rightarrow {}^{[\ ]}_{6}\text{C} + {}^{4}_{[\ ]}[\quad] + \text{energy}$$

(f) Explain why the fusion process is difficult to reproduce on Earth.

_____

_____

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Extra paper for continuation of answers if required.
Clearly number the question.

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