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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, 2006

90184 Demonstrate understanding of heat transfer and nuclear physics

Credits: Three
9.30 am Monday 20 November 2006

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 page(s) 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.

For Assessor's use only	**Achievement Criteria**	
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 30 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: NUCLEAR REACTIONS

An equation for a nuclear reaction is:

$$^{4}_{2}\mathrm{He} + {}^{x}_{13}\mathrm{Al} \rightarrow {}^{30}_{15}\mathrm{P} + {}^{1}_{0}\mathrm{n}$$

(a) Calculate the value of x.

The following equations represent three different nuclear reactions.

Reaction one: $^{1}_{1}\mathrm{H} + {}^{7}_{3}\mathrm{Li} \rightarrow 2\,{}^{4}_{2}\mathrm{He}$

Reaction two: $^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{140}_{54}\mathrm{Xe} + {}^{94}_{38}\mathrm{Sr} + 2\,{}^{1}_{0}\mathrm{n}$

Reaction three: $^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$

(b) Choose from the list above the reaction that represents a **nuclear fusion** reaction.
Give your reason.

Reaction: _____

Reason: _____

(c) State what "**235**" stands for in the symbol $^{235}_{92}\mathrm{U}$.

(d) Calculate the number of **neutrons** in uranium ($^{235}_{92}\mathrm{U}$) atom.

Neutrons: _____

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(e) In reaction two, one atom of uranium ($^{235}_{92}U$) produces **3.2 × 10^{-11} J** of energy. One gram of uranium contains **2.56 × 10^{21}** atoms. Calculate the amount of energy released if only a **third** of the atoms in one gram of uranium take part in the reaction.

Energy: _____

(f) Nuclear reactors use chain reactions to produce energy. Explain how the chain reaction is **controlled** in a nuclear reactor.

QUESTION TWO: THE STEAM IRON

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Michelle irons the dress she made for her school ball. The steam iron she uses has a metal base and a plastic upper body as shown in the diagram.

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http://www.chinagiftware.com

The mass of the metal base is **0.240 kg**. When the iron is turned on for **0.50** minutes, **19 400 J** of heat energy is used to change the temperature of the metal base from **22°C** to **110°C**.

(a) Calculate the **specific heat capacity** of the metal base.

Specific heat capacity = _____

(b) The steam iron is heated by an electric heating element placed inside the base of the iron.

Use the information given above to calculate the **power** output of the heating element.

Power = _____

(c) The upper body of the iron is made of plastic. State one **thermal property** of plastic, and explain how the design feature of the steam iron make use of this property.

Property: _____

Explanation: _____

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Before Michelle irons her dress, she cleans the bottom of the hot iron using a wax-like piece of solid material. As she rubs the solid material onto the bottom of the iron, it melts. The latent heat of fusion of the solid material is **291 000 J kg^{-1}.**

(d) Explain what "**291 000 J kg^{-1}**" means.

(e) During cleaning, **0.015 kg** of the solid material melts. The melting point of the solid material is **57°C**. Calculate the amount of **heat energy** required to melt the solid material at 57°C to liquid at the same temperature.

Energy = _____

The metal base of the steam iron contains a cavity. When water is poured into this cavity, it is heated to produce steam. The steam comes out of the metal base of the iron. Michelle pours 0.20 kg of water into the metal cavity. The initial temperature of the water is 18°C**.**

Data: Specific heat capacity of water = **4 200 J kg^{-1}(°C)$^{-1}$**
The latent heat of steam = **2 260 000 J kg^{-1}.**

(f) Use the information given above to calculate the amount of **heat energy** required to convert **0.20 kg** of water at **18°C** to steam at **100°C.**

Energy = _____

QUESTION THREE: LOOKING COOL

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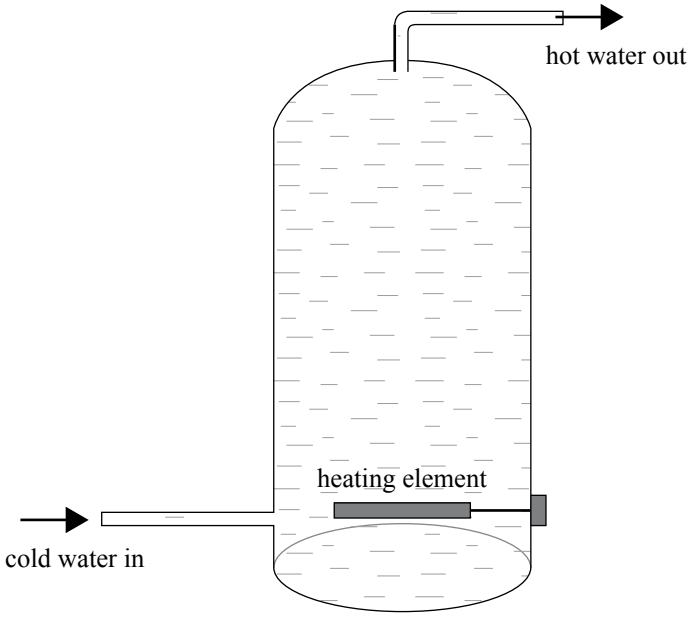
Michelle is having a shower. Hot water for the shower comes from a hot water cylinder. The water in the cylinder is heated by an electric element made from metal. It is placed near the base of the cylinder as shown in the diagram.



(a) Use the methods of heat transfer to explain how the element in the hot water cylinder heats all the water in the cylinder.

The hot water cylinder contains **180 kg** of water and the specific heat capacity of water is **4200 J kg^{-1} (°C)$^{-1}$**. The power output of the heating element is **3.0 kW**.

(b) Calculate the time taken to heat the water from **52°C** to **55°C**.

Time = _____

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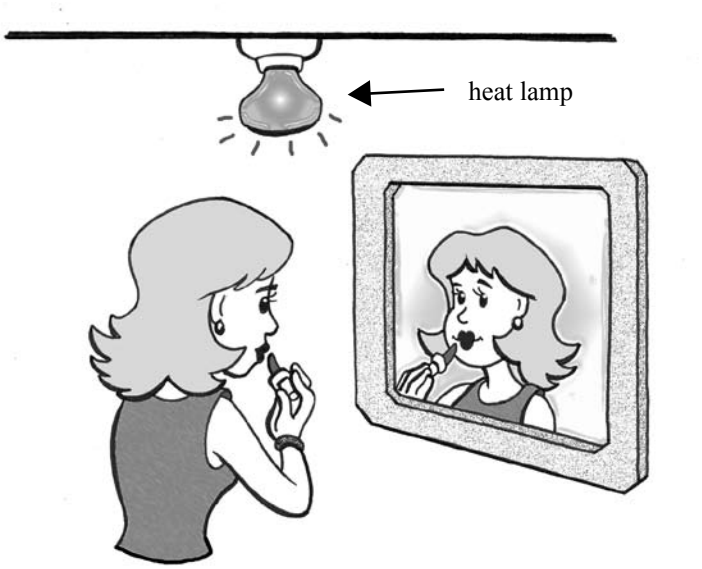
After the shower, Michelle stands directly under a heat lamp in the bathroom to put on her make up. When she turns the heat lamp on, she feels the heat instantly.



(c) State the **method** of heat transfer from the heat lamp to Michelle.

_____

(d) The power output of the heat lamp is **250 W**. Calculate the amount of **heat energy** produced by the lamp when it is turned on for **5.0 minutes**.

_____

_____

_____

_____

Energy = _____

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

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Question number	