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90939

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 1 Physics, 2014

90939 Demonstrate understanding of aspects of heat

2.00 pm Tuesday 25 November 2014
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of heat.	Demonstrate in-depth understanding of aspects of heat.	Demonstrate comprehensive understanding of aspects of heat.

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.

Make sure that you have Resource Sheet L1–PHYSR.

In your answers use clear numerical working, words and/or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

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 2–10 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

TOTAL 11

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QUESTION ONE: THE THERMOS FLASK DESIGN

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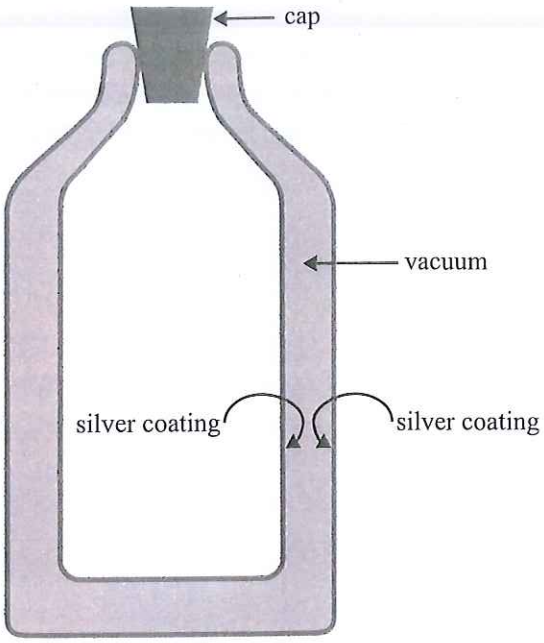

The diagram shows a thermos flask used for keeping hot liquids hot. It consists of two glass containers, placed one inside the other and sealed together at their necks. The air between the walls of the two glass containers is removed to create a vacuum. The inner and the outer glass layers are silvered, and the cap is made of thick plastic.

(a) Explain the purpose of removing the air from between the walls of the two glass containers.

The purpose of this is so that no heat gets trapped between the 2 containers, only inside the containes as the 2 containers are right next to each other it will make it easier for the heat to stay in. Also glass is an insulator so charge doesn't move around easily and will keep the liquid warmer for longer.

a, p

(b) Explain why the inner and the outer walls of the thermos flask are silvered.

The inner walls are silvered so the heat within the flask just reflects off the inside and heat stays trapped in the inside instead of being absorbed by the flask and losing heat. The outside is also silvered so both cool and hot air can not be absorbed and is reflected so everything within the flask stays hot.

a

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(c) The thermos flask can also be used to keep cold things cold. To test the effectiveness of a thermos flask, the flask is initially cooled to 0°C and then 1.2 kg of ice at 0°C is placed inside the flask and the cap is replaced. The flask and its contents are left undisturbed. It is found that after exactly 11.6 hours, all of the ice inside the flask is melted to water at 0°C.

The latent heat of fusion of ice is 3.36×10^5 J kg^{-1}.

(i) Calculate the average rate at which the contents gain heat from the surroundings, in joules per second.

$Q = mL = Q = 1.2 \times 3.36 \times 10^5 = 403,200$

~~336 000~~

~~Q = mL~~

~~Q = 1.2~~

336000 × 1.2

$Q = mL = Q = 1.2 \times (3.36 \times 10^5) = 403,200$

Rate of heat gain: 403,200 J

(ii) After all the ice has melted, the thermos flask and its contents are left for a certain time. It is found that the **rate** of heat gain gradually decreases.

Explain why this is so.

the rate of heat gain ~~gai~~ gradually decreases because once all the ice has melted, it will start to go warmer as the ice ~~sta~~ that has melted starts to go warmer. ~~with~~ Also the frozen ice that was cold has turned into liquid now which can only be done by heat which shows that gradually the rate of heat gain will decrease.

a

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(d) (i) Some hot water is placed in an **empty** thermos flask.

Explain why it is essential for the top of the flask to be closed for the liquid to remain hot over a long period of time.

The flask needs to stay closed so the heat can stay trapped inside the flask and keep reflecting off from the surface inside the flask back onto the water, keeping the water warm. If the top of the flask is open, the heat will be let out and it will no longer be trapped inside so it will cool down much faster.

(ii) In reality, the hot water in the thermos flask will lose heat over a 24-hour period, even if the top of the flask is closed.

Explain why this happens.

Because over time the particles in the hot water start to lose kinetic energy which decreases the heat of the particles which will eventually cause the the water to be cooler and as the particles keep moving and colliding into each other and the sides of the flask, it gradually loses heat energy causing the particles and hot water in the flask to lose heat

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QUESTION TWO: HEATING WATER

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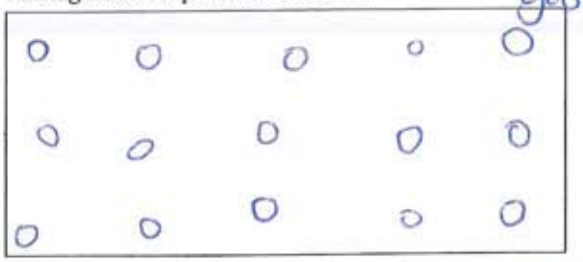
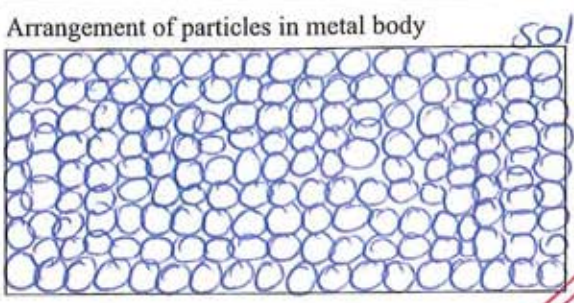
http://motivationnation.wordpress.com/2007/11/25/212-degrees/

Arrangement of particles in steam



Arrangement of particles in metal body



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(a) The photograph above shows water being heated in a container. As the water boils, steam is produced.

In the spaces given above, draw diagrams to show how the particles are arranged in:

(i) steam

(ii) the metal body of the gas burner.

(b) (i) The metal body of the gas burner is made from iron. When the metal body heats up, it expands.

In terms of the arrangement of particles in the metal body, explain why the metal body expands during heating.

This is when conduction is occuring. At first all the particles are the same but when they collide into each other, it causes expansion. When it is heated, heat energy is transfered into kinetic energy and into heat energy again.

(extra page)

(ii) Explain why heat energy is needed to convert boiling water at 100°C to steam at 100°C, even though the temperature remains constant during the change of phase.

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Heat energy is needed because even though the temperature stays constant when it's boiling and steaming. The less dense and hotter particles in the water moves to the top and the more dense cooler particles move to the bottom causing convection currents and when this keeps going it causes the temperature to

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(c) Particles in water are in liquid state, and particles in steam are in gaseous state.

(i) State one similarity between the behaviour of the particles in liquid state and in gaseous state.

particles are the same size and gained heat energy and kinetic energy.

(ii) State one difference between the particles in liquid state and in gaseous state.

The particles in a gaseous state take up more space than in a liquid state.

(d) A liquid is heated with a 150 W electric heater. When the liquid reaches the boiling point, only 85% of the power supplied is absorbed by the liquid to keep it boiling, and the rest is lost to the surroundings.

Calculate the value of the **latent heat of vaporisation** of the liquid, given that 0.0075 kg of the liquid has evaporated in 35 s.

$Q = mL$

$L = Q/m$

$L = 5,250 \times 0.0075$

$= 39.375 \text{ J kg}^{-1}$

$= 39.4 \text{ J kg}^{-1}$

$E = P \times t = 150 \times 35$

$= 5,250 \text{ J}$

$Q = mL$

$L = Q/m$

$L = 5250 \times 0.0075$

$= 39.375 \text{ J kg}^{-1}$

Latent heat of vaporisation: ~~39~~ 39.375 J kg^{-1} 39.4 J kg^{-1}

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A3

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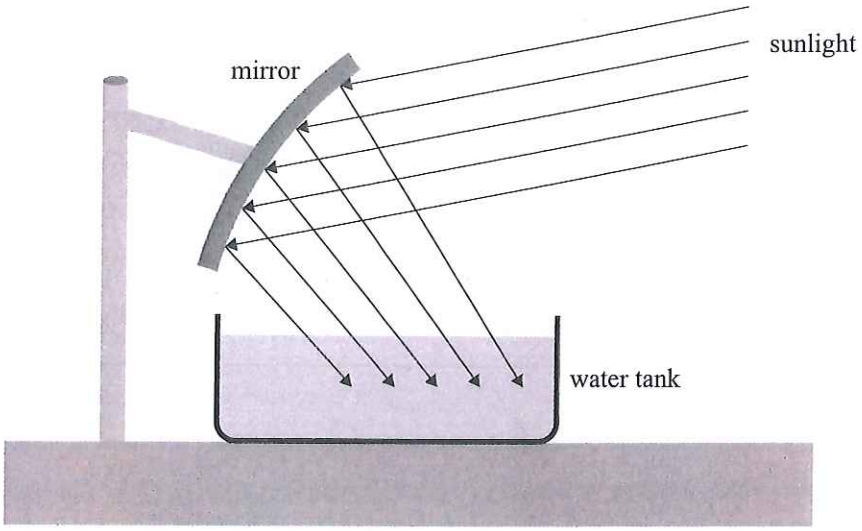
The examination continues on the following page.

QUESTION THREE: SOLAR HEATING

ASSES USE

A curved mirror is used to heat water. The mirror focuses the heat energy from the Sun onto a small metal tank containing water, as shown in the diagram below. The mirror is made from a thin sheet of polished stainless steel and it is arranged so that all of the reflected energy is focussed onto the water and the tank.



(a) Name and describe the method of heat transfer from the Sun to the mirror in the above set-up.

Name: Radiation

Description: Radiation can occur in solids, liquids or gases and doesn't require any matter. Heat radiation (waves) energy from the sun is transfered into infra-red waves.

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(b) Not all the energy incident on the mirror is actually used to heat the water.

Give TWO reasons why this is so.

Reason 1: Because some heat energy is lost when it hits the mirror.

Reason 2: Because some heat energy gets transfered into kinetic energy (within the particles of the water) And some heat energy is absorbed.

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(c) On a particular day, the average amount of energy received from the Sun at the mirror is 630 joules per square metre per second. The area of the mirror is 1.5 m^2.

Specific heat capacity of water is 4200 J kg^{-1} $(°C)^{-1}$.

Calculate the minimum time taken to raise the temperature of 5.0 kg of water from 26°C to 90°C.

Assume that the entire heat energy incident on the mirror is used to heat the water.

$Q = mc\Delta T$ $\quad P = \frac{E}{t}$ $\quad P = \frac{630}{t}$ $\quad t = \frac{E}{P} = t = \frac{630}{P}$

$Q = 5.0 \times 4200 \times (90 - 26 = 64)$ $\quad 630$,

$Q = 5.0 \times 4200 \times 64$

$= \frac{1,344,000}{630}$ $\quad = 2133.3$

M

Minimum time: 2133.3 s

(d) State and explain TWO modifications to the set-up shown in the previous page that would increase the efficiency of heating of the water in the tank.

If the mirror was shiny or silvered, it would increase the efficiency because it would reflect all the heat energy where as the metal tank absorbes some of the heat due it being a dark/dull coloured metal. The efficiency could be increased, if there were 2 mirrors so more heat energy is used to to heat the ~~same~~ same amount of water at the same time. The efficiency could also be increased if there was a smaller amount of water ~~with~~ in the ~~same~~ same container with the same mirror. This would heat the wate faster and if the same amount of water wanted to be heated, 2 sets of this could be set up to heat the water.

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M5

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

QUESTION NUMBER

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Q2 b) Conduction only occurs in solids and the metal body is a solid therefore the particles are held together tightly and don't take up much space and have little or no kinetic energy. //

S3

Achievement exemplar for 90939 2014		Total score	11
Q	**Grade score**	**Annotation**	
1	A3	(a) **Achievement.** A pertinent method of heat transfer prevention (insulation) is described but not explained. (b) **Achievement.** Reflection is correctly described but not why silver is used as the mirror. (c) **Achievement.** There is a partially correct calculation here. For Merit, there has to be a full calculation for the rate of heat energy gain. (d) **Not Achieved.** For Achievement, there has to be some Physics ideas used to explain heat loss.	
2	A3	(a) **Achievement.** Correct diagrams for steam particles and metal particles in solid form. (b) **Achievement.** There is implied vibration when collisions between particles are discussed. For Merit, there needs to be an explanation of the metal particles vibrating more or an explanation about latent heat. (c) **Not Achieved.** For Achievement, there needs to be one valid similarity between the particles in liquid and gaseous state or one valid difference. (d) **Achievement.** There is a correct method for one part of the calculation. For Merit, there has to be at least two parts of the full calculation required to calculate the latent heat of vaporisation using the information given.	
3	M5	(a) **Achievement.** Has correctly identified radiation as the method of heat transfer from the Sun. For Merit, there should be a coherent description of radiation. (b) **Achievement.** There is a least one valid reason for loss of energy stated; but for Merit, there should be at least one explained. (c) **Merit.** There has been a valid method used to calculate the time taken with one error/omission (630 J used when it should have been 945 J). For Excellence, this should have been correct. (d) **Merit.** One valid modification has been stated, with a valid explanation. For Excellence, two valid modifications should be stated, both with valid explanations.	