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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

SUPERVISOR'S USE ONLY

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.

Merit

TOTAL 17

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QUESTION ONE: THE THERMOS FLASK DESIGN

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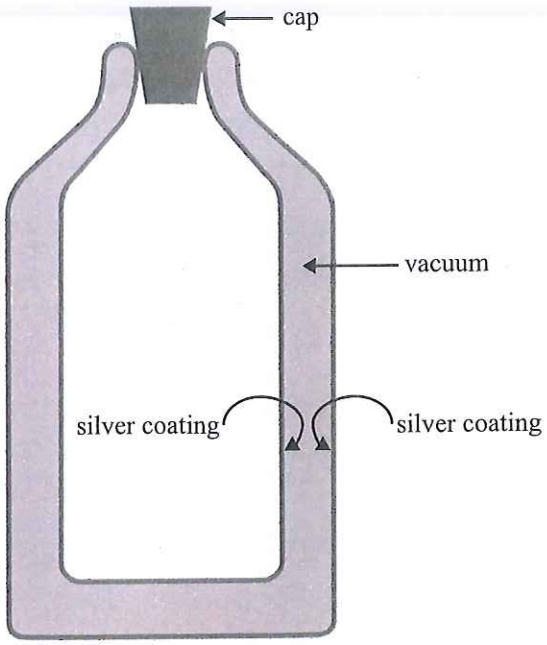

The diagram shows a thermos flask used for keeping hot liquids hot. It consists of two glass containers, placed one inside the other and sealed together at their necks. The air between the walls of the two glass containers is removed to create a vacuum. The inner and the outer glass layers are silvered,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

Air is a poor conductor the air is removed so that there is no air trapped between two glass which ~~heats~~ can insulate the heat being released from thermos flask.

a

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

The silver coating is good reflector of radiant energy therefore reflects the heat back to ~~the~~ thermos flask, ~~to~~ keeping the liquid hot. Also silver coating is a poor radiator/emitter therefore ~~heat~~ heat is ~~not~~ ~~(~~ not radiated easily.

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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.

$Q = m \times L$

$= 1.2 \times 3.36 \times 10^5$

$= 403,200$ J

$11.6 \times 60 \times 60$

$= 41760$ seconds

$\frac{403,200}{41760}$

$= 9.7$ Joules per second

Rate of heat gain: 9.7 Joules per second

(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.

As the ice melts the heat energy from the thermos flask is conducted away by the ice which causes the ice to melt.

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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.

"By ~~cold~~ closing top of the flask it prevents heat escaping through convection, where hot water ~~is~~ becomes less dense which expands and rises to top and cold denser water drop to bottom. Since the waters hot the ~~heat the~~ water can escape the thermos flask by convection."

(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.

It is ~~to~~ impossible to prevent all heat loss, the heat energy is lost through surrounding environments such as: very slowly escaping by convection through the top of the flask.

a

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M5

QUESTION TWO: HEATING WATER

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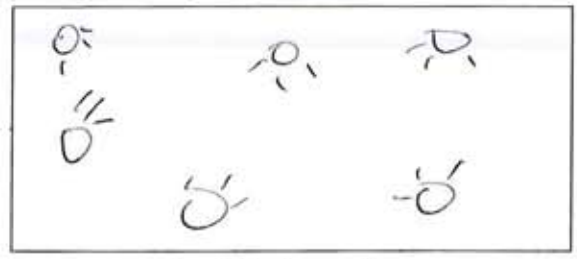
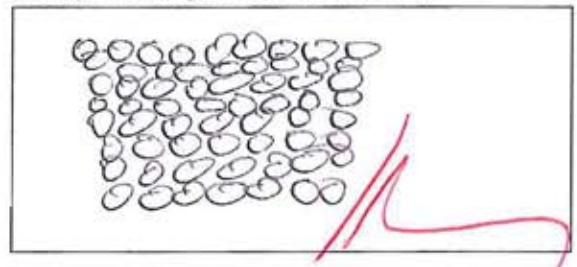
http://motivationnation.wordpress.com/2007/11/25/212-degrees/

Arrangement of particles in steam



Arrangement of particles in metal body



(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.

metal uses conduction to transfer heat energy, where the particles ^vibrate^ and knocking the less vibrating particles and metal expands as the particles vibrate during heating.

(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.

Latent heat of water where it has to absorb certain ~~heat~~ amount of heat energy to change state from liquid to gas but no change in temperature.

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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.

the particles are not packed together as it is in solid state both liquid and gas particles move freely around

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

Liquid state particles fills up in volume but gaseous state particles do not have to fill up from bottom of container in volume as it is more freely enabled to move around

a

(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.

$E = P \times t$

$= 127.5 \times 35$

$= 4462.5\ J$

$P = 150 \times 0.85$

$= 127.5$

e

$L = \frac{Q}{m}$

$= \frac{4462.5}{0.0075}$

$= 595{,}000\ J\,kg^{-1}$

Latent heat of vaporisation: 595,000 J kg⁻¹

E7

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The examination continues on the following page.

QUESTION THREE: SOLAR HEATING

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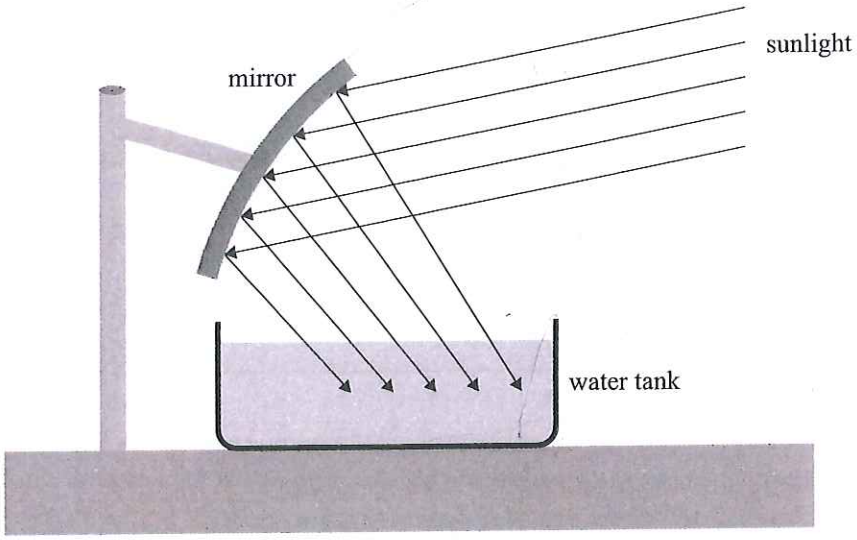
A curved mirror is used to heat water. The mirror focuses the heat energy from the Sun onto a small metal tank containing water, as shown in the diagram below. The mirror is made from a thin sheet of polished stainless steel and it is arranged so that all of the reflected energy is focussed onto the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

a

(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: Some of the radiant energy from the sun is conducted by stainless steel to heat up the ~~metal~~ steel.

Reason 2: Some of the sunlights are bounced off to other direction such as towards the ground.

a

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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.

$Q = mc\Delta T$

$= 5 \times 4200 \times (90-26)$

$= 1,344,000$ J

$P = \frac{E}{t}$ $\quad t = 1,344,000 / (630 \times 1.5)$

$t = \frac{E}{P}$ $\quad = 1422.2$ seconds

Minimum time: 1422.2 seconds

e

(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.

Increase the surface area of the mirror to maximise the sunlight (radiant energy) that are reflected to water tank, ~~to~~ which would speed up the heating of the water tank.

Make sure all equipments (water tank,) are coloured in black to maximise the absorbtion of radiant energy, as the colour black is the best ~~h~~ heat absorber.

Provide L-shape for the mirror and the sun so that the reflection of the sunlight is maximised.

M

M5

Merit exemplar for 90939 2014		Total score	17
Q	**Grade score**	**Annotation**	
1	M5	(a) **Achievement.** Preventing one method of heat transfer (conduction) is described and explained but there is no mention of preventing the other pertinent heat transfer (convection). (b) **Merit.** Reflection is correctly described and why silver is used as the mirror. (c) **Merit.** There is a full calculation for the rate of heat energy gain but no explanation of why the rate of heat gain decreases. (d) **Achievement.** There is mention of Physics ideas used to explain heat loss (convection) but a limited explanation.	
2	E7	(a) **Achievement.** Correct diagrams for steam particles and metal particles in solid form. (b) **Achievement.** Latent heat of vaporisation has been identified as a factor and there is implied vibration when collisions between particles are discussed. For Merit, there needs to be an explanation about latent heat or an explanation of the metal particles vibrating more. (c) **Achievement.** There is one valid similarity between the particles in liquid and gaseous state; but for Merit there has to be one valid difference as well. (d) **Excellence.** There is a full calculation to calculate the latent heat of vaporisation including correct units 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) **Excellence.** There has been a valid method used to calculate the time taken. (d) **Merit.** One valid modification has been stated with a valid explanation. For Excellence, two valid modifications should be stated both with valid explanations.	