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NZQA

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Level 1 Physics, 2015

90939 Demonstrate understanding of aspects of heat

9.30 a.m. Thursday 19 November 2015
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 2–9 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: MILK TANKS

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Dairy farmers store milk in a tank made from stainless steel like the one shown in the photograph.

(a) When a farmer touches an empty stainless steel milk tank with his bare hand, his hand feels cold.

Use physics ideas to explain why his hand feels cold when he touches the tank with his bare hand.

This is because steel conducts heat very well so it takes away the heat from his hand giving it a cold feeling

M

(b) On a sunny day, even though the sunlight falls on only one half of the empty stainless steel tank, the other half also becomes hot.

Use a **heat transfer** method to explain how the heat energy from the **Sun** reaches the tank, and how the **whole** metal body of the tank heats up.

The heat energy reaches the tank from the sun by ~~conduction~~ radiation

(c) An empty tank has a mass of 680 kg. The specific heat capacity of stainless steel is 510 J kg^{-1} $°C^{-1}$. During the day, the tank heats up from 19°C to 28°C.

Calculate the amount of heat energy absorbed by the tank.

Write down your answer in **kilojoules**.

$Q = mL$ $Q = 680 \times 510$

$Q = 346800$ J

Heat energy:

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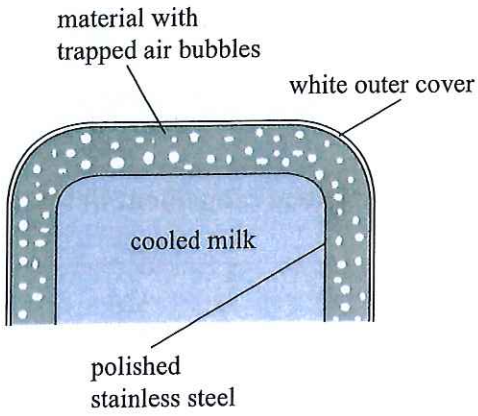
(d) Milk collected from cows on a dairy farm is rapidly cooled and stored until it is transported to a processing factory. The diagram shows an insulated stainless steel tank used to store milk. The tank is initially wrapped using an insulating material with **air bubbles** trapped in it. It is then covered with a **white** waterproof material.

The sketch below shows three main design features of an insulated milk tank.



Explain, in terms of heat transfer, how the design features labelled in the diagram help to keep the milk cool.

White outer cover:

White does not absorb heat energy as well as other ~~colo~~ darker colours such as black, if it does not absorb the heat energy it remains cool

M

Trapped air bubble material cover:

does not allow transfer of heat energy from outside to inside. Method of

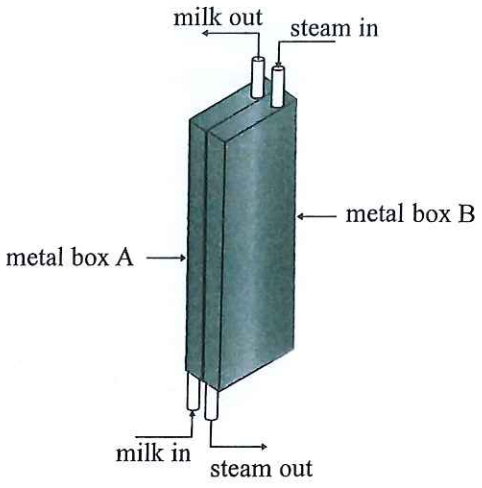
Polished stainless steel inner:

Reflects away some of the heat energy

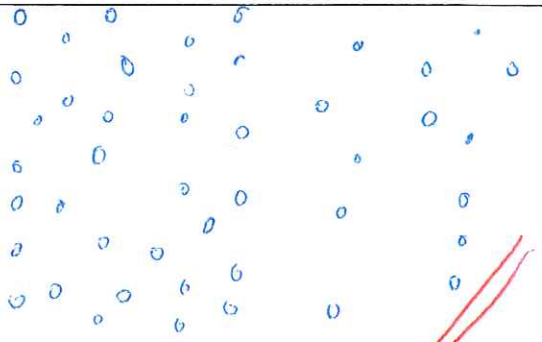
M5

QUESTION TWO: MILK PROCESSING

In a milk processing factory the milk is heated to a specific temperature for a very short time. This is done by using a plate heat exchange system. It consists of a series of a very thin metal boxes placed **touching** each other. The diagram shows a pair of metal boxes used in a plate heat exchange system. Cold milk is continuously passed through box A, while steam continuously passes through box B.



(a) In the space given below, draw diagrams to show the arrangement of particles in the hot metal of box B and in the steam.

Particle arrangement in the HOT metal of box B	Particle arrangement in steam
	

(b) Using a heat transfer method, explain how the heat travels from the metal box B to the cold milk in the metal box A.

The heat travels from metal box b to the cold milk in metal box A by convection

(c) As the milk passes through the metal box A, its temperature quickly increases whilst still staying in a liquid state.

(i) Describe how the distance between the milk particles changes during heating.

they become less squated so less dense but remain in contact due to remaining in liquid state.

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(ii) Explain why this occurs.

this is due to the particles vibrating more ~~fast~~ intensely making them spread out more.

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(d) (i) During the heat transfer process, some of the steam at 100°C condenses to water at 100°C.

Show that the energy released to the surroundings when 1.0 g of steam at 100°C condenses to water at 100°C is 2300 J.

Latent heat of fusion of steam is 2 300 000 J kg^{-1}.

~~Q = m L~~

Q = mL

~~Q = 0.001 × 2300000~~ ~~Q = 0.001 × 2,300,000~~

~~Q = 2300J~~ ~~Q = 2,300J~~

Q = 0.001 × 2300000

Q = 2,300J

(ii) When 1.0 g of steam condenses to water, 2300 J of energy is released to the surroundings. 8.0 g of milk absorbs 85% of the energy released. The specific heat capacity of milk is 3900 J kg^{-1} $°C^{-1}$.

~~Q = m L~~

a

Calculate the increase in temperature of the milk.

Q = mc ΔT Q = 0.008 × 3900 × ΔT

~~Q = 0.008 × 3900 × ΔT~~ 2300 = 0.008 × 3900 × ΔT

~~2300 ÷ 0.008 ÷ 3900 = ΔT~~ Q ÷ m ÷ c = ΔT

~~2.7 °C~~ 2300 ÷ 0.008 ÷ 3900 = ΔT

Increase in temperature: 73.72 °C (2 dp)

(iii) Some of the heat from the plate heat exchange system is lost to the surroundings.

Using one heat transfer method, explain how the heat energy is lost to the surroundings.

lost by radiation

A3

QUESTION THREE: IN A CAFÉ

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When making a coffee in a café, milk is heated by passing steam into a jug of milk. When steam passes through the milk, some steam condenses to water.

Latent heat of fusion of steam is 2 300 000 J kg^{-1}.

(a) Use the given context above to explain the meaning of "latent heat of fusion of steam is 2 300 000 J kg^{-1}".

http://democafedonpaco.cadimo.com/wp-content/gallery/preparation-tips/steaming-milk-for-a-cappuccino.jpg

it takes 3300,000J of energy to ~~Water~~ transfer 1kg of liquid water to steam.

9

(b) In the café, take-away coffee is normally served in a paper cup with a lid.

Use one heat transfer method to explain how the lid **reduces** the loss of heat to the surroundings.

It is done by not letting heat energy escape the coffee so it remains within the cup keeping it warmer for longer.

http://www.dreamstime.com/illustration/takeaway-coffee-cup.html

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(c) (i) The power output of the coffee machine is 1100 W.

Latent heat of vaporisation of water is 2 300 000 J kg^{-1}.

Calculate the time taken to convert 20 g of water at 100°C into steam at 100°C.

$Q = mL$

$Q = 0.02 \times 2300000$

$Q = 46000\ J$

$P = E/t$

$t = E/P$

$T = 46000J / 1100$

$T = 41.82$ (2dp) seconds Time: 41.87 (2dp) seconds

(ii) The temperature of the boiling water and the steam is 100°C.

State whether 200 g of boiling water at 100°C or 200 g of steam at 100°C has more energy.

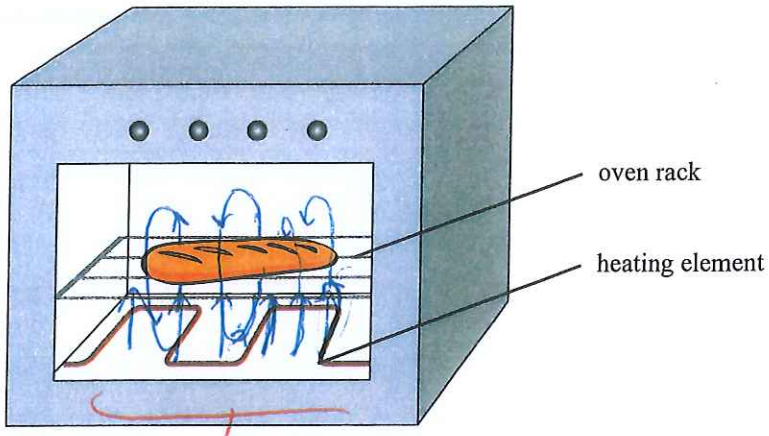
Explain your answer.

~~The steam does~~ The boiling water has more energy because it still contains the 2300000 Jkg^{-1} of energy that is needed to convert itself to gas state.

M

Question Three continues on the following page.

(d) The diagram below shows a breadstick being heated in an oven in the café.



(i) On the diagram, draw arrows to show the direction of movement of air **inside** the oven.

(ii) Explain why the air moves in the direction shown by your diagram.

so then the hot air cooks the bread and hot air rises because it is less dense than cool air.

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a

A3

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

QUESTION NUMBER

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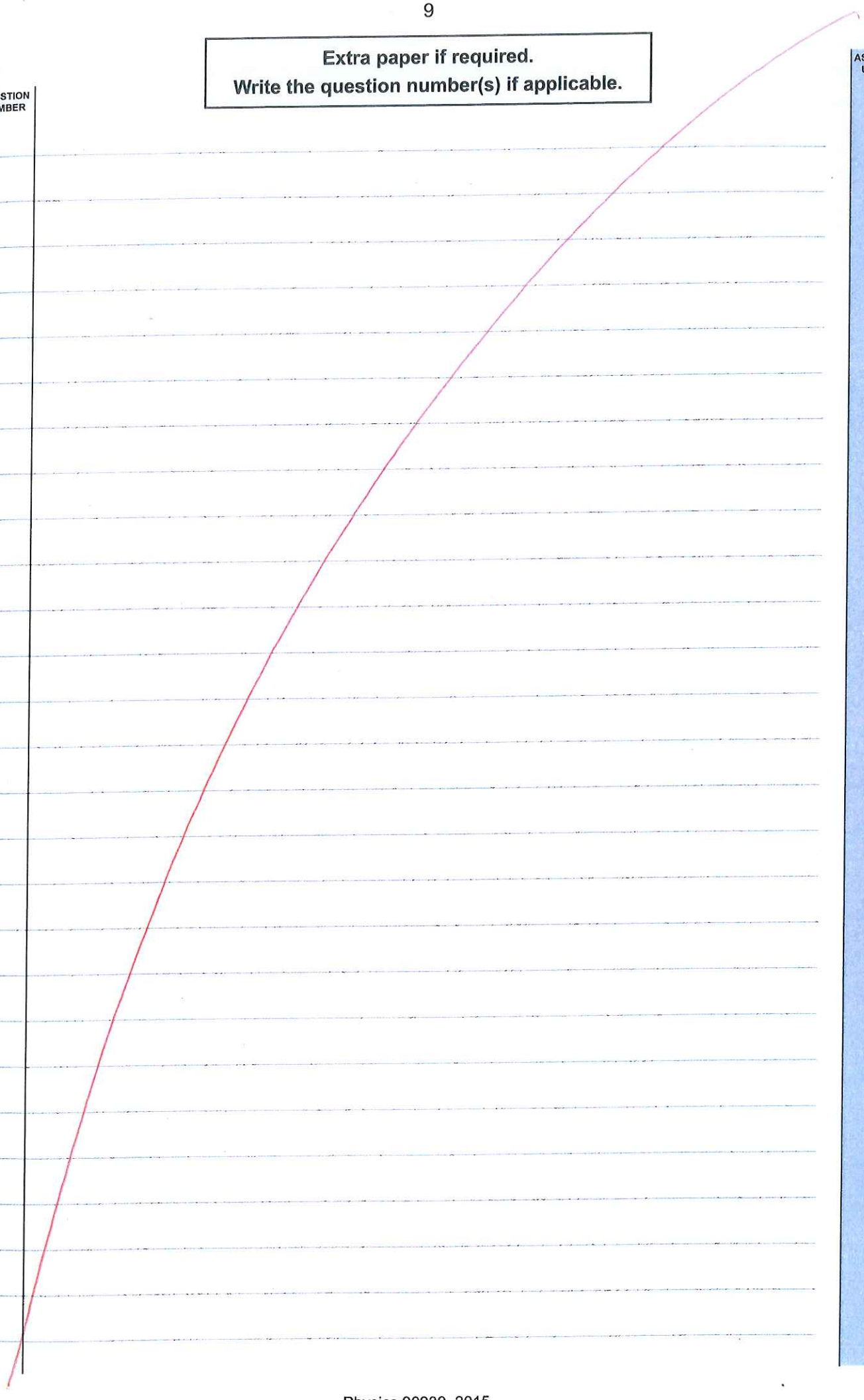

Annotated Exemplars

Achieved exemplar for 90939 2015		Total score	11
Q	**Grade score**	**Annotation**	
1	M5	(a) **Merit.** Clear description of heat transfer from hand to tank and linkage between heat transfer and conductive properties of steel. (b) **Not Achieved.** Clear description of heat transfer by radiation (from Sun to empty tank) but no clear description of heat transfer by conduction (within the body of the tank) (c) **Not Achieved.** For Achieved there has to be a correct attempt to calculate the heat energy gain using the information given (d) **Merit.** One clear explanation of how heat transfer is reduced has been given.	
2	A3	(a) **Achieved.** Correct diagrams for both steam particles and metal particles in solid form are given. (b) **Not Achieved.** For Achieved there needs to be discussion of the metal particles vibrating more or description of conduction. (c)(i) and (ii) **Merit.** There is a clear description in part (ii) of the particles getting further apart and an explanation that they are vibrating more (d) **Achieved.** There has been a valid method to show the energy released is the value given.	
3	A3	(a) **Achieved.** There is a correct description of latent heat. (b) **Not Achieved.** For Achieved there needs to be at least one valid heat transfer method given. (c) **Merit.** The time taken using the information given has been correctly calculated but there is no correct statement that steam has more energy than water with an explanation. (d) **Achieved.** Arrows have correctly been drawn to indicate convection currents.	