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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.

Not Achieved

TOTAL 04

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QUESTION ONE: MILK TANKS

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.

Because the Stainless steel tank is a shade of silver light rays shined on the tank are reflect ~~make~~ which makes the tank feel cold because ~~this~~ no heat was conduted

(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 whole tank is connected and the heat is passed on slowly through the tank, because of particles Spread as the metal expands

(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.

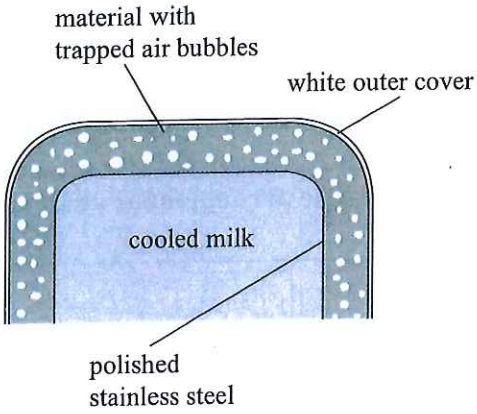
Calculate the amount of heat energy absorbed by the tank.

Write down your answer in **kilojoules**.

Heat energy:

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:

A white outer cover helps to reflect light rays off the tank in order to keep the temperature of the tank low.

Trapped air bubble material cover:

The air bubble material helps to stop the Air particles from moving because they are in a vacuum and can't move which stops heat transfer.

Polished stainless steel inner:

The Stainless Steel helps to keep the ~~S~~ tank by reflecting ~~to~~ the rays that are radiated by the milk

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N1

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QUESTION TWO: MILK PROCESSING

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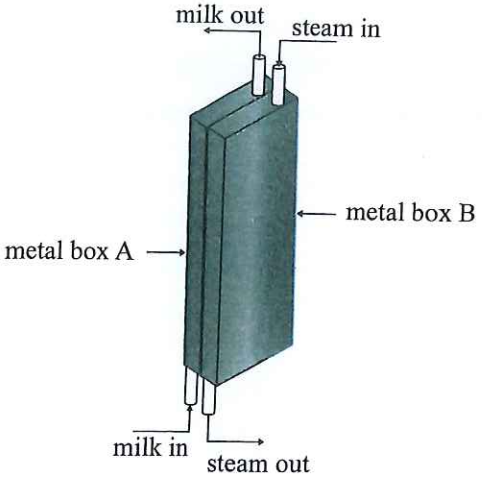
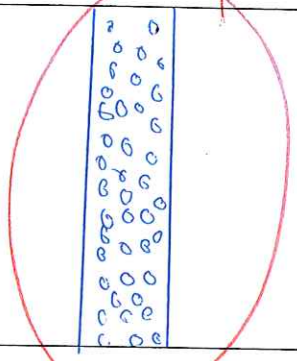
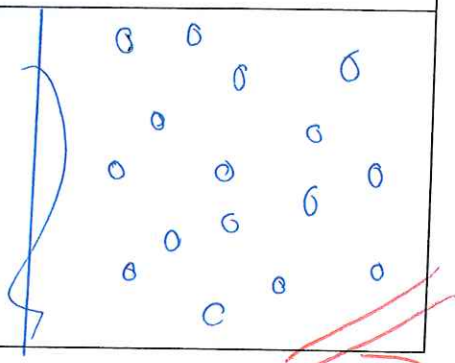
In a milk processing factory the milk is heated to a specific temperature for a very short time. This is done by using a plate heat exchange system. It consists of a series of a very thin metal boxes placed **touching** each other. The diagram shows a pair of metal boxes used in a plate heat exchange 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 boxes are touching each other and over a period of time they expand and particles in the solid heat the ~~boxes~~. milk.

(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.

During heating the distance gets bigger ~~and~~ as the temperature rises.

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(ii) Explain why this occurs.

The milk is heated an expands so the particles spread further from each other.

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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}.

$Q = mL$

~~$Q = m$~~ $Q = 1 \times 2300000$ $Q = 0.001 \times 2300000$

$Q = 2300\,J$

4

(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 $kg^{-1}\,°C^{-1}$.

Calculate the increase in temperature of the milk.

~~$Q = mc\Delta t$~~

Increase in temperature: _____

(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.

The boxes emitt radiation which ~~losses~~ makes the boxes lose heat energy.

N2

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

The amount of energy needed to convert the milk into steam.

(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.

The lid only has a small gap to drink from, so particles find it harder to leave the cup as which contains the heat ~~the loss of heat~~. preventing it from cooling off (~~loosing~~ losing heat)

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=mcΔT~~ Q=mL

~~Q=0.20kg~~ Q=0.20 × 2300 000

Q=460000

P=E/T

T=P×E

T=460000 × 1100

T=506 000 000

Time: ...

(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.

Steam has more energy because of the ability to move freely and is the same temperature but much more powerful because of the particles ability to move.

Question Three continues on the following page.

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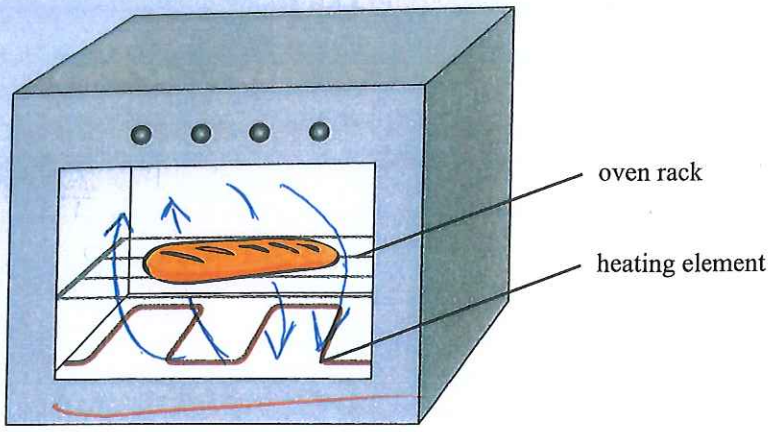
(d) The diagram below shows a breadstick being heated in an oven in the café.



(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.

~~cool~~ hot air rises and cool air drops which forms a convection current.

a

N1

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

QUESTION NUMBER

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Annotated Exemplars

Not Achieved exemplar for 90939 2015		Total score	04
Q	**Grade score**	**Annotation**	
1	N1	(a) **Not Achieved.** No clear description of heat transfer from hand to tank and no linkage between heat transfer and conductive properties of steel. (b) **Not Achieved.** No clear description of heat transfer by radiation (from Sun to empty tank) and no clear description of heat transfer by conduction (within the body of the tank) (c) **Not Achieved.** For Achieved there has to be an attempt to calculate the heat energy gain using the information given (d) **Achieved.** One clear description of how heat transfer is reduced has been given.	
2	N2	(a) **Not Achieved.** Correct diagrams for both steam particles and metal particles in solid form required. (b) **Not Achieved.** For Achieved there needs to be discussion of the metal particles vibrating more or description of conduction. (c)(i) and (ii) **Achieved.** There is a description of the particles getting further apart. (d) **Achieved.** There has been a valid method to show the energy released is the value given.	
3	N1	(a) **Not Achieved.** For Achieved there needs to be a correct description of latent heat. (b) **Not Achieved.** For Achieved there needs to be at least one valid heat transfer method given. (c) **Not Achieved.** For Achieved there has to be a valid attempt to calculate the time taken using the information given or a statement stating that steam has more energy than water with an attempted explanation. (d) **Achieved.** Arrows have correctly been drawn to indicate convection currents.	