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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.

TOTAL

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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.



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- (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.

- (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.

- (c) An empty tank has a mass of 680 kg. The specific heat capacity of stainless steel is $510 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$. 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**.

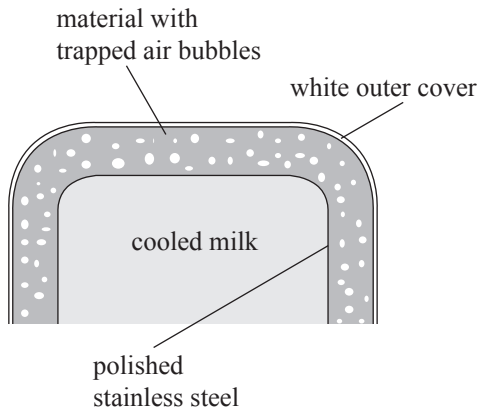
Heat energy: _____

- (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.



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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.

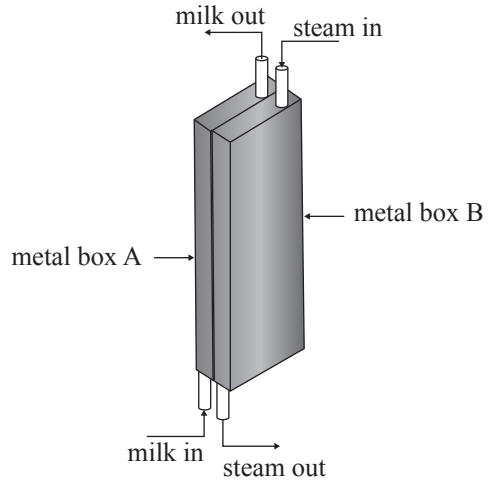
White outer cover:

Trapped air bubble material cover:

Polished stainless steel inner:

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.



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- (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.

- (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.

(ii) Explain why this occurs.

(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 $2\,300\,000\text{ J kg}^{-1}$.

(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 $3900\text{ J kg}^{-1}\text{ }^{\circ}\text{C}^{-1}$.

Calculate the increase in temperature of the milk.

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.

QUESTION THREE: IN A CAFÉ

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 $2\,300\,000\text{ J kg}^{-1}$.

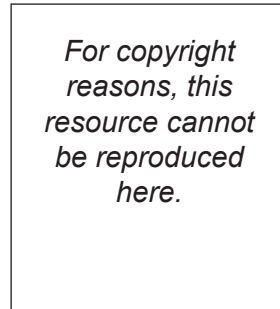


- (a) Use the given context above to explain the meaning of “latent heat of fusion of steam is $2\,300\,000\text{ J kg}^{-1}$ ”.

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

- (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.



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

- (c) (i) The power output of the coffee machine is 1100 W.
Latent heat of vaporisation of water is $2\,300\,000\text{ J kg}^{-1}$.

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

Time: _____

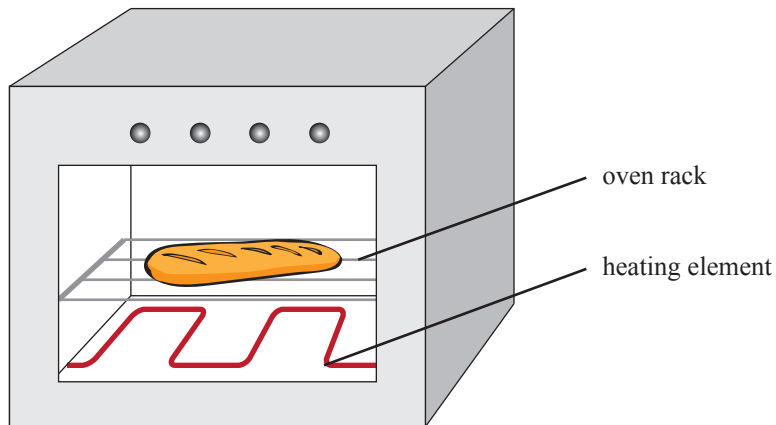
- (ii) The temperature of the boiling water and the steam is 100°C .

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

Explain your answer.

**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.

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