Grade 8 Natural Science Worksheet

Transfer of heat energy

Part One: Conduction

In this activity you will investigate what is meant by conduction.

You will need:

A candle

A metal knitting needle

A saucer

YOU WILL BE WORKING WITH A LIT CANDLE - PLEASE MAKE SURE THAT YOU WORK ON A SUITABLE SURFACE (MAYBE OUTSIDE IN A SHELTERED SPOT). DO NOT LEAVE THE CANDLE BURNING UNATTENDED OR NEAR CHILDREN.

What to do:

1. Light the candle and then carefully drop a blob of wax onto the knitting needle, about 3 cm from the pointed end.
2. Drop four or five more blobs of equal sized wax onto the knitting needle, moving up the needle at 2 cm intervals.
3. Place the lit candle upright in the saucer.
4. Let the wax cool and harden.
5. When the wax is cold, hold the rounded end of the needle and put the pointed tip into the flame. Keep just the tip in the flame and observe what happens.

Note your observations.

What do you conclude from the above investigation? Mention energy transfer in your answer.

Your teacher will award marks for how you conduct the experiment.

[20 marks]

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Part Two: Investigations

In this task:

- You will investigate the *conductivity* of *different* materials.
- You will also investigate the *reliability* of investigations.
- You will further have an opportunity to *postulate/suggest ideas*, based on your investigations.

You will need:

A wooden spoon/thinnish wooden stick or twig, about the diameter of a wooden spoon's handle

A metal tablespoon or serving spoon

A plastic serving spoon/salad server – if you don't have one, use a plastic coat hanger

A tall drinking glass

A candle

4 drawing pins/thumb tacks

Large flat bottomed basin/bowl

Kettle

Water

YOU WILL BE WORKING WITH A CANDLE AND BOILING WATER FROM A KETTLE – PLEASE TAKE CARE

What to do:

Read the following incident:

Disego and Sibusiso were washing up the dishes after dinner for their mother. Suddenly Sibusiso yelled out, "Ow, this knife is hot - it burnt my hand!"

"Don't be a baby, Sibusiso," said Disego, "Look, I'm also washing spoons and other cutlery, but I'm not getting burnt!"

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"Here, touch this one," said Sibusiso, pointing to the carving knife in the water.

Disego picked up the knife, and then dropped it with a yelp, "Ow, it IS hot! But how come these spoons are not as hot?"

"Maybe it's got something to do with the plastic around the spoons' handles," said Sibusiso.

"Let's do an experiment to see which things get hot," said Disego.

Here is what Disego and Sibusiso did. You set up your experiment in the same way.

1. Light the candle and carefully allow a little wax to drop onto the handle of the wooden spoon. While the wax is hot and liquid, push a drawing pin into the wax. Hold the drawing pin in place for a few seconds until the wax solidifies.
2. Repeat with the plastic spoon, metal spoon and place a drop of wax and a drawing pin at the rim of the drinking glass. Make sure that the wax has solidified and that the drawing pins are firmly in place. Also make sure that the amounts of wax holding each drawing pin in place on each implement is roughly the same. (Scrape a small bit off if needs be.)

3. Boil the kettle.
4. When the kettle has boiled, carefully pour the boiling water into the basin.
5. Immediately place all the spoons and the drinking glass into the basin.
6. Watch the implements in the boiling water carefully. Note down your observations and draw a conclusion from these observations regarding heat and the implements tested.
7. These are Disego and Sibusiso's observations and conclusions:

<u>Observations made by Disego and Sibusiso</u>:

We noticed that the wax begins to melt on some of the implements and the drawing pins slip off.

The drawing pin on the metal spoon fell off first.

It was followed by the drawing pin on the glass.

The drawing pins on the plastic and wooden spoons did not fall off.

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When we touched the handle of the metal spoon, it was quite hot and the top of the glass was also hot, but not as hot as the metal spoon.

The handle of the plastic spoon was only warm.

The handle of the wooden spoon was not even warm.

Conclusions made by Disego and Sibusiso:

We think that the metal spoon carries heat better than the glass. The plastic spoon and the wooden spoon do not carry the heat well at all.

8. Compare YOUR observations with those of Disego and Sibusiso.
What similarities and differences are there between the two sets of results and conclusions?

9. When a scientist *repeats* an investigation performed by another scientist, one of two things applies: Either the scientist repeating the investigation could find that his results *contradict* or are *completely different* to the results obtained by the first scientist. Or, the scientist could find that his results are *complementary* or are *the same* as the results obtained by the first scientist. If the results contradict each other, one could say that further investigation is needed in order to establish the truth. If the results are complementary, one could say that the conclusions reached by the first scientist have been strengthened. One could say that the results *verify* or *prove* the point with greater strength. Such an experiment is said to be a *reliable* experiment, and the results are also reliable, because on repeating the experiment, the same results are obtained.
Based on these statements, comment on the *reliability* of Disego and Sibusiso's investigation.

10. A company which makes kitchen implements, pots and pans approaches you for your advice. They want to make a very efficient pot which heats up quickly and to a high temperature. They want the pot to be easy and safe to use - the user must not get burnt while using the pot. This company tells you that the only materials available for making this

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pot are: metal, plastic, glass and wood. Based on your investigations into conductivity, what sort of a pot would you suggest they design?

[25 marks]

Part Three: Convection current

In this task, you will demonstrate *convection current*.

You will need:

A handful of peas (shelled) or corn kernels (corn cut off the mielie cob)

Water

Pot – a glass pot that can be put on a hotplate on the stove would be ideal (you could see through it), a deep Pyrex or Anchorware dish will be right - just check that it can be used on top of a stove/hotplate

YOU WILL BE BOILING WATER IN A POT ON A STOVE/HOTPLATE. TAKE CARE WITH THE BOILING WATER. DO NOT LEAVE UNATTENDED NEAR CHILDREN.

What to do:

1. Fill the pot two-thirds of the way with water.
2. Add a handful of peas/corn kernels.
3. Place on the stove/hotplate and switch on. Bring the water to the boil.
4. Note down what you observe happens to the peas/corn in the water.

Can you account for/explain what you observed, in terms of energy transfer?

Your teacher will award marks for how you conduct the investigation.

[20 marks]

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The above activity demonstrates a convection current in liquids.

Can you explain a convection current you have experienced in gases?

[16 marks]

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Part Four: Radiant energy transfer

This task gives you the opportunity to investigate radiant energy transfer.

You are going to

pose a *hypothesis;*

design an experiment

and carry out the *investigation* in order to prove/disprove your hypothesis.

You are going to explore the ability of shiny materials to absorb and radiate energy.

Beth is going to prepare some potatoes to cook on the fire for dinner. She is going to wrap the potatoes in tin foil, so that they do not dry out or get ash all over them. She takes the tin foil out of the cupboard, and is suddenly faced with a problem. Tin foil has a very shiny side and a duller side. Which side of the foil should she put on the inside, next to the potato, and which side should face outwards, into the fire? She asks you for help. You are not sure of the answer immediately.

What to do:

1. Pose a hypothesis – which side of the foil should face outwards?
2. Design an experiment to prove-disprove your hypothesis. Remember that the experiment should be fair and reliable. You must try out your experiment practically, to see if it works well. Record your investigation below, under the headings:

HYPOTHESIS

HOW I INTEND TO PROVE MY HYPOTHESIS

MATERIALS I NEED

THE EXPERIMENT ITSELF (drawings would help)

OBSERVATIONS

MY CONCLUSIONS

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Rubric to assess a scientific investigation

Criteria	Level 4	Level 3	Level 2	Level 1
RESEARCH QUESTION	Well articulated, based on careful observation, excellent scope for investigation.	Well stated, based on observation, good scope for investigation.	Fairly well stated, observations made, will permit investigation.	Vaguely stated, not really based on observation, limited scope for investigation.
	5	4	3	2
HYPOTHESIS	Well stated prediction, testable.	Prediction is stated, testable.	Vague statement, not really testable.	None.
	3	2	1	0
METHOD: **MATERIALS**	fully listed.	Incomplete.		None.
	2	1		0
METHOD: **STEPS TAKEN**	Logical detailed description of methods, can be clearly followed, innovative, valid hypothesis testing.	Detailed description of methods, easy to follow, some evidence of innovation, largely valid hypothesis testing.	Basic description of methods, generally logical, not very innovative, does address hypothesis in tenuous way.	Vague description of methods, flaws in logic, no innovation, no real valid hypothesis testing.
	10	8	5	3
METHOD: **FAIR TEST**	Excellent steps taken to ensure fair test and reliability.	Good steps taken to ensure fair test and reliability.	Some steps taken to ensure fair test and reliability.	Not a fair test.
	6	4	2	0
RESULTS AND DISCUSSION	Results recorded in a meaningful manner and displayed in a way which communicated findings logically and clearly, results discussed intelligently showing understanding of the information.	Results accurately recorded, displayed appropriately, discussed in a basic way showing a good grasp of the information investigated.	Results adequately recorded, adequate display of results, discussion covered most of the results and showed a fair grasp of the information investigated.	Results not accurately or appropriately recorded or displayed discussion inadequate with flaws in thinking and grasp of information.

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	10	7	5	3
CONCLUSIONS	Well drawn from the research, sensible inferences made, relate back to hypothesis.	Drawn fairly well from research, makes some reference to hypothesis.	Faulty reasoning in conclusion, no relation to hypothesis.	No conclusions offered.
	4	3	2	0

3. Design a cooking foil which is more efficient than regular tin foil. Give reasons for your design.

[44 marks]

[Total: 125 marks]

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Suggested Solutions

Question number	Possible marks	Solution
1	20	Observations: After a few seconds, the first blob of wax begins to melt, ✓✓ followed by the next one, ✓✓ and so on. ✓✓ If you hold the needle long enough, your fingers should also start warming up! ✓✓ [8] Conclusions: The heat is travelling along the needle✓✓ from the source (the candle flame) ✓✓ up the cooler parts of the needle. ✓✓ This means that energy is being transferred up the needle. ✓✓ This is known as *conduction*. ✓ [8] Award [4] for how the learner conducts the practical work.
2	25	8. Hopefully, with your knowledge, your conclusion was more satisfactory than Disego and Sibusiso's! Hopefully you could mention concepts such as the *energy transferred* ✓✓and *conduction*. ✓✓ [4] 9. If your results were the same as those obtained by Disego and Sibusiso, then the investigation is a reliable one. ✓✓ If your results differed, then the investigation was not reliable.✓✓ When I prepared this assessment, I did this activity too. My results were the same as those obtained by Disego and Sibusiso! That should add to the reliability of the investigation even further.✓ [5] 10. Your pot needs to have a metal base. ✓✓ The metal needs to extend up the sides of the pot too, ✓✓ in order to conduct the energy/heat in the most efficient manner and to heat the food up quickly and to a high temperature. ✓✓ The handle of the pot should be made out of a poor conductor of heat. ✓✓ You could have suggested a wooden or plastic handle. ✓✓ The lid of the pot may have been metal too, but the knob to lift the lid needs to be made out of a poor conductor of heat (plastic or wood). ✓✓ Glass may break too easily, although there are certain specially strengthened glasses available for cooking in (e.g. Pyrex glass). ✓✓ But the company wanted a safe pot, and the metal is less likely to break on dropping than the glass - so I'd choose metal over glass. ✓✓ The metal is also a better conductor of heat. (Think of commercial pots on the market today - does your design sound familiar? Manufacturers of cooking implements investigate conductivity very carefully – they know which metals are the best conductors and which plastics are the least

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		successful conductors of heat) [16]
3	36	Observations: The peas/corn move around in the water, as the water gets hotter. ✓✓ Once the water boils, the peas/corn move in a certain pattern in the pot. ✓✓ They rise and fall in circulating patterns. ✓✓ Explanation: The energy in the heated water causes the hot water to rise – it carries peas/corn with it. ✓✓ Cooler water takes the place of the hot water, under it, as the hotter water rises. ✓✓ The peas/corn that were in the cooler water sink. ✓✓ As that cooler water heats up (receives more energy) it will also rise, taking those peas/corn with it. ✓✓ The result is a circulating movement called a convection *current*. ✓✓ Award marks for conducting of investigation. [4] You have experienced a convection current at work in gases too. If you have sat in a room with a heater on, ✓✓ you will know that the entire room heats up – the area around the heater does not just get hotter and hotter – ✓✓ the heat seems to 'spread' throughout the room. ✓✓ The heater heats the air just above it. Hot air rises above the heater ✓✓ and cooler air will move in to take its place. ✓✓ The result is a circulating current of air called a convection current, ✓✓ which quickly carries heat around the room. ✓✓ Air, like all gases, is a poor conductor of heat, but it can transfer heat/energy very quickly by convection. ✓✓
4	4 plus investigation 40 = 44	1 and 2 Your hypothesis would have been either: "The shiny side of the tin foil should face outward." OR "The dull side of the tin foil should face outward."✓ Your thinking should be along the lines of: The side which reflects radiant energy the best should face the potato. The side which reflects it the least (or absorbs it the best) should face inward. There are many different ways of showing which side of the tin foil reflects the energy most efficiently. As long as your investigation shows clearly how you went about proving it – it would be correct. You could use wax blobs on the two different sides of the foil and heat the foil to see which melted first. Or, you could have prepared two potatoes of the identical size and mass, (peel them to get them

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		identical) and wrap each one in foil, one with the shiny side in, the other with the shiny side out. Put them in a fire and see which one cooks first. Remember that if you disprove your hypothesis, you have still done science! You still know which side of the foil reflects the energy most efficiently. See rubric in Appendix of Assessment Tools. 3. A more efficient design for cooking foil may be to have a shiny reflective surface, which you wrap around the food, and a black side which faces outward and absorbs the radiant energy more efficiently. ✓✓✓

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Appendix of Assessment Tools

Rubric to assess a scientific investigation

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	showing understanding of the information.			
	10	7	5	3
CONCLUSIONS	Well drawn from the research, sensible inferences made, relate back to hypothesis.	Drawn fairly well from research, makes some reference to hypothesis.	Faulty reasoning in conclusion, no relation to hypothesis.	No conclusions offered.
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