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UAEU College of Education

جامعة الإمارات العربية المتحدة
United Arab Emirates University

UNITED ARAB EMIRATES UNIVERSITY

COLLEGE OF EDUCATION

DEPARTMENT OF CURRICULUM AND INSTRUCTION

HEAT MISCONCEPTIONS AMONG 11th Grade STUDENTS

Amnah Mohamed Abdullah Al-Kaabi

This thesis is submitted in partial fulfilment of the requirements for the degree of Master of Education in Science Teaching

Under the supervision of Dr Ali K. Al-Naqbi

January 2014

ORIGINALITY OF THE THESIS WORK

I, **Amnah Al-Kaabi**, the undersigned, a graduate student at the United Arab Emirates University (UAEU) and the author of the thesis, entitled "**Heat misconceptions among the 11th grade students**", hereby solemnly declare that this thesis is an original research work done and prepared by me under the guidance of Dr Ali K. Al-Naqbi, in the College of Education at UAEU. This work has not been previously formed as the basis for the award of any academic degree, diploma or similar title at this or any other university. The materials borrowed from other sources and included in my thesis have been properly cited and acknowledged.

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APPROVAL

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ABSTRACT

This study explores the misconception of the female students at 11^{th} grade about the heat concepts (e.g., latency, conduction, equilibrium, boiling point, etc.). The study targets to i- classifying the misconception nature, and ii- distinguishing the heat misconceptions from the point of the lack of knowledge and lucky guess. A sample of 230 female students at 11^{th} grade randomly selected from five secondary schools in the Emirate of Fujairah; northern UAE. The Heat Misconception Test (HMT), *a three-tier diagnostic instrument comprising of ten questions* is used as a data collection tool. The study raises the three research questions i- what the misconceptions are the 11^{th} grade students demonstrating about the heat concepts?, ii- what would be the percentage of the 11^{th} grade students who demonstrate lack of knowledge about the heat conceptions, and iii- what would be the percentage of the 11^{th} grade students who demonstrate lucky guess about heat concept?. The participants classified into four categories according to their understanding about the heat concepts i- misconceptions, ii- lack of knowledge, iii- lucky guess, and iv- scientific Knowledge.

The data analysis reveals that most of participants from the 11^{th} grade students expressing misconceptions about the heat as a physical phenomenon, whereas more than 50% of the participants expressing misconceptions about heat equilibrium. The conception of latent heat, boiling point, specific heat capacity, and heat latent expressed by 62% of the participants. 13% expressing heat misconceptions from the lack of knowledge. However, 3% of the students expressing heat misconceptions that related to lucky guess by all questions in HMT. On the other hand, 21% of the students having a proper scientific knowledge about the heat physics. As the misconception about teaching a physical phenomenon is a learning challenge, the study recommends improving the delivery of the scientific subject to be more practical than theoretical. Moreover, the test should consider conceptions of the students regarding the natural phenomena. The implications of the study are for the science teachers to encourage the students to engage intensively in the classroom interaction. The implications as well for the science curriculum specialists to introduce easy-to-understand scientific knowledge and problem solutions.

Keywords: physics teaching, heat misconception test, 11th grade students, Fujairah, UAE.

المفاهيم الخطأ في الحرارة بين طالبات الصف الحادي عشر

ملخص الرسالة

إن هدف هذه الدراسة هو استكشاف المفاهيم الخطأ في الحرارة عند طالبات الحادي عشر العلمي، وقد استهدفت الدراسة عينة شملت على 230 طالبة من الصف الحادي عشر العلمي، ملتحقين في خمس مدارس في إمارة الفجيرة، وهي إحدى إمارات دولة الإمارات العربية المتحدة.(تقريباً 68% من نسبة الطلبة الكلي في الإمارة).

ولقد تم جمع بيانات الدراسة من خلال اختبار المفاهيم الخطأ في الحرارة HMT وهو يعتبر أداةً تشخيصية شملت على عشر أسئلة وكل سؤال يحتوي على ثلاثة أجزاء.وهناك غرضان لاستكشاف الهدف الرئيسي للدراسة وهما: 1- تصنيف وعرض طبيعة المفهوم الخطأ بالنسبة لطلبة الصف الحادي عشرالعلمي.2- تقسيم الطالبات إلى ثلاث مجموعات وهم الطلبة الذين لديهم مفاهيم خطأ من الطلبة الذين لديهم نقصٌ في المعرفة والطلبة الذين أجابوا إجابات صحيحة بناءً على التخمين.

بينما ركزت الدراسة على ثلاث أسئلة بحثية وهي:

1- ما المفاهيم الخطأ في الحرارة التي حققت أعلى نسبة بين طالبات الحادي عشر العلمي في إمارة الفجيرة؟

2- ما النسبة المنوية للطلبة الذين لديهم نقصٌ في معرفة مفاهيم الحرارة بين طالبات الحادي عشر العلمي في إمارة الفجيرة؟

3- ما النسبة المنوية للطلبة الذين اختاروا إجابات صحيحة بناءً على التخمين في مفاهيم الحرارة بين طالبات الحادي عشر العلمي في إمارة الفجيرة؟

من خلال نتائج الدراسة تم تصنيف الطالبات المشاركات إلى أربع فئات بناءً على فهم واستيعاب الطلبة العلمي: سوء الفهم، نقص المعرفة، التخمين والمعرفة العلمية. وأظهرت النتائج أن معظم الطلاب لديهم مفاهيم خطأ في الحرارة، وأن أكثر من نصف الطلاب يملكون مفاهيم خطأ تحديدا في مفهوم الإتزان الحراري، الحرارة الكامنة، درجة الغليان، السعة الحرارية النوعية والتي بلغت نسبتهم (62٪) من الطلبة المشاركين في الدراسة. بينما (13٪) من الطلبة لديهم نقص في معرفه وفهم مفاهيم الحرارة. بالإضافة إلى أن (3٪) من الطلبة اختاروا الاجابات الصحيحة بناءً على التخمين. من ناحية أخرى، كان هناك (21٪) من الطلبة لديهم معرفة علمية في مفاهيم الحرارة. وفي هذه الدراسة تم تقديم توصيات خاصة للممارسات في مدارس وصفوف الفيزياء والعلوم. وكذلك اقتراحات لتطوير المناهج الدراسية في الفيزياء والعلوم، بالإضافة إلى بعض التوصيات بخصوص البحوث المستقبلية في هذا المجال.

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Amnah Al-Kaabi

DEDICATION

I dedicated this work to my beloved country the United Arab Emirates and to its wise leadership, as considerably as to teaching profession to which I deserved a great interest.

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GLOSSARY

The listed terms herein below are frequently used in this thesis, which reflect the specific meaning within the thesis context, these are:

- *Heat*: A dynamic process of energy transmission (Chiou & Anderson, 2010). Also heat refers to a transfer of thermal energy (the total kinetic energy for atoms and molecules in a substance) due to a temperature difference (Wiser & Amin, 2001).

- *Temperature*: Refers to the measure of the average kinetic energy in a substance (Chiou & Anderson, 2010).

- *Misconception*: Incorrect ideas about physical principles and concepts that the students bring to the science classroom. This term could be used interchangeably as preconceptions or alternative conceptions (Damas, 1994).

- *Concept*: is the notion underlying a class of things or events, as currently intended by the community of scientists. A concept acquires its meaning through its network of relationships with other concepts (Abell & Lederman, 2007).

- *Lack of knowledge*: the situation of being uncertain regardless of correct or incorrect response to the first and/or second tiers (Hasan et al., 1999).

- *Lucky guess*: the correct answers to both tiers with uncertainty (Arslan et al., 2012).

CHAPTER ONE

INTRODUCTION

Since the late 1970s, the education research has been shifted from an emphasis on the behaviourism to be more focused on the cognitive perspective to study the knowledge abilities of the students. Many cognitive psychologists and constructivists stated that the people always create new knowledge to be understood according to what they have already known and believe; however, some parts of these theories are often not consistent with the scientific conceptions to be misconceptions (Chang et al., 2007).

All the conceptual frameworks of the children have been developed from their own experiences to be changed as they mature. However, their intuitive understanding of the physical surrounding world around them does not frequently agree with the scientific explanation. Therefore, it is important to take in account this physical world while planning instruction to know how these misconceptions differ from the scientific explanation, and why the students construct these ideas. Thus, the science teachers should identify, if any, the misconceptions of their own students by several approaches such as diagnostic assessments.

The development of complex concepts needs to be in a series of thoughtful steps as any missing in these steps would generate a misconception, or the correct explanation is becoming unachievable. Consequently, the high quality of education is required to have an appropriate instruction at each grade level so as to develop some key science concepts pertaining the student understanding. Some constructivists recommended to use the student misconceptions as an explicit starting point for developing new learning style.

The research on the science education have long been focused on the misconceptions of the students about the natural science; especially in physics (Kaltakci & Eryilmaz, 2010; Guisasola & Montero, 2010; Kucukozer & Kocakulah, 2008; Chee, 1996; Demirci, 2005; Menekse, et al., 2010; Alwan, 2011; Kirbulut & Beeth, 2010; Zacharia, Olympiou & Papaevripidou, 2008). This study aims at assessing the heat conception and misconception (e.g., latency, conduction, equilibrium, boiling point, etc.) of the female students at 11th grade in Fujairah primary schools. The study targets to classifying the misconception nature, and distinguishing the heat misconceptions from the point of the lack of knowledge and lucky guess.

1.1 Physics

Physics is derived from Ancient Greek to mean *the knowledge of nature*. In modern science, physics is concerned with describing the physical nature and phenomenon of the matter and its motion through space and time, along with related concepts such as energy, force, density, mechanics, etc. The modern extensions of the physics including astronomy and cosmology, atomic and nuclear science, solid-state, plasma, dynamics, etc. (The Free Dictionary, 2013). Many students believe that "Physics is difficult". Angell et al. (2004) investigated the views of high school students and physics teachers about Physics *per se*. the students reported that studying physics is a difficult topic because they had to contend with different representations, such as experiments, formulas and calculations, graphs and conceptual explanations at the same time and had to make transformations among them.

The concepts of physics are considered by many science educators as a difficult concept since these concepts are abstract ideas, *invisible*, (such as atomic structure, nature of the electromagnetic waves, etc.) to be more complicated to be understandable for the students; especially at the primary education (Podolefsky, 2008). However, why the students describing physics as a difficult subject. Redish (1994) explained such student attitudes towards physics as physics is a discipline requires the learners to employ a variety of methods of understanding to interpret the abstract concepts into reality such as in words, numbers, graphs, equations, diagrams, maps, etc. therefore, the physics interpretation requires the ability of using a variety of mathematical applications as algebra, calculus, and geometry, as well as to start from the specific to broaden to the general and *vice versa*. Such patterns of dealing with various physics problems may create a sort of misconceptions among the students about many concepts in physics.

1.2 Science Misconceptions

The notion of the concept itself has been problematic for the research educators. The term *concept* has been received much concern in science education studies. Therefore, concept defined by many authors based upon the use of the term within the context. The *concept* could be defined as the summary of the essential characteristics of a group of ideas and a kind of intellectual framework that manages both old and new information (Al-Jubaili, 2002). On the other hand, Lawson et al. (2000) defined a concept as the one own ideas about how the world works, which could be classified into at least three types; theoretical, descriptive and intermediate concepts.

Furthermore, the misconception is a quite ubiquitous problem in the science education worldwide. Nevertheless, the research attempts that concerned with finding appropriate approaches to solving the conception/misconception related issues. Oglesby (2009) discusses the problem of the science misconceptions among 9th grade students. Yet, most of the students in faculty of education (came from different science background) studying science teaching have even expressed an obvious misconceptions in heat and temperature (Alwan, 2011), whereas Kikas (2004) records that the science teachers and trainees loud out misconceptions.

1.3 Origin of Misconceptions

Although there are many studies in misconceptions, few tackled the origins of the misconceptions. Paik et al. (2007) shed light on the potential relationship between the traditional styles of teaching science and causes of the student's misconceptions in the physical phenomena. However, Kaltakci and Eryilmaz (2010) used document analysis method to investigate sources of students' misconceptions; their study revealed that the subject textbooks, teaching experiences, and language command of the science teachers were found to be the primary of misconception in science education domain.

Moreover, Kikas (2004) points out to several factors involved in such misconceptions as over generalizations on the basis of analogy, concepts belonging to ontologically different categories, how knowledge is presented in school textbooks, and teacher training. Kaltakci and Didis (2007) pointed out that the main sources of the student misconceptions are categorized as the student personal experiences, textbooks, teaching language used, and the cooperation of the science teachers.

1.4 Statement of the Research Problem

The review of the selected literature has revealed a gap the relevant studies on the *science misconceptions* in the various branches of science among the students in the primary and secondary schools. In chemistry, for example, the studies have been conducted for investigating the student misconceptions about various physics-related topics such as matter composition, atomic and molecular bonding, galvanic, electrolytic, climate change, and basic quantum chemistry (Awan et al., 2011; Nahum et al., 2004; Sanger & Greenbowe, 1997; Stefani & Tsaparlis, 2009).

In biology, many studies have concerned with the diagnosis of the student misconceptions some biological phenomena such as respiration, photosynthesis, genetic structure, species classification, human circulatory system, diffusion and osmosis (Odom & Barrow, 1995; Sungur et al., 2001; Takkaya, 2002). In physics domain, the studies have concerned with the student misconceptions about optics (Kaltakci & Eryilmaz, 2010), electricity (Guisasola & Montero, 2010; Kucukozer & Kocakulah, 2008), and force (Chee, 1996; Demirci, 2005; Menekse et al., 2010), force and Newton's Third Law misconceptions have tackled in the UAE high schools (Hassan, 1993). However, the misconceptions about heat and temperature have attracted many scholarly studies (Alwan, 2011; Kirbulut & Beeth, 2010; Zacharia et al., 2008).

Based on the science teaching experience of the author of this thesis, the practical presentation during the explanation of the natural heat phenomena could erase the heat misconception; for instance, an experiment of boiling water conducted at the room temperature under a vacuum bottle to prove the relationship between the boiling degree and the pressure, as well as explaining the latent heat concept through changing the material status from solid (ice cube) to liquid state (water) through increasing temperature. These experiments have proved the importance of the practical lessons in promoting the conception of the students about the heat.

The above mentioned studies have generally shown that the students have misconceptions about the concepts of heat and temperature, which might be in a conflict with the correct scientific explanation that is agreed upon by the physics community. It has been observed that many 11th grade students in some high schools Fujairah Emirate have given incorrect explanation about heat as a natural phenomenon. This misconception is the topical theme of this study.

The study hypothesise that the core causes of heat misconception are attributed to the traditional science teaching style, which largely lacking the critical thinking and based entirely on the memory without reasoning. Therefore, this study proposes that the traditional science teaching style, along with the course-related textbooks are playing effectively in the promotion of the *misconception* about the natural science; in particular, in physics.

1.5 Study Objectives

This study attempts to determine the student misconceptions about various concepts related to the heat physics such as i-thermal equilibrium concept, latent heat concept, boiling point concept, specific heat capacity concept, thermal expansion concept, and heat transfer concept. The investigation aims at finding the difference between the science students who have misconceptions comparing with those having a lack of knowledge and lucky guess. The target participants are the 11^{th} grade female students in Fujairah schools.

A three-tier diagnostic instrument comprising 10 questions used to explore the heat misconceptions. The core objectives of the study are to conduct the following issues:

1. Classify the nature of misconception held by 11^{th} grade female students in Fujairah schools, the UAE.
2. Distinguish students' misconceptions from their lack of knowledge, and lucky guess about heat concepts among 11th grade female students.

1.6 Research Questions

The proposed objectives of this study could be executed through answering the following research questions:

1. What the misconceptions do the 11th grade female students demonstrate about the heat concept?
2. What is percentage of the 11th grade female students who demonstrate lack of knowledge about heat concepts?
3. What is percentage of the 11th grade female students who demonstrate lucky guess about heat concept?

1.7 Significance of this Study

There is a need to identify the misconceptions among the students in all subjects; in particular, the field of natural sciences. Despite many scholarly studies have been conducted in misconceptions in scientific subject worldwide (e.g., Kutluay (2005) and Temizan (2003) in Turkish schools; Chee (1996) in Singapore; Demirci (2005) in the USA; Paik, Cho & Go (2007) in South Korea), little research studies have been done in the Arab schooling environments; particularly in the UAE schools. Therefore, the generated results from the bulk studies conducted in the non-Arab schooling environments, largely in western setting, might be not applicable in non-western culture like the UAE's as the cultural factors play major roles in shaping the students learning (Kaltakci & Eryilmaz, 2010).

This research study is one of the rare studies focused on the conception from educational and teaching point of view. The importance of this thesis might be due to following reasons: i- the results might enhance further research in the misconceptions in the UAE from educational viewpoint. ii- Second, it is anticipated that the findings generated from this study would allow the science teachers to assist the students in overcoming their heat misconceptions. iii- Third, the results and conclusions provide thoughtful information to help the science teachers in taking the students misconceptions into account in their teaching, hereby improving science instruction in Al-Fujairah Zone, iv- Forth, the generated results would provide the UAE science textbook curriculum developers with experimental information about heat misconception in among the high school students; this could however improve the quality of the UAE science curriculum, and Fifth, the Ministry of Education could use these results for a positive change in the UAE educational system and curriculum.

1.8 Limitations and Delimitations

The study encountered with several limitations to complete the investigation in convenient research conditions. Among these limitations, were:

1. The investigation of the study was conducted only among the Fujairah schools whose data and results are not necessary reflect the state of the misconception in other Emirates.
2. The sample of the female students was drawn from only cycle two schools. This sample is afraid to reflect other schools in in Emirate of Fujairah.
3. The study results generated from female participants, where the results might be differed if it has been conducted among the both genders.
4. The instrument that incorporated in the data collection was developed originally in Western Culture, the metrics are written in English. The thesis author translated its contents into Arabic to fit the local cultural norms.

5. This study focused on the concept of heat only, which is one of the units of subject matter that is taught in 11th grade in the scientific track in the UAE public schools. Accordingly, the results of study and conclusions cannot be generalized to other physics concepts.

On the other hand, the delimitations of the investigation were:

1- The sample included 235 student participants from 11th grade, in addition to 337 female students from ten girls' schools in the Emirate of Fujairah.

2- The study was limited to the heat and temperature concepts which assessed on 11th grade student in public school in the UAE.

3- The study was conducted in public schools in Emirate of Fujairah in the third semester of the year 2011-2012. This Study was applied in one week in that semester.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the related published scholarly research studies that conducted on the misconception from learning aspects. Special emphasis is placed on the heat physical phenomena. Heat is very common used term; but how to measure or observe the effect of heat was found quite different in the classroom. The literature reveals that none has been written on the misconceptions from educational and learning aspects in the Emirate of Fujairah. Therefore, this thesis greatly relies on the relevant published works on the topical theme of the heat misconceptions.

2.2 The Student Misconceptions

Many researchers in various fields as education, psychology, and linguistics have long been using different approaches and research tools (e.g., interviews, open-ended questionnaires, multiple choice questions, two-tier questions, and three-tier questions) in detecting the student misconceptions about the scientific phenomena. Both unstructured and structured interview approaches have been adopted for conducting further investigations and research on the misconceptions in science education (Osborn & Gilbert, 1979; Stepans & Dyche, 1987; Gilbert et al., 1982; Treagust, 1988). Chee, (1996) and Menekse et al. (2010) have used the interview to study the force misconception.

The open ended questions such as "*what is a covalent bond*?" and "*why the molecules have different shapes*?" have been employed in studying misconceptions of the students about the chemical bonds and structure (Treagus, 1988). Kucukozer and

Kocakulah, (2008) have incorporated the open-ended questions to examining the views of the students towards the electricity concepts. However, the long-time that consumed in answering the interview and open-ended questionnaire was found to be the major problem in obtaining a considerable amount of information from the students for evaluating their misconceptions.

However, the multiple choice questions (MSQs) were suggested to overcome this limitation. The MSQs consisting of three, four, or five sections. One of these sections represents the students' misconceptions. Some of the MSQ tests were developed in the physics as Force Concept Inventory (FCI) by Hestenes et al. (1992), and as the Conceptual Survey of Electricity and Magnetism (CSEM) developed by Maloney et al. (2001). Guisasola and Montero (2010) investigated the difficulties, which faced 56 Granada university students in the analysis of the operation of simple direct current circuits and others. A major problem, however, with the MSQ approach is that it does not allow the students to demonstrate knowledge beyond the options that provided. In addition, the students may misinterpret the questions, as well as it requires a great deal of time to construct effective multiple choice questions, especially ones that test higher levels of learning.

Two-tier tests were developed to detect student misconceptions and to avoid the limitations of MSQ tests. These types were used to the detect student misconceptions in biology, chemistry, and physics (e.g., Franklin, 1992; Jang, 2003; Odom & Barrow, 1995; Peterson, Treagust & Garnet, 1989; Tan et al., 2002; Voska & Heikkinen, 2000). As noted by several researchers (e.g., Hasan, Bagayoko, & Kelley, 1999), the two-tier, as well as the MSQ tests were found to be with drawbacks in detecting the students' confidence in their responses. In other words, two-tier questions cannot distinguish between misconceptions, lack of knowledge, or lucky guess.

Accordingly, many researchers suggested adding a third tier to the two-tier question to help them making this distinction. Hasan et al. (1999) recommended that the use of a certainty index, along with the two-tier test questions could help in making this distinction. They indicated as well that the low certainty indicates a lucky guessing, which in turn implies lack of knowledge, whereas the high confidence in wrong answers indicates misconception of the concept under the investigation. The confidence scale, which accompanies a three-tier, multiple choice test questions will provide researchers and teachers with information about the nature of misconceptions. In addition, it may help them to distinguish between lack of knowledge, lucky guess, and misconceptions of the female students. Furthermore, considering the confidence levels of the students that may enable researchers to investigate the relationship between students' confidence and their understanding of the scientific concepts. This research aims at collecting the students' confidence levels and examines the relationship between students' confidence and their understanding of the heat concept.

In order to investigate the fifty-eight high school students in the biology course for their understanding about scientifically and acceptable content knowledge, in addition to the student's confidence in these knowledge, Odom and Barrows (2007) used a two-tier diffusion and osmosis diagnostic test (DODT) to assess their understanding of the diffusion and osmosis concepts, in addition to certainty of response (CRI) scale. The results revealed that the DODT test identified correct and incorrect answers and reasons, while certain and uncertain values were identified by CRI values. On one hand, high-certainty with incorrect answers in DODT test indicated misconceptions about diffusion and osmosis concepts, on the other hand. Moreover, the low certainty with incorrect and correct answers in the DODT test indicated lack of knowledge (guess), whereas the high certainty with correct answers indicated the desired knowledge of concepts. The study found that many students showing significant misconceptions in the most of the concepts under the investigation.

Pesman and Eryilmaz (2010) proposed a novel diagnostic instrument to assess the misconceptions of the students about simple electric circuits through developing a three-tier test. The interviews-, construct-, and administer open ended questions were conducted prior to developing and administering the Simple Electric Circuits Diagnostic Test (SECDT). The study was conducted from 124 9th grades in Turkish capital, Ankara. The results showed that the test scores could be a valid and reliable measure of students' misconception on simple electric circuits. With the presence of misconceptions, they found that as well about 36% lack of knowledge.

However, Kaltakci and Didis (2007) identified misconceptions, lack of knowledge and error with a three-tier gravity concept test. The data obtained from forty-one pre-service physics teachers teaching grades 4th and grade 5th students at Middle East Technical University. The results showed that the three-tier test that employed in the identification of lack of knowledge, error, and misconceptions separately become crucial in teacher education process. Also it is important to choose the required instructional designs.

Kutluay (2005) developed a three-tier Geometric Optic Misconception Test (TTGOMT) for assessing the conceptions of the 11th grade students in geometrical optics. The procedure of the test carried out through three stages, *namely* i- interviews, ii- open-ended test, and iii- three-tier misconception test and included three groups of students in those stages. An interview was made with the 15 students from 11th grade and their age varied from 16 to 19 years. The interview based on the misconceptions, which found in the literature. Then, an open-ended test based on the interview results and misconceptions found in the literature. The three-tier misconception test was created by analysing the open-ended test results. Finally, Three-tier Test was presented to 141 students who were taught geometric optic. The results of the study showed that the students expressing misconceptions, which may resist changes and obstruct the learning process. Moreover, the interviews revealed that even the students were above average, the students showing little or no understanding of the conceptual understanding of a physical phenomenon. So, the study argue that it is necessary to use three-tier test to identify the factors behind the misconceptions of the students.

Arslan, Cigdemoglu, and Moseley (2012) applied a three-tier diagnostic test (e.g., answer, reason, and certainty response indices) to assessing the 256 pre-service teachers in an American university to assess their misconceptions about the global warming, greenhouse effect and gases, ozone layer depletion, and acid rain. The study revealed that most of the teachers displayed a limited conceptual understanding of these concepts. However, most previous studies preferred to use three- tier method to investigate this issue. Those studies, which utilized three tier tests, are similar to the current study because it connects three-tier test (e.g., answers, reasons, students confidence) to study the misconceptions students'.

However, this research differs in the context of the study since it investigates 11th grade (16-17 years) misconceptions about heat related concepts in Emirate of Al Fujairah schools. To do so, the researcher collected students' confidence levels and examined relationship between students' confidence and their understanding of the heat concept.

Also the heat misconception test (HMT) in current study used not only to identify students' misconceptions about heat but also to classify these misconceptions from lack of knowledge and lucky guess.

2.3 Heat and Temperature Misconceptions

Heat and temperature are under thermodynamic field, which are consisted of many concepts. The thermal scientists define heat as a dynamic process of energy transmission (Chiou & Anderson, 2010). The heat refers also to a transfer of thermal energy (the total kinetic energy for atoms and molecules in a substance) due to a temperature difference (Wiser & Amin, 2001). Also heat refers to the flow low of internal energy from one object to another (Redish, 1994).

Many researchers in the science education are truly interested in studying the misconceptions of the students about the heat and temperature due to the facts that the both topic are very important in science concepts in physics and chemistry education at the introductory level. Accordingly, the initial knowledge about these topics is necessary to understand other related natural science such as biology, geology, environmental science, and geography. For example, the heat and temperature concepts are necessary to understand earth layers distribution as well as to understand plant respiration process which is refers to edit the thermal energy stored in food using oxygen; it is also related to everyday tangible ideas and is covered across several educational materials through different educational levels (Al Rashed, 2002).

Alwan (2011) investigated the misconception of the students about the heat and temperature; the data were generated by using a Heat and Temperature Concepts Questionnaire (HTCQ), which distributed among 53 students from different major in

Tripoli Libya Faculty of Education. The questionnaire consisted of MCQs about heat, temperature, heat transfer, and temperature change concepts. The results showed that most of students could not distinguish between heat and temperature concepts and more than 50% of students have misconceptions about temperature and 46% of students' have misconceptions about heat transfer and temperature change. In addition, they have misconceptions about heat capacity and specific heat capacity concepts. So, they could not predict the final temperature when two samples of materials at different temperatures are mixed. The researcher found that thermal equilibrium is the most prevailing misconceptions among many students.

Kartal, Öztürk, and Yalvaç (2011) used multiple-choice test to examine the misconceptions of science teachers about heat and temperature. The sample of the study included 60 students in 2nd grade of the science education department of Ahi Evran University in Turkey. The study showed that %38 of students chose the incorrect answers. Those students did not distinguish between heat and temperature and thought that those concepts might be used interchangeably. Also, Kartal, Öztürk, and Yalvaç (2011) sowed that %55 of students have misconception about how heat is transmitted in material environment.

However, Harrison, Grayson and Treagust (1999) and Gonen and Kocaya (2010) studied heat and temperature students' misconceptions whereas Tanahoung, Chitaree and Soankwan (2010) studied misconceptions about temperature, heat, latent heat, specific heat capacity, thermal equilibrium and heat conduction concepts using and open-ended question test. The results of their study indicated that students had difficulty differentiating between concepts such as heat and temperature and that their misconceptions are strong and resistant to change. In addition, Lubben, Netshisaulu and

Campbell (1999) explored African students' misconceptions of heating. The findings showed that almost a third of the sample had heat misconceptions.

Kirbulut and Beeth (2010) examined the consistency of students' misconceptions about evaporation, condensation, and boiling across representational, conceptual framework, and contextual consistency aspects. Data of this study collected by interviewing twelve students enrolled in a Midwestern high school in the USA. The interview included six questions and lasted for 55 minute. The study found that students had a high degree of consistency and inconsistency in their naive ideas. Although students were taught about evaporation, condensation, and boiling concepts from elementary school, they still had misconception of these concepts.

Paik, Cho, and Go (2007) used interview to examined 154 students, involved different age from 4 to 11 conception of heat and temperature which closely related to daily life .The students, 4 and 5 years old, were from the same kindergarten while student 6 to 11 years old were from the same elementary school which is located in a suburban area of South Korea. The instrument of the study was seven questions constructed by three researchers for interview. These questions consisted of two questions on temperature, two on thermal insulation, and three on heat equilibrium. These questions were selected for research usage after a preliminary screening involving 16 students; two from each age group in the range of 4 to 11 years-old.

The individual interviews were conducted in quiet space at the kindergarten and school with necessary physical materials in the open time. Researchers analysed their data by calculating the frequency and percentage per age of student answers to each question. The results indicated that most students did not have clear concepts of thermal equilibrium, and younger students linked the temperature concept with size or a summation of numbers. On the other hand, older students tried to use scientific concepts but still they have incorrect answers. Researchers justified the outcomes of their study that the origin of the mistakes among older students lies in misconceptions formed through learning in science classes.

In conclusion, the investigation on the heat misconceptions of the students have employed various test approaches and tools such as questionnaire, multiple choice items, interview, and open-ended questions. Most of the previous studies have investigated heat misconceptions such as that related to heat, temperature, heat capacity, specific heat, latent heat, thermal equilibrium, and heat conduction concepts. The current study tries to explore students' misconceptions that relate to thermal equilibrium, latent heat, boiling point, specific heat capacity, thermal expansion, and heat transfer concepts.

CHAPTER THREE

METHODOLOGY

This study focuses on the investigation about the heat misconceptions as a learning issue. The investigation carried out to determine the frequency of the *heat misconceptions* among 11th grade female students in Emirate of Fujairah This chapter discusses the research methodology, which adopted to be used in completing the questionnaire structure, data collection, data analysis and interpretation. The investigation screens the heat concepts in the UAE physics curriculum.

3.1 Heat Concepts in the UAE Physics Curriculum

Following of two-year kindergarten education, the public educational system in the UAE compromises of two cycles i- Cycle-one is primary education, which consists of nine years (G-1 to G-9), and ii- Cycle-two is the secondary education, which consists three years (G-10 to G-12). The cycle-two students are studying a general curriculum in the first year, whereas are assigned to choose in 11^{th} and 12^{th} grades their interesting track either science or arts. The cycle-one students are studying various subjects in science and humanities. Physics is being taught as a discrete compulsory subject throughout the cycle-two science curriculum in addition to other compulsory related-science subjects such as mathematics, chemistry, biology, and geology. Statistical summaries show that in the 2011-2012 academic year, the cycle-one students studied science in four classes per week. On the other hand, the cycle-two science programme having a total of six classes; two classes are allocated for physics in grated 10^{th}. In 11^{th} and 12^{th} grades, four classes per week are being devoted to physics (UAE Ministry of Education, 2013).

Heat-related concepts are introduced gradually throughout different grades of science curriculum in UAE governmental schools. Introductory and simple heat concepts first appear in grade one science textbook. The science textbook introduces temperature concept in a unit titled *weather and four seasons*. While, science textbook of 2nd grade includes two units about heat concepts, one of them is about sky and weather which consists of weather, temperature, and water cycle. In water cycle part students study evaporation, water vapour, and condensation concepts. Moreover, students in 2nd grade also explore matter related concepts such as heating and cooling concepts. However science textbook of 3rd grade covers evaporation and condensation concepts when the unit entitled *cycles in earth and space*. Science textbook for 3rd grade also covers evaporation, thermal energy and heat, conduction, and radiation concepts in other two units, which are *exploring matters* and *discovery energy and force*.

Concepts related to the heat effectiveness in matter properties and the states of matter are introduced in a *matter and light unit* in 4th grade science textbook. In 5th grade science textbook, however; abstract heat concepts are introduced. For example, in this grade science textbook, the definitions of heat and temperature are provided. Heat is defined as energy related to the movement of the matter particles and the temperature is defined as a measure of the average kinetic energy of particles in a substance. In addition, 5th grade science textbook covers other heat-related concepts such as weather concepts and methods of heat transfer such as thermal conduction, convection, and radiation. These concepts are provided a unit entitled matter *and heat*.

Sixth and 7th grades science textbooks discuss similar previously mentioned heat concepts but in more depth and details. Moreover, the concept of specific heat capacity is indirectly introduced through discussing non-isothermal heating of the land surface in weather part in the operations that change the earth surface. Also this unit covers humidity, evaporation, and condensation concepts that are in science textbook in 6th grade. Science textbook in 7th grade elaborates on the temperature and change of state concepts and how particles gain and loss energy when matter changes its states. Furthermore, grade 7th students also study the boiling and freezing points and how the temperature is changing during the change of state of matter. Moreover, students in 7th grade also learn about melting, evaporation, boiling, condensation, and sublimation concepts, which are included in a unit entitled *state of matter*.

Eighth grade science textbook covers weather concepts that associate with the heat, temperature, radiation, thermal conduction, convection, greenhouse effect, and global warming concepts in a unit that discusses weather and climate issues. Students in 9th grade study heat, temperature concepts, thermal expansion concept and its applications. Additionally, they study the difference between thermal conductors and thermal insulators in the heat part in a unit that deals with work, machinery, and energy. Finally, physic textbook for 11th grade includes most of the heat concepts that examined by the current study. For examples, heat-related concepts such as thermal equilibrium, latent heat, boiling point, specific heat capacity, thermal expansion, and heat transfer.

3.2 Sample of the Participants

The target population identified as 11th grade female students in Emirate of Fujairah who enrolled in the science track. 337 female students were enrolled in 15 11th grade classes at ten schools during the academic year 2011-2012. A sample of 230 female students were randomly selected (68% of the student population). The selection focused on the schools having a large number of 11th grade science students; whereas the schools having small number of 11th grade science students were not included in this study. The female sample was chosen instead of male because the number of female students in 11th grade is more than the male students; also the author of this study faced some difficulties to reach the male schools to distribute the questionnaire due to the local prevalent socio-cultural norms. Moreover, the time on which the questionnaire thought to be distributed was the end of the school year to limit the visits to all schools.

However, out of 230 11th grade female students, only 206 participants responded and returned usable questionnaires; about 26 incomplete answered questionnaires were excluded. Therefore, the data of this survey were based on 180 complete answered questionnaire. The age of the all 11th grade female students was ranging between 15-16 years. The study was made possible on the third semester of the academic year 2011-12.

Table.3.1: *School-Based Sample Statistics*

Schools	**N**	**Analysis Sample (n)**	**% of total**
Dibba Al-Fujairah Secondary School	85	75	42 %
Merbeh Secondary School	52	43	24 %
Madhab Secondary School	39	23	13 %
Masafi School	34	22	12 %
Tawyeen School	20	17	9 %
Total	230	180	100 %

3.3 The Instruments

The Misconceptions Identification in Science Questionnaire (MISQ) is frequently being used a diagnostic test in detecting the student misconceptions about the physic-related phenomena (such as heat, light, force, electricity, magnetism, etc.), in the science curriculum (Franklin, 1992). Therefore, MISQ incorporated in this study to measure the heat misconceptions expressed by grade11th female students as shown in Appendix A. In this study, the heat part of the MISQ, namely the *Heat Misconception Test* (HMT) was only used to identify the heat misconceptions. The HMT consisted of three-tier multiple-choice items:

- The first tier consists of a content question with 4 or 5 alternatives.
- The second tier consisted of 4 to 6 possible reasons for the first tier; three alternative reasons and one scientifically accepted reason. The heat misconception test has 10 items that assessed the heat understanding of the concepts.
- The third tier required students to express their confidence in their responses to the first and second tiers by using a confidence scale with 1 and 7 corresponding to "Just Guessing" and "Absolute Confidence" respectively.

The participants have been informed that the test is a diagnostic test, and not an achievement test, as well as the results of the test would not affect their school grades. That step was necessary to encourage the female students to actively participate in the test. Thereafter, the participants have been asked to focus on their responses for the first and second tiers and then give their confidence rating. Moreover, they were, but would be used by their teachers in planning their remedial lessons. This encouraged ensuring that the students do not provide socially desirable responses to the confidence scale.

3.3.1 HMT Arabic version

The HMT was translated into Arabic, and revised by experienced Arabic language and physics teachers to fit with the mother tongue of the participants. This step was conducted to ensure that the test items were correctly translated, and the terms used in Arabic would be familiar to the students within the physics context. For example, the physic teachers recommended to replacing Fahrenheit degrees to Celsius degrees in temperatures measurement as mentioned in the UAE formal science curriculum and textbooks.

3.3.2 Validity of the instrument

The validity of the (HMT) was determined by content-related and face-related evidence. For content-related validity, HMT was reviewed by two experts in science education. Each expert was provided with a copy of the test, and a brief explanation of the data collection procedures. Moreover, the two experts were asked to comment on the clarity of the wording of each item and on the difficulty of each item. The two experts were encouraged to suggest possible changes with respect to the test items and their wording. Both experts made comments on the wording of the items and their difficulty.

The experts' recommendations were addressed and the necessary changes were made. Such as reformulation of the questions in Arabic languages to decrease the error rate in the study and do not even reinforce misconceptions regarding language. For example, "colder" word had been translated as objects which the least in the temperature and not a literal translation that is in first three questions. Also "Absorbed" in questions 4, 5, and 9 had been translated to scientific concept. Moreover, names had been changed to familiar names such as "Maryam" instead to "Mary" in question four. The outcome of this process provided an indication of the content validity of test (Cohen et al. 2000).

Moreover, the test was given to five physics teachers and one science teacher who have been teaching physics or science for at least eight years and each one was asked to comment on the appropriateness of the wording and difficulty of each item, taking into account the characteristics of 11^{th} grade students in UAE as well as the relevance of the test items to what is taught in the physics course in the 11^{th} grades in UAE schools. Based on the feedback that was given by the teachers the test underwent minor modifications, mostly with respect to wording of the test items. To establish face validity, a field test was conducted after the review by the experts. A group of individuals (n = 5) from target population (not included in the study sample) was asked to comment on the clarity, wording, thoroughness, ease of use, and appropriateness of the instrument. This process provided more support to the suitability of the test and indicated possible sources of difficulties on the part of the students, which were reconsidered through minor revisions to the test. For example, amendment of some words that were repeated by mistake and the adoption of the second part of the question, because it agrees with students' answers.

3.3.3 Pilot study- the initial HMT reliability

A pilot study was conducted involved thirty four (n= 34) students not included in the study sample to determine the score reliability of test items. Initial reliability for the HMT was determined by using data collected in the pilot study. After the HMT was pilot-tested, the researcher analysed the HMT for reliability. The reliability coefficient (Cronbach's alpha) for the HMT used in the pilot study was 0.70. However, the analysis of the actual study data showed that the reliability coefficient was 0.60 (n = 180).

There were some drawbacks in conducting the pilot study, and the gained results were below the expectation. This might be because the study test was applied at the end of the semester and before exams; also, there were a lot of absence among students. However, the pilot study was conducted during the commitment of the students to school attendance and there was no pressure on the students during the test. Another purpose in conducting the pilot study was to determine the time required to complete the test. The pilot study indicated that about 50 minutes was sufficient time. Therefore, the study sample students were given 50 minutes to complete the 10 items in the actual test.

3.3.4 Data Collection

The data utilized in this investigation were obtained from 180 11^{th} grade female students from ten schools in Emirate of Fujairah at the end of the third semester of academic year 2011-2012. The questionnaires were distributed to the students sample upon the official approval issued by the Fujairah Educational Zone. All data were collected during a regular class meeting period in classroom within one hour in the last week of the third semester after the heat and temperature chapter was entirely completed in June 2012.

3.3.5 Data Analysis

The HMT-based questions were first examined and scored following the procedures suggested by Caleon and Subramaniam (2010), Sreenivasulu and Subramania (2013), and Arslan, Cigdemoglu, and Moseley (2012). For each question of the test, a score of "1" were given for the correct choice in the first tier (content tier) and a "0" when otherwise; a reasoning score of "1" was given for each correct choice, and a "0" when otherwise. A score of "1" was assigned when both the content tier and the reason tiers were correct and a "0" when otherwise. These scores were reported as percentages. Below each HMT questions was another question about student confidence level to indicate the level of their confidence in their selection for both tiers in each item of the HMT. The question is stated as follows: how confident are you of your responses? Please choose a number on the answer sheet using the following scale:

I'm sure, I'm right 7 6 5 4 3 2 1 Just a blind guess

The student confidence level was determined by the number that has been selected by students (Franklin, 1992). To simplify the analysis of the confidence scale, the researcher considered a value greater than or equal to 4 representing confidence in the HMT answers. A value less than 4 was defined as being unconfident in the HMT answer. To distinguish between scientific knowledge misconceptions and lack of knowledge, the researcher used the table suggested by Arslan, Cigdemoglu and Moseley (2012) (Table 3.2). In this table, the students' response to the first tier, second tier, and confidence scale were taken together to classify the students, response into five categories: Scientific Knowledge, Misconception, Lucky Guess and Lack of Knowledge.

Table.3.2: *Decision Matrix for Classifying Level of Understanding*

1st tier	2ed tier	3rd tier	Categories
Correct	Correct	Certain	Scientific Knowledge
Correct	Incorrect	Certain	Misconception
Incorrect	Correct	Certain	Misconception
Incorrect	Incorrect	Certain	Misconception
Correct	Correct	Uncertain	Lucky guess
Correct	Incorrect	Uncertain	lack of knowledge
Incorrect	Correct	Uncertain	lack of knowledge
Incorrect	Incorrect	Uncertain	lack of knowledge

Scientific knowledge: This category was examined based on students' response (correct/correct/ certain) in each item of the test.

Misconceptions: Misconception was indicated when students have a high confidence (being certain) in their incorrect response to both the first and second tiers.

Lack of knowledge: As shown in table 3, lack of knowledge occurred when the combination of the three tier were as follows: (1) correct/incorrect/uncertain, (2) incorrect/correct/uncertain and (3) incorrect/incorrect/uncertain (Potgieter, 2012; Arslan, Cigdemoglu and Moseley (2012).

Lucky Guess: Many researchers such as Hassan et al. (1999) and Odom & Barrow (2007) have dealt with all uncertain answers with correct response to both tiers as a lack of knowledge. However Arslan, Cigdemoglu and Moseley (2012) considered correct answer to both tier accompanied with uncertain response as lucky guess. The present study used the similar procedures as Arslan, Cigdemoglu and Moseley (2012) have done.

3.3.6 HMT Reliability

The overall reliability of the HMT scores as measured by Chronbach alpha was (0.6). As for the certainty index, Chronbach alpha was (0.9). However, Chronbach alpha was (0.4) for the answers. As for the reasons tier, Chronbach alpha was low (0.2). Moderate reliability was also obtained by Caleon and Subramaniam (2010) and Sreenivasulu and Subramaniam (2013) for their four-tier tests. This lower value of alpha could be attributed to that the Heat Misconception test is a diagnostic test which could be one type of criterion referenced tests rather than a norm referenced test. Moreover, the test itself is not a unidimensional.

CHAPTER FOUR

THE RESULTS

4.1 Introduction

The Heat and Temperature Concepts Questionnaire (HTCQ) explores the misconceptions of the 11th grade female students about the heat and temperature. A three-tier diagnostic instrument comprises of 10 questions was used to distinguish students' misconceptions from their lack of knowledge and lucky guess on the heat concepts. This survey aims to answer the research questions as proposed in Chapter One (ref. 1.6). This chapter presents the results generated from the analysis of the collected data. The answers that related to each research questions are illustrated in Tables.

Tables 4.1 to 4.10 show the distribution of the female students into two main groups: i- The students with correct answers, and ii- the students with incorrect answers o tier 1 and tier 2 questions. However, Table3.2 in Chapter Three provides more details as it classifies the students into four categories according to their certainty level: i- scientific knowledge, ii- misconception, iii- lack of knowledge, and iv- lucky guess. So, Tables 4.11 to 4.15 show the percentage of the students depends on the data of shown in Table3.2.

4.2 Answers of the Research Questions

4.2.1 Research Question One

What misconceptions do students demonstrate about heat concepts among 11th grade students in the Emirate of Fujairah? This question is a set of 11 queries.

Q1 concerned is with the measurement of the thermal equilibrium concept using HMT.

Q1: A wooden board, a piece of metal and piece of wool cloth have been placed in a freezer for two days. The temperature inside the freezer was -10 °C. How will the temperature of the objects compare?

i. Correct response in answer part (3): They will all be same temperature.

ii. Correct response in reason part (c): Heat energy will even out for objects that are in contact with their surroundings making the temperature the same.

Table4.1 shows students' responses to tier 1 and tier 2 for Q1, which measures the thermal equilibrium concept. The correct response in tier 1 is 3 while the correct response in tier 2 is C (see Appendex.A). Twenty three percent (23%; $n = 41$) of students answered the two tiers correctly (i.e., the reasoning tier and the answer tier) while 77% ($n = 139$) of students provided wrong answers.

Table.4.1: *Students Percentage Selecting each Response Combination for Question 1 of the HMT*

		Tier 1				Total
Choice		1	2	3	4	
	A	91 (51%)	8 (4%)	1 (0.5%)	1 (0 .5 %)	101 (56%)
	B	8 (4%)	12 (7%)	0	0	20 (11%)
Tier 2	C	1 (0.5%)	0	41 (23%)	3 (2%)	45 (25.5%)
	D	1 (0.5%)	0	2 (1%)	4 (2%)	7 (3.5%)
	E	4 (2%)	1 (0.5%)	1 (0.5%)	1 (0.5%)	7 (3.5%)
Total number of students						180 (100%)

Q2 is concerned with the measurement of thermal equilibrium concept using HMT.

Q2: There are three bowls of the same size that have been sitting on a kitchen table overnight. One is made of wood. Another of metal and the third of plastic .the temperature of the room has been 24 °C the entire time. How do the temperature of the bowls compare to each other?

i. Correct response in answer part (2): the temperature of the three would be the same as the temperature of the room 24 °C.

ii. Correct response in reason part (D): Heat energy will even out for objects that are in contact their surroundings making the temperature for each the same.

Table 4.2 shows students' responses to tier 1 and tier 2 for question 2 which measures thermal equilibrium concept. The correct response of question 2 in tier 1 is 2 while the correct response in tier 2 is D. The percentage of the students who have correct answer in two tiers (i.e., the reasoning tier and the answer tier) is 27 % (n = 49) while 74% (n = 131) of students who selected the wrong answers.

Table.4.2: *Students Percentage Selecting each Response Combination for Question 2 of the HMT*

		Tier 1					Total
Choice		**1**	**2**	**3**	**4**	**5**	
	A	11 (6%)	1 (0.5%)	22 (12%)	19 (11%)	0	53 (29.5%)
	B	11 (6%)	2 (1%)	4 (2%)	2 (1%)	0	19 (10%)
Tier 2	C	10 (6%)	3 (2%)	10 (6%)	7 (4%)	0	30 (18%)
	D	0	49 (27%)	3 (2%)	0	4 (2%)	56 (31%)
	E	2 (1%)	0	1 (0.5%)	1 (0.5 %)	7 (4%)	11 (6%)
	F	1 (0.5%)	3 (2%)	2 (1%)	5 (3%)	0	11 (6.5%)
Total number of students							180 (100%)

Q3 is concerned with the measurement of thermal equilibrium concept using HMT.

Q3: A container of flour, a container of nails and container of water are all placed in an oven that has been heated to 60° C all three materials are allowed to remain in the oven for four hours. Which of the following statements best describes the temperature of the three substances?

i. Correct response in answer part (2): all three will have a temperature of 60° C.

ii. Correct response in reason part (D): heat energy will even out for objects that are in contact with their surroundings making the temperature the same.

Table 4.3 shows the results of students' responses in tier 1 and 2 for question 3 which measures thermal equilibrium concept. The correct response in tier 1 is 2 while the correct response in tier 2 is D. The results shows that 14% (n = 25) of students answered the two tiers correctly. While 87% (n = 155) of students provided wrong answers.

Table 4.3: *Percent of Students Selecting each Response Combination for Question 3 of the HMT*

		Tier 1					Total
Choice		1	2	3	4	5	
	A	3 (2%)	1 (0.5%)	15 (8%)	14 (8%)	9(5%)	42 (23.5%)
	B	0	0	1 (0.5%)	1 (0.5%)	0	2 (1%)
Tier 2	C	3 (2%)	0	63 (35%)	8 (4%)	16(9%)	90 (50%)
	D	3 (2%)	25 (14%)	3 (2%)	3 (2%)	0	3 (20%)
	E	9 (5%)	0	0	0	0	9 (5%)
	F	0	0	0	1 (0.5%)	2(1%)	3 (1.5%)
Total number of students							180 (100%)

The results of the first three questions that measure thermal equilibrium concept show that: 51% (n = 91) of students answered that the metal has low materials in temperature when placed in the refrigerator. as the first question. 12% (n = 22) of students answered that the metal is the highest temperature when you put three materials. a wood. plastic and metal on the table at room temperature. as the second question; 35% (n = 63) of the students answered that the metal is the highest material in temperature degree among wood and plastic in the oven. as the third question.

Table.4.11 shows that 67% (n =120). 50% (n = 90). 69% (n =125) of students have misconceptions on the thermal equilibrium concept in the first three questions in respectively.

Q4 is concerned with the measurement of changing states of matter concept using HMT.

Q4: Mariam puts a piece of zinc metal in an oven at 1000°C. She reads the temperature at 0°C .the zinc once every minute using a thermometer capable measuring 2000°C. She got temperatures of 30°C. 70°C. 200°C, 420°C, 420°C. 420°C and 420°C for the first eight readings. Why does the thermometer have several reading of 420°C?

i. Correct response in answer part (2): The Zinc is melting.
ii. Correct response in reason part (A): When substance changes from a solid to a liquid .its temperature will not change until the solid had melted.

Table 4.4 shows the results of students' responses in tier 1 and tier 2 for question4. which measures changing states of matter concept. The correct response of tier 1 is 2 while the correct response in tier 2 is A. The percentage of students who answered correctly in the two tiers is 28% (n =50). While 70% (n = 130) of students provided wrong answers.

The results of the question 4 show that 19% (n = 35) of students chose wrong answers also they cannot distinguish between the thermal equilibrium and latent heat concept. However, the thermal equilibrium concept is the condition under which the two substances in physical contact with each other exchange no heat energy. Two substances in thermal equilibrium are said to be at the same temperature. While, the latent heat is the quantity of heat absorbed or released by a substance undergoing a change of state, such as ice changing to water or water to steam, at constant temperature and pressure. (The Free Dictionary, 2014). Consequently, fifty three percent (53%, n = 96) of students have misconception in this question (see Table 4.11).

Table 4.4: *The Percent of Students Selecting Each Response Combination for Question 4 of the HMT*

		Tier 1					Total
Choice		**1**	**2**	**3**	**4**	**5**	
	A	2 (1%)	50 (28%)	13 (7%)	0	0	65 (36%)
	B	13 (7%)	4 (2%)	13 (7%)	0	0	30 (16%)
Tier 2	C	0	3 (2%)	2 (1%)	0	7 (4%)	12 (7%)
	D	6 (3%)	2 (1%)	35 (19%)	2 (1%)	1 (0.5%)	46 (24.5%)
	E	0	0	3 (2%)	2 (1%)	1 (0.5%)	6 (3.5%)
	F	0	1 (0.5%)	17 (9%)	1 (0.5%)	2 (1%)	21 (11%)
Total number of students							180 (100%)

Q5 is concerned with the measurement of the boiling point concept using HMT

Q5: In container A there is a little water and in container B there is a lot of water both containers are set over camping stoves which have flames set at the same level. Thermometers of the same type are used to measure the temperature of the water in each container when the water is boiling. How will the temperature compare?

i. Correct response in answer part (2): Temperature will be same in both containers.

ii. Correct response in reason part (C): Water boils at the same temperature no matter amount what amount (volume) you have.

Table 4.5 shows the generated results regarding the responses of the female students in tier 1 and tier 2 for the question 5, which measures the boiling point concept. The correct response of tier 1 is 2 while the correct response in tier 2 is C. Twenty two percent (22%, n =37) of the students chose the correct answer while 78% (n = 143) of students gave an incorrect answer. The results showed that 44% (n = 81) of the female students chose the wrong answer as the students have interpreted that the boiling point depends on the amount of water. However, a little water become higher in temperature compared with a lot of water when boiling. At the same time 70% (n =126) of students have misconception in boiling point concept as illustrated in Table 4.11.

Table 4.5: *The Percentage of Students Selecting each Response Combination for Question 5 of the HMT*

		Tier 1			
Choice		1	2	3	Total
	A	3 (2%)	1(0.5%)	15 (8%)	19 (10.5%)
	B	13 (7%)	0	1 (0.5%)	14 (7.5%)
	C	0	37(22%)	0	37 (22%)
Tier 2	D	81 (44%)	2(1%)	1 (0.5%)	84 (45.5%)
	E	10 (6%)	0	2 (1%)	12 (7%)
	F	3 (2%)	1(1%)	0	4 (3%)
	G	5 (3%)	1(1%)	4 (2%)	10 (6%)
Total number of students					180 (100%)

Q6 is concerned with measurement of the specific heat capacity concept using HMT.

Q6: A cup contains water at 30 °C and bath tub contains water at 10 °C as shown in the diagram below. Which contains more heat energy?

i. Correct response in answer part (2): The tub.

ii. Correct response in reason part (A): Heat energy is determined by the temperature and the number of molecules present. The more molecules a substance has the more energy it can contain.

Table 4.6 shows the results of student's responses in tier 1 and tier 2 for question 6 which measures specific heat capacity concept. The correct response of the first tier is 2 while the correct response in the second tier is A. The percentage of students who answered correctly in the first tier and second tier is 12 % (n=22) while 88% (n=158) of the students chose the incorrect answer. However the percentage of students who have the misconceptions in specific heat capacity concept is 73% as shown in Table 4.11.

Table 4.6: *Students Percentage Selecting Each Response Combination for Question 6 of the HMT*

Choice		Tier 1			
		1	2	3	Total
Tier 2	A	34 (19%)	22 (12%)	3 (2%)	59 (33%)
	B	75 (42%)	7 (4%)	0	82 (46%)
	C	3 (2%)	3 (2%)	23 (13%)	29 (17%)
	D	9 (5 %)	0	1 (0.5 %)	10 (5.5%)
Total number of students					180 (100%)

Q7 is concerned with measurement of specific heat capacity concept using HMT.

Q7: A cup contains water at 30°C and a bathtub contains ice at 0°C. As shown in the diagram below. Which contains the most heat energy?

i. Correct response in answer part (1): The cup.

ii. Correct response in reason part (D): Ice doesn't have any heat in it. Things at 0°C have lost all their heat energy.

Table 4.7 shows that the correct response of question 7 in the first tier is 1, while the correct response in the second tier is D. The percentage of the students gave correct answers in the two tiers is 29% (n = 53), whereas 70% (n =127) of the students chose the wrong answers in at least one of the tiers; therefore, 55% (n= 99) of students had misconception in this concept.

Table 4.7: *The Percentage of Students Selecting each Response Combination for Question 7 of the HMT*

		Tier 1		
Choice		1	2	Total
	A	24 (13%)	11 (6%)	35 (19%)
	B	65 (36%)	4 (2%)	69 (38%)
Tier 2	C	11 (6%)	2 (1%)	13 (7%)
	D	53 (29%)	3 (2%)	56 (31%)
	E	5 (3%)	2 (1%)	7 (4%)
Total number of students				180 (100%)

The results of questions 6 and 7 showed that 42% (n = 75) of the students in Q6 and 36% (n = 65) of the students in Q7 chose the wrong answer, which showed that the heat depends only on the temperature and not on other factors as the specific heat capacity.

Q8 is concerned with the measurement of thermal expansion concept using HMT

Q8: The length of the iron rod in the diagram below is measured and found to be 22 cm at room temperature. The rod is then heated for 15 minutes and its length is measured again. The length of the heated rod should be?

i. Correct response in answer part (1): More than 22 cm.

ii. Correct response in reason part (A): Because the metals are good conductors of heat the flows through the rod causing the metal to expand.

Table 4.8 shows the results of student's responses in tier 1 and tier 2 for question 8 which measures thermal expansion concept. The correct response of the first tier is 1 and A for the second tier. The results show that the percentage of students who gave correct answers in both tiers is 53% (n= 96), while 45.5% (n=84) of students chose the wrong answers in at least one of the tiers. In addition, 38% (n = 68) of students had misconception in thermal expansion concept as shown in Table 8).

Table 4.8: *The Percentage of Students Selecting each Response Combination for Question 8 of the HMT*

		Tier 1				
	Choice	1	2	3	4	Total
	A	96 (53%)	2 (1%)	0	6 (3%)	104 (57%)
	B	13 (7%)	6 (3%)	4 (2%)	4 (2%)	27 (14%)
Tier 2	C	1 (0.5%)	11 (6%)	2 (1%)	3 (2%)	17 (9.5%)
	D	0	0	13 (7%)	0	13 (7%)
	E	0	13 (7%)	3 (2%)	3 (2%)	19 (11%)
Total number of students						180 (100%)

Q9 is concerned with the measurement of heat transfer concept using HMT.

Q9: A piece of metal that has a temperature of 0° C is dropped into a container of water that has a temperature of 20° C.As shown in the diagram below. What will happen to the temperature of the metal and water?

i. Correct response in answer part (3): The temperature of the metal will rise and the water will drop.

ii. Correct response in reason part (B): The water particles are vibrating faster than the metal particles. When they collide with each other the water particles lose energy and the metal particles gain energy.

Table 4.9 shows students' responses in tier 1 and tier 2 for question 9 which measures heat transfer concept. The correct response of the first tier is 3 while the correct response in the second tier is B. Twenty four percent (24%, n = 43) of students gave correct answers on both tiers and they were in scientific group (see table 4.12) while 76% (n= 137) of students gave an incorrect answers. In addition, 33% (n = 60) of students chose the wrong answer. Students were not able to determine the accurate interpretation to describe the reason for increasing the temperature of the metal when placed in water, which has high temperature than the metal. Whereas 68% (n =123) of students have misconception in this question as illustrated in Table 4.9.

Table 4.9: *The Percentage of Students Selecting each Response Combination for Question 9 of the HMT*

		Tier 1				
Choice		1	2	3	4	Total
Tier 2	A	1(0.5%)	4 (2%)	18 (10%)	3 (2%)	26 (14.5%)
	B	0	4 (2%)	43 (24 %)	2 (1%)	49 (27%)
	C	1(0.5 %)	3 (2%)	60 (33 %)	7 (4%)	71 (39.5%)
	D	1(0.5 %)	1 (0.5%)	3 (2%)	1 (0.5%)	6 (3.5%)
	E	0	3 (2%)	5 (3%)	1 (0.5%)	9 (5.5 %)
	F	0	2 (1%)	13 (7%)	4 (2%)	19 (10%)
Total number of students						180 (100%)

Q10 is concerned with measurement of the heat transfer concept using HMT.

Q10: The diagram below shows a house on a winter day .the window is off and the temperature inside the house begins to drop. Which of the following best describes what is happening?

i. Correct response in answer part (1): The house is losing heat.

ii. Correct response in reason part (D): Heat always moves from hot to cold.it usually moves out through the window pane.

Table 4.10 shows the results of students' responses in tier 1 and tier 2 for question 10 which measures heat transfer concept. The correct response for the first tier is 1 while the correct response in the second tier is D. The data shows that the total percentage of students who have correctly answered the both tiers is 8% (n=15) while 92.5% (n= 165) of students gave an incorrect answer. 34% (*n* = 62) of students have interpreted that as the heat moves from one place to another as well as the cold moves. While the correct answer is that the heat is transferred from hot to cold place. Table 4.10 shows that the percentage of students in scientific group is 8% (n=14) while the percentage of students who had misconception in heat transfer concept is 78% (n=140) as illustrated in Table 4.10.

Table 4.10: *The Percentage of Students Selecting Each Response Combination for Question 10 of the HMT*

		Tier 1			
Choice		1	2	3	Total
	A	18 (10%)	1 (0.5%)	12 (7%)	31 (17.5%)
	B	1 (1%)	9 (5 %)	24 (13%)	34 (19%)
Tier 2	C	3 (2%)	5 (3%)	62 (34 %)	70 (39%)
	D	15 (8%)	0	15 (8%)	30 (16%)
	E	3 (2%)	2 (1%)	10 (6%)	15 (9%)
Total number of Students					180 (100%)

Table 4.11 shows that the percentages of participants who had misconceptions in 11th grade in Emirate of Fujairah schools. Sixty two percent of students (62%) or more than half of students have misconceptions. The highest percentage of students who have misconceptions was 78% (n=140) in question 10 (the question about the concept of heat transfer) in comparison to all questions.

Table 4.11: *Student's Distribution in Misconception Categories*

			Questions										
1st tier	2ed tier	3rd tier	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
			n	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	
Correct	Incorrect	Certain	4	4	0	3	3	5	79	12	90	20	22
Incorrect	Correct	Certain	5	5	6	12	0	29	2	9	6	12	9
Incorrect	Incorrect	Certain	111	81	119	81	123	98	18	47	27	108	81
Total number of students			120	90	125	96	126	132	99	68	123	140	112
Percentage (n = 180)			67%	50%	69%	53%	70%	73%	55%	38%	68%	78%	62%

Table 4.12 shows the percentage of the students in the scientific knowledge category and indicates that twenty one percent (21 %) of students have scientific knowledge.

Table 4.12*: Student's Distribution in Scientific Knowledge Category*

			Questions										
1st tier	2ed tier	3rd tier	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
			n	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	Mean
Correct	Correct	Certain	37	37	20	47	35	16	49	85	44	14	38
Percentage (n = 180)			21%	21%	11%	26%	19%	9%	27%	47%	24%	8%	21%

4.2.2 Research Question Two

What is the percentage of the 11th grade female students who demonstrate lack of knowledge about heat concept in Emirate of Fujairah?

Lack of knowledge score is the situation of being uncertain regardless of correct or incorrect responses to the first and/or the second tiers. The mean percentage of students who had a lack of knowledge in all questions is 13% of the students. Table 4.13 shows the approximate percentages of the questions. The highest percentage of students who have a lack of knowledge was 21% (n=37) in question 2 as shown in Table 4.13.

Table 4.13: *Student's Distribution in* Lack of Knowledge *Categories*

			Questions										
1st tier	2ed tier	3rd tier	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
			n	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	
Correct	Incorrect	Uncertain	0	5	1	6	2	5	23	1	7	4	5
Incorrect	Correct	Uncertain	0	1	2	3	0	5	1	2	0	2	2
Incorrect	Incorrect	Uncertain	15	31	27	25	14	16	4	14	5	18	17
Total number of students			15	37	30	34	16	26	28	17	12	24	24
Percentage (n = 180)			8 %	21 %	17%	19%	9%	14%	16%	9%	7%	13%	13%

4.2.3 Research Question Three

What is the percentage of students who demonstrate lucky guess about heat concept among 11th grade students in Emirate of Fujairah?

Lucky guess students have correct answers in the first and the second tier with uncertain in their answers. Table 4.14 shows that 3 % of the 11th grade female students in Emirate of Fujairah used a lucky guess with regards the concepts of heat. As shown in table the highest percentage of students who have a lucky guesses was 9% (n=16) in question 2.

Table 4.14: *Student's Distribution in* Lucky Guess *Categories*

1st tier	2ed tier	3rd tier	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean
			n	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	
Correct	Correct	Uncertain	8	16	5	3	3	6	4	10	1	2	6
Percentage (n = 180)			4 %	9%	3%	2%	2%	3%	2%	6%	1%	1%	3 %

Table 4.15 shows the different distributions of student's percentages according to four categories. As shown in this table, most students had misconceptions in most heat concepts, while the percentages of students who had correct scientific knowledge were very low throughout all MHT questions.

Table 4.15: *Total Percent for All Students in Different Categories*

Questions	Scientific Knowledge	Misconceptions	Lack of Knowledge	Lucky guess	Total
Q1	21 %	67 %	8 %	4 %	100 %
Q2	21 %	50 %	21 %	9 %	100 %
Q3	11 %	69 %	17 %	3 %	100 %
Q4	26 %	53 %	19 %	2 %	100 %
Q5	19 %	70 %	9 %	2 %	100 %
Q6	9 %	73 %	14 %	3 %	100 %
Q7	27 %	55 %	16 %	2 %	100 %
Q8	47 %	38 %	9 %	6 %	100 %
Q9	24 %	68 %	7 %	1 %	100 %
Q10	8 %	78 %	13 %	1 %	100 %

CHAPTER FIVE

DISCUSSION

This chapter discusses the generated results of the proposed research questions (ref. 1.6). The chapter is divided to three parts; each part tackles separately the discussion on the results of each research question.

5.1 Research Question One

Q1: ***What misconceptions do students demonstrate about heat concepts among 11th grade students in Emirate of Fujairah schools?***

Generally, the current study found that more than half of the 11th female students (62%) who participated in the survey had misconceptions about heat related concepts. The Q1, Q2 and Q3 were concerned with the measurement of the thermal equilibrium concept.

As for the thermal equilibrium concept, which covered in the first three questions of the (HTM), the percentages of students who had misconceptions were 67%, 50%, and 69% (n=120, n=90, and n=125 respectively), which shows high percentage for this concept. As shown in the results, students were not able to respond correctly to the items related to thermal equilibrium concept. It appears that students might use non-scientific language when they express their ideas or knowledge about this concept in their daily lives. This finding is consistent with the findings of previous studies with higher or lower of the percentage reported. For example, Gonen and Kocakaya (2010) reported lower percentage. They found that 29% of students in 6th, 34% of students in 7th grade, and 43% of students in 8th grade had specific misconceptions in equilibrium heat concept.

Tanahoung, Chitaree, and Soankwan (2010) documented higher percentage when they investigated students' thermal equilibrium misconnects and their findings revealed that 83% of the students had misconception. In addition Lubben, Netshisaulu, and Campbell (1999) also reported slightly higher percentage when their study showed that 77% of their study sample carried misconception related to thermal equilibrium concept. Moreover, Weiss (2010) study's showed that 66% of the students had misconception in the same concept, which is almost similar to the percentage reported in the current study. Finally, Alwan (2011) study's reported that 62.3%, 90.6%, 54.7%, and 81.1% of the students chose wrong responses for different questions related to thermal equilibrium.

In regard to the latent heat concept that covered in question four in (HTM), the results revealed that 53% of students (n=96) had misconceptions. The percentage reported in the current study is higher that reported by Tanahoung, Chitaree, and Soankwan (2010) who found that 41% of students were not able to give correct and complete explanation to open-ended questions about the latent heat related concept and lower than the percentage reported by Alwan (2011) who found that 84.9% of students chose the wrong answer to questions related to the latent hear concepts. This finding could be interpreted by the fact that this concept has more abstract in its nature. It could also relate to how science textbooks present this concept. It appears that school science textbooks may address this concept in a way that makes the concept looks difficult to the students.

However, although physics textbook for 11^{th} grade; for example, provides enough experiences for students to practice learning latent heat concept, the students still have alternative concepts about it. This support believes that the way this concept is presented in science textbooks does not support students learning. Another way to interpret this result comes from the fact that students need to use their mathematics skills and knowledge to solve problem related to latent heat concept.

In regard to exploring misconception that relate to the boiling point concept, which covered in question 5 (HMT), the results showed that 70% of the students (n=126) had misconception. This result indicated that more than half of the participants had misconception about boiling point concept. The percentage reported in this study is higher than the percentages reported by Alwan (2011), 52.3%, and by Kartal, Öztürk, and Yalvaç (2011), 47%. This result may be due to lack of understanding of the students to the water boiling point. Students may believe that water boiling point may not exceed 100°c as it could happen in certain conditions.

The sixth and seventh question in HMT examined specific heat capacity for water and ice and thermal energy concepts. For question 6, the percentage of students who had misconceptions was 73% (n =132) and for question 7, the percentage was 55% (n =99) of the students participated in the study. This result is consistent with the findings of Streveler et al. (2011) with lower percentage reported when they found that 50% of engineering students have misconception in this concept. In the thermal expansion concept which was covered in question 8 (HMT) less than half of the participants (38% and 47%) had correct scientific knowledge.

This result indicates that most of the students hold the correct understanding of the thermal expansion concept. This finding may due to the practical works that students do when they study this concept. In such practical works, students gained correct scientific knowledge and understanding when they for example, measure rate of expansion and contraction, observe expansion and contraction of metals. It also could be due to the fact that students deal with thermal expansion as a concrete more than an abstract concept.

The results of this study revealed that 68% (n=123) of the students participated in this study had misconception in regard to the heat transfer concept (question 9 of HMT) and 78% (n=140) of the students (question 10 of HMT). The last result showed that most participants had misconception in the heat transfer concept. The wordings, which used to write question 9 in HMT could be one of the reasons behind this partially high percentage. Option B which was the correct interpretation of this question was written in an accurate way and very careful to clarify the process of heat transfer between water molecules and metal. Because heat transfer is an abstract concept, most students preferred to choose the direct interpretation without applying deeper thinking. Therefore, 24% (n=43) of the students selected the correct answer while the majority of them chose the direct interpretation.

In responding to question 10 (HMT), students were unable to differentiate between heat and cold concepts; whichever is moving toward the other. Sixty eight percent (68%, n = 123) of the students selected both processes occur which indicated a wrong response to answer tier (see table 4.10 in chapter 4; third choice in tier 1). The main reason behind occurring this misconception could be explained because of the language that students usually use in their everyday communication. For example, it appears that local people believe that the good idea is to close the door of cold room so that the cold air does not come out. This believe opposes the scientific fact that the heat which is transmitting from the hot place to a cold place. This result and its explanation are consistent with the finding of Alwan (2011) who found that 54.7% of the respondents have their own ideas regarding to perceptions of hot and cold are unrelated to energy transfer. However, the percentage reported in the current study is higher than that reported by Alwan (2011).

5.2 Research Question Two

Q2: What is the percentage of 11th grade students who demonstrate lack of knowledge about heat concepts in Emirate of Fujairah schools?

Lack of knowledge refers to the situation of being uncertain regardless of correct or incorrect response to the first and/or second tiers (Hasan et al., 1999). In current study the results showed that the percentage of students, who had misconceptions that related to the lack of knowledge in thermal equilibrium concept in first three questions were 8% (n=15), 21% (n=37), and 17% (n=30), respectively. However, the percentage of lack of knowledge students had in the latent heat concept that was covered in question four (HMT) is 19% (n =34), which represents a high percentage among all questions in the HMT, whereas 9% (n= 16) of the students had misconceptions related to lack of knowledge in boiling point concept that stated in question 5 (HMT) and 14% (n=26) and 16% (n= 28) of students in specific heat capacity concept for water and ice and thermal energy concept in Q6 and Q7, respectively.

On the other hand, 9% (n =17) of the students showed lack of knowledge in thermal expansion, whereas 7% (n=12), and 13% (n =24) of the students had misconceptions in the heat transfer in Q9 and Q10. This lack of knowledge showed by this study could be related to possibility that school science materials present scientific knowledge as facts to be memorized without providing student with opportunity to use their mental capabilities. Science teachers could also be hold responsible because some of them still using teaching methods that do not sharp and develop students' thinking skills.

5.3 Research Question Three

Q3: What is the percentage of students who demonstrate lucky guess about heat concept among 11th grade students in Emirate of Fujairah schools?

Lucky guess in this study refers to the correct answers to both tiers with uncertainty (Arslan, Cigdemoglu, and Moseley, 2012). The percentages of the students, who had misconceptions that could be related to lucky guess in first three questions were 4% (n=8), 9% (n=16), and 3 % (n=5) in thermal equilibrium concept. In question 4 and 5 two percent (2%, n =3) of the participated students showed lucky guess in latent heat as well as in boiling point concepts. Meanwhile, 3% (n=6) and 2% (n=4) of the students used lucky guess in the specific heat capacity concept for water, ice, and thermal energy concept in Q6 and Q7 (HMT). Moreover, 6% (n=10) used lucky guess in thermal expansion concept in Q8 and one percent of students (1%, n=1) applied lucky guess in heat transfer concept in Q9 and Q10.

As the results illustrated, students percentage in lucky guesses category was very few compared to other groups. In any classroom sitting, determining the lucky guesses group of students could help teachers to identify students whom are not serious in taking any educational test. It also confirms that the three-tier method is appropriate in helping teachers to divide students into several categories according to their scientific knowledge about any concepts taught in the classroom. Thus, teachers will be able to take suitable action towards each categories or groups of students.

CHAPTER SIX

SUMMARY AND RECOMMENDATIONS

6.1 Summary

This section summarises the findings of this study. As the core concern of this study is the exploration of the misconceptions of the 11th grade female students about the heat concepts using a three-tier diagnostic instrument comprising of 10 questions. The proposed research problems were:

1- Distinguish students' misconceptions from their lack of knowledge on the heat concepts among 11th grade students in Fujairah schools, UAE.
2- Distinguish students' misconceptions from their lack of knowledge, and lucky guess on the heat concepts among 11th grade students in Emirate of Fujairah schools, UAE.

One hundred eighty 11th grade female students enrolled in ten classrooms from five secondary schools in Emirate of Fujairah participated in this study. All students were in science section and there were in the age ranged from 15-16 years. The study was applied on the third semester in 2011-2012 after the heat and temperature chapter was entirely completed in June 2012. The instrument used in the study was the Heat Misconception Test (HMT) which consisted of three-tier multiple-choice items. The first tier consisted of content questions with 4 or 5 alternatives. The second tier consisted of 4 to 6 possible reasons explained students selection of each item in the first tier; three alternative reasons and one scientifically accepted reason. The heat misconception test has 10 items that assessed the heat understanding of the concepts. The third tier required students to express their confidence in their responses to the first and second tiers by using a confidence scale with 1 and 7 corresponding to "Just Guessing" and "Absolute Confidence" respectively.

6.2 Recommendations

The study proposes some recommendations sparked from the findings of this study for improving physics teaching and classroom practices; in particular, enhancing the conceptions of the students about the physical phenomena such as heat, temperature, magnetism, etc.

Based on the purposes, findings, and conductions of this study, recommendations are proposed for three areas related to physics and science teaching and learning in the United Arab Emirates (UAE). These areas are physics and science school and classroom practices, physics and science curriculum development, and future research.

6.2.1 Physics and Science School and Classroom Practice

1. The findings of the study showed that multiple-choice tests and also two-tier tests cannot estimate the misconception of the students. Because, they do not take into account the lucky guess of the students and lack of knowledge of the students. Moreover, both types of tests also overestimate the correct answers of the students. Therefore, to avoid from lucky guess and lack of knowledge causing the wrong answers of the students teachers should use three-tier tests to investigate the misconceptions of the students. They should consider that the results of the multiple-choice tests or even if two-tier tests can be misleading while investigating the misconceptions of the students.

2. The current study divided student to four categories. So, teacher should be seeking to distinguish between them then instructional deliveries should be modified accordingly, with the explicit intent of removing the misconceptions such as classroom examples, homework assignments, quizzes should be designed to ascertain the grasp of the correct concepts.in addition, give the student the opportunity to participate in the lesson planning, as well as choice the test method.
3. The data which obtained by using three-tier test can used to address other areas of instruction. In particular, it could be used: as a diagnostic tool, enabling the teacher to modify their lesson instructions, as a tool for assessing progress or teaching effectiveness when both pre- and post-tests are administered; and as a tool for comparing the effectiveness of different instruction methods, including technology integrated in promoting understanding and problem solving proficiency.
4. Using social constructivism ideas such as students working together and helping each other develop ideas may lead to students' wrong ideas. Teachers should monitor students' discussion and bring them together to discuss what they have learned to assist them in making accurate interpretations when doing lab activities.
5. Physics and science teachers as well need to use appropriate techniques to identify students' misconceptions and help them replace their misconceptions with accepted correct science concepts (conceptual change). To do so, teachers may use the following strategy: (1) identifying students' misconceptions; (2) allowing students to apply their concepts; (3) seeking students' un-satisfaction; and allowing students to apply new concepts.

6. Schools administrators need to prepare professional development programs for their physics and science teachers that include methods and advanced practices to help them to deal and correct students` misconceptions.

6.2.2 Physics and Science Curriculum Development

1. Because physics and science school educational materials play a consider role in students` learning new science concepts, curriculum developers in the UAE should include more practical works in the physics and science school textbooks. As indicated from the findings of this study, conducting enough school practical works could lead to decrease students` science misconceptions.
2. As the conclusions of this study suggested, student`s limited experiences with physical and scientific experiences in their everyday life could be responsible for increasing their misconceptions. Therefore, physics and science curriculum and school textbooks should include materials and experiences relate to student personal life and experiences.

6.2.3 Future Research

Although this study supported the value of exploring students' misconception in heat concepts, much research is still needed. Accordingly the researcher of this study comprised a list of recommended future studies as below:

1. The results pave the way to further research to focus on heat concepts employing more teaching sources and methods.
2. More researches are needed to apply the findings this study on the students in other UAE schools.

3. This study focuses on 11^{th} grade female students misconceptions. Future research may need to focus on the science and physics teachers.
4. The study focuses only on female students who are enrol in 11^{th} grade and their misconceptions in the heat concepts. Additional research needed to explore the 11^{th} grade male students' misconceptions additional to different grade to help determine the beginning of the problem.

LIST OF REFERENCES

Abell, S.K., & Lederman, N.G. (2007). *Handbook of research on science education*. Routledge: New York.

Al-Jubaili, A.Y. (2002). *Science misconceptions and work memory capacity among Saudi adolescents: A neo-Piagetian investigation* (Doctoral dissertation). Retrieved from Pro Quest Dissertation and Thesis database (UMI No 3057532)

Al Rashed, A.A.(2002). *Al mafahem al elmeya al kata a ladatolap al qyesm al elmiafecolleyat almoalemmen fe Al Riyadh. Journal of the Faculty of Education, 19*(17), 35-67 [in Arabic]

Alwan, A.A. (2011). Misconception of heat and temperature among physics students. *Procedia Social and Behavioral Sciences, 12*, 600-6014.

Angell, C., Guttersrud, O., Henriksen, E.K., & Isnes, A. (2004). Physics: Frightful, but fun pupils and teachers' views of physics and physics teaching. *Science Education, 88*(5), 683-706.

Arslan, H.O., Cigdemoglu, C., & Moseley, C.(2012).A three-tier diagnostic test to assess pre-service teachers misconceptions about global warming, greenhouse effect, ozone layer depletion and acid rain. *International Journal of Science Education, 34*(11), 1-20.

Awan, A.S., Khan, T.M., Mohsin, M. N & Doger, A, H. (2011).Students' misconceptions in learning basic concept composition of matter in chemistry. *International Journal of Applied Science and Technology, 1(4)*, 161-167

Caleon, I.,& Subramaniam, R. (2010). Development and application of a three-tier diagnostic test to assess secondary students' understanding of waves. *International Journal of Science Education*, 32(7), 939-961.

Chang, H. P., Chen, J. Y., Guo, C. J., Chen, C. C., Chang, C. Y., Lin, S. H., Su, W. J., Lain, k. D., Hsu, S. Y., Lin, J.L., Chen, C. C., Cheng, Y. T, Wang, L. S & Tseng, Y.T. (2007). Investigating primary and secondary students' learning of physics concepts in Taiwan. International Journal of Science Education. 29(4). 465--482.

Chee, C.T. (1996). Common misconceptions in frictional force among university physics students. *Teaching and Learning, 16*(2), 107-116.

Chiou, G. L., & Anderson, O.R. (2010). A study of undergraduate physics students' understanding of heat conduction based on mental model theory and an ontology–process analysis. *Science Education, 94*(5), 825-854.

Cohen, L., Lawrence, M., & Morisson, K. (2000). *Research methods in education* (5th Ed.). London: Routledge Falmer

Damas, G. (1994). *Factors influencing conceptual understanding in introductory college physics courses.* (Doctoral dissertation). Retrieved from Pro Quest Dissertation and Thesis database (UMI No 9432479)

Demirci, N. (2005). A study about students' misconceptions in force and motion concepts by incorporating a web-based physics program. *The Turkish Online Journal of Educational Technology, 4*(3), 1303 -6521.

Franklin, B.J. (1992). *The development, validation, and application of a two-tier diagnostic instrument to detect misconceptions in the areas of force, heat, and electricity.* (Doctoral dissertation) Retrieved from ProQuest Dissertation and Thesis database (UMI No 9301049)

Gilbert, J.K., Osborne, R.J. & Fensham, P.J. (1982). Children's science and its consequences for teaching. *Science Education, 66*(4), 623-633.

Gonen, S., & Kocaya, S. (2010). A cross-age study on the understanding of heat and temperature. *Eurasian Journal of Physics and Chemistry Education, 2*(1), 1-15.

Guisasola, J., & Montero, A. (2010). *An energy –based model for teaching the concept of electromotive force. Students' difficulties and guide lines for a teaching sequence.*

Paper presented at ESERA 2009 Conference of the contemporary science education research, Turkey.

Harrison, A.G., Grayson, D.J., & Treagust, D.F. (1999). Investigating a grade 11 student's evolving conceptions of heat and temperature. *Journal of Research in Science Teaching, 36*(1), 55-87

Hassan, A.A. (1993). Tasweeb al tasawerat al khatea ldatalebat al marhalateen al thanaweah wa al gammeyah an al kwa we kanoon al thaleth le newton. *Journal of Education Research, 3*, 84-163

Hasan, S., Bagayoko, D., & Kelley, E.L. (1999).Misconceptions and the certainty of response index (CRI).*Physics Education, 34*(5), 294-299.

Hestenes, A., Wells, M., & Swackhamer, G. (1992). Force concept inventory, *Physics Teacher, 30*, 141- 158.

Jang, N.H. (2003). *Developing and validating a chemical bonding instrument for Korean high school students* (Doctoral dissertation) Retrieved from Pro Quest Dissertation and Theses Database (UMI No 3115557)

Kaltakci, D., & Didis, N. (2007).Identification of pre-service physics teachers' misconceptions on gravity concept: A study with a3-tier misconception test. *Academic Journal, 899*(1), 499-500.

Kaltakci, D., & Eryilmaz, A. (2010). *Source of optics misconceptions.* Paper presented at ESERA 2009 Conference of the contemporary science education research, Turkey.

Kartal, T.,Öztürk, N., & Yalvaç, G. (2011). Misconceptions of science teacher candidates about heat and temperature. *Procedia Social and Behavioral Sciences, 15*, 2758–2763.

Kikas, E. (2004). Teachers' conceptions and misconceptions concerning three natural phenomena. *Journal of Research in Science Teaching, 41* (5), 432–448.

Kirbulut, Z.D., & Beeth, M. E. (2010). *The inconsistency of students' ideas across evaporation, condensation and boiling*. Paper presented at ESERA 2009 Conference of the contemporary science education research, Turkey.

Kucukozer, H., & Kocakulah, S .(2008).Effect of Simple Electric Circuits Teaching on Conceptual Change in Grade 9 Physics Course. *Journal of Turkish Science Education*, *5*(1), 59-74.

Kutluay, Y. (2005). *Diagnosis of eleventh grade student misconceptions about geometric optic by a three-tier test* (Doctoral dissertation). (Unpublished master`s thesis). Middle East Technical University, Turkey.

Lawson, A.E., Alkhoury, S., Benford, R., Clark, B.R., & Falconer, K.A.(2000). What kinds of scientific concepts exist? Concept construction and intellectual development in college biology. *Journal of Research in Science Teaching*, *37* (9), 996-1018.

Lubben, F., Netshisaulu, T. & Campbell, B.(1999). Students` use of cultural metaphors and their scientific understandings related to heating. *Science Education*, *83* (6), 761-774

Maloney, D.P., O'Kuma, T.L., Higgelke, C. J., & Heuvelen, A. (2001). Survieng students` conceptual knowledge of electricity and magnetism. Physics Education Research, *American Journal of Physics Supplement*, *69*(7), S 12- 23.

Menekse, M., Clark, D., Ozdemir, G., Dangelo, C., & Scheligh, S. (2010). *Turkish students force meaning*. Paper presented at ESERA 2009 Conference of the contemporary science education research, Turkey.

Nahum, T.L., Hofstein, A., Naaman, R. M & Bar-dov, Z.B. (2004). Can final examinations amplify students` misconceptions in chemistry? *Chemistry Education: Research and Practice*, *5* (3), 301-325.

Ministry of Education. (2013). *Summary of statistics in education*. UAE: Author.

Oglesby, M.L. (2009). *Efficiency of changing physics misconceptions held by ninth grade students at varying development levels through teacher addition of a prediction phase to the learning cycle* (Doctoral dissertation). Retrieved from ProQuest Dissertation and Thesis database (UMI No 3394757)

Odom, A.L., & Barrows, L.H. (2007). High school biology students' knowledge and certainty about diffusion and osmosis concepts. *School Science and Mathematics, 107*(3), 94-101.

Odom, A. L., & Barrow, L. H. (1995). Development of a two-tier diagnostic test measuring college biology students` understanding of diffusion and osmosis after a course of instruction. *Journal of Research in Science Teaching, 32*(1), 45- 61.

Osborn, R.J., & Gilbert, J.K. (1979). Investigation of students understanding of basic physics concepts using interview about instances approach. *Research in Science Education, 9*, 85- 93.

Paik, S.H., Cho, B.K., & Go, Y.M. (2007). Korean 4- to 11-year old student conceptions of heat and temperature. *Journal of Research in Science Teaching, 44*(2), 284–302.

Pella, M. O. (1966). Concept learning in science. *The science Teacher*, 33(9), 31-34.

Pesman, H., & Eryilmaz, A. (2010). Development of a three-tier test to assess misconceptions about simple electric circuits. *The Journal of Educational Research*, 103, 208–222.

Peterson, R. P., Treagust, D. F., & Garnet, P. (1989). Development and application of a diagnostic instrument to evaluate grade11 and 12 students` concepts of covalent bonding and structure following a course of instruction. *Journal of Research in Science Teaching, 26* (4), 301- 314.

Podolefsky, N. S. (2008). *Analogical scaffolding: making meaning in physics through representation and analogy.* (Doctoral dissertation) Retrieved from ProQuest Dissertation and Thesis database (UMI No 3303886).

Redish, E. F. (1994).The implications of cognitive studies for teaching physics. *American Journal of Physics*, *62*(6), 796-803

Sanger, M. J., & Greenbowe, T. (1997). Common student misconceptions in electrochemistry: galvanic, electrolytic, and concentration cells. *Journal of Research in Science Teaching, 34*(4), 377-398.

Sreenivasulu, B., & Subramaniam, R. (2013). University students' understanding of chemical thermodynamics. *International Journal of Science Education, 35*(4), 1-35.

Stefani, C., & Tsaparlis, G. (2009). Students' levels of explanations, models, and misconceptions in basic quantum chemistry: A phenomenographic study. *Journal of Research in Science Teaching*, *46*(5), 520–536.

Stepans, J., & Dyche, S. (1987). *Using the personal interview to determine students' misconceptions in science and suggestions to alleviating those misunderstanding.* Proceeding of the Second International Seminar: Misconceptions and Educational Strategies. Vol1, pages 466- 480, Cornell University. Ithaca, New York.

Streveler, R.A., Millr, R.L., Santiago-Roman, A.I., Nelson, M.A., Geist, M.R., & Olds, B.M. (2011). Rigorous methodology for concept inventory development: using the 'assessment triangle' to develop and test the thermal and transport science concept inventory (TTCI). *International Journal of Engineering Education, 27*(5), 968–984.

Sungur, S., Tekkaya, C., & Geban, O. (2001). The contribution of conceptual change texts accompanied by concept mapping to students' understanding of the human circulatory system. *Journal of School Science and Mathematics, 101*(2), 91–101.

Takkaya, C. (2002). Misconceptions as a barrier to understanding biology. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 23, 259-266.

Tanahoung, C., Chitaree, R., & Soankwan, C. (2010). Probing Thai freshmen science students' conceptions of seat and temperature using open-ended questions: A case study. *Eurasian Journal of Physics and Chemistry Education*, *2*(2), 82-94.

Tan, C., Goh, N.K., Chia, L.S., & Treagust, D.F. (2002). Development and application of a two-tier multiple choice diagnostic instrument to assess high school students' understanding of inorganic chemistry quantitative analysis. *Journal of Research in Science Teaching, 39*(4), 283- 301.

Temizan, D. (2003). *The effect of gender on different categories of students' misconception about force and motion.*(Unpublished master's thesis). Middle East Technical University, Turkey.

The Free Dictionary (2013). http://www.thefreedictionary.com/physics

The Free Dictionary (2014). http://www.thefreedictionary.com/thermal+equilibrium

The Free Dictionary (2014). http://www.thefreedictionary.com/latent+heat

Treagust, D. F. (1988). Development and use of diagnostic tests to evaluate student's misconceptions in science. *International Journal of Science Education, 10(*2), 159-169.

Voska, K.W., & Heikkinen, H. R. (2000). Identification and analysis of students' conceptions used to solve chemical equilibrium problems. *Journal of Research in Science Teaching, 37*(2), 160-176.

Weiss, L. (2010). Ell and non-ell students' misconceptions about heat and temperature in middle school (Master dissertation) Retrieved from http://purl.fcla.edu/fcla/etd/CFE0003238

Wiser, M., & Amin, T. (2001). Is heat hot?" Inducing conceptual change by integrating every day and scientific perspectives on thermal phenomena. *Learning and Instruction, 11*(4), 331-355.

Zacharia, Z.C., Olympiou, G., & Papaevripidou, M. (2008). Effects of experimenting with physical and virtual manipulative on students' conceptual understanding in heat and temperature. *Journal of Research in Science Teaching, 45*(9), 1021–1035.

APPENDIX A: Heat Misconception Test (HMT) in Arabic

اختبار تحديد المفاهيم الخطأ في الحرارة

اسم الفيزيائية المتميزة : .... من مدرسة : ....

السنة الدراسية 2012- 2011

التعليمات :

من فضلك اقرأ التعليمات الآتية قبل أن تبدأ في الإجابة على أسئلة الاختبار:

1- لكل سؤال من الأسئلة المتضمنة في الاختبار ثلاثة فروع متصلة وهي كالتالي:.

- **جزء الإجابة** :

عليك اختيار أحد الإجابات المكتوبة .

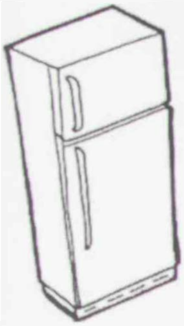
- **جزء السبب**:

إن لم تجد سبب يتناسب مع فهمك للسؤال ضمن الاختيارات المذكورة ، عليك أن تكتب السبب المناسب في الفراغ المحدد لذلك.

- **جزء مدى تأكدك من الإجابات ومدى استيعابك للإجابة:**

عليك أن تختاري أحد الأرقم من 1 إلى 7 بحيث كلما اقتربتِ من الرقم 7 هذا يعني أنك متأكدة من صحة إجابتك أو أن الإجابة واضحة المعنى بالنسبة لك والعكس صحيح كلما اقتربت من الرقم 1

1- وضعت لوحة خشبية، وقطعة من المعدن وقطعة من قماش الصوف في الثلاجة لمدة يومين. و كانت درجة الحرارة داخل الثلاجة $-10°C$ ، إذا قارنا درجة حرارة الاجسام الثلاثة فان:



الاجابة:

1- درجة حرارة المعدن ستكون أقل من درجة حرارة الخشب أو الصوف.

2- كلا من المعدن والخشب سوف يكون لهما نفس درجة الحرارة والتي ستكون أقل من درجة حرارة الصوف.

3- الأجسام الثلاثة سيكون لها نفس درجة الحرارة.

4- الأجسام الثلاثة لها نفس درجة الحرارة، ولكن درجة حرارتها أقل من $-10°C$

السبب :

أ) المعدن يصبح أكثر برودة لأن لديه القدرة على سحب البرودة إليه .

ب) قطعة الصوف ستمتص الحرارة بشكل أفضل من المعدن أو الخشب. لذلك تستخدم للتدفئة في الشتاء.

ج) الطاقة الحرارية سوف تنبعث من الأجسام التي تكون على تماس مع محيطها مما يجعل درجة الحرارة متساويه فيها جميعا.

د) الجسم الذي يبقى في الثلاجة لمدة أطول سوف يكون الأكثر برودة .

هـ) إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي.

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

2- لدينا ثلاثة اطباق بأحجام متساوية وضعت على طاولة مطبخ طوال الليل. أحد هذه الاطباق مصنوع من الخشب ، والاخر مصنوع من المعدن والاخير مصنوع من البلاستيك. وكانت درجة حرارة الغرفة $24°C$ طوال الوقت.، كم ستكون درجة حرارة الاطباق مقارنة مع بعضها البعض :

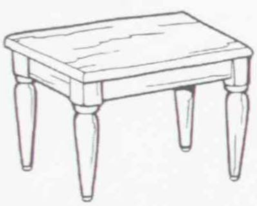
الاجابة:

1 - درجة حرارة الطبق الخشبي ستكون أعلى من درجة حرارة الطبق البلاستيكي، ودرجة حرارة الطبق البلاستيكي ستكون أعلى من درجة حرارة الطبق المعدني.

2 - تتساوى درجة الحرارة في الأطباق الثلاثة مع درجة حرارة الغرفة $24°C$.

3-درجة حرارة الطبق البلاستيك ستكون أقل من درجة حرارة الطبقين الأخرين ، أما طبق الخشب فدرجة حرارته ستكون أعلى من درجة حرارة طبق البلاستيك وستكون درجة حرارة طبق المعدن أعلى الأطباق الثلاثة حرارةً.

4 -درجتا حرارة كل من الطبق الخشبي والبلاستيكي ستكونان متساويتين أما درجة حرارة الطبق المعدني فستكون أعلى من درجتي حرارة الطبق الخشبي والبلاستيكي.



5- درجة حرارة الأطباق الثلاثة ستكون أقل من درجة حرارة الغرفة.

السبب:

أ- المعدن يوصل الحرارة بصورة أفضل.

ب- المعادن تفقد الحرارة بسرعة وبالتالي تصبح الأقل في درجة الحرارة.

ج -لأن البلاستيك والخشب من المواد العازلة وبالتالي تكون الأعلى في درجة الحرارة.

د- الطاقة الحرارية ستنبعث من الأجسام التي تكون على تماس مع محيطها مما يجعل درجة الحرارة متساويه فيها جميعا.

هـ-لأن الأجسام مثل المعدن و الخشب والبلاستيك ليست موادا حية أي لا يمكن ان تمتص الحرارة. لذا فدرجة حرارتهم ستكون أقل من درجة حرارة محيطهم .

و-إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي.

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

3 ـ لدينا ثلاثة أواني الاول به طحين والآخر به مسامير والوعاء الثالث به ماء ، وضعت في فرن درجة حرارته 60 ° C لمدة أربع ساعات ، أي من العبارات التالية هي الافضل في وصف درجة حرارة المواد الثلاث؟

الاجابة

1 ـ درجة حرارة المواد الثلاثة أكثر من 60°C

2- درجة حرارة المواد الثلاثة تساوي 60° C

3 - درجة حرارة الدقيق أقل من 60 °C ، أما درجة حرارة المسامير فأعلى من 60°C بينما درجة حرارة الماء تساوي 60° C

4- درجة حرارة كلا من الماء والطحين 60 ° C بينما درجة حرارة المسامير ستكون أعلى من 60° C

5- درجة حرارة كلا من الماء والطحين أقل من 60° C ، بينما درجة حرارة المسامير ستكون أعلى من 60° C.

السبب :

أ ـ لأن المعدن يعتبر موصل جيد للحرارة ، أي له القدرة على امتصاص الحرارة بصورة أفضل.

ب- لأن المعدن يفقد الحرارة بسرعة لذا سيكون الأقل في درجة الحرارة .

ج- لأن المسامير من معدن الحديد فسوف تمتص الحرارة بشكل أفضل. أما الماء فسيكون أقل من الحديد في درجة الحراة لأنه في حالة غليان ، وبالنسبة للدقيق فهو الأقل في درجة الحرارة .

د- لأن الطاقة الحرارية سوف تنبعث من الأجسام الى الوسط المحيط وبالتالي سوف تصل إلى حالة الاتزان الحراري مع محيطها.

هـ- طالما أن الأوعية الثلاث في الفرن فسوف تزداد درجة حرارتها بدرجة أعلى من درجة حرارة الفرن .

و- إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي.

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

4- وضعت مريم قطعة من معدن الزنك في فرن درجة حرارته 1000 ° C. ثم استخدمت مريم ترمومتر قادر على قياس درجة حرارة تصل إلى 2000° C لقياس درجة حرارة الزنك وهو في الفرن ، و كانت مريم تصفر الترمومتر في كل مرة تستخدمه عند أخذ القراءة. حيث حصلت مريم على أول ثمان قراءات التي كانت كالتالي : 30° C ، 70° C ، 200°C ، 420°C ، 420 °C ، 420°C. لماذا تكررت قراءة الترموميتر لدرجة 420 ° C.

الاجابة:

1-هذه أعلى درجة حرارة ممكنة للزنك

2-لأن الزنك في حالة انصهار.

3- معدن الزنك وصل الى حالة الاتزان الحراري

4-هذه أقصى درجة حرارة ممكن أن يقيسها الترمومتر بدقة.

5-هذه القراءات هى نتيجة خطأ تجريبي.

السبب:

أ- عندما تتغير المادة من الحالة الصلبة الى الحالة السائلة فإن درجة حرارتها لن تتغير حتى ينصهر الصلب تماما.

ب ـ المعادن مثل الزنك يمكن تسخينها فقط الى درجة حرارة معينة.

ج ـ لا يوجد سبب علمي يدل على أن درجة الحرارة تبقى كما هي فإما أن تكون مريم قد أخطأت أو أن الترمومتر به عطل.

د ـ كلما تم تسخين الزنك فان درجة الحرارة ترتفع بسرعة في البداية لكن بعد فترة فان درجة الحرارة تبدأ ترتفع ببطء لأن المعدن امتص الحد المطلوب من الحرارة.

هـ ـ إن الزنك امتص كل الحرارة في الفرن.

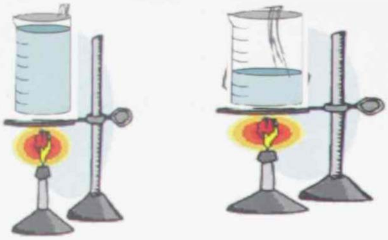
و ـ إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي.

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

5- إذا كان لدينا كأسان مدرجان كما في الشكل ، الأول (أ) يحتوي على قليل من الماء والثاني (ب) مملوء بالماء. و وضع كلا الكأسان فوق موقد بنزن ثم تم ضبط مستوى اللهب بنفس المقدار . إذا تم استخدام ترمومترين من نفس النوع لقياس درجة حرارة الماء في كل كأس عند غليان الماء، كيف سنقارن درجة حرارة كل ترمومتر؟



أ ب

الاجابة:

1- درجة الحرارة في الكأس (أ) ستكون أعلى من درجة الحرا رة في الكأس (ب)

2- درجة الحرارة ستكون نفس الشيء في كلا الكأسين.

3- درجة الحرارة في الكأس (أ) ستكون منخفضة عن درجة الحرارة في الكأس (ب

السبب :

أ - كلما زادت كمية الماء كلما ارتفعت درجة الحرارة لأن الماء يمتص طاقة حرارية أكبر.

ب - الكمية القليلة من الماء لا يمكن أن تمتص كل الطاقة الحرارية لذلك درجة الحرارة سوف تكون أعلى.

ج - الماء يغلي عند نفس درجة الحرارة بغض النظر عن كمية الماء.

د - الكمية القليلة من الماء ستصل إلى حالة الغليان بوقت زمني أقل أي أسرع من كمية الماء الكبيرة لذلك درجة حرارتها تكون أعلى.

هـ -المقدار الأكبر من الماء يصل إلى حالة الغليان بشكل أبطأ لذلك يحتاج إلى وقت أكثر لكي يسخن وتعتمد درجة الحرارة على مستوى اللهب.

ز - إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي.

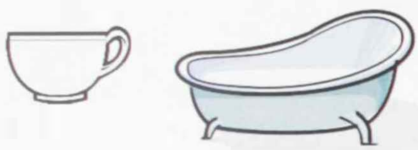
....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

6- لدينا فنجان يحتوي على ماء درجة حرارته 30 °C وحوض يحتوي على ماء كذلك درجة حرارته 10 °C ، كما هو موضح بالشكل الآتي ،أيهما يحتوي على طاقة حرارية أعلى ؟

30 °C



10 °C

الاجابة:

1- الفنجان

2- الحوض

3- الاثنان لهما نفس المقدار من الطاقة الحرارية.

السبب:

أ- لأن الطاقة الحرارية تحدد بدرجة الحرارة وعدد الجزيئات الموجودة. فكلما زادت عدد جزيئات المادة كلما زادت الطاقة التي تحويها المادة .

ب - لأن الطاقة الحرارية تحدد بدرجة حرارة المادة ، كلما زادت درجة الحرارة كلما زادت كمية الطاقة الحرارية.

ج - يحتوي الفنجان على كتلة من الماء أقل ودرجة حرارة عالية بينما الحوض يحتوي على كتلة من الماء اعلى ودرجة حرارة أقل ، لذلك فعامل الكتلة يلغي عامل درجة الحرارة مما يجعل الإثنين لهما نفس المقدار من الطاقة الحرارية.

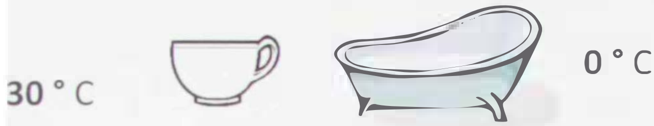
د- إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

7- لدينا فنجان يحتوي على ماء درجة حرارته 30 ° C وحوض يحتوي على ثلج كذلك درجة حرارته 0 ° C ، كما هو موضح بالشكل التالي ،أيهما يحتوي على طاقة حرارية أعلى ؟



الاجابة:

1- الفنجان

2- الحوض

السبب:

أ-- لأن الطاقة الحرارية تحدد بدرجة الحرارة وعدد الجزيئات الموجودة. فكلما كانت المادة تحتوي على عدد جزيئات أكبر كلما زادت الطاقة التي تحتويها .

ب - الطاقة الحرارية تحدد بدرجة حرارة المادة فكلما ارتفعت درجة الحرارة كلما ارتفعت الطاقة الحرارية .

ج - الطاقة الحرارية في الفنجان أكثر تركيزا!

د - الثلج لا يملك طاقة حرارية. فالأجسام عند درجة حرارة صفر فقدت كل طاقتها الحرارية.

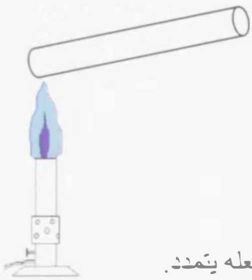
هـ إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

8- يوضح الشكل المقابل قضيب حديدي تم قياس طوله عند درجة حرارة الغرفة فكانت 22 cm ، إذا سخن القضيب لمدة 15 دقيقة فماذا يحدث لطول قضيب الحديد إذا تم قياسه من جديد؟



الاجابة:

1- يصبح أكثر من 22 cm.

2- يبقى 22cm

3-يصبح أقل من 22 cm.

4-يعتمد على مقدار درجة حرارة الحديد.

السبب:

أ- لأن الحديد موصل جيد للحرارة وبالتالي سوف تنتقل الحرارة عبر القضيب المعدني مما يجعله يتمدد.

ب - يزيد تسخين القضيب المعدني من الطاقة الحركية مسببا حركة الذرات.

ج - درجة حرارة أحد طرفي القضيب أقل من درجة حرارة الطرف الأخر مما يلغي درجة حرارة بعضهما بعضا.

د - تسخين القضيب المعدني يجعله يصبح أعرض مما يقلل من طوله .

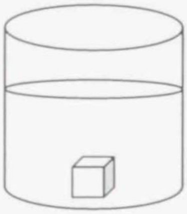
ه - إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

9-اسقطت الطالبة موزة قطعة من المعدن درجة حرارتها 0° C في وعاء من الماء درجة حرارته 20° C ، كما هو في الشكل التالي، ماذا سيطرأ على درجة حرارة المعدن والماء؟



الاجابة:

1- درجة حرارة المعدن ستبقى بنفس المقدار و لكن درجة حرارة الماء ستتناقص.
2- درجة حراة الماء ستبقى كما هى لكن درجة حرارة المعدن ستزداد.
3- درجة حرارة المعدن ستزداد بينما تقل درجة حرارة الماء.
4- درجة حرارة المعدن ستقل وتزداد درجة حرارة الماء.

السبب:

أ- بما أن المعدن أقل في درجة الحرارة بالتالي سيعادل حرارة الماء.
ب - جزيئات الماء تهتز أسرع من جزيئات المعدن عندما تتصادم مع بعضهما البعض ، وبالتالي سوف تفقد جزيئات الماء الطاقة الحرارية وتكتسبها جزيئات المعدن .
ج - سوف تنتقل حرارة الماء إلى المعدن بينما تنتقل البرودة من المعدن إلى الماء.
د- الماء سيفقد الحرارة وستقل درجة حرارته، المعادن دائما أقل في درجة الحرارة لذلك لن تتغير درجة حرارة المعدن
ه - المعدن سوف يمتص الحرارة أسرع لأنه الأقل في درجة الحرارة والماء ليس ساخنا جدا لذلك لن تتغير الحرارة كثيرا.
و - إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي.

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل.

10- يوضح الشكل التالي منزل مغلق النوافذ في فصل الشتاء، تبدأ درجة الحرارة داخل المنزل بالانخفاض، اي من التعبيرات التالية تعتبر وصفا صحيحا لما يحدث؟

الاجابة:

1- البيت يفقد الحرارة.
2- البرد يتسرب الى البيت.
3- كلا العمليتين تحدثان.

السبب:

أ- تفقد الطاقة الحرارية عن طريق الاتصال بين الحوائط والهواء بالخارج.
ب - البرودة قادرة على التسرب داخل البيت عن طريق الشقوق والفتحات حول الأبواب والنوافذ. والبرودة هذه تعادل درجة الحرارة في البيت.
ج - بينما البرد يتحرك للداخل تتحرك الحرارة للخارج وهذا يحدث حيث توجد الشقوق والفتحات أو سوء العزل.
د - تنتقل الحرارة دائما من المكان الساخن للبارد عبر إطار النوافذ.
ه - إذا لم تتفق مع أي من هذه الأسباب فعليك أن تحدد رأيك من فضلك في الفراغ التالي.

....

ما درجة تأكدك من الإجابات . من فضلك حددي مدى تأكدك كما يلي :

متأكدة أنني على صواب 7 6 5 4 3 2 1 مجرد تخمين بلا دليل

Shrieen M Wolieed
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