University Physics Series سلسلة الفيزياء الجامعية

الانجليزية للفيزيائيين

English for physicists

كمال أ. خليفة كرفة

Kamel A. Khelifa-Kerfa

جامعة غليزان

آخر تحديث : December 6, 2021

Contents

Preface

تمهيد

Chapter 1

Classical physics

1.1 Forces and motion

«Measure what is measurable
and make measurable what is not so»
Galileo

Pre-reading

Discuss the following questions with colleagues before reading the text below. Then read the text to check out your information.

- What is motion ?
- Is the motion of a ghost an example of a motion ?
- Can something stop moving? How would you show this ?
- Does a body moving forever in a straight line show that the space is infinite ?
- Can the universe move ?

Vocabulary

Word	Pronunciation	Translation
attract, v.	/ə'trækt/	جذب
average, adj.	/'ævəridʒ/	متوسط

acceleration, n.		تسارع
brake, n.		فرامل، مكبح
conservation, n.		انحفاظ
direction, n.		اتجاه
drop, v.		سقط، ترك
float, v.		طفا
force, n.	/fôrs/	قوة
friction, n.		احتكاك
gravity, n.		جاذبية
inertia, n.		عطالة
law, n.	/lə:/	قانون
marble, n.		كرة زجاجية
mass, n.		كتلة
molecule, n.		جسيم
motion, n.		حركة
obstacle, n.		عقبة، عائق
orbit, n.		مدار
pole, n.		قطب
pull, v.		سحب
push, v.		دفع
resistance, n.		مقاومة
roll, v.		تدحرج
rub, v.		فرك، حك
slide, v.		انزلق
smooth, adj.		أملس، ناعم
speed, n.		سرعة (قيمة عددية)
spin, n.		لف
surface, n.		سطح
tide, n.		مد و جزر
universe, .n		كون
vector, n.		شعاع، متجه
velocity, n.		سرعة (طويلة واتجاه)
weight, n.		وزن

Reading

Read and translate the following text:

Motion is the most fundamental observation in nature. Everyday motion is predictable and deterministic. Predictability is reflected in six aspects of motion: continuity, conservation, reversibility, mirror-invariance, relativity and minimization. Some of these aspects are valid for all motion, and some are valid only for everyday motion.

The world and the Universe are action-packed. People and animals are always on the move. The planets are constantly circling the Sun. Are there any rules to all this activity? Our world and the whole Universe are governed by the laws of nature. Scientists who try to understand and learn about these laws are called physicists. Here are some questions that physicists across history have wondered about: When you drop a ball, why does it fall on the ground? Why does not it float up? If you spin a top, why does not it spin forever? Why does it eventually stop? Maybe you have wondered about these things, too. To answer those questions, physicists needed to discover the laws of motion. What is motion? Motion is movement in any direction. You can move up, down, forwards, backwards, and sideways. You can move in circles. You can wiggle, wave, twist, turn, roll, flip, sway, bend, pivot, shake, and spin.

A force is a push or a pull. Here is a simple example: A cat hits a ball with its paw and makes the ball roll across the floor. The cat uses force to make the ball move. When you kick a ball or pull open a door, you are also using force. The more force you use, the faster the object will move.

Speed measures how far an object moves in a certain amount of time. However, things do not always move at the same speed. Forces can cause moving objects to speed up or slow down. «Average speed» equals «distance divided by time».

So why do things in motion slow down and a stop after a while? The answer is «friction». Friction is another kind of force. Friction is two things rubbing or sliding against each other. Skis on snow. A car on a road. A ball rolling across a carpet. Friction is a force that slows down moving objects. If you roll a ball across a shaggy rug, you can see that there are lumps and bumps in the rug that make the ball slow down. The rubbing, or friction, between the ball and the rug is what makes the ball stop rolling. But what would happen if you rolled the ball across a very smooth surface and there was no wall or obstacle in the way? Would the ball keep rolling forever? Unfortunately, no. There is no such thing as a «frictionless surface». There is friction between all objects and materials when they are touching.

To the naked eye, an object or surface may look perfectly smooth. If you looked at it under a microscope, you could see the tiny lumps and bumps that create friction when any two objects slide against each other. There is even friction when an object moves through the air. The less friction there is, the longer objects in motion can keep moving. For example, if you pushed off and tried to slide across the sidewalk in sneakers, you would not get very far. There is too much friction between the rubber soles of your sneakers and the rough concrete sidewalk. However, if you wore ice skates and used the same amount of force to push off and slide across an ice rink, you would glide for a long way. There is not much friction between the thin metal blade of an ice skate and the slick ice of the rink.

Some forces are invisible and can make objects move without touching them. You have probably played around with magnets before and know that magnets have an invisible pull – a force that can attract iron and steel objects. A magnet has a «north pole» and a «south pole». If you take two magnets, the north pole of one magnet and the south pole of the other will pull toward each other. If you try to join the north poles of the two magnets, however, the magnets will push each other away. The same is true if you try to put the two south poles together – the magnets will repel each other.

Magnets may seem mysterious because they can pull on other objects and make them move without touching them. It would be wise to mention that there is another invisible force that you interact with every second of every day and you probably take it for granted. That force is gravity. Gravity is the invisible force that holds us to the surface of the Earth. Earth's gravity pulls objects toward the center of the Earth. So when you drop a book, it falls to the ground instead of floating away. When you jump up, gravity pulls you back down.

Every object actually has gravity, whether it is the Earth, the Sun, a person, or just a marble. The more «mass» an object has, the stronger its force of gravity. Mass just means how much «stuff» is in an object. Some materials are packed with more stuff than others. For example, steel has more stuff in it than Styrofoam. If two balls are the same size, and one is made of foam and one is made of steel, the steel ball will have greater mass.

The Earth and moon both have gravity that is strong enough to pull them toward each other. Although the moon's gravity is not as strong as Earth's, it pulls on the water in our oceans and creates the tides. So, if the Earth and moon are pulled toward each other, why don't they crash into each other? The moon is held in orbit by the force of Earth's gravity. The speed of the moon's orbit is what prevents the moon from falling down to Earth. If the moon went slower, it would fall to Earth. If it went faster, it would escape the Earth's gravity and fly off into space.

Isaac Newton was a famous scientist who was interested in all sorts of things, from gravity and the orbits of planets to the rules about how objects move. One of his most important discoveries is called Newton's First Law of Motion. Using experiment and observation, Newton showed that objects have a tendency to keep doing what they are doing. Objects that are still, stay still. Objects that are moving, keep moving. A still object stays still and a moving object keeps moving in the same straight line, unless a force pushes or pulls it. Whether they are moving of not moving, objects resist changing their «state of motion». This is called inertia.

Inertia is the reason seatbelts are important. If you are in a fast-moving car and the driver slams on the brakes, the car will stop, but you will keep moving forward. The seatbelt stops you, so you do not hit the dashboard or windshield.

Mass vs. weight. The mass of an object stays the same no matter where you are in the Universe. That is because the amount of stuff in the object does not change. Weight is actually the pull of gravity on an object. You feel your weight because the ground is pushing against the pull of gravity. So the weight of an object can change depending on where it is in the Universe. An object that weighs 60 kg on Earth would weigh only about 10 kg on the moon because the force of gravity on the moon is only one-sixth as strong as it is on Earth. Although your mass would stay the same, you would feel much lighter on the moon or you would if you did not have to wear that heavy spacesuit.

Air resistance is a kind of friction. Molecules in the air push up against falling bodies while gravity down. The force of air resistance pulls them opposes the force of gravity. The friction created by air resistance is not strong enough to stop falling objects, but it can stop them from speeding up. Thanks to air resistance, falling objects reach a top speed, also called «terminal velocity», that is based on their size and mass.

The concepts of force, motion, gravity, mass, and inertia and more govern the world and our Universe. They are complex ideas but once you understand them, you will see everything a little more clearly.

(*Adopted from* Kids Discover *website*)

Comprehension

A. *Answer the following questions:*

- What questions have physicists wondered about ?
- What is motion ?
- What is force ?
- What is average speed ? What can objects move without actual touch ?
- What governs the universe ?

B. *Complete the following definitions:*

- ... is a push or pull.

- ... is a force that slows down moving objects.
- ... is the invisible force that holds us to the surface of the earth.
- ... is the reason seatbelts are important.
- ... is a kind of friction.

C. *State if the following statemets are true or false:*

- People and animals are always on the move.
- Scientists who try to understand and learn about these laws of nature are called historians.
- Things always move at the same speed.
- The less friction there is, the shorter objects in motion can keep moving.
- A magnet has a «north pole» and a «west pole»/

Exploration

A. *Translate the following nouns to Arabic and give the corresponding verbs:*
Division, collection, emission, evolution, relation.

B. *Translate the following adjectives to Arabic and give the corresponding nouns:*
Original, directional, universal, centrifugal, tidal.

C. *Think of all possible questions to the following sentences:*

- The planets are constantly circling the sun.
- Forces can cause moving objects to speed up or slow down.
- The earth and the moon both have gravity.
- Molecules in the air push up against falling bodies.
- The mass of an object stays the same no matter where you are in the universe.

D. *Re-order the following words to obtain a comprehensive sentence:*

- is - movement - in - direction - motion - any.
- the - moon's - is not - strong - as earth's - gravity - as.
- causes - force - to make - move - cat - the ball - the.

- a - still - stays object - still.
- motion - the - physicists - to - laws - discover - needed - of.

E. *Starting with the following expressions, ask questions to the statements below:*
I wonder . . . - Could you clarify . . . - Could you tell me . . . - I'd like to know . . . - Do you any idea . . . - I'm interested to know . . .

- People and animals are always in the move. (why?)
- The planets are constantly circling the sun. (why?)
- There are some rules to all this activity. (what?)
- Our world and the whole universe are governed by the laws of nature. (what laws?)
- Thanks to air resistance, falling objects reach a top speed. (why?)

F. *Read and translate the following passage to Arabic:*

Newton, one of the greatest scientists of all times was born in 1642 in the little village in Lincolnshire, England. His father was a farmer and died before Newton was born. His mother was a clever woman whom he always loved.

After the school, Newton studied mathematics at Cambridge University and received his degree in 1665. Then the university was closed because of the danger of plague and Newton went home for eighteen months. It was most important period in his life when he made his three great discoveries – the discoveries of the differential calculus, of the nature of white light, and of the law of gravitation.

These discoveries are still important for the modern science. Newton had always been interested in the problems of light. Many people saw colours of a rainbow but only Newton showed, by his experiments, that white light consists of these colours.

It is interesting how he discovered the law gravitation. Once, as he sat at the garden, his attention was drawn by the fall of an apple. Many people saw such an usual thing before. But it was Newton who asked himself a question: "Why does that apple fall perpendicularly to the ground? Why doesn't it go sidewards or upwards?" The answer to this question was the theory of gravitation, discovered by Newton.

Newton died at the age of 84, and was buried in Westminster Abbey, where his monument stands today.

(*Adopted from www.linguistic.ru*)

G. *Translate and then read the following passage in English:*

شأن كل العلوم التي تتقدَّم وتتطوَّر مع تعاقب الأمم والحضارات، قامت العلوم الطبيعيَّة عند المسلمين في بدئها على مؤلَّفات اليونان، تلك التي استند فيها اليونانيُّون إلى الفلسفة المجرَّدة في محاولاتهم فَهْم الطبيعة، ودون أن يكون للتجربة دور يُذْكَر في تلك المحاولات، غير أن العلماء المسلمين ما لبثوا أن طوَّروا هذا الأساس، وخاضوا غمار علم الفيزياء ببراعة وذكاء منقطعَي النظير، حتى لكأنهم أنشئوا علمًا جديدًا، وذلك حين جعلوا علم الفيزياء عِلمًا يستند إلى التجربة والاستقراء، عوضًا عن الاعتماد على الفلسفة أو التأمُّلات والأفكار المجرَّدة.

فكان من جرَّاء ذلك أنهم استنتجوا نظريات جديدة وبحوثًا مبتكرة، مثل: قوانين الحركة، والقوانين المائية، وقانون الجاذبية الأرضيَّة، كما بحثوا في الوزن النوعي للمعادن والسوائل، واستطاعوا قياس الوزن النوعي للسوائل، والذي يُعَدُّ في هذا العصر، بما فيه من وسائل متطوِّرة، أمرًا عسيرًا!

فقد اتَّكأ المسلمون في البدء على كتب السابقين، مثل كتاب (الطبيعة) لأرسطوطاليس الذي تحدث فيه عن علم الحركة، وكذلك مؤلفات أرشميدس التي تحوي معلومات عن الأجسام الطافية في الماء والوزن النوعي لبعض الموادِّ، ومصنفات أكتسبيوس التي تتضمَّن نتائج علميَّة عن المضخَّة الرافعة والساعات المائيَّة، وكذلك هيرون السكندري الذي تحدَّث عن البكرة والعجلة وقانون الشغل. ثم ما لبث العلماء المسلمون أن طوَّروا نظريات وأفكار السابقين الفيزيائية، واستطاعوا أن يخرجوها من طور النظريَّة المجرَّدة إلى طور التجربة العمليَّة، والتي هي عماد هذا العلم.

من موقع قصة الاسلام

Writing

Write (in English ans Arabic) a report/presentation about the history of what is now referred to as "Newton's laws of motion", and the role played by earlier Muslim physicists/polymaths in this regard.

1.2 Energy and its sources

«Energy cannot be created or destroyed; it can only be changed from one form to another»
Albert Einstein

Pre-reading

Discuss the following questions with colleagues before reading the text below. Then read the text to check out your information.

- What is energy?
- Where does most of the energy we use on earth come from ?
- What are the most common sources of energy in nowadays world?
- What do you know about renewable energy sources?
- Can we extract energy from nuclear reactions?

Vocabulary

Word	Pronunciation	Translation
clipper ship, n.	/ /	سفن شراعية
dam, n.	/ /	سد
energy, n.	/ /	طاقة
engine, n.	/ /	محرك
fission, n.	/ /	انشطار
flow, v.	/ /	تدفق
fossil, n.	/ /	حفري، متحجر
fuel, n.	/ /	وقود
fusion, n.	/ /	اندماج
grind, v.	/ /	طَحَن
kinetic energy, n.	/ /	طاقة حركية
lumber, n.	/ /	خشب
potential energy, n.	/ /	طاقة كامنة
slingshot, n.	/ /	مقلاع
steam, n.	/ /	بخار

split, v.	/ /	فَصَل
waterwheels, n.	/ /	عجلات مائية
waves, n.	/ /	موجات
windmill, n.	/ /	طاحونة هوائية
work, n.	/ /	عمل

Reading

Read and translate the following text:

Scientists define energy as the ability to get work done. You could be breathing, giving a presentation, building a pyramid, or even taking a nap. But where is energy? You can't touch it, but you can certainly see and hear its results. Energy is in the sounds and images your television produces. It's also in the fuel that powers the vehicles that take you to different places. And it's in the electricity that runs the gadgets and machines you use. Energy is in wind, waves, and sunlight, as well as in streams and rivers. There is definitely energy in you. And it's in every other living thing, whether animal or vegetable. There's even energy in a slingshot when you stretch the strap to its limit and then release it.

You can think of energy as something that can be stored; that's called potential energy. It's also something that flows from one place to another, and that's called kinetic energy. A slingshot stretched to its limit has potential energy, or the ability to do work in the future. Once you let the elastic go, the flying stone has kinetic energy, or the energy of something in motion.

Wood-burning fires were among the earliest forms of energy humans used. But people are clever, and as the centuries rolled by, they found more and more ways to get their work done. Flowing water can help get work done. For centuries, waterwheels have been used to grind grain, cut lumber, and irrigate fields.

For thousands of years, people have used wind energy to move from place to place. The clipper ship was developed in the United States in the early 1800s. Back then, clippers were the fastest sailing vessels ever made. But pretty soon, people found that steam could make ships go faster than wind could. Heating water makes steam, which is what powers steam engines.

The ancient Greeks and Romans burned coal as fuel. But coal only became a popular energy source in the early 1700s. That's when it became harder to find wood in England, right around the time of the Industrial Revolution. Coal fuelled the new steam-powered engines. Those engines changed the way people travelled–and the way they got work done. Much of the fuel that we use today–coal, oil, and natural gas–is fossil fuel. It's called that because it's the remains of plants and animals that lived millions of years ago.

The first commercial oil well began operating in 1859 in Titusville, Pennsylvania. Oil was mainly used in lamps back then. But ever since the invention in 1876 of the internal combustion engine, it's been in great demand. Combustion engines run on oil, in the forms of gas and diesel fuel. Oil gets us where we want to go, and it's also used to heat buildings.

Using the wind's power on land began more than a thousand years ago in ancient Persia (now Iran). In a windmill, the wind moves sails that are connected to a vertical pole. Using gears, the pole turns a stone. The stone grinds grain into flour. Windmills can also be used to bring water to crops and to drain wetlands. By 1800, 12,000 windmills were helping keep Holland dry. Modern windmills are called wind turbines. They're made of metal, and they don't grind grain anymore. They convert wind energy into electricity.

There's a limited supply of fossil fuels (coal, oil, and natural gas). What we use today is gone forever, so it's important to develop other sources of energy. Also, burning fossil fuels releases harmful pollutants into the atmosphere.That's the bad news. The good news is that people have been experimenting with energy sources that aren't fossil fuels. Some are as old as the Sun. Others are as young as the twenty-first century.

Todays hydroelectric power plants are very different from old-fashioned watermills. But they still use water to produce electric energy. A dam holds back a rivers water, releasing it in a steady flow. The flowing water turns a turbine, a modern waterwheel, which turns an electric generator.

People have used the Sun's energy for thousands of years. Cave dwellers stayed warm by choosing caves that faced the Sun. However, people have only recently started using technology to catch and use the Sun's energy. Solar cells in solar panels use the Sun's radiation to produce electricity.

Geothermal (land heat) energy comes from natural, harmless elements in the Earth. It's one of our few energy sources that does not come from the Sun. Geothermal energy could never serve all our needs, but it could reduce our need for fossil fuels. Volcanoes are visible evidence of the heat trapped deep inside our planet.

It doesn't take big things to make big energy. The greatest man-made release of energy ever came from splitting the atom. Atoms are the smallest particles of a chemical element. In the early 1900s, scientists discovered that atoms are made of smaller particles. They also found that splitting the nucleus, or core, of an atom (nuclear fission) could release huge amounts of energy. During World War II, scientists used this information to build an atom bomb. The United States dropped atom bombs on the Japanese cities of Hiroshima and Nagasaki. More than 150,000 people were killed, and thousands more were disabled. After the war, scientists found a way to use nuclear fission to produce useful energy. Now there are nuclear power plants all over the world. The bad news is that the waste from these plants is very dangerous. A nuclear plant accident can be disastrous. In 1986, an accident occurred at the Ukraines Chernobyl nuclear plant. That area is still unsafe, and no one lives there. Some scientists think nuclear fusion is the answer to the problems caused by nuclear fission. Nuclear fusion is forcing together atoms of hydrogen. It produces helium, along with huge amounts of energy. The same process creates the energy of the Sun and other stars. Fusion produces even more energy than fission. It's also safer and cleaner. But making a nuclear fusion reaction in a lab uses up more energy than it creates, so it's not practical . . . yet.

(*Adopted from Kids Discover website*)

Comprehension

A. *Answer the following questions:*

- What is energy ?
- List the various energy sources mentioned in the text?
- What are the different engines that people have used?
- What are the drawbacks of fossil fuels?
- What is geothermal energy?

B. *Complete the following sentences:*

- . . . is something that can be stored.
- . . . is something that flows from one place to another.
- . . . is the remains of plants and animals that lived millions of years ago.
- . . . is splitting the nucleus of an atom to release huge amounts of energy.
- . . . is forcing together atoms of hydrogen to produce energy.

C. *State if the following statements are true or false:*

- Most of the energy we use on Earth comes from water.
- The energy that an object has while moving is called potential energy.
- Wind-powered clipper ships were the fastest sailing ships until the development of combustion engines.
- Wind energy is no longer used to get work done.
- Hydroelectric power generators depend on water to produce electricity.

Exploration

A. *Translate the following nouns to Arabic and give the corresponding verbs:*
Transfer, modern, conservation, environment, revolution.

B. *Translate the following adjectives to Arabic and give the corresponding nouns:*
Natural, commercial, internal, flowing, ancient.

C. *Think of all possible questions to the following sentences:*

- Energy is in wind, waves, and sunlight, as well as in steams and rivers.
- Flowing water can help to get work done.
- Much of the fuel we use today – coal, oil, and natural gas – is fossil fuel.
- Geothermal energy comes from natural, harmless elements in the Earth.
- Atoms are the smallest particles of a chemical element.

D. *Re-order the following words to obtain a comprehensive sentence:*

- windmills - The - air - blades - does - on - the - of - the - moving - work
- concept - The - of - is - one - science - of - the - most - topics - in - energy - important
- Energy - forms - is - in - Universe - in - present - various - the
- The - laws - energy - of - can - be - mechanical - applied - to - without - systems - resorting - to - Newtons - concept
- Every - energy - process - Universe - that - in - transformations - energy - the - involves - and physical - transfers - or - occurs

E. *Starting with the following expressions, ask questions to the statements below:*
I wonder ... - Could you clarify ... - Could you tell me ... - I'd like to know ... - Do you have any idea ... - I'm interested to know ...

- Energy is in the sounds and images your television produces. (how?)
- Hydroelectric power plants are very different from old-fashioned watermills (how?)
- People have used Sun's energy for thousands of years (why?)
- Geothermal could never serve all our needs (why?)

- Fusion produces safer, cleaner and more energy than fission but currently not used. (why?)

F. *Read and translate the following passage to Arabic:*

Engineers under the Caliphates adopted watermill technology from former provinces of the Byzantine Empire, having been applied for centuries in those provinces prior to the Muslim conquests, including modern-day Syria, Jordan, Palestine, Algeria, Tunisia, Morocco, and Spain.

The industrial uses of watermills in the Islamic world date back to the 7th century, while horizontal-wheeled and vertical-wheeled watermills were both in widespread use by the 9th century. A variety of industrial watermills were used in the Islamic world, including gristmills, hullers, sawmills, shipmills, stamp mills, steel mills, sugar mills, and tide mills. By the 11th century, every province throughout the Islamic world had these industrial watermills in operation, from al-Andalus and North Africa to the Middle East and Central Asia. Muslim engineers also used crankshafts and water turbines, gears in watermills and water-raising machines, and dams as a source of water, used to provide additional power to watermills and water-raising machines. Fulling mills, and steel mills may have spread from Al-Andalus to Christian Spain in the 12th century. Industrial watermills were also employed in large factory complexes built in al-Andalus between the 11th and 13th centuries.

The engineers of the Islamic world used several solutions to achieve the maximum output from a watermill. One solution was to mount them to piers of bridges to take advantage of the increased flow. Another solution was the shipmill, a type of watermill powered by water wheels mounted on the sides of ships moored in midstream. This technique was employed along the Tigris and Euphrates rivers in 10th-century Iraq, where large shipmills made of teak and iron could produce 10 tons of flour from corn every day for the granary in Baghdad.

(*Adopted from Wikipedia*)

G. *Translate and then read the following passage in English:*

يرتبط تاريخ الطاحونة بتاريخ صناعة الخبز، فالقمح والشعير والذرة وغيرها من الحبوب كان لابد من طحنها لصناعة الخبز، لذا عرف الإنسان الطحن منذ فجر التاريخ: طحن الحبوب، فبدأ في دقه بمدقات من حجر هي أشبه بالهاون »المجرس«، تضرب بقوة في تجويف كتلة حجرية (جرن)، حيث يهبط الهاون على القمح بداخلها، ويكون المدق ثقيلا مصنوعا من حجر صلد أيضا.

تطورت آليات عملية الطحن إلى استخدام المدق الرحى: حجران مستديران، يدار أعلاهما على أسفلهما باليد، وفي أوسط الأعلى فرجة مستديرة يصب فيها القمح، ليجري بين القرصين فيطحن مع هذه الحركة. وكبرت »الرحوات« حتى كانت تدار بالحيوانات، أو بقوة اندفاع الماء من مجاريه الطبيعية، أو بمراوح الهواء التي تطول عاليا نحو السماء، لتتشكل الطواحين، التي اتخذت أشكالا وأحجاما تختلف باختلاف المكان، ولم تخل منها مدينة أو قرية في العالم القديم والحديث، وهي تنتشر حتى الآن في صورها البدائية في القرى هنا أو هناك، في مختلف البلدان العربية والإسلامية، جنبا إلى جنب مع المطاحن الكبرى في المدن التي تصنع وتدار بأحدث التقنيات التكنولوجية الحديثة. وفي القرن الرابع الهجري ابتكر العرب المسلمون نوعا جديدا من الطواحين يدار بالماء، إذ صنعوا سفنا وركّبوا عليها طواحين تدور بفعل ضغط مياه الأنهار، ويذكر الجغرافي العربي المقدسي في كتابه »أحسن التقاسيم في معرفة الأقاليم«، أن أهل البصرة في ذلك الزمان كانوا يعانون من مشكلة المد والجزر في شط العرب كل يوم، فعمد بعض الصناعيين من أهل المدينة إلى صناعة الطواحين، وجعلوها على أفواه الأنهار ليديرها الماء أثناء حركته خارجا وداخلا، وبذلك استطاعوا حل مشكلتهم بما يعود بالفائدة عليهم.

من موقع مجلة البيان

Writing

Write (in English and Arabic) a report/presentation about renewable and sustainable sources of energy and their importance to save our planet.

1.3 Gravity

«Gravity may put the planets into motion, but without the divine Power, it could never put them into such a circulating motion as they have about the Sun; and therefore, for this as well as other reasons, I am compelled to ascribe the frame of this System to an intelligent Agent.»
Isaac Newton

Pre-reading

Discuss the following questions with colleagues before reading the text below. Then read the text to check out your information.

- What is gravity?
- Why does a diver fall faster (until he hits the water)?
- How is it that blood moves up (from the tips of your toes to your heart) against gravity which always pulls down ?
- When the moon is directly overhead, the amount of rainfall decreases just a little bit. Why?
- How does gravity actually work?

Vocabulary

Word	**Pronunciation**	**Translation**
bulge, n.	/ /	انتفاخ، نتوء
bristle, v.	/ /	شعيرة
broom, n.	/ /	مكنسة
earlobes, n.	/ /	شحمة الأذن
escape, v.	/ /	هرب
chin, n.	/ /	ذقن
gravity, n.	/ /	جاذبية
hop, v.	/ /	قفز
mass, n.	/ /	كتلة
matter, n.	/ /	مادة، أمر، موضوع
molecule, n.	/ /	جزيء
nauseated, n.	/ /	قرفان، مشمئز

seesaw, n.	/ /	أرجوحة
cheek, n.	/ /	خد
sagging, n.	/ /	ترهل
squeeze, v.	/ /	ضغط، عصر
speck, n.	/ /	بقعة، نقطة
spine, n.	/ /	عمود فقري
universe, n.	/ /	الكون
valve, n.	/ /	صمام
varicose, n.	/ /	دوالي
vein, n.	/ /	عرق
vertebrae, n.	/ /	فقرات

Reading

Read and translate the following text:

Gravity is the attraction between objects that causes them to move toward each other. You can't see it, taste it, or smell it, yet gravity affect everything. From the tiniest molecules to the biggest things in the universe. There are many things you might escape, but you can't escape gravity.

The mass of an object is the amount of matter it has. Everything that has mass has gravity, and the more mass something has, the stronger its gravity. For instance, the gravitational pull of a speck of dust doesn't affect us, because it has so little mass. But the Earth is a different matter. The Earth has so much mass that it exerts a huge gravitational pull on everything. It's no wonder everything that goes up . . . must come down.

Every object has a centre of gravity – the place with the same amount of mass on all sides. Say you lay a ruler across your finger. Its centre of gravity would be the place where it balanced, probably in the middle. The centre of gravity of a broom is near the bristles. The midpoint on a seesaw, the place where it balances, is the centre of gravity between you and the other person. In astronomy, the centre of gravity between objects is called the barycentre. It is always closer to the object with greater mass. The barycentre between the Earth and the sun is inside the sun, near the centre.

Every second of every day, your body works against gravity. You can jump, hop, and stand up from a chair. All of these things require upward motion, against the pull of gravity. But in some ways, your body does not work against gravity. Over time, its pull takes a toll and causes changes you might not even notice from one day to the next. As the body ages, veins may become weaker, and blood may not move as efficiently from one valve in a vein to another. Instead, it may collect in pools. As a result, muscles may not be able to push the blood along. When this happens, veins may become enlarged and twisted. These are known as varicose veins.

Your veins are working against gravity all day, every day. Veins are part of your circulatory system. They carry blood from all parts of your body back to your heart. Your veins have tiny valves. They open to let blood flow toward your heart and close to keep blood from flowing away from your heart. As you stand, hop, walk, or otherwise move about, your leg muscles squeeze your veins, forcing your blood to keep moving.

Every day, you lose and gain about half an inch of height, because of gravity. All day long, gravity pulls you toward Earth's centre, and the vertebrae in your spine get packed together. That's the half-inch you lose. At night, gravity does not pull down on your spine. So it expands, and you're back to your full height. You can see for yourself. Ask a family member or friend to measure your height in the morning and then again just before you go to bed. As you get older, your spine becomes permanently compressed from all those years of gravity pulling it down. You may actually end up an inch or two shorter.

How do you keep your balance when you stand up, lie down, or move around? Its because of tiny calcium crystals in your inner ear that respond to gravity. They are inside a gel-like material that covers hair cells in your inner ear. The hair cells trigger nerves that go to your brain. When you stand up, gravity pulls the crystals down. As the crystals move, they pull the hair cells along with them. This motion triggers a nerve that sends information to your brain, allowing you to keep your balance. When this process doesn't work right, you may end up feeling ill or nauseated.

Gravity has an effect on other body parts, too. Over lots of time, the gravitational pull on your ears makes your earlobes longer. It may also cause a double chin and sagging cheeks.

The Earth and the moon are like most siblings. One is older than the other, and one is bigger than the other – yet both are made from the same material. And, like many siblings, they hang around together and affect each other. The moon is significantly smaller than the Earth, but it has a big effect on us and our planet. The moon has gravity, just like all objects. Its gravity is much weaker than Earth's – about 83 percent weaker. Since weight is a measure of the pull of gravity, astronauts on the moon weigh less than they do on Earth.

Gravitational attraction crosses long distances in space. That helps explain why Earth has tides, or rising and falling ocean water. When the moon is directly above an ocean, its gravitational force pulls the water toward it. The water rises in what we call high tide. As the Earth rotates, the location of high tides changes based on where the moon is overhead. The pull of the moon's gravity also makes a bulge in Earth's land. But the movement is small, so we don't notice it. The Earth's gravitational pull creates lunar body tides on the moon. Those bulges measure about 20 inches. High and low tides create a tiny bit of friction between Earth's land and the tidewater. This friction, as small as it is, slows down the Earth's rotation. In 1000 years, the days will be about two milliseconds longer than they are today. (How long is two milliseconds? It's about the time it takes a car going at 55 miles per hour to move two inches.)

Suppose you tied a ball to one end of a string, held onto the other end, and swung your arm in large circles over your head. If you let go of the string, the ball would go flying away. That's exactly what would happen to the moon if there were no gravity. The string is like the gravitational attraction between the Earth and moon. Without the Earth's gravity, the moon would leave the Earth's orbit. Earth's gravity is also what keeps human-made satellites orbiting the planet.

The sun and other stars, the planets, and objects in distant galaxies all have gravity. Even space dust has it. The sun isn't just the biggest object in our solar system. It has 99 percent of the mass of all the objects in the solar system. As a result, it has the strongest gravitational pull. Just as the Earth's gravitational pull keeps the moon circling around us, the sun's gravitational pull keeps the planets orbiting the sun. Without gravity, they – and we – would fly away into space. The sun's gravity is much stronger than Earth's, because of its mass, but it is not strong enough to pull Earth in. If it were, our planet would crash into the sun. That's exactly what happens with a black hole. That's a place with a gravitational pull so strong, it pulls everything into it. Nothing escapes a black hole, not even light. That's nothing we need to worry about, though. The nearest black hole is 3,000 light-years away. (A light-year is the distance light travels in a year, about 5.9 trillion miles.) In April 2019, scientists studied a black hole directly for the first time. Before that, they could only conclude that a black hole existed by observing the matter around it.

(*Adopted from* Kids Discover *website*)

Comprehension

A. *Answer the following questions:*

- Why "everything that goes up must come down"?
- What happens to blood veins as human body ages?
- How does gravity affect human's body height?
- Why is the moon's gravity smaller than that of the Earth?
- What is the reason that in 1000 years Earth's days will be about 2 millisecond shorter?

B. *Complete the following sentences:*

- ... is the attraction between objects that causes them to move toward each other.
- ... is the amount of matter an object has.
- ... is th place of the same amount of matter on all sides.
- ... is a measure of the pull of gravity.
- ... is a place with a gravitational pull so strong, it pulls everything into it.

C. *State if the following statements are true or false:*

- The centre of gravity between the Earth and moon is near the Earth.
- Gravity affects many parts in human body including spine, chin, earlobes and cheeks.
- The Earth has tides because of the sun's gravitational pull.
- Gravitational attraction has a short range.
- Light can easily escape a black hole.

Exploration

A. *Translate the following nouns to Arabic and give the corresponding verbs:*
Gravitation, attraction. weight, relativity, effect.

B. *Translate the following adjectives to Arabic and give the corresponding nouns:*
Great, heavy, curved, strong, solar.

C. *Think of all possible questions to the following sentences:*

- Everything that has mass has gravity.
- The centre of gravity of a seesaw is the midpoint.
- Your veins are working against gravity all day, everyday.
- As you get older, you may end up an inch or two shorter than your current height.
- Gravity helps in keeping you balanced when standing up or down.

D. *Re-order the following words to obtain a comprehensive sentence:*

- is - example - action - gravity - by - an - distance - of

- the - the - mass - gravity - centre - centre - of - of - same - the - is - as
- blood - known - varicose - known - is - as - collection - pools - of - in
- height - changes - night - and - your - night - between - day
- longer - gravity - earlobes - make - can - your

E. *Starting with the following expressions, ask questions to the statements below:*
I wonder ... - Could you clarify ... - Could you tell me ... - I'd like to know ... - Do you have any idea ... - I'm interested to know ...

- The sun has the strongest gravitational pull (why?)
- If Earth had no gravity there would be no moon (why?)
- The moon causes rising and falling of ocean water (how?)
- An object weigh less on moon than on Earth (why?)
- Gravity has an effect on many parts of the body (what?)

F. *Read and translate the following passage to Arabic:*

General relativity is physicist Albert Einstein's understanding of how gravity affects the fabric of space-time. The theory, which Einstein published in 1915, expanded the theory of special relativity that he had published 10 years earlier. Special relativity argued that space and time are inextricably connected, but that theory didn't acknowledge the existence of gravity.

Einstein spent the decade between the two publications determining that particularly massive objects warp the fabric of space-time, a distortion that manifests as gravity. In his theory of special relativity, he determined that the laws of physics are the same for all non-accelerating observers, and showed that the speed of light within a vacuum is the same no matter the speed at which an observer travels. As a result, he found that space and time were interwoven into a single continuum known as space-time. And events that occur at the same time for one observer could occur at different times for another.

As he worked out the equations for his general theory of relativity, Einstein realized that massive objects caused a distortion in space-time. Imagine setting a large object in the center of a trampoline. The object would press down into the fabric, causing it to dimple. If you then attempt to roll a marble around the edge of the trampoline, the marble would spiral inward toward the body, pulled in much the same way that the gravity of a planet pulls at rocks in space.

(*Adopted from space.com*)

G. *Translate and then read the following passage in English:*

الهمداني (ت٣٣٤ هـ – ٩٤٥م) : واسمه (الحسن بن أحمد بن يعقوب) قال في كتابه (الجوهرتين العتيقتين المائعتين من الصفراء والبيضاء) في سياق حديثه عن الأرض ككرة (وهذا سبق آخر) وما يرتبط بها من مياه وهواء:

"فمن كان تحتها (أي تحت الأرض من الجهة الأخرى ككرة) فهو في الثابت في قامته كمن فوقها، ومسقطه وقدمه إلى سطحها الأسفل كمسقطه إلى سطحها الأعلى، وكثبات قدمه عليه، فهي بمنزلة حجر المغناطيس الذي تجذب قواه الحديد إلى كل جانب.."

أبو جعفر الخازن (القرن الرابع الهجري): وقد تحدث عن التسارع (أو العجلة) في سقوط الأجسام نحو الأرض واحتوى كتابه (ميزان الحكمة) ما يدل على معرفته بالعلاقة الصحيحة بين السرعة التي يسقط بها الجسم نحو سطح الأرض والبعد الذي يقطعه والزمن الذي يستغرقه، وهي العلاقة التي تنص عليها المعادلات الرياضية المنسوبة لجاليليو في القرن السابع عشر الميلادي – ومن أقواله :

" إن ذلك ناتج عن قوة تجذب هذه الأجسام باتجاه مركز الأرض "

أبو الريحان البيروني (ت٤٤٠هـ – ١٠٤٨م): يؤكد ما سبق إليه الهمداني من أن الأرض تجذب ما فوقها نحو مركزها حيث جاء في كتابه (القانون المسعودي) أن الأثقال إلى أسفل.

هبة الله بن ملكا البغدادي (ت٥٦٠هـ – ١١٦٥م): وقد نجح في تصحيح الخطأ الجسيم الذي وقع فيه أرسطو عندما قال بسقوط الأجسام الثقيلة أسرع من الأجسام الخفيفة، بل وسبق جاليليو في إثبات أن سرعة الجسم الساقط سقوطا حرا تحت تأثير الجاذبية الأرضية لا تتوقف إطلاقا على كتلته، وذلك عندما تخلو الحركة من أي معوقات خارجية، وقد عبر عن هذه الحقيقة العلمية الهامة في كتابه (المعتبر في الحكمة) فقال:

"... وأيضا لو تحركت الأجسام في الخلاء لتساوت حركة الثقيل والخفيف والكبير والصغير والمخروط والمتحرك على رأسه الحاد والمخروط المتحرك على قاعدته الواسعة، في السرعة والبطء؛ لأنها إنما تختلف في الملاء بهذه الأشياء بسهولة خرقها لما تخرقه من المقاوم المخروق كالماء والهواء وغيرهما..".

بل وقد أضاف البغدادي حقائق جديدة أخرى عن ظاهرة الجاذبية من خلال دراسته لحركة المقذوفات، وذلك من حيث إن حركتها إلى أعلى عند القذف تعاكس فعل الجاذبية الأرضية، أو أن القوة التي قذف بها الجسم إلى أعلى تعمل في تضاد مع قوة الجاذبية الأرضية، فيقول:

"... فكذلك الحجر المقذوف فيه ميل مقاوم للميل القاذف؛ إلا أنه مقهور بقوة القاذف؛ ولأن القوة القاسرة عرضية فيه، فهي تضعف لمقاومة هذه القوة والميل الطبيعي ولمقاومة المخروق.. فيكون الميل القاسر في أوله على غاية القهر للميل الطبيعي، ولا يزال يضعف ويبطئ الحركة ضعفا بعد ضعف وبطئا بعد بطء حتى يعجز عن مقاومة الميل الطبيعي، فيغلب الميل الطبيعي فيحرك إلى جهته".

وهنا تجدر الإشارة إلى أن البغدادي لا يستخدم مفهوم " الميل" كقوة خفية أو "وحشية" طبيعية في اتجاه الحنين إلى حضن الأم: كوكب الأرض، مثلما قال أرسطو، ولكنه عنى به القوة المادية التي تتحكم علميا في حرمة المقذوف صعودا ضد الجاذبية وهبوطا في اتجاهها، والسؤال الذي طرحه البغدادي فيما

يتعلق بهذه القضية العلمية هو: هل يتوقف الحجر المقذوف عند أعلى نقطة يصل إليها حين يبدأ في الارتداد إلى سطح الأرض؟ ويجيب هو نفسه بالنص الواضح الصريح:

"من توهم أن بين حركة الحجر علوا المستكرهة بالتحليق وبين انحطاطه وقفة فقد أخطأ، وإنما تضعف القوة المستكرهة له وتقوى قوى ثقله، فتصغر الحركة، وتخفي حركته على الطرف، فيتوهم أنه ساكن".

من موقع الباحثون المسلمون

Writing

Write (in English and Arabic) a report/presentation about the theory of general relativity.

1.4 Solutions

1.4.1 Forces and motion

1.4.2 Energy and its sources

1.4.3 Gravity

Chapter 2

Oscillations and Waves

2.1 Sound waves

« .... »

A. A

Pre-reading

Discuss the following questions with colleagues before reading the text below. Then read the text to check out your information.

- What is sound and how does it travel?
- How do animals, such as wolves, stay connected with each other?
- How does sound travel in different media?
- What causes the sound a thunder clap?
- How do human sound receivers (ears) work?

Vocabulary

Word	Pronunciation	Translation
anvil, n.	//	عظيمة السندان في الأذن
astonishing, adj.	//	مذهل
barking, adj.	//	نباح
blow, v.	//	نفخ

cochlea, n.	//	قوقعة
compression, n.	//	ضغط
crowd, v.	//	حشد
distort, v.	//	شَوَّه
fade, v.	//	تلاشى
fainter, adj.	//	خافت، باهت
float, v.	//	طفى
funnel, n.	//	قُمع
garbled, adj.	//	مشوه
hammer, n.	//	مطرقة
humming, adj.	//	طنين
oval, n.	//	بيضاوي
rarefactions, n.	//	تخلخلات
ripple, n.	//	تموج
roaring, adj.	//	زئير
shudder, v.	//	ارتجف
stimulate, v.	//	حفز
stirrup, n.	//	عظم الركاب
throat, n.	//	حنجرة
transmit, v.	//	نقل، بث، أحال
twang, n.	//	رنين وتر
weaken, v.	//	تضعف
whistling, n.	//	صفير

Reading

Read and translate the following text:

It's a planet of sound! Sound starts with just a simple vibration. It's at the heart of everything from One Direction's latest song to the conversations you have with friends. But how does sound work? What turns the motions of molecules into the symphonic sounds of orchestras, whistling tea kettles, and barking dogs? Let's explore the phenomenal world of sound and vibration–and how this natural phenomenon is used for communication and even navigation. Sound good?

Sound is an invisible form of energy. Most animals have the ability to sense it. Along with sight and smell and the skin's ability to sense temperature, our sense of hearing tells us what's happening outside our bodies. It can tell us what's happening far away and out of sight–and it's a powerful form of communication. Think about a lion roaring or someone crying for help.

Sounds are made by vibrations. Some vibrations are easy to see. For example, if you stretch out and twang a rubber band, you can see it moving back and forth. Other vibrations are less obvious, but you can feel them. Try putting your hand around your throat and humming a tune. Can you feel the vibrations? Those are your vocal cords moving rapidly back and forth. Without vibrations, the world would be silent.

So how do vibrations travel and get to your ears? The vibrations that create sound must travel through a medium, such as air or water–or anything made of molecules. To understand sound, it's important to remember that air isn't just empty space. Air is actually a fluid–a fluid we live in, just like fish live in water. Although you can't see air, you can feel it flow past you, and you can use it to blow bubbles or fill up a balloon. Air can move, flow, and fill up spaces because it is made of invisible gas molecules. The molecules in air are loosely packed, floating and bumping around. It is those air molecules that transmit most sounds. Here's how: If you hit a spoon against a drinking glass, it will cause the glass to vibrate. As the glass shudders and shakes with vibrations, it pushes on the surrounding air molecules and causes them to move. With each forward motion, air molecules pulse outward, pushing other air molecules and crowding them together. With each backward motion, the molecules get less crowded. The forward and backward vibration of the glass creates a chain reaction of crowded and not-so-crowded molecules that ripples through the air. This traveling vibration is called a sound wave.

A loudspeaker generates a sound wave: The areas where the air molecules are pushed together are called compressions. The areas where the air molecules are more spread out are called rarefactions. The distance from one high point, or compression, to another is called the wavelength. Sound waves can travel through all kinds of mediums–some better than others–and that is why sound can travel through solid objects (like a wall or closed window). In fact, most solid materials are better at directly transmitting sound than air. For example, if you take an object, such as a spoon, hold it right in front of your nose and tap the far end very lightly with your finger, you probably won't hear anything. But if you put one end of the spoon next to your ear and tap the other end, a sound wave will travel straight through the spoon and you will hear it clearly.

Sound waves can't travel forever. After a while they lose energy and fade away. They can also be weakened and distorted. When a sound wave traveling through the air encounters an obstacle, such as a tree or wall, some of the energy of the sound wave gets absorbed, so the sound comes out fainter and sometimes garbled on the other side.

Sound waves travel through different mediums at different speeds. At sea level, sound waves travel through the air at about 760 mph–about five miles a second–which means you can hear nearby sounds almost instantaneously. But they move through water 4 times that fast and through steel more than 17 times as fast. When an object moves at the speed of sound, it is said to be traveling at Mach 1. When a jet surpasses the speed of sound, it breaks the sound barrier and causes a sonic boom–which sounds like a clap of thunder. When it's humid, jets form a vapor cone as they break the sound barrier.

Sound waves move through the air with astonishing speed. But what happens when they reach your ears? In fact, your ears are so fine-tuned they can process information 1,000 times faster than your eyes. Sound waves are captured by the outer ear and cause the eardrum (tympanic membrane) to vibrate. These vibrations are transmitted via three connected bones: the hammer (malleus), anvil (incus), and stirrup (stapes). The vibrating stirrup tap-tap-taps on the oval window and causes fluid inside the cochlea to pass the vibrations on to the basilar membrane and organ of Corti, which is covered in thousands of microscopic sound receptors (hair cells). From there the vibrations are turned into electrical signals and passed on to the brain for interpretation.

Ears are phenomenal sound wave catchers. Their curvy shape funnels sound waves into your ear canal. The sound waves roll into you eardrum–which really is a bit like the skin of a drum. Your eardrum vibrates–and this vibration is sent along a series of connected bones (the hammer, anvil, and stirrup), which are the smallest bones in the human body. The last tiny bone (the stirrup) passes the vibration on to a membrane called the oval window. And heres where things get really interesting. The oval window is the window to the inner ear. When the oval window vibrates, it causes fluid inside the spiral-shaped inner ear (cochlea) to vibrate, too.

Inside the cochlea, there are 15,000 to 20,000 microscopic sound receptors, called hair cells. The hair cells are tuned to different frequencies and the ones that are stimulated send an electrical signal–a form of code–to the brain. The brain interprets the signals and that is how we hear sound.

(*Adopted from Kids Discoverer website*)

Comprehension

A. *Answer the following questions:*

- Why would the world be silent without vibrations?
- Who is responsible for transmitting most sounds?
- Which materials are better in transmitting sound?
- Why cannot sound waves travel forever?
- What happens to sound when reaching the ears?

B. *Complete the following definitions:*

- . . . is an invisible form of energy.
- . . . is a fluid, a fluid we live in, just like fish live in water.
- . . . is called a sound wave.
- . . . is the distance from one compression to another.
- . . . is the sound caused by a jet that surpasses the speed of sound.

C. *State if the following statements are true or false:*

- Sound waves move through the air quite slowly.
- Sound waves are interpreted into meanings in the ear.
- Eardrum vibrations are caused by sound waves and then sent along a series of connected bones.
- Hair cells, sound receptors in the ear, are located in the outer ear.
- Only hair cells with the same frequencies as those carried by the sound wave get stimulated and hence interpreted.

Exploration

A. *Translate the following nouns to Arabic and give the corresponding verbs:*
Oscillations, motion, resemblance, phenomena, propagation.

B. *Translate the following adjectives to Arabic and give the corresponding nouns:*
Periodic, repetitive, harmonic, mechanical, rigid.

C. *Think of all possible questions to the following sentences:*

- Most animals have the ability to sense sound.
- Sounds are made by vibrations.
- Sound waves travel through different mediums at different speeds.
- Jets form a vapor cone as they break the sound barrier.
- The brain interprets signals coming from hair cells in the ear.

D. *Re-order the following words to obtain a comprehensive sentence:*

- motion-Periodic-is-motion-of-that-returns-given-regularly-to-a-position -an-object

- Falling-oscillate-of-drops-a-water-water-surface-cause-to
- be-rigid-although-oscillate-skyscrapers-appear-to-they-and-bridges-actually
- motions-as-All-can-be-periodic-motions-modelled-simple-combinations-of-harmonic
- Sound-in-hair-receptors-are-the-ear-called-cells

E. *Starting with the following expressions, ask questions to the statements below: I wonder . . . Could you please clarify . . . Could you please tell me . . . I'd like to know . . . Do you have any idea . . . I'm interested to know . . .*

- Sound is at the heart of everything (why?)
- Sounds are made by vibrations (how?)
- Air can move, flow, and fill up spaces (how? why?)
- A loudspeaker generates sound (how?)
- The vibrations in the ear are transmitted via three connected bones (what? how?)

F. *Read and translate the following passage to Arabic:*

The sound barrier or sonic barrier is the large increase in aerodynamic drag and other undesirable effects experienced by an aircraft or other object when it approaches the speed of sound. When aircraft first approaches the speed of sound, these effects are seen as constituting a barrier, making faster speeds very difficult or impossible. The term sound barrier is still sometimes used today to refer to aircraft approaching supersonic flight in this high drag regime. Flying faster than sound produces a sonic boom.

In dry air at 20 °C (68 °F), the speed of sound is 343 metres per second (about 767 mph, 1234 km/h or 1,125 ft/s). The term came into use during World War II when pilots of high-speed fighter aircraft experienced the effects of compressibility, a number of adverse aerodynamic effects that deterred further acceleration, seemingly impeding flight at speeds close to the speed of sound. These difficulties represented a barrier to flying at faster speeds. In 1947, American test pilot Chuck Yeager demonstrated that safe flight at the speed of sound was achievable in purpose-designed aircraft, thereby breaking the barrier. By the 1950s, new designs of fighter aircraft routinely reached the speed of sound, and faster.

(*Adopted from wikipedia.org*)

G. *Translate and then read the following passage in English:*

يتضمن السمع ثلاث درجات معروفة في علم وظائف الأعضاء، وهي مذكورة في كتاب الله تعالى، فأول ذلك: الإحساس بالصوت دون فهم، وذلك مثل الطفل الوليد الذي لا يفقه معنى الكلام وهو يحس بالصوت لكنه لا يفقه معناه، أو كالدواب السارحة التي إذا نعق بها راعيها، أي دعاها إلى ما يرشدها فلا تسمع إلا دعاءه ونداءه، فلا تفهم ما يقول، بل إنما تسمع صوته فقط، وهذا مذكور في قول الله تعالى: وَمَثَلُ الَّذِينَ كَفَرُواْ كَمَثَلِ الَّذِي يَنْعِقُ بِمَا لاَ يَسْمَعُ إِلاَّ دُعَاء وَنِدَاء [البقرة: 171]

والثاني: هي الإحساس بالصوت مع الفهم وذلك في قوله تعالى: وَقَدْ كَانَ فَرِيقٌ مِّنْهُمْ يَسْمَعُونَ كَلاَمَ اللّهِ ثُمَّ يُحَرِّفُونَهُ مِن بَعْدِ مَا عَقَلُوهُ وَهُمْ يَعْلَمُونَ [البقرة: 75]

والثالث: هي الإحساس بالصوت مع الفهم بالإضافة إلى الاقتناع والإيمان والطاعة وهي أعلى درجات السمع التي تُمنح للمؤمنين كما في قوله تعالى: إِنَّمَا يَسْتَجِيبُ الَّذِينَ يَسْمَعُونَ..[الأنعام: 36]

هذه المعاني الثلاثة تتوافق مع ما هو معروف في علم وظائف الأعضاء من الإحساس بالصوت والتمييز والفهم والوظائف العليا الأخرى للمخ التي تتضمن العواطف والإرادة والتصرفات.

والقرآن العزيز فرّق بين السماع والاستماع والإصغاء والإنصات بطريقة بليغة ودقيقة ومناسبة للموقف: فالسمع يكون بقصد ومن دون قصد، ومثاله في كتاب الله العزيز قوله تعالى: وَإِذَا سَمِعُوا اللَّغْوَ أَعْرَضُوا عَنْهُ [القصص: 55] والاستماع يكون بقصد من أجل الاستفادة، قال الله تعالى: وَإِذْ صَرَفْنَا إِلَيْكَ نَفَراً مِّنَ الْجِنِّ يَسْتَمِعُونَ الْقُرْآنَ [الأحقاف: 29] والإصغاء: حيث التركيز وتفاعل القلب والمشاعر، قال تعالى: إِن تَتُوبَا إِلَى اللَّهِ فَقَدْ صَغَتْ قُلُوبُكُمَا [التحريم: 4] والإنصات هو ترك الأشغال والسكوت والتفرغ للاستماع، وَإِذَا قُرِئَ الْقُرْآنُ فَاسْتَمِعُواْ لَهُ وَأَنصِتُواْ لَعَلَّكُمْ تُرْحَمُونَ [الأعراف: 204] وعن أبي موسى الأشعري قال، قال رسول اللّه صلى اللّه عليه وسلم: "إنما جُعِل الإمام ليؤتمّ به فإذا كبّر فكبّروا وإذا قرأ فأنصتوا". أخرجه مسلم في صحيحه ورواه أهل السنن.

من موقع الأنباء

Writing

Write (in English ans Arabic) a brief report/presentation about the physics of sound waves.

2.2 Pitch, echoes and ultrasound

« .... »
A. A

Pre-reading

Discuss the following questions with colleagues before reading the text below. Then read the text to check out your information.

- What do you know about oscilloscopes?
- What is the difference between: pitch, loudness and timbre?
- Why ancient people put their art in locations where there are strong echoes?
- What is echolocation?
- Which part of physics might be of use in human embryology studies?

Vocabulary

Word	**Pronunciation**	**Translation**
absorb, v.	//	امتص
amplitude, n.	//	سعة
echo, n.	//	صدى
fine-tune, n.	//	ضبط دقيق
frequency, n.	//	تردد
infrasonic, adj.	//	تحت صوتي
loudness, n.	//	جهارة الصوت
navigation, n.	//	ملاحة
pitch, n.	//	نغمة
pressure, n.	//	ضغط
prey, n.	//	ضحية
reflect, v.	//	يعكس
spooky, adj.	//	مرعب
squeak, n.	//	صرير
swooping, adj.	//	انقضاض
transmit, v.	//	يحيل

ultrasonic, adj.	//	فوق صوتي
wavelength, n.	//	طول الموجة
whispering, v.	//	يهمس
yelling, v.	//	صراخ

Reading

Read and translate the following text:

The deep roar of a lion has a low pitch and the squeak of a mouse has a high pitch. Pitch is created by sound waves having shorter or longer wavelengths. The longer the wavelength is the lower the pitch. The shorter the wavelength is the higher the pitch. Pitch is measured by the number of wavelengths that travel through the air per second–or the frequency. The frequency of sound waves is measured in Hertz (abbreviated as Hz). Humans can hear in the range of 20 Hz to 20,000 Hz. Anything below about 20 Hz is called infrasonic. Anything above 20,000 Hz is considered ultrasonic.

Now let's take loudness–this might seem pretty obvious: Yelling is loud and whispering is quiet. But loudness is actually a measure of the change in air pressure created by a sound wave. In fact, extremely loud noises can create so much pressure that they damage your hearing. Different levels of loudness are created by sound waves that have different amplitudes, or heights. The bigger the sound wave is the louder the noise. The smaller the sound wave is, the quieter the noise. Loudness is measured in decibels (abbreviated as dB). Normal conversation is about 60 dB. A crying baby is about 110 dB. Anything louder than 120 decibels can cause your ears to hurt. It's said that the loudest sound ever heard was the volcano Krakatoa exploding in 1883–it was heard 3,000 miles round the world and may have been as loud as 180 dB.

What about timbre? Why does everyone in the world have a different-sounding voice–almost like a fingerprint? The answer is that most sounds are not made of one sound wave but many. These sound waves combine to form the distinctive sound of your voice–and the unique signature of different animals.

Maybe you've been in a tunnel or a cave and shouted, "HELLO, OUT THERE!" and heard your voice faintly repeated back to you–maybe even multiple times: HELLO, HELLO, HELLO...What causes a sound to echo? Just like a mirror reflects light, an echo is a reflection of sound. When a sound wave rolls through the air and hits a flat surface (such as a wall), some of the energy from the sound wave will be absorbed or transmitted and some of the energy will be reflected so that it bounces back through the air. Under certain conditions, the sound reflection is so good that you can hear an echo.

Echoes can be fun (and sometimes spooky) to hear, but they are also surprisingly useful. For example, many species of bats can use echoes to find food on the wing–a skill called "echolocation". Bats make rapid-fire high-pitched calls or clicks and listen for the echoes of the sounds off objects. The bats' ears and brains are so fine-tuned that they can hear the echoes coming back from tiny objects like mosquitoes. They can use the echoes to create a "sound picture" that helps them avoid obstacles while flying and swooping in on their miniscule prey. Bats can hear higher pitches than humans– and the calls used for echolocation are too high for people to hear. Such sounds are called "ultrasound."

Echolocation in bats is a form of natural sonar. Sonar stands for "Sound Navigation and Ranging." Submarines and fishing boats use sonar to locate objects underwater. Sonar equipment emits ultrasounds and measures how long it takes for the ultrasounds echoes to bounce back. With that information, the sonar equipment can calculate how far away underwater objects are and even what shape they are.

Dolphins use echolocation underwater to find food and navigate. Dolphins make rapid-fire clicking noises, called "click trains" at different pitches. The higher the pitch, or frequency, the more detail they can get back about the object–and the smaller the object they can locate. Dolphins can hear frequencies as high as 200,000 Hz.
Using an ultrasound machine, millions of high-frequency ultrasonic sound waves are transmitted into the human body–and the reflections, or echoes, they send back are used to see what's going on inside. Ultrasound is commonly used to look at how fetuses are doing inside their mothers wombs.

(*Adopted from* *Kids Discoverer* *website*)

Comprehension

A. *Answer the following questions:*

- What is the relationship between the pitch and the wavelength of a sound wave?
- Can humans hear everything?
- Why do people have different voices?
- What causes a voice to echo?
- List few animals that can hear sounds that humans cannot.

B. *Complete the following definitions:*

- . . . is created by sound waves having shorter and longer wavelengths.
- . . . is a measure of the change of air pressure created by a sound wave.
- . . . is a sound wave with frequency above 20,000 Hz.

- . . . is a reflection of sound off flat surfaces.
- . . . is using echoes to navigate around.

C. *State if the following statemets are true or false:*

- Humans can hear pitches in the range 20 - 10,000 Hz.
- Loudness is related to the frequency of a sound wave.
- Echoes are caused by the absorption of the energy transported by sound waves.
- Echolocation is used by submarines because of the lack of vision underwater.
- Some animals emit sounds at higher pitches to get fine details about objects.

Exploration

A. *Translate the following nouns to Arabic and give the corresponding verbs:*
Perception, density, variation, sensitivity, intensity.

B. *Translate the following adjectives to Arabic and give the corresponding nouns:*
Disturbed, audible, imaging, infrasonic, ultrasonic.

C. *Think of all possible questions to the following sentences:*

- Echoes can be fun and sometimes spooky.
- Dolphins and bats use echolocation to navigate their journeys.
- Sounds used for echolocation are called "ultrasonic".
- Sonar equipment uses physics of waves to explore life underwater.
- Ultrasound machines use echoes to make "sound pictures" of the inside of human bodies.

D. *Re-order the following words to obtain a comprehensive sentence:*

- Threshold-a-human-ear-corresponds-to-the-detect-faintest-of-hearing-sounds-at-1kHz-can
- of-pain-Threshold-corresponds-to-ear-can-sounds-a-the-1kHz-loudest-human-tolerate-at
- A-jet-produces-of-about-a-nearby-150dB-sound-airplane

- The-effect-change-known-apparent-in-to-motion-frequency-due-is-as-the-Doppler
- Shock-sound-waves-the-speed-happen-when-of-exceeds-the-an-object-speed-of

E. *Starting with the following expressions, ask questions to the statements below:*
I wonder . . . - Could you clarify . . . - Could you tell me . . . - I'd like to know . . . - Do you any idea . . . - I'm interested to know . . .

- The shorter the wavelength is the higher the pitch (why?)
- Extremely loud noises can damage your ear (why?)
- Your voice is repeated back to you inside a tunnel (what? How?)
- Bats can locate their preys using echolocation (How?)
- Ultrasound is commonly used to follow up growth of fetuses (why? How?)

F. *Read and translate the following passage to Arabic:*

It might be invisible to us standing on the oceans shore, but beneath the waves, the ocean churns with a constant orchestra of noise. Under the waves, light vanishes. By just 200m below the surface, photosynthesis becomes impossible. At 1,000m down, sunlight disappears entirely, as explained by the National Ocean Service. The deep ocean the largest habitat on earth is also the darkest.

As light becomes increasingly irrelevant underwater, sound becomes more important than ever. Its unsurprising that cetaceans - dolphins and whales - rely on sound more than any other sense to understand, navigate and manipulate their world.

All humans have been doing for the past 70 years developing sonar detection equipment, really, is learning from cetaceans about how they do what they do, and trying to figure out how to use our own sonar systems in a similar way to what they have been doing for millions of years.

While humans can hear sounds ranging from 20Hertz (Hz) to 20,000Hz, bottlenose dolphins can hear up to 160,000Hz beyond the range of dogs, famously sensitive to high pitches we cannot hear: they tap out at 44,000Hz. All creatures on earth use sound waves to some degree, but toothed whales are the sonic masters of the upper registers of the animal kingdom.

While toothed whales emit high-pitched whistles to communicate with each other, and even higher pitched clicks to pinpoint prey, baleen whales sing to each other with rumbling, low moans and growls that often are too low for humans to hear blue whales for example can make calls just 14Hz in frequency, invisible to our ears.

Because low frequency sounds travel further with less scattering, distortion and transmission loss, baleen whales can communicate to each other over enormous distances thousands of kilometres.

(*Adopted from BBC Earth*)

G. *Translate and then read the following passage in English:*

{وَأَخَذَ الَّذِينَ ظَلَمُواْ الصَّيْحَةُ فَأَصْبَحُواْ فِي دِيَارِهِمْ جَاثِمِينَ}[سورة هود]. إن المجال الصوتي الذي نسمعه يتراوح بين 20 هرتز و 20000 هرتز، والترددات التي تقل عن 20 تعتبر موجات تحت صوتية ، والترددات التي تزيد على 20000 تعتبر ترددات فوق صوتية. وتقاس قوة الصوت بواحدة قياس تدعى الدسبيل dB فعندما تصل قوة الصوت إلى 120 ديسيبل تتعرض الأذن لآلام واضحة، وعند 140 ديسبيل تنفجر طبلة الأذن، وعند 150 ديسيبل يبدأ القفص الصدري بالاهتزاز ويتعرض الإنسان للغثيان والسعال الحاد وضيق شديد في التنفس، وعند 200 ديسيبل تنفجر الرئتين، ثم أكثر من ذلك تتأذى كل أنحاء الجسم وتنتهي باضطرابات في عمل القلب والدماغ وتكون النتيجة هي الموت.

وقد وصفت وسيلة الإهلاك بأوصاف كثيرة منها: الصيحة وهي صيحة من السماء فيها صوت كل صاعقة، وصوت كل شيء في الأرض، فتقطعت قلوبهم وماتوا بالطاغية أي بالصيحة المجاوزة لحد الصيحات من الهول. والصوت (أي الصيحة) يسبب الاهتزاز والرجفان وهذا ما عبر عنه القرآن بقوله تعالى: (فَأَخَذَتْهُمُ الرَّجْفَةُ)، وذلك لأن الصوت هو عبارة عن أمواج اهتزازية، وعندما يتعرض الإنسان لترددات صوتية عالية فوق سمعية فإن درجة حرارة جسده ترتفع ثم يبدأ بالاحتراق، بسبب موجات الضغط العالية التي تسخن الهواء من حوله. وعندما تكون الترددات عالية والصوت شديداً فإن هذا الصوت سيولد فقاعات في الجسم وجروح دقيقة ويبدأ النسيج العضلي بالتمزق ويصبح الإنسان غثاء كغثاء السيل. والصوت يؤثر ليس على الأذن فحسب بل إنه يؤثر على العظام والجلد وتجاويف الجسم، وكذلك على النظام العصبي لدى الإنسان، ويقول العلماء إن التأثيرات الحقيقية للأصوات الشديدة لا تزال مجهولة حتى الآن. والصوت القوي يسبب الصعق والحرائق وهذا ما عبر عنه القرآن بكلمة (الصاعقة) يقول تعالى: (فَأَخَذَتْهُمُ الصَّاعِقَةُ)، لأن الترددات العالية والشديدة تجعل الهواء يتمدد بشكل مفاجئ وينضغط بشدة، وهذا يؤدي إلى رفع درجة حرارة الهواء إلى آلاف الدرجات المئوية، فيكون الصوت مترافقاً بالحرارة العالية وهذه هي الصاعقة.

من موقع طريق الاسلام

Writing

Write (in English ans Arabic) a report/presentation about the history of "sound torture" (both from the stories in the Quran and then from modern world).

2.3 Solutions

2.3.1 Sound waves

2.3.2 Pith, echoes and ultrasound

Chapter 3

Thermodynamics

3.1 The arrow of time

«Arrow of time flies in only one direction »
A. Einstein

Pre-reading

Discuss the following questions with colleagues before reading the text below. Then read the text to check out your information.

- Why do we remember the past but not the future?
- What does the fact that time moves forward say about the universe?
- ?
- ?
- ?

Vocabulary

Word	Pronunciation	Translation
arrow, n.	/ /	سهم
consistent, v.	/ /	متسق، متوافق
dive, v.	/ /	غطس

direction, n.	/ /	اتجاه
disperse, n.	/ /	شتت
disorder, n.	/ /	فوضى، اضطراب
entropy, n.	/ /	الإنتروبيا أو القصور الحراري
haphazardly, adv.	/ /	عشوائيا
ingrain, v.	/ /	غرس
irreversible, adj.	/ /	لا يعكس، لا رجعة فيه
measure, v.	/ /	يقيس
neatly, adv.	/ /	بعناية
melt, v.	/ /	يذوب
process, n.	/ /	عملية
ramification, n.	/ /	تشعب، نتيجة
stack, v.	/ /	كومة
watch, v.	/ /	راقب

Reading

Read and translate the following text:

Time has a direction, an arrow pointing from the past to the future, and it has the same direction for everybody. What does it mean to say that time has a direction? Think about watching a movie played in reverse. Generally, it's pretty clear if we are seeing something running the "wrong way" in time. A classic example is a diver and a pool. If the diver dives, and then there is a big splash, followed by waves bouncing around in the water, all is normal. But if we see a pool that starts with waves, which collect into a big splash, in the process lifting a diver up onto the board and becoming perfectly calm, we know something is up: the movie is being played backward.

Certain events in the real world always happen in the same order. It's dive, splash, waves, never waves, splash, spit out a diver. Take milk and mix it into a cup of black coffee; never take coffee with milk and separate the two liquids. Sequences of this sort are called *irreversible processes*. Irreversible processes are at the heart of the arrow of time. Events happen in some sequences, and not in others. Furthermore, this ordering is perfectly consistent, as far as we know, throughout the observable universe. The arrow of time, then is the brute fact about our universe. The fact that things happen in one order and not in the reverse order is deeply ingrained in how we live in the world. Why is it like that?

The answer lies in the concept of *entropy*. Like energy or temperature, entropy tells us something about the particular state of a physical system; specifically, it measures how disorderly the system is. A collection of papers stacked neatly on top of one another has a low entropy; the same collection, scattered haphazardly on a desktop, has a high entropy. All of the irreversible processes that reflect times arrow–we can turn eggs into omelets but not omelets into eggs, perfume disperses through a room but never collects back into the bottle, ice cubes in water melt but glasses of warm water don't spontaneously form ice cubes–share a common feature: entropy increases throughout, as the system progresses from order to disorder. Whenever we disturb the universe, we tend to increase its entropy.

The principle underlying irreversible processes is summed up in the second law of thermodynamics: the entropy of an isolated system either remains constant or increases with time. The second law is arguably the most dependable law in all of physics. Boltzmann, in 1877, realized that when we look at some macroscopic system, we certainly dont keep track of the exact properties of every single atom. (If we have a glass of water in front of us, and someone sneaks in and, say, switches some of the water molecules around without changing the overall temperature and density and so on, we would never notice. There are many different arrangements of particular atoms that are *indistinguishable* from our macroscopic perspective.) The situations that we characterize as "low entropy" seem to be easily disturbed by rearranging the atoms within them, while "high-entropy" ones are more robust.

Before Boltzmann, entropy was a phenomenological thermodynamic concept, which followed its own rules (such as the second law). After Boltzmann, the behavior of entropy could be derived from deeper underlying principles. In particular, it suddenly makes perfect sense why entropy tends to increase in an isolated system: because there are more ways to be high entropy than to be low entropy.

At least, that formulation sounds like it makes perfect sense. In fact, it sneaks in a crucial assumption: that we start with a system that has a low entropy. If we start with a system that has a high entropy, we'll be in equilibrium–nothing will happen at all. That word start sneaks in an asymmetry in time, by privileging earlier times over later ones. And this line of reasoning takes us all the way back to the low entropy of the Big Bang. For whatever reason, of the many ways we could arrange the constituents of the universe, at early times they were in a very special, low-entropy configuration.

This is all fascinating stuff, at least to physicists. But the ramifications of these ideas go far beyond steam engines and cups of coffee. The arrow of time manifests itself in many different ways–our bodies change as we get older, we remember the past but not the future, effects always follow causes. It turns out that all of these phenomena can be traced back to the second law. Entropy, quite literally, makes life possible

So the arrow of time isn't just about simple mechanical processes; it's a necessary feature of the existence of life itself. But it's also responsible for a deep feature of what it means to be a conscious person: the fact that we remember the past, but not the future. According to the fundamental laws of physics, the past and future are treated on an equal footing; but when it comes to how we perceive the world, they couldn't be more different. We carry in our heads representations of the past, in the form of memories. Concerning the future, we can make predictions, but those predictions have nowhere near the reliability of our memories of the past. Ultimately, the reason we can form a reliable memory of the past is that the entropy was lower then. In a complicated system like the universe, there are many ways for the underlying constituents to arrange themselves into the form of "you, with a certain memory of the past, plus the rest of the universe."

(*Adopted from The Arrow of Time by S. Caroll*)

Comprehension

A. *Answer the following questions:*

- Does the arrow of time apply only to Earth's events?
- Does the entropy tend to increase or decrease?
- What does a low entropy macroscopic state correspond to at the microscopic level?
- What would happen in a universe which starts with high entropy?
- How does entropy relate to human's consciousness?

B. *Complete the following definitions:*

- ... is a sequence of events that always happen in the same order.
- ... is a measure of how disorderly a system is.
- ... is the most reliable law of all physics.
- ... is the physicist who explained entropy in terms of arrangements of microscopic atoms.
- ... is the state of the universe with the lowest possible entropy.

C. *State if the following statements are true or false:*

- All events in the universe always follow the arrow of time.
- Reversible processes are sequences of events that can be played back.
- A perfume dispersing through a room has a higher entropy.
- The entropy of an isolated system can only increase with time.
- Entropy is also related to the fact that effect always follow causes.

Exploration

A. *Translate the following nouns to Arabic and give the corresponding verbs:*
State, system, transfer, matter, properties.

B. *Translate the following adjectives to Arabic and give the corresponding nouns:*
Atomic, chemical, erratic, molecular, thermal.

C. *Think of all possible questions to the following sentences:*

- The reason we can form a reliable memory of the past is that the entropy was lower then.
- The arrow of time is a necessary feature of the existence of life itself.
- According to the fundamental laws of physics, the past and future are treated on an equal footing.
- The constituents of the universe, at early times they were in a very special, low-entropy configuration.
- Entropy tends to increase in an isolated system.

D. *Re-order the following words to obtain a comprehensive sentence:*

- the-of-equilibrium-law-zeroth-law-is-known-of-thermodynamics-as-the
- Internal-a-system-energy-of-that-is-its-associated-with-microscopic-atoms-components-and-molecules-energy-is-all-the
- Heat-is-of-defined-as-a-process-transferring-the-boundary-energy-of-a-across-system
- The-of-of-energy-thermodynamics-first-is-a-law-special-law-of-case-of-the-conservation
- The-process-of-by-heat-energy-transfer-be-called-can-also-conduction-conduction-or-thermal

.

E. *Starting with the following expressions, ask questions to the statements below:*
I wonder ... - Could you clarify ... - Could you tell me ... - I'd like to know ... - Do you have any idea ... - I'm interested to know ...

- Before Boltzmann, entropy was a phenomenological thermodynamic concept (why?)
- There are many different arrangements of particular atoms that are *indistinguishable* from our macroscopic perspective (how?)
- The second of law of thermodynamics(what?)
- Entropy tells us something about the particular state of a physical system (what?)
- Time has a direction (how?)

F. *Read and translate the following passage to Arabic:*

The common understanding of entropy and time implies a very low-entropy state just after the Big Bang. Yet, that moment is often described as a "soup" of photons, quarks and electrons, something that, by comparison with everyday textbook examples, seems very high entropy.... How is that primal state low-entropy?

The answer is black holes. If you think about all the particles that go into making a black hole, it's a tremendous number. Once you fall into a black hole, you inevitably arrive at a singularity. And the number of states is directly proportional to the masses of the particles in the black hole, so the more black holes you form (or the more massive your black holes get), the more entropy you get in the Universe. The Milky Way's supermassive black hole, alone, has an entropy that's$S = 10^{91}\,\mathrm{k_B}$, about a factor of $1,000$ more than the entire Universe at the Big Bang. Given the number of galaxies and the masses of black holes in general, the total entropy today has reached a value of $S = 10^{103}\,\mathrm{k_B}$.

So why was the early Universe so low-entropy? Because it didn't have any black holes. An entropy of $S = 10^{88}\,\mathrm{k_B}$ is still a tremendously large value, but it's the entropy of the entire Universe, which is almost exclusively encoded in the leftover radiation (and, to a slightly lesser extent, neutrinos) from the Big Bang. If there were no such things as black holes, the entropy of the Universe would have been almost constant for the past 13.8 billion years! That primal state actually had a considerable amount of entropy; it's just that black holes have so much more, and are so easy to make from a cosmic perspective.

(*Adopted from* Forbes)

G. *Translate and then read the following passage in English:*

القانون الثاني من الديناميكا الحرارية ينفي القول بالصدفة !!

فصيغة القانون الثالثة وهي تتعلق بالإنتروبيا : يميل أي نظام مغلق –الكون- إلى التغير أو التحول تلقائيا بزيادة إنتروبيته حتى يصل إلى حالة توزيع متساوٍ في جميع أجزائه.

فمثال على الإنتروبيا وتزايدها حتى تتضح صيغة القانون لدينا: عند إلقاء قطرة من الحبر الأزرق في كوب ماء، تذوب قطرة الحبر وتنتشر في الماء حتي يحدث حالة من التجانس بين كل جزء من الماء وقطرة الحبر، عند هذه الحالة نقول أن إنتروبيا النظام تزايدت أي أن مجموعي إنتروبيا نقطة الحبر و الماء النقية تكون أقل من إنتروبية النظام (حبر مختلط بالماء).

الكون طبقا لنظرية الإنفجار العظيم يُعتبر نظاما مغلقا.. إذ تخبرنا نظرية الانفجار بأن الكون كان عبارة عن شيء غاية في الدقة والصغر، وذو طاقة وكثافة عالية جدا ثم انفجر (أي بدأ بانتروبيا وعشوائية قليلة جدا) ومع الزمن تستمر العشوائية في الازدياد حتى تقل الطاقة المتاحة -التي بدأ بها الكون- إلى درجة ينتهي عندها الكون .

وفي النظام المغلق لا يمكن أن تكون الانتروبيا –العشوائية- صفرا أو أن تتناقص، بل العكس فهي في تزايد مع الزمن، ومن هذا نجد الكون قد بدأ بعشوائية-انتروبيا- قليلة جدا مع طاقة عالية جدا، وهو ما يتناقض مع القول بأن الكون وُجِد صدفة، إذ الصدفة تحدث في عشوائية عالية جدا وطاقة قليلة جدا، فكلما زادت العشوائية زاد احتمال وجود الصدفة..ولكننا نجد العلم يقول لنا عكس ذلك، وأن الكون نشأ من حالة قليلة جدا في العشوائية وعالية جدا في الطاقة، عكس ما تحتاج إليه الصدفة !!

حاول روجر بنروز العالم الرياضياتي الشهير إيجاد التقدير العشوائي لاحتمالية حدوث الكون صدفة و بطريقة تجعل من ظهورالحياة أمرا ممكناً، فقام بإجراء حسابات تبين احتمال نشوء الكون إلي أن يكون مهيأً لنشوء الحياة صدفة، وذلك من خلال صيغة رياضية وضعها جاكوب بكنشتاين وستيفن هوكينج تتعلق بالقصور الحراري للثقب الأسود فتبين له أن هذا الاحتمال عبارة عن ا من 10 أس 10 أس 123= $10^{10^{123}}$ ، وبمقارنة هذا العدد بعتبة المستحيل التي وضعها ديمبسكي 10^{150} نجد أنه يتخطاها بمراحل كبيرة جدا، ولقد أشار روجر بنروز إلى أنه إذا كان من المستطاع وضع صفر واحد بجانب كل جسيم أولي موجود في الكون فسأظل لا أستطيع كتابة العدد بالكامل إنه عدد مذهل، موضحاً بذلك الدقة التي بدأ بها الانفجار الكبير، قائلا: إنها دقة متناهية في الغاية دون أدنى شك

من موقع الباحثون المسلمون

Writing

Write (in English and Arabic) a report/presentation about the three laws of thermodynamics, including illustrations and worked-out examples.

3.2 Solutions

3.2.1 The arrow of time

Chapter 4

Electricity & magnetism

4.1 Electricity of things

« .... »

...

Reading

Read and translate the following text:

Every inch of a living body hums with electrical activity. In fact, electrical energy literally holds us together. It keeps solid things solid. Our atoms would fly apart if their electric charges didn't attract one another. But that's just the beginning of electrical energy's contribution to our make-up.

The human body's electrical signals are weak. A popular test for reading them is an electrocardiogram, or ECG. It shows the heart's electrical impulses as a series of wavy lines. A bundle of nerves in the heart acts like an electric power plant. If a heart stops working properly, doctors may install a pacemaker. A pacemaker sends out tiny electrical impulses to stimulate the heart and keep it beating.

In 1924, German psychiatrist Hans Berger pasted two small pieces of silver foil to his 15-year-old son's scalp. He attached wires to the foil and connected the wires to a galvanometer. That's a device that measures electrical current. His invention was a forerunner of the electroencephalogram, or EEG. It showed electric signals called brain waves. We still don't know exactly where in the brain the signals come from. But they change from one activity to another, and at times even during the same activity. For example, a normal sleep pattern includes periods of REM, or Rapid Eye Movement. That's when we do most of our dreaming. An EEG shows different signals during REM sleep and non-REM sleep.

The body's electrical nature can be used against it. About half of U.S. police agencies now use Tasers, or stun guns, on unruly suspects. Tasers fire two darts as far as 21 feet. The darts deliver a painful five-second shock of up to 50,000 volts. That causes muscles to go stiff. Usually, the suspect quickly recovers. While many police say Tasers reduce violence, critics say that stun guns can sometimes cause heart attacks.

Ancient Romans believed that putting one on someone's head could jolt away a headache. They may have been right. Scientists have found that small, controlled electrical currents can relieve pain. They've also found that electrical currents can speed up the healing of wounds and regrow damaged nerves.

All living things give off small amounts of electricity. Electric eels are the most powerful of all electric fish. They have special organs that work like high-powered generators. These eels can stun or kill prey with a strong shock. One of the first Europeans to discover South America's electric eels made the mistake of stepping on one. He wrote, "I was affected during the rest of the day with violent pain in the knees and in almost every joint."

Flying over a city at night shows how common electric lights have become. The ground looks like a glowing web of lit-up streets and buildings. Yet electrical energy can do more than make light. It can also make heat, produce magnetic fields, and change chemicals. Busy electrons reach into all parts of modern life.

Calculators, DVD players, and other electronics use electrical signals to create their numbers, pictures, words, and sounds. The signals zip through transistors made of silicon. Silicon is a semiconductor. That's a material that can be changed to either conduct or resist an electric current, like a switch. Millions of transistors fit on one silicon chip. But they're getting even smaller and more powerful. Computers today can hold more than 2.5 billion transistors!

Electrical energy creates big changes in chemicals. For example, passing a current through salt water gives us chlorine. Most silverware is not made of pure silver. Instead, a silver coating gets stuck to a cheaper metal. This process is called electroplating. In it, a metal item is hooked up to a negative charge and dunked in a silver cyanide solution. A positive electrode in the silver cyanide causes silver atoms to cling evenly to the metal.

The incandescent bulb has been lighting our homes for years. Its key part is a very thin coiled wire called a filament. It's made of tungsten, a tough metal. As electrons move through the filament, resistance causes it to heat up. The filament reaches more than 4,500°F (2482°C). That's hot enough to glow. A gas in the bulb keeps the filament from burning up. The incandescent bulb is now being phased out in favor of more energy-efficient options. These include compact fluorescent bulbs and LED bulbs.

Toasters, hair dryers, and many other appliances work a lot like light bulbs. But they need to make more heat than light. So instead of a filament, they have a heating element. It's made of loops of wire made from special mixtures of metals. Electrons move through the wires, where electrical resistance is high. That makes the heating element warm up quickly.

Electric motors produce mechanical power quickly and quietly. In a simple electric motor, a loop of wire, or coil, hangs in the magnetic field between two magnets. The magnetic field puts a force on the electric current. The current flows through the coil. The force causes the coil to rotate. As it rotates, current continues to flow. This energy can be used to do work, such as power machines from electric toothbrushes to space satellites.

Chemicals also produce electrical energy. Batteries are the oldest artificial electrochemical power plants. They pump out and suck in electrons, thanks to the chemical reaction between an acid and two elements. Those elements are usually zinc and carbon. Fuel cells work like batteries. They produce energy through the chemical reaction of hydrogen, oxygen, and an acid. Batteries and fuel cells were both invented in the 1800s. But fuel cells werent used much until the 1960s, when they became useful for U.S. Moon missions.

(*Adopted from* *Kids Discoverer* *website*)

Vocabulary

Word	Pronunciation	Translation
appliances, n.	/ /	أجهزة
bundle, n.	/ /	باقة
cling, v.	/ /	تشبث
dart, n.	/ /	نبلة
dunked, adj.	/ /	مغمور
eel, n.	/ /	الانقليس، الجريث
electrocardiogram, n.	/ /	تخطيط القلب الكهربي
filament, n.	/ /	الحامل المئبر، سلك كهربائي
fly apart, v.	/ /	تطير بعيدا
forerunner, n.	/ /	رائد، سابق
galvanometer, n.	/ /	المقياس الكلفاني
glowing, adj.	/ /	متوهج
headache, n.	/ /	صداع الراس
hook up, v.	/ /	مربوط
hum, v.	/ /	يهمهم
impulse, n.	/ /	دفعة
incandescent, adj.	/ /	ساطع
nerve, n.	/ /	عصب

pacemaker, n.	/ /	منظم ضربات القلب
pump out, v.	/ /	ضخ
scalp, n.	/ /	فروة الرأس
unruly, adj.	/ /	جامح، عنيد
stiff, adj.	/ /	قاس
stun, v.	/ /	صعق
jolt, v.	/ /	هزة، صدمة
lit-up, v.	/ /	أضيئ
silverware, n.	/ /	الفضيات

Comprehension

A. *Answer the following questions:*

- What is ECG used for?
- Where doe the brain waves originate from?
- Are Tasers (stun guns) beneficial or harmful?
- List few medical uses of electrical currents.
- How does an incandescent bulb work?

B. *Complete the following definitions:*

- ... is an instrument that sends out tiny electrical impulses to stimulate the heart.
- ... is a device that measures electrical current.
- ... is the most powerful of all electric fish.
- ... is a material that can be changed to either conduct or resist electricity.
- ... is the oldest artificial electrochemical power plant.

C. *State if the following statements are true or false:*

- All living things release electricity in some form.
- Electrical energy can only make light.
- Modern electronics can hold a handful of resistors.
- Chemicals cannot be affected by electricity.
- Electricity may be produced by chemical reactions.

Exploration

A. *Translate the following nouns to Arabic and give the corresponding verbs:*
Circuit, charge, wire, current, amber.

B. *Translate the following adjectives to Arabic and give the corresponding nouns:*
Deflected, reflected, electromagnetic, circulating, accelerating.

C. *Think of all possible questions to the following sentences:*

- Batteries produce electrical energy.
- Many home appliances work just like bulbs.
- The human body has electricity.
- Electrical energy holds us together.
- Electrical currents may be used in treating some aches.

D. *Re-order the following words to obtain a comprehensive sentence:*

- observed-Greeks-and-magnetic-electric-as-early-BC-phenomena-as-700.
- The-electric-amber-word-elecktron-from-the-comes-word-for-Greek
- Electromagnetism-study-of-electricity-and-given-to-magnetism-the-is-name-combined-a
- experimental-Maxwell-used-to-formulate-observations-laws-the-electromagnetism-of
- The-electricity-play-role-in-the-smartphones-a-central-laws-of-operation-of

E. *Starting with the following expressions, ask questions to the statements below:*
I wonder ... - Could you clarify ... - Could you tell me ... - I'd like to know ... - Do you have any idea ... - I'm interested to know ...

- Medical doctors install pacemakers for some patients (why?)
- The electrical nature of human body can be a weapon against it (how?)
- Eels can stun or kill their preys (how?)
- Electrons reach into all aspects of modern life (why?)
- Most silverware is not made of silver (why?)

F. *Read and translate the following passage to Arabic:*

There are very few electric animals and the majority of them are fish. The electric catfish is found in tropical Africa and the Nile River and can emit 350 volts. The electric ray, or torpedo fish, can produce around 220 volts and was documented by the Ancient Greeks and nicknamed the numbfish because it was used as a basic anaesthetic in early medicine.

There are also animals that use electricity to help them locate prey or navigate in murky waters. Sharks are famously spectacular at electroreception, which is why theyre such good predators. If your muscles give off a spark of electricity (which they do if youre alive), sharks will find you.

Most electroreceptive animals are water-dwellers. But there are a limited number of electric mammals, such as the land-dwelling echidna (sometimes known as a spiny anteater), and its cousin the duck-billed platypus, which lives both in water and on dry land.

Both the echidna and the platypus have tiny electroreceptors on their snouts (up to 40,000 in the case of a platypus), which detect currents and allow them to burrow through silt or dry land and locate prey with their eyes closed. The echidnas electrical capabilities are all the more remarkable for being on land. More recently, a species of dolphin, the Guiana dolphin (also technically a mammal), has also been found to use electroreception.

On dry land, the honeybee is known to beat its wings at such a fast rate that it generates an electrical charge, which is then transferred to a flower when it is pollinated. Another bee can therefore detect the presence of an electrical charge if visiting the same flower, and it tells them not to bother foraging there.

(*Adopted from* BBC Earth)

Translate and then read the following passage in English:

يُعرف العلاج الطبيعي بالكهرباء بأنَّه عبارة عن مجموعة من العلاجات المستخدِمة للكهرباء بهدف تقليل الألم، إصلاح الأنسجة، تقوية العضلات، تعزيز نمو العظام بالإضافة إلى تحسين الدورة الدموية، وهذا من شأنهِ أن يحدث تحسينات ملحوظة في الأداء البدني، ومن المهم الإشارة إلى أنَّ العلاج الطبيعي بالكهرباء يجدي نفعًا مع المرضى الذين فقدوا سيطرتهم على الألم والأعراض الأخرى.

ويتمثل العلاج الكهربائي بتوجيه نبضات كهربائية خفيفة إلى المنطقة المراد علاجها، ومن المهم الإشارة إلى آلية عمل العلاج الكهربائي التي تتمثل باستخدام جهاز يعمل بالبطاريات يكون متصلًا بأسلاك تعمل

على منصات كهربائية تلتصق على الجلد، وبمجرد توصيل الأقطاب الكهربائية، وتشغيل وحدة العلاج، يتم إرسال تيار كهربائي معتدل إلى الجلد عن طريق القطب، وفي هذا المقال سيتم الحديث عن أضرار العلاج الطبيعي بالكهرباء.

ومن الجدير بالذكر أنَّ العلاج الكهربائي وفوائده العائدة على المريض بتخفيف الألم تعود للعصور القديمة، فقد بدأ عصره مع العلاجات من الولايات المتحدة التي استعانت بهِ في علاج القلق والاكتئاب، ومنذ ذلك الحين زادت استخداماته، حيثُ تم استخدامه لعلاج الألم المزمن بالإضافة إلى التعب المزمن عمومًا.

من موقع سطور

Writing

Write (in English and Arabic) a report/presentation about the physics of electricity.

4.2 Our own giant magnet

« .... »

...

Reading

Read and translate the following text:

The ancients learned to make a compass and use it to find north, but they could never have figured out why it worked. For that, we can thank English scientist William Gilbert. He was the first to describe the Earth itself as a magnet in his important work "De Magnete", published in 1600. The rest is modern science.

He could not have known why the Earth acts like a magnet. That was left to scientists who could study earthquakes deep inside the Earth. They used what they observed to figure out the planet's magnetic behavior. At Earth's center is a hot, solid core. The core is made mostly of iron, and it's as hot as the sun's surface (about 10,300°F $\approx$ 5704 °C). Around the core is a thick layer of liquid iron and other metals. This liquid rises and sinks as it heats and cools around the core. The flow creates a current that makes a magnetic field. It works a lot like an electric current flowing through a wire. Except that it's at the center of the Earth and turns our whole planet into a magnet – an electromagnet.

Earth's magnetic field is called the magnetosphere. It reaches deep into space and protects us from the sun's harmful charged particles. The size of the magnetosphere changes as Earth rotates. The change happens because of solar wind, a steady stream of electrons and other charged particles flowing out of the sun. On the side of Earth facing the sun, pressure from solar wind shrinks the magnetosphere. The wind does not affect the side facing away from the sun. So, the magnetosphere on that side expands. Charged particles in the solar wind break through the magnetosphere. The particles speed along the lines of Earth's magnetic field toward the North and South Poles. When they reach our atmosphere, they bump into gas atoms. The collision makes the atoms release photons. We see them as bursts of colourful light (northern lights -aurora borealis- and southern lights -aurora australis).

The next time someone tells you Santa lives at the North Pole, you might ask, "Which one?" There are three. The north geographic pole is the one most people mean when they say North Pole. It's at the northern point of the axis around which Earth rotates. The north geomagnetic pole is the north pole of the Earth's magnetosphere. It lies just off the northwest coast of Greenland (Denmark). Finally, the north magnetic pole is the north that a compass points to.

The north geographic and geomagnetic poles stay pretty much where they are. The north magnetic pole does not. The swirling motion of liquid iron near Earth's core pulls on the magnetic field and makes it move. The north magnetic pole is moving toward Siberia, Russia. Until the 1990s, the movement was slow, about seven miles ($\approx$ 11 km) a year. Since then, the movement has become much faster and is now about 34 miles ($\approx$ 55 km) a year. This change created a problem. The World Magnetic Model needed to be adjusted. That is a computer program that uses the north magnetic pole to map out Earth's magnetic field. The technology is used in navigation systems such as satellites and smartphones. The model is usually updated every five years. Thanks to the increased speed in the movement of the north magnetic pole, it had to be changed early. In February 2019, almost a year ahead of schedule, a new model was released.

What could happen if the north and south magnetic poles continue to move? Eventually, they may reverse themselves, which has happened before. The last time was about 780,000 years ago. Scientists say a pole reversal may create major changes for the planet. Those could include increased ultraviolet radiation and more streams of charged particles from the sun. These events could make parts of Earth impossible to live in. The good news is that, if a reversal does happen, it would take place over a thousand years and not begin for a very, very long time. So, we don't need to hold our breath waiting for it.

(*Adopted from Kids Discoverer website*)

Vocabulary

Word	Pronunciation	Translation
behavior, n.	/ /	سلوك
burst, n.	/ /	انفجار، اندفاع
collision, n.	/ /	تصادم
compass, n.	/ /	بوصلة
cool, v.	/ /	يبرد
current, n.	/ /	تيار
earthquake, n.	/ /	هزة أرضية
figure out, v.	/ /	عرف، اكتشف
iron, n.	/ /	حديد
liquid, n.	/ /	سائل
metal, n.	/ /	معدن، فلز
model, n.	/ /	نموذج
pole, n.	/ /	قطب

pull, n.	/ /	سحب
reversal, n.	/ /	انعكاس، ارتداد، انقلاب
rise, v.	/ /	تصاعد، ارتفع
schedule, n.	/ /	جدول
shrink, v.	/ /	إنكمش، تقلص
sink, n.	/ /	حوض، بالوعة
steam, v.	/ /	تبخر
swirling, v.	/ /	يحوم
wire, n.	/ /	سلك

Comprehension

A. *Answer the following questions:*

- Who pioneered the idea that the Earth is a magnet?
- What is the origin of the magnetic field of the Earth?
- Describe the north "poles" of the Earth.
- What causes the magnetic north pole to move?
- Is a "pole reversal" possible? how?

B. *Complete the following definitions:*

- ... is a tool used to find the north pole.
- ... is made mostly of iron and has temperature of about 5k degrees.
- ... is the region filled with Earth's magnetic field.
- ... is a phenomenon caused by solar wind in the atmosphere.
- ... is a computer program that uses the north magnetic pole to map Earth's magnetic field.

C. *State if the following statements are true or false:*

- The north geographic pole lies along the axis of rotation of Earth.
- Both geographic and geomagnetic poles change position with time.
- The World Magnetic Model is a simulation program that maps out Earth's magnetic field.
- A pole reversal may happen during one decade.
- Earth's magnetic field map is used for navigation systems.

Exploration

A. *Translate the following nouns to Arabic and give the corresponding verbs:*
Needle, field, source, charge, circuit.

B. *Translate the following adjectives to Arabic and give the corresponding nouns:*
Magnetic, repulsive, isolated, interacting, permanent.

C. *Think of all possible questions to the following sentences:*

- Scientists used observations of earth-quakes to study Earth's magnetic behaviour.
- The size of the magnetosphere changes as earth rotates.
- Northern aurora is a consequence of Earth's magnetic field.
- There are three north poles for the Earth.
- Pole reversal may create major problems for our planet.

D. *Re-order the following words to obtain a comprehensive sentence:*

- The-of-the-origin-invention-is-Arabic-or-of-compass-Indian
- every-and-south-regardless-magnet-of-has-its-poles-called-shape-two-north-poles
- never-Unlike-been-isolated-charges-pole-a-single-electric-magnetic-has
- The-was-discovered-magnetism-1819-and-between-electricity-relationship-in
- a-an-electric-electric-changing-changing-creates-creates-magnetic-magnetic-field-field-field-field-and-a-a

E. *Starting with the following expressions, ask questions to the statements below:*
I wonder ... - Could you clarify ... - Could you tell me ... - I'd like to know ... - Do you have any idea ... - I'm interested to know ...

- The earth was first described as a giant magnet in 1600 (who?)
- Earth is an electromagnet (why?)
- The solar wind affects the magnetic field of the Earth (how?)
- The motion of the magnetic north pole is speeding up (why?)
- Earth's magnetic field maps are updated regularly (why?)

F. *Read and translate the following passage to Arabic:*

You may be familiar with GPS, which stands for for Global Positioning System. GPS uses satellites to zoom in on users' locations and tell them how to get where they want to go. Without GPS, many would have a hard time finding their way around. Animals don't have GPS, yet they rarely get lost. Sometimes, animals travel long distances without losing their way. Their secret, some scientists say, is a magnetic sixth sense. Some plants have it, too.

Sea turtles and salmon swim hundreds of miles to go home to breed. Honeybees may travel more than three miles back to their hive each day. Desert ants search for food and return to their nest after traveling several hundred yards – a huge distance for such tiny creatures. Bats and many birds can do similar things. Homing pigeons, well, find their way home from far away. There are types of bacteria that swim along Earth's magnetic field. All these animals have one thing in common. Certain cells in their bodies contain small levels of magnetite. That means they're sensitive to Earth's magnetic field. Scientists believe they use this sensitivity like a built-in GPS.

You might be wondering if humans have bits of magnetite in their cells, too. In 1992, researchers asked that question and then investigated to find the answer. Yes, there is magnetite in the human brain. Since then, geophysicists have learned more. They have discovered magnetite in the brain stem. It is also in the cerebellum, which controls muscle movement, including speech, balance, and posture. The exact effect of these particles is still not known.

(*Adopted from Kids Discoverer website*)

G. *Translate and then read the following passage in English:*

من المعروف أن المجال المغناطيسي للأرض يعكس اتجاهه بانتظام مزعج إلى حدٍّ ما؛ فالشمال المغناطيسي يتحول إلى الجنوب، والعكس صحيح. أما العمليات التي تدفع هذا التغيير فهي غير مفهومة بقدرٍ كافٍ؛ إذ يعرف العلماء أن الانعكاس الأخير حدث منذ نحو 773 ألف سنة، ولكن ما يحدث بالضبط داخل لُب كوكبنا لإحداث هذا التغيير هو شيء غير معروف. غير أن دراسةً جديدةً يمكن أن تساعد في توضيح السبب الكامن وراء هذا التغيير؛ لأنها تشير إلى أن الانعكاس يستغرق وقتًا أطول بكثير مما كنا نظن سابقًا. كذلك سيكون للنتائج آثار محتملة على البشرية خلال الانعكاس القادم.

في بحثهم المنشور اليوم في دورية «ساينس أدفانسز» العلمية، يُقَدِّر براد سينجر من جامعة ويسكونسن-ماديسون وزملاؤه أن الانعكاس الأخير للمجال المغناطيسي للأرض استغرق حوالي 22 ألف سنة. وكانت دراسات سابقة قد قدرت أن الظاهرة استغرقت ما بين 4000 إلى 9000 سنة. ويوحي الرقم الجديد بأن الانعكاس هو حدث أكثر عنفًا واضطرابًا مما كنا نظن. يقول سينجر: "عملية الانعكاس أكثر تعقيدًا

بكثير، واستمرت مدةً أطول وفق تقديرنا". ويضيف قائلًا: "تشير دراستنا إلى عملية أكثر امتدادًا وتعقيدًا وراء دفع انعكاس المجال المغناطيسي الأرضي وتوجيهه".

وتشير النتائج إلى أن المجال المغناطيسي ثنائي القطب للأرض بدأ في الانهيار منذ نحو 795 ألف سنة، وشهد ما يُعرف بحدث الانحراف؛ إذ يفقد المجال المغناطيسي جزءًا كبيرًا من قوته الأصلية ولكنه لا ينعكس. وقد وقع الانحراف الأخير –حدث «لاسشامب» Laschamp –event منذ نحو 41 ألف سنة. وبعد التعافي قليلًا منذ 784 ألف سنة، انهار مجال الكوكب مرةً أخرى ثم عكس اتجاهاته في نهاية المطاف بعد 11 ألف سنة، مع استمرار عملية الانعكاس القطبي الأخيرة لمدة 4000 سنة. يقول سينجر: "ما تُظهره سجلات تدفق الحمم البركانية بوضوح هو وقوع بضع محاولات قام بها الدينامو لعكس القطبية قبل الانعكاس النهائي".

قد يكون للنتائج التي توصل إليها الفريق معانٍ ضمنية مهمة تتعلق بالانعكاس المغناطيسي التالي للأرض، والذي يعتقد بعض العلماء أننا ربما كنا قريبين منه. فمثلًا، في أثناء الانحراف أو الانعكاس، يضعف المجال المغناطيسي إلى حدٍّ كبير، ويسمح لقدر أكبر بكثير من الأشعة الكونية بالوصول إلى سطح الكوكب. ويمكن لهذه الجسيمات عالية الطاقة القادمة من الفضاء أن تدمر الحياة على الأرض إذا وصل الكثير منها إلى سطح الأرض. وإضافةً إلى ذلك، ستفقد الأقمار الصناعية التي تدور حول الأرض المجال المغناطيسي للكوكب الذي يوفر الحماية لإلكترونياتها الحساسة، مما يجعلها أكثر عرضةً للتلف بسبب الأشعة الكونية. يقول كوينتِن سايمون، الذي يعمل في «المركز الأوروبي للبحوث والتدريس في علوم الأرض البيئية» CEREGE، والذي لم يشارك في الدراسة: "إذا اختفى القطبان المغناطيسيان، فسيختفي معهما الدرع الذي يحمينا من جسيمات الأشعة الكونية القادمة من الفضاء".

من موقع American Scientific بالعربي

Writing

Write (in English and Arabic) a report/presentation about Magnetic Resonance Imaging (MRI) technique.