

TASK

Read the New Scientist article: "It's Super Carbon" and completed a brief article analysis, using the questions provided.

Research the different carbon allotropes (Graphite, Graphene, Diamond, Bucky balls, Carbon nanotubes) and types of nanotechnology (E.g. Nanomedicine, nanomaterials, Nano electronics, Molecular nanotechnology, environmental nanotechnology, consumer nanotechnology). Use the information to answer the questions. You must use at least three appropriate websites/texts/articles/etc. and they must be referenced correctly. Use your own words where you can and always acknowledge the original author. (Don't use technical words unless you know what they mean.)

Complete an in-class validation to test your understanding of the research you have done and your understanding of the properties of different carbon allotropes and nanotechnology.

"It's Super Carbon" Article Analysis Questions

What are the sources of the author's information?(1 mark)

(Science , vol 306, p666)

(Nano letters, vol 9, p30)

(Nature Nanotechnology DOI: 10.1038/nnano.2009.292.)

(Nano letters, vol 9, p2600)

(Nature, vol 458, p877)

(physical review letters, vol 103, p046801.)

(Advanced functional materials, Vol 18, p3403)

(arxiv.org/abs/0906.2216)

Who published this document?(1 mark)

New Scientist on the 28th of november 2009

Is the publisher a "reputable source"? Justify your answer.(2 marks)

It's not a reputable source, there is a large amount of discourse as to whether or not it is reputable to begin with- thus telling me it is probably not. And to say physics forums "think that the vast majority of its articles are credible" is entirely concerning in general. Not one website has identified New Scientist as a 'reputable source' a semi-accurate one at best.

Is the document objective or subjective? Explain using examples e.g. Does the author acknowledge other viewpoints, avoid emotive words and generalizations, and support statements with evidence?(3 marks)

Most of the article is objectively written to a degree. Some of the article is however too subjective for something that should be completely unbiased. Language used like "flashy newcomer", "we"- which is inclusive, and "causing the biggest stir" seem just too personal and unprofessional for this document. Overall I would label this subjective purely due to language however that is disputable. It doesn't acknowledge others viewpoints merely stacks point upon point. The quotes used say "fantastic" and "exciting" both of which are too emotive for a scientific article.

Rate the document in terms of its usefulness as a resource for other students in your class.

Write a statement to explain the reasoning for your rating.(2 marks)

4/10 rating, somewhat useful. Through my previous answer of it being un-credible and partially subjective it can be assumed the resource is not useful because it is not accurate. However there is some truth discussed in the article that can be used, it's just how much has been exaggerated as we can already see the resource isn't 100% accurate.

Summarize the main ideas in the document using words or a concept map.(5 marks)

Graphene has the potential to revolutionise gadgets due to the efficient movement of electrons through graphene. What makes it such a promising alternative is that a regular chip loses approx 75% of power to heat while graphene doesn't do this. The heat dissipated can damage the technology so changing this will further out tech greatly.

Silicon has been the leading material in many prices of tech with flowing currents due its ability to have a band gap. To act as a conductor and an insulator. Graphene can now compete with silicon as it has been discovered to have nanoribbons - when less than 10nm wide its properties undergo a dramatic change turning it into a semiconductor. However the manufacturing of nanoribbons remains an issue on a large enough scale to be useful. As a result, potentially more subtle ways of turning graphene into a semiconductor may make nanoribbons ineffective before they even reach a marketable point. To create a semiconductor in both silicon and nanoribbons they create a fixed object by slicing or placing impurities throughout, with graphene sheets this is avoided as twisting and pulling the graphene sheet gives it a new set of properties without permanently altering anything. While this looks promising, all the tests completed so far have been in low temp ideal conditions and further advancements are hopeful to be more reliable and useful for the future. Carbon nanotubes have made breakthroughs as well, with the ability to be mass produced they are used for a large variety of stuff. Nanotubes are conductive with a high tensile strength and immune to deformation thus making it useful to industries- even as diverse as the oil industry.

What are the broader implications (for science and society) of the information found in the article?(4 marks)

Potential to make graphene: Although graphene itself may end up bull and void by market time the development of methods to create it is applicable to other areas that could further the use of carbon for other things.

Replacing silicon: The possibility of replacing silicon with a better option that doesn't emit as much heat waste is good for not only the environment but also the technology affected, allowing us to further the capacity of high end computing technology that may have otherwise been damaged by heat output.

Some are already being used: Carbon nanotubes discovered over half a century ago are now one of the most sought after things in production for the versatile ability and structure including being conductive and relatively resilient to deformation.

More efficient lifestyle: With the advancement of technology in general we have the ability to have more efficient technology but also a wider application of solar power and the like creating an overall efficient livelihood.

Part 2: Allotrope and Nanomaterials Research Questions.

What is nanotechnology?(2 marks)

Nanotechnology is a type of science engineering that deals with dimensions of less than 100 nanometers. (Where a nanometer scale is utilised in production, involving manipulation of singular atoms)

Why is nanotechnology important in our modern society?(2 marks)

Nanotechnology has the ability to improve a variety of systems involving purification, energy, production and more. It can also create better food production and nutrition. Many products we use daily rely on nanotechnology of some form.

Choose two types of nanotechnology from the given list.

-Describe the positive and negative impacts these technologies have on our lives.(8 marks)
-What are the future prospects/potentials of these technologies?(4 marks) Nanotechnology focuses on the singular manipulation of atoms and things below 100 nanometers in size. Advancements in this area are few and far between however usually quite progressive. Nanotech already provides many benefits in our current life: information technology, energy, medicine, national security and more.

Nanomedicine

- A major drawback in nanomedicine is because every nanoparticle behaves differently they have to individually assess every particle. Also due to their mass vs surface area change being largely dramatic at a nanoscale their behaviour from 100nm to 1nm can greatly differ. for example a non-toxic particle at 1nm may be toxic at 100nm.
- A really obvious drawback is it can get into the wrong hands. A tiny microscope, invisible to the naked eye particle, can enter your body and do unforeseen amounts of damage- especially from people
- Considered enemies. scientists aren't 100% sure how to stop them once they are in you either, meaning they can't afford it getting into the wrong hands.
- There is an insane cost of development for nanomedicine and a large amount is still unknown. As this is discovered and money goes into it the cost to use nanomedicine is going to rise. This almost negates the original purpose as normal people would struggle to afford it.
- Doxil (doxorubicin) disrupts cancer genes to stop the cells from dividing(spreading) This currently treats ovarian cancers, multiple myeloma, and Kaposi's sarcoma.
- As this technology develops we have the ability to remotely target specific cells- at least that's the goal, the dose response can happen inside the body as new attempts at treating cancer and lifelong disabled people. This is still in development.
- Nanomedicine can also be used to increase the amount of time a drug remains active in your body thus allowing a longer exposure to necessary treatments.
- There are a range of trials being done in the medical industry in an attempt to further nanotechnology uses. The delivery of drugs to specific cells is an aspect that is being researched in hopes that nanotechnology can be used to attach themselves to injured stem cells and repair damaged heart tissue. -
- Another thing they're looking into is the antibacterial property of gold nanoparticles. The goal is that they may be able to improve the cleanliness of instruments in hospitals.

Environmental nanotechnology

This is the process of including nanotechnology in an attempt to reduce or revert damage to our environment.

- Nanotechnology has the ability to create less pollution during the manufacturing process of material. With the use of silver nanoclusters polluting byproducts can be significantly reduced in the process to manufacture propylene oxide which is used in the manufacturing of plastics, detergent paint and more.
- Carbon nanotubes and a few other nano products have been identified with the possibility of helping improve the water quality. Considered photo catalysts they can oxidise the organic pollutants into harmless materials.

- because nanotechnology has uncertain shapes, size, dimension, behaviour and composition there can be increased toxicological pollution of the environment. or certain nanotech can bind with materials and be rendered inert.
- *Apparently* you can inhale nanoparticles involved in the technology allowing your lungs to swell/be negatively impacted.
- Environmental nanotechnology advancing in society is heavily related to the advancement of other areas of science that relate to gene-editing, AI, spacecraft and more that will allow nanotech to improve the environment in more abstract ways.
- The potential to include nano structures that increase durability against mechanical stresses and weathering are hopeful to lead for a longer more useful life in products resulting in less waste.

Define the term "allotrope"(1 mark)

an element that exists in different physicals form has different "allotropes"

an allotrope: is a particular form of an element which may have multiple eg. bucky ball, carbon nanotube etc.

Choose two types of carbon allotrope from the given list.

-List the chemical and physical properties of each.(4 marks)

-Describe two uses of each allotrope.(4 marks)

-For each use described, explain how the material can be used in this way by referring to the relevant property of the material (e.g. hardness, electrical conductivity, etc.) and the bonding structure of the material which gives it this property.(8 marks)

Carbon nanotubes

Physical properties

- metallic or semiconducting in there electrical behaviour (high electrical conductivity)
- high thermal conductivity
- very high tensile strength
- CNTs are flexible and can be bent to a degree without damage
- Low thermal expansion (ratio of material expansion to 1C° temperature increase)

Chemical properties - struggled to find information.

- Not sure if it counts but CNTs have been researched and identified with the possibility of having the same carcinogenic effect as asbestos.
- If CNTs can be incinerated i'm not sure if that's flammable?
- On their own I can't find information however studies have discovered concentrated light can raise the temp. of CNTs hot enough to potentially ignite combustion reactions from a safe distance.
- Carbon nanotube chemistry is the process of modifying properties of CNTs. Covalent and Non-Covalent are the two main methods of functionalisation.

Used a thermal conductor in many applications, especially advanced electronics with chips as they can reach over 100C° regularly. The reason they are such a good thermal conductor is the stiffness created from the hexagonal bonding forming stronger bonds than diamond, however still allowing heat to transfer easily.

CNTs can be used for water purification of all three types, organic, inorganic and biological. This is due to the aspect ratio and their large surface area. They have a large surface area because of the structure of their physical form. With a high aspect ratio it results in higher porosity and lower flowability making an excellent filter.

Graphite

Physical Properties

- Good electrical conductivity
- Good thermal conductor
- Soft Solid
- Malleable
- Insoluble

Chemical Properties

- Nonflammable
- Combustible
- Corrosion resistant against common acids

The most known use of graphite is in pencils and this is because it is a soft solid that is bonded in layers. The layers of graphite are weakly bonded which allows them to slide past each other with ease. This leaves layers of graphite on the paper resulting in the mark.

Graphite is also used as an electrode in electrolysis because it is an excellent conductor of electricity. Graphite is bonded in hexagonal structure which means that there are only three bonds which leaves the fourth electron moving freely. These delocalised electrons are able to conduct electricity.

https://ec.europa.eu/health/scientific_committees/opinions_layman/en/nanotechnologies/l-3/1-introduction.htm

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3462600/>

<https://www.itmedicalteam.pl/articles/nanotechnology-and-medicine-the-upside-and-the-downside-100763.html>

<http://nanoday.com/single/242/what-are-the-disadvantages-of-nanomedicine>

<https://www.understandingnano.com/environmental-nanotechnology.html>

<https://www.treehugger.com/how-does-nanotechnology-impact-the-environment-5186947>

https://faculty.atu.edu/cgreco/aseemw_2011/asee_2011_proceedings/Peer_Reviewed_Papers/ASEE-MIDWEST_0030_c25dbf.pdf

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2844666/>

<https://www.american.edu/sis/centers/security-technology/the-applications-and-implications-of-nanotechnology.cfm>

<https://www.scientificworldinfo.com/2019/10/importance-of-nanotechnology-education-in-modern-society.html?m=1>

<https://www.azonano.com/amp/article.aspx?ArticleID=4842>

[https://chem.libretexts.org/Bookshelves/Introductory_Chemistry/Map%3A_Introductory_Chemistry_\(Tro\)/03%3A_Matter_and_Energy/3.05%3A_Differences_in_Matter-Physical_and_Chemical_Properties](https://chem.libretexts.org/Bookshelves/Introductory_Chemistry/Map%3A_Introductory_Chemistry_(Tro)/03%3A_Matter_and_Energy/3.05%3A_Differences_in_Matter-Physical_and_Chemical_Properties)

<https://www.physicsforums.com/threads/is-new-scientist-credible.478718/>