

SOUTH AFRICAN AGENCY FOR SCIENCE AND TECHNOLOGY ADVANCEMENT 13th NATURAL SCIENCE OLYMPIAD

GRADES 7 - 9

2024

INSTRUCTIONS

Please read the instructions carefully before answering the questions

This is a multiple choice paper. Please answer all the questions on the answer sheet provided. Each question is followed by answers marked A, B, C, and D. **Only one answer is correct**. Choose the correct answer and shade the corresponding circle on the answer sheet completely, using an HB pencil.

NB! The answer sheets are marked electronically – do not make any other dots or marks on the answer sheet. Select only one answer for each question or your answer will be discarded. **Ensure that you shade your selection clearly.**

Note that the question numbers 1 to 100 on the answer sheet moves from top to bottom in several columns. Ensure that the number of your selection on the answer sheet corresponds with the number of the question in your examination paper. Should you make a mistake, please erase the incorrect answer completely

The use of **non-programmable** electronic calculators is permitted.

To avoid disqualification - You are required to complete **all** the information requested on the answer sheet. Please complete the information in script, as well as shade the corresponding blocks. If the corresponding blocks are not shaded appropriately, your results will be returned without a name and you will be disqualified. Do not fold the answer sheets.

Two hours are allowed to answer the questions.

Turn page over to start

1. Matter exists mainly in THREE states (not counting Plasma). These are...

- A. ice, water and steam.
- B. gas, liquid and solid.
- C. candle wax, melted candle wax and black smoke.
- D. frost, snow and hail.

Consider the illustrations in the table below, depicting different methods of producing electricity in South Africa and answer questions 2 and 3.



- 2. Which of the above are NOT using sustainable energy resources?
 - A. 4 only
 - B. 6 only
 - C. 4 and 6
 - D. 4, 5 and 6
- 3. Which of the above uses kinetic energy as the primary source of energy?
 - A. 2 only
 - B. 3 only
 - C. 2 and 3
 - D. 2, 3 and 4
- 4. Which path represents the correct one taken by the sperm cell as it travels internally to leave the male body?
 - A. Testis, vas deferens, urethra.
 - B. Urethra, vas deferens, testis.
 - C. Urethra, testis, vas deferens.
 - D. Testis, urethra, vas deferens.

5. How long does it take the Earth to complete one full rotation on its axis?

- A. 1 day
- B. 1 week
- C. 1 month
- D. 1 year
- If we could gather ALL of the Earth's water into one place in space, it would form a sphere that is tiny in relation to the size of our home planet. This is true because...



- A. the total mass of all the water on and inside the Earth is only 0,02% of the total mass of the whole rocky planet.
- B. water (density 1 kg/litre) weighs less than rocks (average density: 1,5 to 3,5 kg/litre).
- C. water can be fresh or salty.
- D. water at the North and South Poles is frozen.
- 7. The illustration below shows a dynamo that is used to generate energy to power the light of a bicycle when cycling at night.



The energy conversion in the dynamo is ...

- A. kinetic energy to electrical energy.
- B. potential energy to electrical energy.
- C. heat to electrical energy.
- D. electrical energy to light.

QUESTIONS 8 AND 9 ARE BASED ON THE DIAGRAM BELOW WHICH REPRESENTS A FOOD CHAIN IN A GARDEN.



- 8. The Blackbird in the diagram is a:
 - A. Herbivore
 - B. Predator
 - C. Producer
 - D. Primary consumer
- 9. If all the ladybirds in this garden were removed, what would happen to the population of Greenflies?
 - A. It will decrease.
 - B. It will stay the same.
 - C. It will increase.
 - D. Nothing will happen.

10. Where do the stars go during the day?

- A. They switch off so that they can recharge their starlight.
- B. They are still in the sky but we cannot see them because of the bright sunshine.
- C. They move around to the night-side of the Earth.
- D. The gravity of the Moon pulls them over to the night side.

11. Which metal is in the liquid state at room temperature?

- A. Water
- B. Steel
- C. Candle wax
- D. Mercury
- 12. Three charged spheres X, Y and Z, supported by insulating threads of equal length, hang from a beam, as shown in the diagram below. Sphere X is negatively charged.

Sphee X attracts sphere Y, but repels sphere Z.

Which ONE of the following conclusions is CORRECT?



- A. Sphere **Y** is positively charged, and sphere **Z** is positively charged.
- B. Sphere **Y** is positively charged, and sphere **Z** is negatively charged.
- C. Sphere **Y** is negatively charged, and sphere **Z** is negatively charged.
- D. Sphere **Y** is negatively charged, and sphere **Z** is positively charged.
- 13. The table below shows the differences between plant and animal cells. Which comparison is INCORRECT?

	Plant cell	Animal cell
A	Large vacuole	Small or no vacuole
В	Cell membrane present	No cell membrane
C	Cellulose cell wall present	No cellulose cell wall
D	Chloroplasts present	No chloroplasts

Background: In 2006 a spacecraft called *New Horizons* was launched by NASA. Nine years later, it finally flew past Pluto at 49 600 km/h after covering 5,3 billion kilometres. It took clear photographs of the Pluto System. It collected data on Pluto with its 5 moons.

We have now concluded that Pluto and Charon (the largest moon) actually form a linked binary pair orbited by the 4 smaller moons. So our Solar System has 8 major planets, several minor planets, and one Binary Planet Pair.

14. Why was Pluto downgraded from a major planet to a minor planet in 2006?

- A. Pluto has on five moons.
- B. Pluto is too far from the Sun.
- C. Pluto is an ice-covered dwarf planet in the Kuiper belt.
- D. Pluto has failed to clear out the objects from its orbit and is surrounded by lots of space debris.

15. Oxygen has a melting point of -218°C and a boiling point of -183°C.

If you fell into a bath filled with liquid oxygen...

- A. You would be boiled to death.
- B. You would freeze to death.
- C. Oxygen is a gas and cannot be liquefied.
- D. The oxygen would be boiled away by your body heat and you will be unharmed.
- 16. The diagram below shows two light bulbs, X and Y, connected in series to an electrical cell with negligible internal resistance.



If bulb X glows brighter than bulb Y, then the ...

- A. current through bulb X is smaller than that through bulb Y.
- B. resistance of bulb X is smaller than that of bulb Y. $\label{eq:balance}$
- C. resistance of bulb X is greater than that of bulb Y.
- D. current through bulb X is greater than that through bulb Y.

17. Vitamin C is found in:

- A Butter, plantoils and milk.
- B Milk, fish liver oil and cheese.
- C Citrus fruit, tomatoes and spinach.
- D Meat, liver and whole grain bread.

18. Occasionally Venus crosses between Earth and the Sun.

This is called a "Transit of Venus." It happened in 2004 and again in 2012. It will happen again only in 2117 and 2125.



The diagram shows how the planet blocks the sunlight as it crosses the face of the Sun.

This shows that...

- A. That Venus is a Gas Giant.
- B. Earth lies closer to the Sun than does Venus.
- C. Venus lies closer to the Sun than does Earth.
- D. That Venus is hot enough to melt lead.

- 19. In history, the ancient Greeks had weapons made of bronze, while the later Romans had weapons made of iron. The reason that the Bronze Age happened <u>before</u> the Iron Age is...
 - A. Bronze consists of metals that have lower melting points than iron has.
 - B. Bronze consists of metals that have higher melting points than iron has.
 - C. Melting points of metals has no influence on weapon design.
 - D. We have no way of knowing this because it happened very long ago.



20. The following illustration shows light moving through different mediums.



Which of the following is NOT true?

- A. The arrows show the reflection of light as it moves from one medium to the other.
- B. Light moves faster through water than through glass.
- C. Light bends towards the normal.
- D. Water is denser than air.

QUESTION 21 refers to the following list of some of the compounds and gases involved in the metabolic processes in the human body.

- (i) Oxygen
- (ii) Proteins
- (iii) Carbon dioxide
- (iv) Water
- (v) Glucose
- 21. Astronauts should take along a supply of the following on a space flight:
 - A. (i), (ii). (iii), (iv) and (v)
 - B. (ii), (iv) and (v)
 - C. (i), (ii), (iv) and (v)
 - D. (iii), (iv) and (v)

22. Background: Exoplanets are very, very distant planets orbiting stars that are very far outside our Solar System. Astronomers have confirmed the discovery of 5699 exoplanets. A few are somewhat 'earth-like' but they are too far away for us to detect any signs of life.

It is very difficult just to detect an exoplanet.



- 22. One method scientists use to detect exoplanets is the so-called "wobble method." This phenomena can be observed because ...
 - A. the gravity of an orbiting exoplanet causes the distant star to wobble back and forth as the planet moves around it.
 - B. the gravity of an orbiting exoplanet causes the starlight to change colour.
 - C. the mass of an orbiting exoplanet causes the star to switch on and off.
 - D. this is false the universe is too big for us to detect "exoplanets".
- 23. When a mercury thermometer is placed in hot water, the mercury column drops slightly at first, and then rises up in the thermometer to give the temperature of the water. This happens because...
 - A. The glass bowl of the thermometer expands first causing the mercury to drop into it.
 - B. The mercury is confused and takes time to decide whether to go up or down.
 - C. The hot water draws heat out of the glass bowl.
 - D. This does not happen and the mercury will rise immediately.

24. A battery is connected in a circuit as shown below. The resistances of R_1 and R_2 are high.



Which ONE of the following combinations about the ammeter readings will be CORRECT when switch S is open and when switch S is closed?

	SWITCH OPEN	SWITCH CLOSED
Δ	Ammeter reads only	Ammeter reads only
~	the current in R ₁	the current in R ₂
В	Ammeter reads only the current in R ₂	Ammeter reads the current in both R_1 and R_2
	Ammeter reads the	Ammeter reads the
C	current in both R_1	current in both R ₁ and R ₂
	Ammeter reads the	Ammeter reads the current in R ₂ only
D	current flowing	
	through R_1 and R_2	

25. Which of the following is NOT true of cells?

- A. Cells are the structural units of living organisms.
- B. Cells are the functional units of living organisms.
- C. All cells come from pre-existing living cells.
- D. Organelles in cells are the same for all living organisms.
- 26. Most of the exoplanets that have been identified in orbit around very distant stars are very LARGE (many are even bigger and heavier than Jupiter) This is because...
 - A. they are easier to see through a telescope.
 - B. we can detect them using RADAR.
 - C. more massive exoplanets will cause a bigger wobble of the star.
 - D. gas giants are shinier than rocky planets.

GRADES 7 - 9

- 27. Your school organises a fete to raise funds for Science Kits. One of the stalls sells party balloons filled with hydrogen gas. When a balloon is released it rises high up into the sky. What happens to the balloon after a while?
 - A. It expands as it rise because hot air rises.
 - B. It expands because the external pressure on them increases.
 - C. It expands because external air pressure decreases, until they burst.
 - D. It expand a small amount and then stay at that size.
- 28. Learners investigate the relationship between current (I) and potential difference (V) at a constant temperature for three different resistors; X, Y and Z. They obtain the graphs shown below. The resistances of X, Y and Z are R_x, R_Y and R_z respectively.



Which ONE of the following conclusions regarding the resistances of the resistors is correct?

- A. $Rz > R_Y > Rx$
- B. $R_x > R_y > R_z$
- C. $R_X = R_Y = R_Z$
- D. $R_X > R_Y$ and $R_Y < R_Z$.

Questions 29 and 30 refer to an investigation, which was conducted to determine the number of people that suffer from different heart diseases.

29. What is the independent variable in this investigation?

- A. Heart diseases.
- B. Number of people.
- C. Time of investigation.
- D. Date of investigation.

- 30. The following factors were considered during the investigation:
 - 1. The sample size.
 - 2. Time of the day.
 - 3. Repeat the investigation.
 - 4. The investigation must be done over a long period of time.

Which one of the following combination of factors will affect the reliability of the investigation?

- A. 1 and 2 only
- B. 1, 2 and 4 only
- C. 1, 2, 3 and 4
- D. 1 and 3 only
- 31. The nearest star to Earth is the Sun, and the next nearest star is Proxima Centauri – which is 4,25 Light Years away from us. Since light travels at 300 000 km per second, and there are 365,24 x 24 x 60 x 60 = 31 556 736 seconds in a year, how far is Proxima Centauri from Earth measured in kilometres?
 - A. 9 467 020 800 000 km.
 - B. 40 234 838 400 000 km.
 - C. 4 543 billion years.
 - D. 13.7 billion years.
- 32. Which one of the following processes is a chemical reaction?
 - A. Melting of candle wax.
 - B. Boiling of alcohol.
 - C. Bending of copper wire.
 - D. Rusting of iron.
- 33. A helicopter is flying at a constant speed of 80 km.h⁻¹ as shown in the sketch below. A 1 kg object is dropped from the helicopter.

Which of the paths numbered 1 to 4 will likely be the trajectory that the object will follow as it falls to the ground?

- A. 1 80 km h
- B. 2 C. 3
- D. 4



34. The diagram below illustrates part of the human digestive system.



Which of the following lists the correct order of the labels for A, B, C and D?

- A. Stomach, liver, pancreas, gall bladder.
- B. Liver, pancreas, stomach, gall bladder.
- C. Liver, gall bladder, stomach, pancreas.
- D. Stomach, pancreas, liver, gall bladder.
- 35. There is an exoplanet in orbit around Proxima Centauri called "Proxima b". We don't think that it is habitable because its host star has a tendency to send out deadly flares.

If, however, intelligent life actually does live there and they sent us a radio signal, next New Year (1 January 2025), when would this radio signal reach the Earth?

- A. In March, 2029.
- B. In March, 2030.
- C. In March, 2039.
- D. It will never reach us because radio waves cannot travel in space.

36. Which one of the following chemical reactions is NOT exothermic?

- A. Carbon + oxygen \rightarrow carbon dioxide
- B. Zinc metal + hydrochloric acid → zinc chloride + hydrogen gas.
- C. Photosynthesis: carbon dioxide + water → glucose + oxygen.
- $\label{eq:D.D.D} D. \quad \text{The burning of petrol inside the engine of a car.}$

37. Circuit I shows two identical lamps X and Y connected to a cell of negligible internal resistance. Switch S is closed.



A wire T, of negligible resistance, is now connected across X as shown in Circuit II.

Which ONE of the statements below best describes how the brightness of the lamps have changed after T had been connected?

	X	Y
А	Does not light up	Dimmer
В	Brighter	Dimmer
С	Brighter	Brighter
D	Does not light up	Brighter

38. In which part/s of the living organisms below does respiration occurs?



- A. Z only
- B. W and X only
- C. Z and Y only
- $D. \quad W,\,X,\,Y \text{ and } Z$

GRADES 7 - 9

Background (39) : Earth's atmosphere has several layers viz. the Troposphere, Stratosphere, Mesosphere, Thermosphere and Exosphere. Our weather occurs in the lowest layer, the Troposphere. Although temperatures get cooler and cooler as you go higher, the Thermosphere – being closer to the incoming Solar Radiation – is very HOT, as hot as 2000°C.

Some conspiracy theorists have noted that since the Thermosphere has temperatures higher than the melting point of aluminium, that this as "proof" that humans have never gone into space because their spacecraft would have melted.

Note: Temperature is determined by the average kinetic energy of the molecules.

39. We know that NASA astronauts, Russian cosmonauts and Chinese taikonauts regularly pass through the Thermosphere without any harm. This is because...

- A. they are lying; no human and no spacecraft have ever gone into space.
- B. they pass through the layer so quickly that they don't have time to heat up.
- C. the outer skin of the spacecraft does melt, but the people inside are safe.
- D. although the gas molecules are moving very quickly, at that altitude they are spread out very thinly, so their "heat content" is actually very low.

40. Which one of the following is an example of a physical process?

- A. The fire on the braai cooking your meat.
- B. Water in a pressure cooker boiling to become steam.
- C. Lighting a cigarette.
- D. Burning of coal dust inside the furnace at a power station.

41. Multiplugs are used to connect many electrical devices in our homes. Surge charge protection is built into some multiplugs.



Which one of the following statements is incorrect?

- A. Devices are connected in series.
- B. When more devices are added, the total resistance will decrease.
- C. When more devices are added, the total current will increase.
- D. The function of the surge charge protection is to prevent damage to the devices.
- 42. HIV is the virus that causes AIDS and it can be spread
 - .
 - A. through indirect contact.
 - B. during sexual intercourse.
 - C. in the air.
 - D. through food and water.
- 43. Chemistry and astronomy are closely linked sciences. Each element on the periodic table has a unique "line spectrum" which they emit when heated. We can use this line spectrum as a "fingerprint" to identify chemicals here on Earth and also in the light of distant stars because ...
 - A. line spectra are caused by electrons changing energy levels in an atom.
 - B. line spectra have revealed that most stars contain mainly hydrogen and helium.
 - C. heavy elements like Uranium, Lead and Gold form when huge stars collide.
 - D. all three of the above statements are correct.

GRADES 7 - 9

44. A diamond is a solid made up of pure carbon. What could happen if you were to hold a diamond ring in the hot flame of a Bunsen burner?



- A. The diamond could melt and form a puddle around the burner.
- B. The diamond could catch on fire and burn to form carbon dioxide if the temperature reaches around 1000 degrees Celsius.
- C. Nothing will happen because diamonds are hard and indestructible.
- D. The diamond will become 'red hot' and turn into a ruby.

Consider the information given below and answer questions 45 to 48.

Some in Southern Africa's energy sector, including Namibia and South Africa, are exploring the potential benefits of embracing a hydrogen economy, a clean and natural energy source. South Africa produces between 80 and 85% of the world's iridium and 75% of the world's platinum, needed as a catalyst for the production of hydrogen.

It takes energy to produce hydrogen. The source of energy and the production method used to make hydrogen determines whether it is classified as grey hydrogen, blue hydrogen, or green hydrogen. Hydrogen can be made from natural gas, coal, or biomass, but these energy sources have associated greenhouse gas emissions. Hydrogen can also be made using an electrolysis process to split water into oxygen and hydrogen. Fuel cells that run on hydrogen that reacts with oxygen, are used in cars, power plants, cell phones, and computers.



45. Which of the following is sources of energy suitable to produce green hydrogen?

- A. Coal and natural gas.
- B. Biomass and wind.
- C. Solar and wind.
- D. Natural gas and biomass.

46. Which of the following are formed as products of a hydrogen fuel cell?

- A. Hydrogen and oxygen.
- B. Hydrogen and carbon dioxide.
- C. Water vapour and heat.
- D. Water and carbon dioxide.

47. Which of the following makes South Africa a region with enormous potential for renewable energy?

- A. Its climate and engineering expertise.
- B. Its climate and natural resources.
- C. Its natural resources and engineering expertise.
- D. Its climate and abundance of coal resources.

48. The production of which type of hydrogen will contribute most to the reduction of global warming?

- A. Both blue and grey hydrogen.
- B. Grey hydrogen.
- C. Blue hydrogen.
- D. Green hydrogen.

49. Which equation describes the process of photosynthesis the best?

- A. Water + Carbon dioxide + Energy → Glucose + Oxygen
- B. Oxygen + Water \rightarrow Carbon dioxide + Energy + Glucose
- C. Energy + Carbon dioxide \rightarrow Oxygen + Glucose + Water
- D. Glucose + Water \rightarrow Carbon dioxide + Energy + Oxygen

GRADES 7 - 9

Background (50):

At first the early Earth was a ball of molten magma. The **crust** cooled first and was made up of Primary Rocks called igneous rocks (e.g. Granite, Basalt). Weathering broke these rocks down to small grains, and erosion by rivers, ice and wind carried them away and deposited them in layers of sediment which slowly turned into sedimentary rock (e.g. Sandstone, Mudstone).

Weathering and erosion also worked on these Secondary Rocks grinding them down to grains again and then depositing them to form new sedimentary rocks. In some areas the rocks were subjected to heat and great pressure, which formed them into Metamorphic Rocks (e.g. Slate, Quartzite).

Sometimes surface rocks are carried down into the mantle and re-melted. In this way rocks break up, get deposited, and then form new rocks which may also break up again. Very slowly the grains form soil which can easily be washed away by heavy rains.

This cycle is repeated over and over – we call it the Rock Cycle – it is important to life on Earth.



- 50. Igneous and sedimentary rocks can be reheated and changed into ...
 - A. stalagmites and stalactites.
 - B. metamorphic rocks.
 - C. limestone.
 - D. chalk.

- 51. While it is easy to change the state of water from solid ice to liquid water and then gaseous steam, it is more difficult to start with a gas like oxygen and then liquefy it, and eventually freeze it. To get oxygen gas to change to liquid oxygen, we need...
 - A. To lower the temperature and increase the pressure.
 - B. To lower both the temperature and the pressure.
 - C. To use high temperature but low pressure.
 - D. Just to lower the temperature (the pressure is not important).
- 52. Inhalation is the process during which ...
 - A. the muscles of the diaphragm contract, the intercostal muscles contract and air is forced out of the lungs.
 - B. the muscles of the diaphragm contract, the intercostal muscles contract and air flows down the air passages into the lungs.
 - C. the muscles of the diaphragm relax, the intercostal muscles relax and air is forced out of the lungs.
 - D. the muscles of the diaphragm relax, the intercostal muscles relax and air flows down the air passages into the lungs.
- 53. This photograph shows quartzite in the Magaliesberg mountains.



We can see that the sediments were laid down in...

- A. sand.
- B. desert conditions.
- C. water.
- D. we can't tell because it happened many millions of years ago.

54. Background: The ancient Greek scientist, Archimedes, was called to the palace of the king. He was told to find out if the new crown that he had ordered was pure gold or not. He was not allowed to damage the crown in any way.

Archimedes knew that the density of gold is 19,3 g/cm³ and he was able to weigh the crown to determine its mass. Since he knew that density is mass divided by volume, all he needed to do was to measure the volume BUT the crown was an irregular shape. **How did he measure the volume?**

- A. He placed the crown in a full container of water and measured the volume of water that overflowed.
- B. He weighed the crown but guessed the volume because he knew that the king didn't understand science and would never know.
- C. He cut the crown into small pieces and used a measuring cylinder to get the volume.
- D. He fled the palace and hid in the mountains until the king passed away.
- 55. The concentration of urine varies under different conditions. After which of the following activities would a person produce the most concentrated urine [dark yellow], assuming that conditions are similar in other respects before the start of the various activities?
 - A. A long drink of cold water.
 - B. An hour's swimming in cold water.
 - C. A strenuous game of netball.
 - D. An hour's studying on a cool morning.
- 56. How did the thick beds of iron ore that we mine at Thabazimbi and Sishen form?
 - A. They were deposited in ancient seas when cyanobacteria released oxygen.
 - B. The iron was delivered to Earth by asteroid impacts.
 - C. Meteorite impacts provide the energy for their production.
 - D. There is no possible way we can determine this.

- 57. Electric cars (like the Tesla) are heavy because of the mass of the batteries. In order to try to keep the weight as low as possible, the South African born entrepreneur, Elon Musk, uses a lightweight metal for many parts of the body. This metal is...
 - A. Copper.
 - B. Lithium.
 - C. Chromium.
 - D. Aluminium.
- 58. After the fuel of the sun runs out in 5 billion years' time...
 - A. It will explode and then become a black hole.
 - B. It will become a neutron star.
 - C. It will become a brown dwarf.
 - D. It will become a red giant and then shrink to become a white dwarf.
- 59. Many people use Propane Gas (C₃H₈) as a fuel for cooking. The exothermic reaction produces water and CO₂ as well as heat. Some of this water collects on the kitchen window glass (together with steam from the cooking process). Which one of the following is the correct balanced equation for the reaction?
 - A. $C_3H_8 + O_2 \rightarrow 3CO_2 + 4H_2$
 - B. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$
 - C. $2 C_3H_8 + 16O_2 \rightarrow 8CO_2 + 8H_2O$
 - D. $2 C_3 H_8 + 8O_2 \rightarrow 6CO_2 + 10H_2O$
- 60. Which one of the following statements is correct?
 - A. Herschel's telescope was an early radio telescope.
 - B. SALT was specifically designed to observe the Moon and track ocean tides.
 - C. Both these telescopes (Herschel's and SALT) were used to photograph black holes.
 - D. SALT observes its targets using visible light.

The end

GRADES 7 - 9