

SOUTH AFRICAN AGENCY FOR SCIENCE AND TECHNOLOGY ADVANCEMENT

PHYSICS OLYMPIAD

GRADE 10 - 11

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.

This paper consists of 14 pages and 5 data sheets.

Three hours are allowed to answer the questions

 An aurora is the phenomenon known as the northern lights (aurora borealis) in the Northern Hemisphere and the southern lights (aurora australis) in the Southern Hemisphere.



What causes the aurora borealis?

- A. Ocean currents near the North Pole
- B. Volcanic eruptions in the Arctic region
- C. Interaction of solar winds with Earth's magnetic field
- D. Reflection of sunlight off the moon's surface
- 2. The Koeberg Nuclear Power Station in the Western Cape, a province of South Africa, primarily uses nuclear fission as its energy source.

What is nuclear fission?

- A. The process of combining two small nuclei to form a larger nucleus.
- B. The process of splitting a heavy nucleus into smaller nuclei.
- C. The process of converting nuclear energy into electrical energy.
- D. The process of releasing radiation from a nuclear reactor.

Use the illustration below to answer questions 3 to 5.



- 3. What type of electromagnetic wave is emitted by a red-hot stove plate to heat food?
 - A. Radio waves
 - B. Microwaves
 - C. Infrared waves
 - D. Ultraviolet waves

- 4. Which type of electromagnetic radiation causes skin cancer due to over exposure to sunlight?
 - A. X-rays
 - B. Infrared rays
 - C. Blue light
 - D. Ultraviolet rays
- 5. Red light has a wavelength of 620 nm. Which one of the following is the frequency of the red light?
 - A. 6,2 x 10¹⁴ Hz
 - B. 4,84 x 10¹⁴ Hz
 - C. 1,43 x 10¹⁴ Hz
 - D. 1,61 x 10⁶ Hz
- 6. Which one of the following is an example of a contact force?
 - A. Frictional force
 - B. Magnetic force
 - C. Electrostatic force
 - D. Gravitational force
 - 7. The free-body diagram below shows the relative magnitudes and directions of all the forces acting on an object moving horizontally in an easterly direction.



The kinetic energy of the object ...

- A. is zero.
- B. increases.
- C. decreases.
- D. remains constant.
- 8. The magnitude of the gravitational force exerted by one body on another body is *F*. When the distance between the centres of the two bodies is doubled, the magnitude of the gravitational force, in terms of *F*, will now be ...
 - A. ¼**F**
 - B. ½ **F**
 - C. 2**F**
 - D. 4**F**

9. A block rests on a table. The table stands on a concrete floor. The normal force is represented by *N*, as shown in the diagram below.



Which one of the following forces will form an actionreaction pair with the normal force (*N*)?

- A. Force of the block on the earth
- B. Force of the block on the table
- C. Force of the table surface on the block
- D. Force of the block on the concrete floor
- 10. The electric field pattern for two charged spheres, A and B, is shown below.



Which one of the following statements regarding the charges on spheres A and B is correct?

- A. Spheres **A** and **B** are both positively charged.
- B. Spheres **A** and **B** are both negatively charged.
- C. Sphere **A** is positively charged and sphere **B** is negatively charged.
- D. Sphere **A** is negatively charged and sphere **B** is positively charged.
- 11. P, Q and R are three charged spheres. When P and Q are brought near each other, they experience attractive forces. When Q and R are brought near each other, they experience repulsive forces. Which one of the following is true?
 - A. **P** and **R** have charges with the same sign.
 - B. **P** and **R** have charges with opposite signs.
 - C. **P**, **Q** and **R** have charges with the same sign.
 - D. **P**, **Q** and **R** have equal charges.

12. Two charged particles are placed a distance, *r*, apart. The electrostatic force exerted by one charged particle on the other is F_{E} . Which one of the graphs below correctly represents the relationship between the electrostatic force, F_{E} , and the square of the distance, r^{2} , between the two charges?



- 13. Two oppositely charged point charges move towards each other. Which one of the following is correct? The point charges move at ...
 - A. constant velocity.
 - B. decreasing velocity.
 - C. constant acceleration.
 - D. increasing acceleration.
- 14. What is the alternative term for the phenomenon of nearsightedness that occurs when the eye grows too long from front to back, leading to difficulty in focusing on distant objects?
 - A. Myopia
 - B. Cataract
 - C. Presbyopia
 - D. Hypermetropia

15. Which statement is true for the reflection of light?

- A. The angle of incidence and the angle of reflection are equal.
- B. The reflected light is less bright than the incident light.
- C. The sum of the angle of incidence and the angle of reflection is always greater than 90°.
- D. The beams of the incident light, after reflection, diverge at unequal angles.

16. A set of identical light bulbs are connected as shown in the circuit diagrams below. The internal resistance of the battery is negligible. In which one of these circuits will the light bulbs glow the brightest?



17. The diagram below shows a cell of emf (ε), and two resistors, R₁ and R₂, in series, with $R_1 < R_2$. The cell has negligible internal resistance, and the voltmeters have very high resistances.



Which one of the following is correct?

A. $V_1 = V_2 = \varepsilon$

B.
$$V_1 > V_2$$

C.
$$\frac{r_1}{R_1} = \frac{r_2}{R_1}$$

- D. $\frac{V_1^2}{R_1} > \frac{V_2^2}{R_2}$
- 18. The energy level diagram for an element is shown below. E_0 represents the ground state. The energy change from E_0 to E_1 is smaller than that for E_2 to E_1 .



The electron transition from E_2 to E_1 corresponds to a green line in the element's spectrum. The transition from E_0 to E_1 corresponds to ...

- A. absorption of green light.
- B. emission of green light.
- C. emission of red light.
- D. absorption of red light
- 19. Which one of the following pairs of physical quantities consists of one scalar and one vector quantity?
 - A. Distance and speed
 - B. Speed and acceleration
 - C. Displacement and velocity
 - D. Velocity and acceleration
- 20. A car is travelling at a constant velocity along a straight road. It then slows down uniformly. Which one of the velocity-time graphs below best represents the motion of the car?



21. The amplitude of a sound wave is increased without changing the frequency. How does this change affect the loudness and pitch of the sound?

	LOUDNESS	PITCH
A	Decrease	Decrease
В	Decrease	Increase
С	Increase	Unchanged
D	Increase	Increase

22. Consider the resultant vector R represented below.



Which one of the following represents the components of R?



23. A light ray passes from glass to air. The angle of incidence is 40°. The critical angle of glass is 38°.

The light ray will undergo ...

- A. diffraction.
- B. refraction and bend away from the normal.
- C. total internal reflection.
- D. refraction and bend towards the normal.

The position-time graph below represents a wave. Use this graph to answer questions 24 to 26.



- 24. The period of this wave is ...
 - A. 1s
 - B. 2s
 - C. 0,125 m
 - D. 0,25 m

25. The speed of this wave is ...

- A. 0,125 m·s⁻¹
- B. 0,25 m·s⁻¹
- C. 1 m·s⁻¹
- D. 2 m·s⁻¹

- 26. As the wave moves to the right, point Y will move ...
 - A. to the right
 - B. to the left
 - C. upwards
 - D. downwards
- 27. A ship sends out a sonar signal and detects a shipwreck at the bottom of the ocean. The speed of sound in sea water is 1 450 m⋅s⋅1. The signal is received 1,5 seconds later. The depth of the ocean at that point is ...
 - A. 2175 m.
 - B. 1933,3 m.
 - C. 1 087,5 m.
 - D. 966,7 m.



28. Why does a compass needle point north?

- A. Because of gravity
- B. Because of the earth's magnetic field
- C. Because of the wind
- D. Because of the sun's position
- 29. The illustration below shows a positively charged sphere B, brought near to a neutral object A.



Which one of the following correctly describes the situation afterwards?

- Object A becomes positively charged due to the influence of sphere B.
- B. Object **A** becomes negatively charged as electrons in **A** are attracted towards the positively charged sphere **B**.
- C. Object A becomes polarized due to electrons in A being attracted towards B.
- D. Both objects **A** and **B** become neutral due to charge balance.

30. Oil dripping from a truck at equal time intervals leaves the pattern below on the road. Which one of the combinations below best describes the speed of the truck during the intervals?



M to Q, Q to V and V to Z if the truck is moving eastwards?

	M TO Q	Q TO V	V TO Z
A	Decreases	Remains constant	Increases
В	Increases	Remains constant	Decreases
С	Decreases	Increases	Increases
D	Increases	Decreases	Remains constant

- 31. The SI unit for gravitational potential energy is ...
 - A. kg·m·s⁻¹
 - B. kg·m·s⁻²
 - C. kg·m²·s⁻²
 - D. kg·m⁻¹·s⁻¹
- 32. The energy transferred per unit electric charge in a circuit is ...
 - A. current.
 - B. charge.
 - C. power.
 - D. potential difference.

The following graph shows the movement of an object over a period of seven seconds. Use the information in the graph to answer questions 33 to 36.



- 33. The magnitude of the acceleration of the object after five seconds is ...
 - A. 1 m·s⁻²
 - B. 1,25 m·s⁻²
 - C. 1,5 m⋅s⁻²
 - D. 9,8 m·s⁻²

34. The total distance covered by the object in seven seconds is ...

- A. 3,5 m
- B. 4,5 m
- C. 8 m
- D. 12,5 m

35. The average speed of the object is ...

- A. 0,5 m·s⁻¹
- B. 0,64 m·s⁻¹
- C. 1,14 m·s⁻¹
- D. 1,79 m·s⁻¹

36. The object is moving at ...

- A. constant acceleration.
- B. constant velocity.
- C. constant speed.
- D. zero acceleration.

Use the information below to answer questions 37 to 39.

An 8 N force (F) is applied to the right, at an angle of 30° with the horizontal, to a stationary block with a mass of 1 kg. The maximum static frictional force (f) on the block is 7 N.



- 37. The normal force (*N*) on the block will be ...
 - A. 4 N
 - B. 5,8 N
 - C. 9,8 N
 - D. 13,8 N

- 38. The magnitude of the horizontal component of the applied force (*F*), will be ...
 - A. 0 N
 - B. 4 N
 - C. 6,93 N
 - D. 7,4 N

39. Which one of the following correctly describes the motion of the block?

- A. The block will stay motionless.
- B. The block will move to the right.
- C. The block will lift upwards.
- D. The block will move to the right and lift upwards.

Use the law of conservation of mechanical energy and the information below to answer questions 40 to 42.

An object with mass 1 kg is projected upwards from the roof of a 10 m high building. The letters A to D in the sketch below indicates the position of the object as it moves from the top of the building until it reaches the ground. The kinetic energy when the object reaches the ground at point D is 117,6 J.

Ignore the effects of air friction.



- 40. The potential energy of the object at point C is ...
 - A. 0 J
 - B. 9,8 J
 - C. 10 J
 - D. 98 J

41. The kinetic energy of the object is 0 J at point ...

A.	A
л.	

- B. B
- C. C
- D. D

- 42. The height of the object above the ground at point B is ...
 - A. 11 m
 - B. 12 m
 - C. 13 m
 - D. 14 m

Use the information given below to answer questions 43 to 46.

Three identical resistors \mathbf{R}_1 , \mathbf{R}_2 and \mathbf{R}_3 , each with a resistance of 2 Ω , are connected in a circuit as illustrated below. The battery, with negligible internal resistance, has an emf of 3 V. The resistance of the wires and ammeters can be ignored.



With the switch open.

- 43. The reading on V is ...
 - A. 0 V
 - B. 1V
 - C. 1,5 V
 - D. 3V

44. The reading on A_2 is ...

- A. 0 A
- B. 0,5 A
- C. 0,75 A
- D. 2,26 A

The switch is now closed.

45. The reading on V is ...

- A. 0 V
- B. 1V
- C. 1,5 V
- D. 3 V

46. The reading on A_2 is ...

- A. 0 A
- B. 0,5 A
- C. 0,75 A
- D. 2,26 A
- 47. 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 one 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
- B. 2
- C. 3
- D. 4
- 48. In the following diagram, three charges are placed with their centers in a straight line.



The direction of the net electrostatic force on each charge due to the other two charges is:

	Р	Q	R
A	To the left	To the right	To the right
В	To the left	To the right	To the left
С	To the right	To the right	To the left
D	To the left	To the left	To the right

- 49. A girl with a WEIGHT of 600 N is standing on a Newton scale in an elevator when she notices that the scale reads 620 N. Which one of the following conclusions is correct regarding the movement of the elevator to explain the reading on the scale?
 - A. The elevator accelerates upwards.
 - B. The elevator accelerates downwards.
 - C. The elevator moves upwards at a constant speed.
 - D. The elevator moves downwards at a constant speed.
- 50. The diagram shows the displacement of an object. What is the direction of this displacement?



51. A marine scientist is studying the effects of plastic pollution on marine life. They find that many marine animals mistake plastic for food, which can cause harm or even death.
Which of the following is not a way that plastics impacts out

Which of the following is not a way that plastics impacts our oceans and the creatures that inhabit them?

- A. Plastic bags and other large items can cause suffocation.
- B. Animals get entangled in plastic fishing nets, ropes, and other debris.
- C. Plastics release toxic chemicals into seawater.
- D. Enhancement of coral reef growth.

52. How many water molecules are there in 1 kg of water?

- A. 6,02 x 10²³
- B. 6,02 x 10²⁶
- C. 3,34 x 10²²
- D. 3,34 x 10²⁵

53. What name is given to the elements of group 18?

- A. Alkali metals
- B. Alkali earth metals
- C. Noble gasses
- D. Halogens

- 54. The electron configuration of an element M is 1s², 2s², 2p⁶, 3s², 3p². In the periodic table, the element M is placed in ...
 - A. Group 2.
 - B. Group 4.
 - C. Group 14.
 - D. Group 18.

55. What is the trend of valency along the periods in the modern periodic table?

- A. It increases from left to right.
- B. It decreases from right to left.
- C. It increases and then decreases.
- D. It decreases and then increases.
- 56. Aluminium is used for making cooking utensils, such as pots and pans. Which of the following properties of aluminium makes it suitable?
 - (i) Good thermal conductivity
 - (ii) Good electrical conductivity
 - (iii) Light weight
 - A. (i) and (ii)
 - B. (i) and (iii)
 - C. (ii) and (iii)
 - D. (i), (ii) and (iii)
- 57. When hydrochloric acid is added to barium hydroxide, a white-coloured compound is formed. Which of the following options gives the balanced chemical reaction?
 - A. HCl + Ba(OH)₂ \rightarrow BaCl₂ + 2H₂O
 - B. $2HCI + Ba(OH)_2 \rightarrow BaCI_2 + 2H_2O$
 - C. $2HCI + Ba(OH)_2 \rightarrow BaH_2 + 2HCI + O_2$
 - D. HCl + 2Ba(OH) \rightarrow 2BaCl₂ + 2H₂O + O₂

58. Which of the following is a strong acid?

- A. HCI
- B. CH₃COOH
- C. Lemon juice
- D. Pure Milk

59. Na_2CO_3 is also known as ...

- A. baking soda.
- B. baking powder.
- C. washing soda.
- D. bleaching powder.
- 60. An aqueous solution turns the red litmus solution blue. Excess addition of which of the following solutions would reverse the change?
 - A. Baking powder
 - B. Lime
 - C. Ammonium hydroxide solution
 - D. Hydrochloric acid

61. Biodegradable wastes include ...

- A. aluminium foils.
- B. glass bottles.
- C. pesticides.
- D. wood shavings.
- 62. 1 mol of CaCO₃ reacts with excess HCI. At the end of the reaction 0,78 mol of CO₂ is obtained. The balanced equation for the reaction is

of CO_2 is obtained. The balanced equation for the reaction is below.

$$CaCO_{3}(s) + 2HCI(aq) \rightarrow CaCI_{2}(aq) + CO_{2}(g) + H_{2}O(I)$$

The percentage yield of the chemical reaction is:

- A. 78%
- B. 100%
- C. 128,2%
- D. 1,78%

63. Which of the following elements have the largest atomic radius?

- A. NaMg
- B. Al
- C. Si
- D. Si

64. What is the process by which a solid change into a gas?

- A. Condensation
- B. Evaporation
- C. Sublimation
- D. Vaporization

65. Which element is essential for the formation of proteins?

- A. Calcium
- B. Iron
- C. Nitrogen
- D. Sodium

66. Which one of the following processes is an example of an exothermic reaction?

- A. Photosynthesis
- B. Combustion of gasoline
- C. Melting of ice
- D. Cooking

67. Which type of bond involves the sharing of electrons between atoms?

- A. Ionic bond
- B. Covalent bond
- C. Metallic bond
- D. Hydrogen bond

68. Which ONE of the bonds between the atoms below is less polar?

- A. H C
- B. H Cl
- C. H O
- D. H N
- 69. The graph below shows how the potential energy varies with distance between the nuclei of a carbon and nitrogen atom when a single bond (C - N) is formed between them.



Choose from the table the bond length and bond energy for C - N.

	BOND LENGTH (pm)	BOND ENERGY (kJ·mol-1)
А	120	0
В	125	518
С	125	418
D	130	-100

70. Which of the following explains why ethanol is soluble in water?

- A. Ethanol forms a strong ionic bond with water.
- B. Ethanol has a large nonpolar region.
- C. Ethanol forms hydrogen bonds with water.
- D. Ethanol has a high molecular weight.
- 71. Water (H₂O), ethanol (C₂H₅O), chloroform (CCI₃) and bromine (Br₂) are all liquids at room temperature. Which one will have the highest vapour pressure?
 - A. Water
 - B. Ethanol
 - C. Chloroform
 - D. Bromine
- 72. The gas in a certain weather balloon has an initial volume of 12,6 m³ and pressure of 105 000 Pa at a temperature of 25 °C when it is released into space.



Calculate the amount of gas (in moles) in the balloon.

- A. 0,534 mol
- B. 534,25 mol
- C. 6 368,2 mol
- D. 534 247,6 mol

Consider the reaction between dichromate ions ($Cr_2O_7^{2-}$) and iron(II) ions (Fe²⁺) in an acidic medium below and answer questions 73 to 75.

 $Cr_2O_7^{2-}(aq) + Fe^{2+}(aq) + H^+(aq) \rightarrow Cr^{3+}(aq) + Fe^{3+}(aq) + H_2O(\ell)$

- 73. Determine the oxidation number of CHROMIUM in $Cr_2O_7^{2-}$ (aq).
 - A. +2
 - B. +4
 - C. +6
 - D. +12

74. The substance that undergoes oxidation is ...

- A. dichromate ions
- B. iron
- C. Fe²⁺
- D. H⁺

75. The formula of the oxidising agent is ...

- A. Cr₂O₇²⁻
- B. Fe²⁺
- C. H⁺
- D. Cr³⁺
- 76. Two moles of H₂ gas at STP occupy a volume of ...
 - A. 2 dm³
 - B. 11,2 dm³
 - C. 22,4 dm³
 - D. 44,8 dm³

77. Which one of the following balanced equations represents a redox reaction?

- A. $H^+(aq) + OH^-(aq) \rightarrow H_2O(I)$
- $\mathsf{B.} \quad \mathsf{Mg}(s) + \mathsf{CuSO}_4(\mathsf{aq}) \longrightarrow \mathsf{Cu}(s) + \mathsf{MgSO}_4(\mathsf{aq})$
- C. $2NaCl(aq) + Pb(NO_3)_2(aq) \rightarrow 2NaNO_3(aq) + PbCl_2(s)$
- $\mathsf{D}. \quad \mathsf{H}_2\mathsf{SO}_4(\mathsf{aq}) + \mathsf{Ba}(\mathsf{NO}_3)_2(\mathsf{aq}) \longrightarrow \mathsf{Ba}\mathsf{SO}_4(\mathsf{s}) + 2\mathsf{HNO}_3(\mathsf{aq})$

- 78. The volume of a gas at a certain temperature and pressure is V. If the temperature is doubled and the pressure is halved, the volume of the gas will be ...
 - A. 4V
 - B. 2V
 - C. V
 - D. ½V

Consider the information below and answer questions 79 to 81.

Excess sodium thiosulphate, $Na_2S_2O_3(s)$, reacts with 200 cm³ of a hydrochloric acid solution, HCI(aq), of concentration 0,2 mol·dm⁻³ according to the following balanced equation:

 $Na_2S_2O_3(s) + 2HCI(aq) \rightarrow 2NaCI(aq) + S(s) + SO_2(g) + H_2O(I)$

- 79. Calculate the volume of $SO_2(g)$ that will be formed if the reaction takes place at STP.
- A. 0,004 dm³
- B. 0,45 dm³
- C. 0,9 dm³
- D. 448 dm³

80. Which substance in the reaction above is an ampholyte?

- A. HCI
- B. S
- C. SO₂
- D. H₂O
- 81. Which of the following is the conjugate base of HCI?
- A. Na⁺
- B. Cl-
- C. SO₂
- D. H₂O

Consider the information given below and answer questions 82 to 85.

Some countries 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, used 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's classified as grey hydrogen, blue hydrogen, or green hydrogen. Hydrogen production can use natural gas, coal, or biomass as energy sources, but these 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.



- 82. Which of the following are 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
- 83. 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

84. 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.
- 85. The production of will have the greatest effect on the reduction of global warming.
- A. both blue and grey hydrogen
- B. grey hydrogen
- C. blue hydrogen
- D. green hydrogen

Consider the information given below and answer questions 86 to 88.

A barium hydroxide solution, $Ba(OH)_2(aq)$, reacts with a nitric acid solution, $HNO_3(aq)$, according to the following balanced equation:

 $\mathsf{Ba}(\mathsf{OH})_2(\mathsf{aq}) + 2\mathsf{HNO}_3(\mathsf{aq}) \longrightarrow \mathsf{Ba}(\mathsf{NO}_3)_2(\mathsf{aq}) + 2\mathsf{H}_2\mathsf{O}(\ell)$

The potential energy graph below shows the change in potential energy for this reaction.



- 86. The activation energy for the forward reaction is ...
- A. A B
- B. B A
- C. B C
- D. C B
- 87. ΔH for the reverse reaction is ...
- A. A B
- B. B A
- C. B C
- D. C B

- 88. The amount of energy released or gained during the reaction if 0,18 moles of Ba(OH)₂(aq) reacts completely with the acid is ...
- A. 20,88 kJ released.
- B. 20,88 kJ gained.
- C. 41,76 kJ released.
- D. 41,76 kJ gained.
- 89. Which one of the following ions has an electron configuration different from that of neon?
- A. Na⁺
- B. Cl-
- C. Mg²⁺
- D. Al³⁺
- 90. Which of the following indicates the correct boiling point of water in Cape Town and Gauteng?

	Cape Town	Gauteng
А	100 °C	100 °C
В	100 °C	98 °C
С	98 °C	100 °C
D	100 °C	102 °C

- 91. The frequency of an object oscillating is 8,6 MHz. What is the frequency when expressed in kilohertz?
- A. 0,0086 kHz
- B. 8,60 kHz
- C. 8,6 × 10⁻³ kHz
- D. 8,6 × 10³ kHz

Consider the information given below and answer questions 92 to 94.

Four methods to separate mixtures are summarised in the table below.

Method A:	Distillation of a water-ethanol mixture to
	(Distillation is the process by which a liquid is heated to produce a vapour, which is then condensed.)
Method B:	Filtering of a sand-water mixture.
Method C:	Separation of water and sugar using heat.
Method D:	Separation of a water-sunflower oil mixture by using a separating funnel. Sunflower oil is less dense than water.

92. In which of the above methods are the mixtures homogeneous?

- A. A and C
- B. A and D
- C. B and C
- D. C and D

93. Method C used to separate sugar from water is known as ...

- A. filtration.
- B. distillation.
- C. evaporation.
- D. condensation.

- 94 A mixture is separated by distillation based on the difference in ...
- A. boiling points.
- B. insolubility
- C. solubility.
- D. density.
- 95 In which one of the following diagrams does the dashed line (----) correctly show the formation of a hydrogen bond between two molecules?



Consider the information given below and answer questions 96 to 98.

In the cell shown below, a concentrated aqueous solution of copper(II) sulfate is electrolysed using graphite electrodes.



- 96 The chemical symbol for graphite is ...
- A. Gr
- B. Ge
- C. C
- D. Ga

- 97 At the cathode ... will be reduced.
- A. graphite
- B. Cu²⁺
- C. H₂O
- D. SO42-

98 What will your observation be when the cell is in operation?

- A. Bubbles will be released at the negative electrode.
- B. A brown residue will form at the negative electrode.
- C. A brown residue will form at the positive electrode.
- D. The blue colour of the solution will become more intense.

99 Which of the following is the most reactive element of group 17?

- A. Fluorine
- B. Chlorine
- C. Bromine
- D. Iodine

100 Which one of the following gases is monatomic?

- A. Chlorine
- B. Argon
- C. Oxygen
- D. Nitrogen

-----End-----

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 m·s ⁻²
Universal gravitational constant	G	6,67 x 10 ⁻¹¹ N·m ² ·kg ⁻²
Radius of Earth	R _E	6,38 x 10 ⁶ m
Mass of Earth	M _E	5,98 x 10 ²⁴ kg
Speed of light in a vacuum	с	3,0 x 10 ⁸ m·s⁻¹
Planck's constant	h	6,63 x 10 ⁻³⁴ J⋅s
Coulomb's constant	k	9,0 x 10 ⁹ N⋅m ² ⋅C ⁻²
Charge on electron	e	-1,6 x 10 ⁻¹⁹ C
Electron mass	me	9,11 x 10 ⁻³¹ kg

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2 \text{ or }$	$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_{f}^{2} = v_{i}^{2} + 2a\Delta x \text{ or } v_{f}^{2} = v_{i}^{2} + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right) \Delta t \text{ or }$	$\Delta y = \left(\frac{v_i + v_f}{2}\right) \Delta t$

WORK, ENERGY AND POWER

$W = F \Delta x \cos \theta$	U=mgh	or	$E_{p} = mgh$
$K = \frac{1}{2}mv^2$ or $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$	or	$W_{\text{net}} = \Delta E_{k}$
2 2	$\Delta \mathbf{K} = \mathbf{K}_{\mathbf{f}} - \mathbf{K}_{\mathbf{i}}$	or	$\Delta \mathbf{E}_{\mathbf{k}} = \mathbf{E}_{\mathbf{k}\mathbf{f}} - \mathbf{E}_{\mathbf{k}\mathbf{i}}$
$W_{nc} = \Delta K + \Delta U \text{or} \qquad W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$		
$P_{ave} = Fv_{ave}$			

FORCE

F _{net} = ma	p=mv
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$	w=ma
$\Delta \mathbf{p} = \mathbf{m}\mathbf{v}_{\mathbf{f}} - \mathbf{m}\mathbf{v}_{\mathbf{i}}$	
$F=G\frac{m_1m_2}{d^2} \text{or} F=G\frac{m_1m_2}{r^2}$	$g = G \frac{M}{d^2}$ or $g = G \frac{M}{r^2}$

WAVES, SOUND AND LIGHT

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{V \pm V_L}{V \pm V_s} f_s$ or $f_L = \frac{V \pm V_L}{V \pm V_b} f_b$	$E = hf$ or $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(max)}$ or $E = W_0 + K_{max}$	where
$E = hf$ and $W_0 = hf_0$ and $E_{k(max)}$	$=\frac{1}{2}mv_{max}^{2}$ or $K_{max} = \frac{1}{2}mv_{max}^{2}$

ELECTRIC CIRCUITS

$R = \frac{V}{V}$	$emf(\epsilon) = I(R + r)$			
	$emk(\epsilon) = I(R + r)$			
$R_{s} = R_{1} + R_{2} + \dots$ $\frac{1}{R_{p}} = \frac{1}{R_{1}} + \frac{1}{R_{2}} + \dots$	q = I∆t			
W = Vq	$P = \frac{W}{At}$			
$W = VI_{\Delta}t$	24			
$W = I^2 R \Delta t$	P = VI			
\/2 At	$P = I^2 R$			
$W = \frac{V \Delta t}{R}$	$P = \frac{V^2}{R}$			

ALTERNATING CURRENT

$$I_{ms} = \frac{I_{max}}{\sqrt{2}}$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$P_{ave} = V_{rms}I_{rms}$$

$$P_{ave} = I_{rms}^{2}R$$

$$P_{ave} = \frac{V_{rms}^{2}}{R}$$

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or $n = \frac{Q}{q_e}$	

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	pθ	1,0 <mark>1</mark> 3 x 10 ⁵ Pa
Molar gas volume at STP	V _m	22,4 dm ³ ·mol⁻¹
Standard temperature	٣	273 K
Charge on electron	e	-1,6 x 10 ⁻¹⁹ C
Avogadro's constant	N _A	6,02 x 10 ²³ mol ⁻¹

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{\mathbf{c_a v_a}}{\mathbf{c_b v_b}} = \frac{\mathbf{n_a}}{\mathbf{n_b}}$	$pH = -log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14} \text{ at}$ 298	3 K
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$	
or $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$	
or $E_{cell}^{\theta} = E_{oxidisingagent}^{\theta} - E_{reducingagent}^{\theta}$	

DATA FOR PHYSICAL SCIENCES GRADE 10 to 11																					
TABLE 3: THE PERIODIC TABLE OF ELEMENTS																					
	1 (I)		2 (II)		3		4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
	1	1		KEY KEY														1	2		
2,1	H										+	_									He
\vdash	3	+	4	1				Flect	onegati	vity	29	SV	mbol			5	6	7	8	9	10
2	Li	1,5	Be					Licon	onegan	····/ ->	e Cu	I ← °,	in ber			S B	5 C	S N	5 0	ŞF	Ne
_	7		9								63,5	•				11	12	14	16	19	20
-	11	-	12								Ţ					13	14	15	16	17	18
0	Na	-	Mg						Appro	oximate	relativ	e atomi	c mass			3A -	÷ Si	N P	5' S	50 m	Ar
⊢	23	+	24	-	01	-	~~	02	04	05		07	00		20	27	28	31	32	35,5	40
	K	0	Ca	2	Sc	2	22 Ti	9 V	9 Cr	20 Mn	8 E0	· Co	~ Ni	0 Cu	9 7n	9 Ga	- Go	9 40	4 Co	00 Dr	Kr
P	39	-	40	-	45	-	48	- 51	- 52	- 14111		- 59	- 59	63.5	- 211	- 30	73	75	79	80	84
F	37		38	-	39	\vdash	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
8,0	Rb	2	Sr	5	Y	1,4	Zr	Nb	[∞] Mo	P Tc	a Ru	a Rh	2 Pd	₽ Ag	2 Cd	₽ In	₽ Sn	Sb 55	Te V	1 5'8	Xe
	86		88		89	L.	91	92	96		101	103	106	108	112	115	119	122	128	127	131
-	55	-	56		57		72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
0	Cs	õ	Ba		La	1	Hf	Та	W	Re	Os	Ir	Pt	Au	Hg	₽ TE	₽ Pb	# BI	N PO	a At	Rn
⊢	133	+-	137	-	139	⊢	1/9	181	184	186	190	192	195	197	201	204	207	209			
5	Fr	σ	Ra		Ac																
P	••	P	226		70			58	59	60	61	62	63	64	65	66	67	68	69	70	71
						-		140	141	144	Pm	Sm	152	157	159	Dy	165	167	169	173	175
								140	01	00	02	150	152	157	100	100	105	107	103	100	102
								Th	B0	92	93 Np	94 D.	Am	Cm	BL	98	59	Em	Md	No	103
								232	Fa	238	Mp	Fu	A	Cill	DK		ES	Fm	INIC	NO	
										200											

Increasing oxidising ability

19

TABLE 4A: STANDARD REDUCTION POTENTIALS

Half-reactions.		8	E ^θ (V)	
F2(g) + 2e-	44	2F-	+ 2,87	r
Co ³⁺ + e ⁻	un.	Co2+	+ 1,81	
H ₂ O ₂ + 2H* +2e ⁻	-	2H ₂ O	+1,77	
MnO + 8H* + 5e-	#	Mn2* + 4H2O	+ 1,51	
Cf2(g) + 2e-		201	+ 1,36	
$Cr_2O_7^{2-} + 14H^* + 6e^-$	-	2Cr3+ + 7H2O	+ 1,33	
O ₂ (q) + 4H ⁺ + 4e ⁻	4	2H ₂ O	+ 1,23	
MnO2+4H*+2e*	2	Mn2+ + 2H2O	+ 1.23	
Pt2+ + 2e-	_	Pt	+ 1,20	
Br2(1) + 2e-	-	2Br ⁻	+ 1,07	
NO3 + 4H* + 3e-	ŧ	NO(g) + 2H ₂ O	+ 0,96	
Ha ²⁺ + 2e ⁻		Hq(l)	+ 0.85	
Aa* + e*	-	Aq	+ 0.80	
NO. + 2H* + e	20	$NO_{2}(q) + H_{2}O$	+ 0.80	
Fe ³⁺ + e ⁻	- 170 - 170	Fe ²⁺	+0.77	
O ₂ (n) ★ 2H [*] ★ 2e ⁻	-	H-O	+0.68	
02(g) + 211 + 2e	1	21-	+ 0.54	
Cu* + e-	5	Cu	+ 0.52	
50. + 4H [*] + 4e ⁻	-	S+2H-0	+ 0.45	
24.0+0+40	*	404-	+0.40	
$2\pi_{2}0 + 0_{2} + 4e$	-	401	+ 0.34	
Cu + 2e	*	00 (0) - 011 0	+ 0,04	
SO 4 + 4H + 2e	aų.	SU ₂ (g) + 2H ₂ U	+0,17	
Cu ⁻ + e ⁻	-	Cu	+0,16	
Sn* + 2e-	=	Sn	+ 0,15	
S + 2H" + 2e"	-	H ₂ S(g)	+0,14	3
2H" + 20"	=	H ₂ (g)	0,00	Dil
Fe ³⁺ + 3e ⁻	#	Fe	- 0,06	a
Pb2+ + 2e-	*	Pb	- 0,13	du
Sn** + 2e-	-	Sn	- 0,14	P
Ni2* + 2e-	=	Ni	- 0,27	p
Co2* + 2e-	*	Co	- 0,28	2
Cd** + 2e*	-	Cd	- 0,40	ů
Cr* + e-	44	Cr	- 0,41	as
Fe ^{2*} + 2e ⁻	-	Fe	- 0,44	ē
Cr** + 3e-	≠	Cr	- 0,74	ů
Zn2* + 2e-	**	Zn	- 0,76	
2H ₂ O + 2e ⁻	аų.	H ₂ (g) + 2OH ⁻	- 0,83	
Cr= + 2e-	ŧ	Cr	- 0,91	
Mn ² + 2e	ųa.	Mn	- 1,18	
At" + 3e"	wh:	At	- 1,66	
Mg* + 2e*	ųa.	Mg	- 2,36	
Na + e	wh :	Na	- 2,71	
Ca* + 2e	#	Са	- 2,87	
Sr* + 2e	*	Sr	- 2,89	
Ba** + 2e*	-1	Ba	- 2,90	
Cs + e	#	CS	- 2,92	
K" + e"	*	к	- 2,93	
Li*+e	-	u	- 3,05	

Increasing oxidising ability

TABLE 4B: STANDARD REDUCTION POTENTIALS

	Half-rea	E ^θ (V)			
	Li* + e*	**	Li	- 3,05	
	K*+e-	**	к	- 2,93	
	Cs⁺ + e⁻	-	Cs	- 2,92	
	Ba ^{2*} + 2e ⁻	-	Ba	- 2,90	
	Sr2+ + 2e-	**	Sr	- 2,89	
	Ca ²⁺ + 2e ⁻	**	Ca	- 2,87	
	Na*+e	-	Na	- 2,71	
	Mg2* + 2e-	**	Mg	- 2,36	
	At" + 3e"	**	AL	- 1,66	
	Mn** + 2e*	**	Mn	- 1,18	
	Cr* + 2e-	wA.	Cr	- 0,91	
	2H2O + 2e	**	H ₂ (g) + 20H ⁻	- 0,83	
	Zn* + 2e-	**	Zn	- 0,76	- 愁
	Cr" + 3e"	**	Cr	- 0,74	
	Fe" + 2e	**	Fe	- 0,44	
	Cr" + e	**	Cr	-0,41	
	Cd + 2e	**		- 0,40	
	Co + 2e	**	CO	- 0,28	
	So ^{2*} + 20 ⁻		Sn	- 0,27	
	Dh ²⁺ + 2e ⁻		Ph	-0,14	
	Fo + 20	-	Fe	- 0.06	
	24+ 20-		H ₂ (a)	0.00	· ·
	S + 2H* + 2e-	Ξ.	H ₂ S(a)	+ 0.14	
	Sn ^{4*} + 2e ⁻	_	Sn2+	+ 0.15	
	Cu2+ + e-	-	Cu*	+ 0.16	
	SO2-+4H++2e-	-	SO2(g) + 2H2O	+ 0,17	12
	Cu ²⁺ + 2e ⁻		Cu	+ 0,34	Ξţ
	2H2O + O2 + 4e-	**	40H-	+ 0,40	abi
	SO2 + 4H* + 4e"	-	S+2H2O	+ 0,45	6
	Cu* + e-	**	Cu	+ 0,52	ci.
	l2 + 2e-	an.	21-	+ 0,54	p
	O2(g) + 2H* + 2e-	**	H ₂ O ₂	+ 0,68	Le
	Fe ³⁺ + e ⁻	**	Fe ²⁺	+ 0,77	Bu
	NO3 + 2H* + e-	**	NO2(g) + H2O	+ 0,80	asii
,	Ag* + e ⁻	**	Ag	+ 0,80	e
	Hg ^{2*} + 2e ⁻	**	Hg(l)	+ 0,85	<u> </u>
	NO3 +4H*+3e	**	NO(g) + 2H2O	+ 0,96	
	Br2(() + 2e-	**	2Br	+ 1,07	
	Pt ²⁺ + 2 e ⁻	**	Pt	+ 1,20	
	MnO2+4H*+2e-	**	Mn2* + 2H2O	+ 1,23	
	O2(g) + 4H* + 4e-	-	2H ₂ O	+ 1,23	
	Cr2O7 + 14H + 6e	yA.	2Cr3+ + 7H2O	+ 1,33	
	Ct2(g) + 2e-	-	201	+ 1,36	
	MnO _ + 8H* + 5e-	*	Mn2+ + 4H2O	+ 1,51	
	H2O2 + 2H* +2 e-	**	2H₂O	+1,77	
	Co ³⁺ + e ⁻	**	Co ²⁺	+ 1,81	
	F2(g) + 2e-	**	2F-	+2,87	