

53rd NATIONAL SCIENCE OLYMPIAD

PHYSICAL SCIENCE

2 MARCH 2017

12:00 – 15:00

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 most 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 – 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.

The last three pages of the examination paper contain data for physics as well as a periodic table that you are allowed to use.

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.

Three hours are allowed to answer the questions

The NRF|SAASTA Education Unit wishes you the best of luck

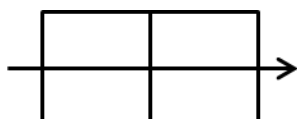
National Science Olympiad Physics 2017

- If the speed of light in vacuum is c , its speed in a medium of refractive index n is:
 - nc
 - c
 - $\frac{c}{n}$
 - n^2c
- When some oil is spilled on water, many colours are visible. This is due to:
 - Refraction of light
 - Diffraction of light
 - Scattering of light
 - Thin film interference of light
- Two photons travelling in a vacuum have different energies. This implies that they have different:
 - Velocities
 - Amplitudes
 - Polarizations
 - Frequencies
- Which one of the following shows the least change in value when measured all over the world?
 - Acceleration due to gravity, g .
 - Speed of sound
 - Density of the air
 - The speed of light
- John is standing on the bank of a river that is flowing from his left to his right. In which direction should he swim in order to reach the opposite bank in the shortest time?
 - Slightly to his left, (slightly upstream.)
 - He should swim directly towards the opposite bank.
 - slightly to his right, (slightly downstream)
 - Swim in such a direction that he reaches the opposite bank at a point directly opposite starting point.
- The speed of sound in air is 333 m.s^{-1} . A man, standing 50 m from a cliff, claps his hands regularly so that each clap coincides with the echo of the previous clap. With what frequency, in Hz, does he clap his hands?
 - 0.33
 - 0.167
 - 3.33
 - 6.66
- Anne is waiting to cross the road, when an ambulance, with its siren wailing, approaches her at a speed of 120 km.h^{-1} . If Anne hears a frequency of 13 kHz, what is the frequency of the ambulance's siren? (Assume the speed of sound in air is 333 m.s^{-1} .)
 - 7.67 kHz
 - 13.0 kHz
 - 11.7 kHz
 - 18.8 kHz
- When Vuyo walks into a shop, he sees a plane mirror 9 m away from him. He walks directly towards it at a speed of 1.4 m.s^{-1} . What is the distance between Vuyo and his image 5 s after he started walking towards the mirror? The rate of emission of energy will increase by a factor of:
 - 2 m
 - 4 m
 - 7 m
 - 16 m
- When a constant resultant force acts on a body on a smooth horizontal surface, the acceleration ...
 - will decrease till the body reaches a constant speed.
 - is constant but not zero.
 - increases uniformly with respect to time.
 - is proportional to the displacement from a fixed point.
- A "speed trap" is placed on the road to enforce speed limits. Two detector wires are placed on the road, 80 cm apart. A car travelling at 72 km.h^{-1} passes over the wires. How long does it take for the front wheels of the car to cross over the wires?
 - 40 ms
 - 11 ms
 - 1.1s
 - 90 ms
- Two projectiles are launched at the same time with the same initial speed and from the same point in the same vertical plane. One is launched at 70° to the horizontal and the other

at 20° to the horizontal. Assume that the air resistance is negligible and that the projectiles are launched on a horizontal surface.

Which of the following is **TRUE**?

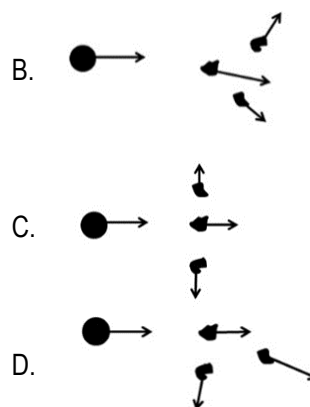
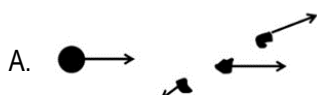
- A. The projectiles will land at the same time
 - B. Both land at the same point.
 - C. The projectile launched at 70° to the horizontal will land first.
 - D. The horizontal component of each is constant and has the same value.
12. A 1000 kg car collides head-on with a 2500 kg minibus. They stop instantly on collision. If before the impact the car was travelling at 20 ms^{-1} , the minibus' speed was:
- A. 5.7 ms^{-1}
 - B. 8.0 ms^{-1}
 - C. 14.3 ms^{-1}
 - D. 20.0 ms^{-1}
13. A toy RC car travels in a straight line across a tiled floor. The tiles are square and are 33 cm each side. The car crosses two consecutive tiles in 3 and 2 seconds respectively, as shown below.



What is the acceleration (in m.s^{-2}) of the toy car?

- A. 0.0071
 - B. 0.04
 - C. 0.022
 - D. 0.055
14. A cannonball is travelling in straight-line when it suddenly explodes into three pieces. The direction of motion of the canon ball before the explosion and the direction of the three pieces after the explosion are shown below by arrows.

Which one of the following diagrams is **NOT** a possible answer?

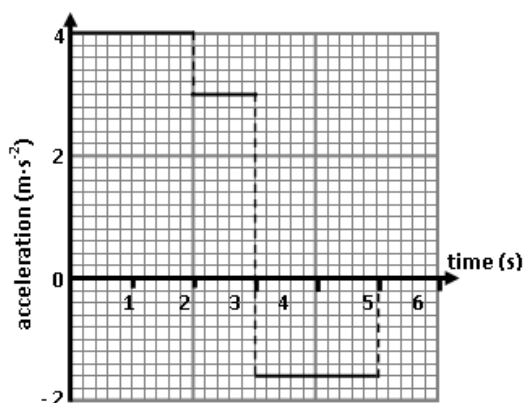


A car of mass 800kg is freewheeling down a slope, at 30° to the horizontal, at a constant speed of 54 km. h⁻¹. Use this information to **answer questions 15, 16 and 17.**

15. The loss of potential energy each second is:
- A. 12 J
 - B. 120 J
 - C. 6 000 J
 - D. 60 000 J
16. The car is now travelling along a horizontal road at the same speed and all other conditions are the same as before. What is the operating power of the car's engine?
- A. 60 kW
 - B. 6 kW
 - C. 43.2 kW
 - D. 12 kW
17. The car now turns round and drives up the slope at the same speed and all other conditions remain the same. What is the operating power of the engine now?
- A. 103.2 kW
 - B. 60 kW
 - C. 120 kW
 - D. 180 kW
18. Which of the following pairs have the units of momentum?
- A. J.s^{-1} ; N.s
 - B. kg.m.s^{-1} ; N.s
 - C. N.s^{-1} ; N.m. s^{-2}
 - D. kg.s; N.m.s
19. Two objects, P and Q, have equal momentum. Object P has a mass of 1 kg and object Q has a mass of 4 kg. Which one of the following represents the ratio of their kinetic energies?
- A. 2:1
 - B. 4:1

- C. 8:1 D. 16:1

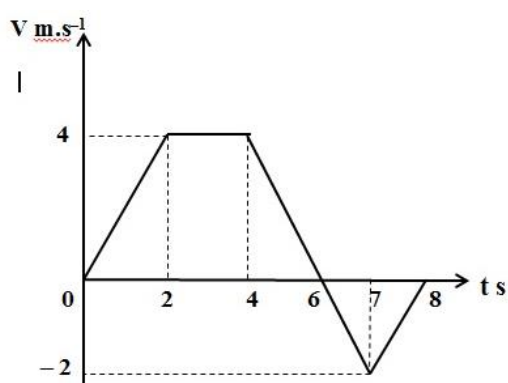
20. An object starts from rest and accelerates in a straight line. The acceleration change of the object with time is shown in the graph below



The speed, in $\text{m}\cdot\text{s}^{-1}$, of the object at $t = 5 \text{ s}$ is:

- A. 0 B. 1.6
C. 7.8 D. 14.2

The graph below shows the velocity-time graph of an object starting from rest, moving off in a straight line and coming to rest 8 s later. Use this information to answer **questions 21, 22 and 23**.



21. What is the maximum acceleration of the object in $\text{m}\cdot\text{s}^{-2}$?
- A. 4 B. 3
C. 2 D. 1
22. What is the average velocity, in $\text{m}\cdot\text{s}^{-1}$, of the object during its 8 s movement?
- A. 1.33 B. 1.50
C. 1.75 D. 1.00

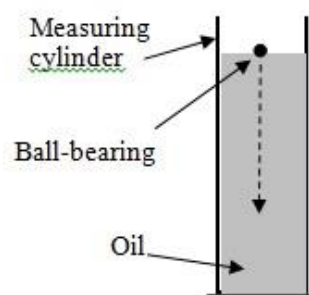
23. During which time intervals was it moving towards its starting point?

- A. 4s – 6s only
B. 4s – 6s and 6s – 7s
C. 7s – 8s only
D. 6s – 7s and 7s – 8s.

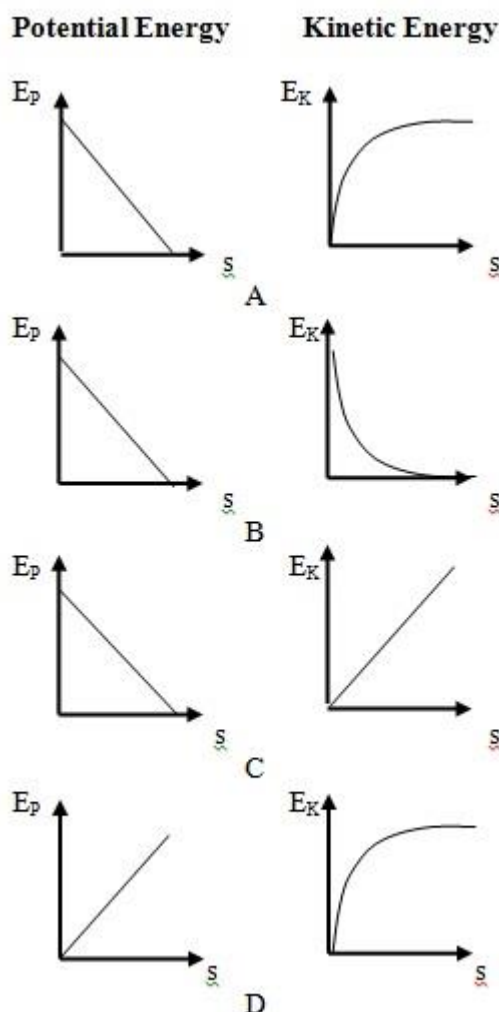
24. A train is moving slowly on a straight track with a constant speed of $2 \text{ m}\cdot\text{s}^{-1}$. A passenger gets up from his seat and walks at a steady speed of $2 \text{ m}\cdot\text{s}^{-1}$ to the back of the train. To an observer standing outside the train, the passenger will appear to be:

- A. moving in the opposite direction to the train at $4 \text{ m}\cdot\text{s}^{-1}$
B. stationary
C. moving in the same direction as the train at $4 \text{ m}\cdot\text{s}^{-1}$
D. moving in the same direction as the train at $2 \text{ m}\cdot\text{s}^{-1}$

25. The diagram below shows a tall measuring cylinder filled with cooking oil. A small, steel ball-bearing is held on the surface of the oil and then released.



Which one of the following pairs of energy (E) versus distance (s) graphs correctly shows the change of potential energy, E_P , and kinetic energy, E_K of the ball-bearing?



26. A Formula 1 racing car has momentum P and kinetic energy T just before it crashes into a tyre wall. It comes to rest after travelling a distance of d metres in t seconds. What is the work done by the tyre wall in stopping the car?

A. $(P \times d)/T$ B. ΔT
C. $P \times d$ D. P/t

27. A ball whose kinetic energy is E , is thrown at an angle of 45° with the horizontal. Its kinetic energy at the highest point of its flight is (ignore air resistance):

A. 0 B. $\frac{E}{\sqrt{2}}$
C. $\frac{E}{2}$ D. $\frac{E}{4}$

28. Hashim Amla receives a cricket ball, of mass 0.16 kg , from Stewart Broad at a speed of 144 km.h^{-1} . Amla drives it back past Broad at speed of 108 km.h^{-1} . If the ball is in contact with Amla's bat for 0.1 s , what is the magnitude average force exerted by bat on ball?

A. 100 N B. 360 N
C. 112 N D. 2520 N

29. A car reaches a speed of 18 m.s^{-1} after accelerating at 4 m.s^{-2} for 3 seconds. What distance has the car covered?

A. 40.5 m B. 36 m
C. 27 m D. 13.5 m

30. A recently discovered exo-planet was found to have a radius $12\,000 \text{ km}$ and that " g " on its surface was 8 m.s^{-2} . What is the mass of the planet?

A. $1.73 \times 10^{25} \text{ kg}$ B. $1.44 \times 10^{18} \text{ kg}$
C. $1.73 \times 10^{19} \text{ kg}$ D. $1.73 \times 10^{23} \text{ kg}$

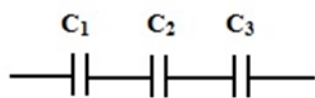
31. At a distance d from a point charge Q , the electric field strength is $E = \frac{kQ}{d^2}$ where k is constant. What will be the field strength at a distance $\frac{d}{2}$ from the charge Q ?

A. $2E$ B. $4E$
C. $6E$ D. $8E$

32. Three insulated conductors, X, Y and Z carry charges of charges of $+6 \mu\text{C}$, $-3 \mu\text{C}$ and $+6 \mu\text{C}$ respectively. All three are simultaneously brought into contact with each other and separated. They are then, in turn, placed a distance D apart and the force between them measured. Which pair would show the largest magnitude of force between them?

A. X and Y
B. X and Z
C. Y and Z
D. The magnitude of the force is the same for all the above.

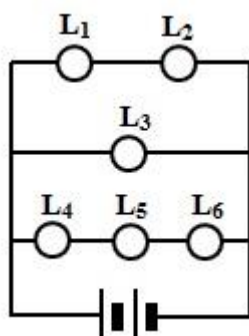
33. Three capacitors, C_1 , C_2 and C_3 are connected in series as shown below, with $C_1 < C_2 < C_3$.



The effective total capacitance, C_T , is:

- A. $C_T < C_1$
- B. $C_T > C_3$
- C. $C_T = \frac{C_1 C_2 + C_2 C_3 + C_1 C_3}{C_1 C_2 C_3}$
- D. $C_T > C_1 + C_2 + C_3$.

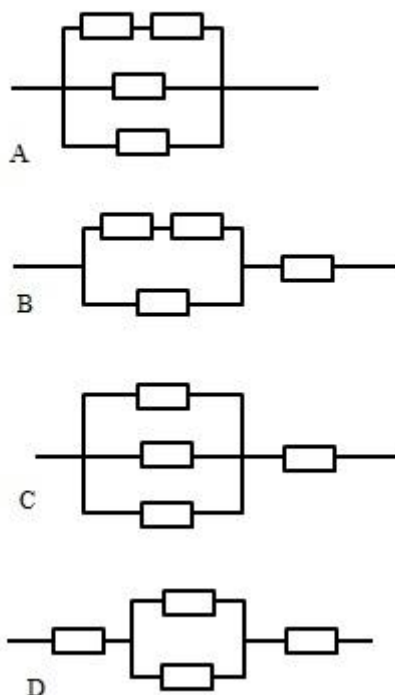
The circuit diagram shows 6 identical bulbs, L_1 to L_6 , connected to a battery.



Use this information to answer questions 34, 35 and 36.

34. Which bulb(s) shine most brightly?
- A. L_4 , L_5 and L_6
 - B. L_3
 - C. L_1 and L_2
 - D. All bulbs shine equally bright.
35. Bulb L_3 is now replaced with an ammeter. Which bulbs now shine brightest?
- A. L_4 , L_5 and L_6
 - B. L_1 and L_2
 - C. All shine equally brightly
 - D. No bulbs shine.
36. The ammeter is now replaced by a voltmeter. Which bulbs now shine most brightly?
- A. L_1 and L_2 are out so L_4 , L_5 and L_6 shine equally brightly
 - B. No bulbs shine.
 - C. L_1 and L_2 shine the brightest since L_4 , L_5 and L_6 do not shine at all.
 - D. L_1 and L_2 shine equally bright, but more brightly than L_4 , L_5 and L_6 .
37. Each one of the following particles is released in a uniform electric field in a vacuum. Which one will have the highest speed after travelling 10 mm?
- A. An electron
 - B. A proton
 - C. An alpha-particle (a Helium nucleus)
 - D. A neutron
38. Four 3Ω resistors are connected together in different combinations as shown below. Which one of these will give a total resistance of 5Ω ?

= 3Ω Resistor




39. A cell has an emf E volt and internal resistance $r\Omega$. It is connected to an external resistance $R\Omega$. What is the power dissipated in the external resistance R , if $R = 2r$?

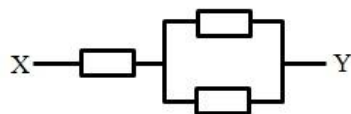
- A. $\frac{E^2}{3R}$ B. $\frac{E}{(R + 2r)}$
 C. $\frac{2E^2}{9r}$ D. $\frac{E^2}{3r}$

40. Two cells (connected in series) of the same emf E , but different internal resistances r_1 and r_2 , are connected in series with an external resistance R . The potential drop across the first cell is found to be zero. The external resistance R is:

- A. $r_1 - r_2$ B. $\frac{r_1}{r_2}$
 C. $r_1 r_2$ D. $r_1 + r_2$

Three $100\ \Omega$ resistors are connected as shown in the figure below. The maximum power that can safely be delivered to any one resistor is $25.0\ W$.

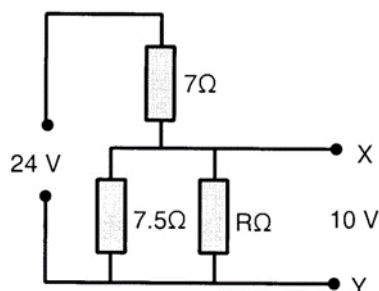
 = $100\ \Omega$ Resistor



Use this information to answer questions 41, 42 and 43.

41. What is the maximum current in the circuit?
- A. $1.00\ A$ B. $0.50\ A$
 C. $0.25\ A$ D. $1.50\ A$
42. What is the equivalent resistance in the circuit?
- A. $300\ \Omega$ B. $100\ \Omega$
 C. $150\ \Omega$ D. $66.7\ \Omega$
43. What is the maximum voltage that can be applied to the terminals X and Y?
- A. $300\ V$ B. $150\ V$
 C. $75.0\ V$ D. $50.0\ V$

The circuit below shows three resistors connected to a $24\ V$ supply with no internal resistance. A voltmeter connected between X and Y reads $10\ V$.



Use this information to answer questions 44 and 45.

44. What is the current through the $7\ \Omega$ resistor?
- A. $0.5\ A$ B. $1.0\ A$
 C. $1.33\ A$ D. $2.0\ A$
45. What is the value of R in Ω ?
- A. 7.5 B. 15
 C. 6.66 D. 13.33
46. A light emitting diode (LED) is connected to a coil as shown below. A bar magnet is moved within the coil to generate an electric current.



Which one of the following actions will make the LED light up? The bar magnet is:

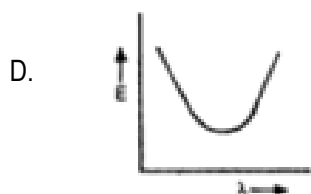
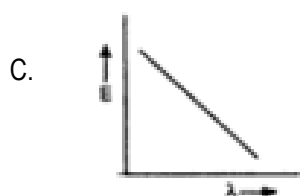
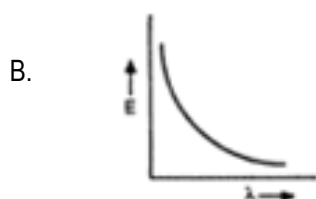
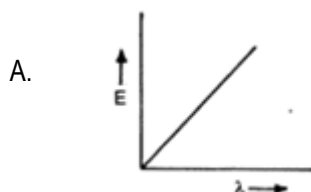
- A. Dropped vertically, N-pole down, through the plane of the coil
 B. Dropped vertically, S-pole down, through the plane of the coil
 C. Rotated horizontally in a clockwise direction in the plane of the coil,
 Rotated horizontally in an anti-clockwise direction in the plane of the coil,
 D. Rotated horizontally in an anti-clockwise direction in the plane of the coil,
47. The shortest wavelength limit of X-rays emitted by an electron of energy $30\ keV$ ($1\ eV = 1.6 \times 10^{-19}\ J$) is:

- A. $4.14 \times 10^{-11} \text{ m}$ B. $1.43 \times 10^{-11} \text{ m}$
 C. $3.14 \times 10^{-10} \text{ m}$ D. $13.4 \times 10^{-10} \text{ m}$

48. A source of light is placed at a distance of 1 m from a photo cell and the cut-off potential is found to be V_0 . If the distance is doubled, the cut-off potential will be:

- A. $2V_0$ B. $\frac{V_0}{2}$
 C. V_0 D. $V_0/4$

49. Which curve represents the correct relation between energy (E) of a photon and its wavelength (λ)?



50. What is the maximum kinetic energy (in eV) of a photoelectron emitted from a surface whose work function is 5 eV when illuminated by a light whose wavelength is 200 nm?

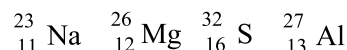
- A. 1.90 B. 1.21
 C. 3.10 D. zero

Chemistry 2017

51. Which electron configuration is most likely to give a stable -3 ion?

- A. $1s^2 2s^2 2p^6$
 B. $1s^2 2s^2 2p^3$
 C. $1s^2 2s^2 2p^6 3s^2$
 D. $1s^2 2s^2 2p^6 3s^2 3p^1$

52. There Consider the atoms represented below:



Which of the above atoms have the same number of neutrons?

- A. Al and S B. S and Mg
 C. Na and Mg D. Mg and Al

53. Atomic radii generally ... from top to bottom in a group and ... from left to right in a period.

- A. increase, decrease
 B. decrease, increase
 C. increase, remain the same
 D. remain the same, decrease

54. An element occurs as two isotopes and the percentage occurrence of one of the isotopes is 60,1% and its atomic mass is 68,9256 amu. If the atomic mass of the second isotope is 70,9247 amu, what is the average atomic mass of the element?

- A. 69,7 amu B. 70,1 amu
 C. 69,9 amu D. 139,9 amu

55. The element with the lowest heat and electrical conductivity of all the metallic elements is:

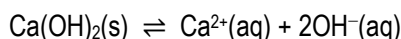
- A. Silver B. Mercury
 C. Tin D. Gold

56. Which one of the following statements about the alkali metals is **FALSE**?
- They all have two valence electrons.
 - They have the lowest first ionisation energies in a period.
 - At room temperature, they are low-density solids.
 - They are highly reactive elements.
57. Which of the following statements is **TRUE**?
- One litre of ice weighs the same as one litre of water.
 - One litre of ice weighs less than one litre of water.
 - One litre of ice weighs more than one litre of water.
 - One litre of ice weighs the same as approximately 1.1 litres of water.
 - One litre of ice weighs the same as approximately 0.91 litres of water
- (i) only
 - (ii) and (v)
 - (iii) and (iv)
 - None of the statements is true.
58. Which one of the following elements has the largest number of allotropes?
- Sulfur
 - Selenium
 - Oxygen
 - Phosphorous
59. Salts of which one of the following elements can be used in fireworks to produce a red (crimson) colour?
- Strontium
 - Barium
 - Potassium
 - Sodium
60. Consider the following substances:
- Diamond
 - Ice
 - SiC
 - SiO₂
- Which of the above is an example of a covalent crystal?
- (i) and (ii)
 - (ii) and (iii)
 - (i), (iii) and (iv)
 - All of the above.
61. The first aluminium alloy to be used in aircraft manufacture was known as Duralumin. This alloy contains 95% aluminium as the major component, but also contains 4% ...
- copper.
 - titanium.
 - gold.
 - vanadium.
62. The first element to be discovered in nature (in tiny amounts) only after it had been produced artificially was:
- Rubidium
 - Actinium
 - Technetium
 - Ruthenium
63. Which one of the following minerals contains mercury?
- Magnetite
 - Cinnabar
 - Bauxite
 - Galena
64. Silicones can be oils or they can be rubber-like materials. This depends on the:
- Oxidation state of silicon in the chain
 - Ratio of silicon to oxygen
 - Chain length and degree of cross-linking
 - Number of carbon atoms present
65. The mineral anorthite has the formula CaAl₂Si₂O₈.
- The percentage by mass of calcium in this mineral is:
- 20,0%
 - 14,4%
 - 28,5%
 - 12,9%
66. A platinum oxide (7,5 g) is heated in a stream of hydrogen gas and produces only two products:
- Pt solid and 1,191 g of H₂O
- The formula of the oxide that was heated is:
- Pt₂O
 - PtO
 - PtO₂
 - Pt₂O₅
67. The poisonous compound strychnine, which has a molecular mass of between 300 and

- 500 g·mol⁻¹, was analysed and found to have the following composition:
- C: 75,42%
N: 8,38%
H: 6,63%
The remainder of the mass is oxygen.
- What is strychnine's molecular formula?
- A. C₂₂H₂₂N₂O₂ B. C₁₀H₁₀NO
C. C₂₀H₂₀N₂O₂ D. C₂₁H₂₂N₂O₂
68. A 12,572 g sample of hydrated magnesium bromide, MgBr₂·xH₂O is completely dried in an oven. When the anhydrous salt is removed from the oven, it has a mass of 7,921 g. The value of x is:
- A. 8 B. 6
C. 4 D. 3
69. The human body is made up largely of water. The ability of humans to regulate their body temperature is greatly assisted by the fact that water has a ...
- A. low melting point.
B. high boiling point.
C. low specific heat.
D. high specific heat.
70. For dimethylamine molecules, (CH₃)₂NH, the predominant intermolecular interaction is:
- A. Ion-dipole forces
B. Dipole-dipole forces
C. Hydrogen bonding
D. London forces
71. Which of the following statements is/are **CORRECT**?
- (i) All ionic compounds dissolve in water.
(ii) All molecular compounds are insoluble in water.
(iii) All ionic compounds that are soluble in water are electrolytes.
(iv) Most ionic compounds containing chloride ions are soluble in water.
- A. (iv) only B. (i) and (ii)
C. (iii) and (iv) D. (ii) and (iii)
72. A chemical reaction that releases heat into the surroundings is an ... reaction and the value of ΔH is ... at constant pressure.
- A. exothermic, positive
B. endothermic, negative
C. endothermic, positive
D. exothermic, negative
73. The reaction Hg₂Cl₂ (s) → Hg + HgCl₂ is an example of a/an:
- A. Combustion reaction
B. Addition reaction
C. Substitution reaction
D. Disproportionation reaction
74. The decomposition of nitroglycerine proceeds as shown in the equation below:
- $$_C_3H_5(NO_3)_3(l) \rightarrow _N_2(g) + _O_2(g) + _CO_2(g) + _H_2O(g)$$
- The respective coefficients when the equation is balanced with the smallest integer values are:
- A. 3, 5, 2, 10, 8 B. 2, 3, 2, 6, 5
C. 4, 6, 1, 12, 10 D. 1, 1, 1, 1, 1
75. Aluminium oxide can be produced according to the following reaction:
- $$4Al + 3O_2 \rightarrow 2Al_2O_3$$
- If 7,5 g of aluminium reacts with 7,5 g of oxygen to produce 10,5 g of aluminium oxide, what is the percentage yield of the reaction?
- A. 100% B. 57%
C. 62% D. 74%
76. Consider the reaction below:
- $$P_4(s) + 6Cl_2(g) \rightarrow 4PCl_3(g)$$
- What is the maximum amount of PCl₃ that can be produced from 5,0 g P₄ and 5,0 g Cl₂?
- A. 9,68 g B. 22,19 g
C. 6,45 g D. 5,41 g
77. Which one of the following is an exothermic process?

- A. Water boiling
- B. Ice melting
- C. Water vapour condensing
- D. Water evaporating

78. Consider the following system at equilibrium:



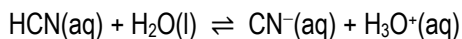
The solubility of $\text{Ca(OH)}_2(\text{s})$ will be **INCREASED** by the addition of:

- A. $\text{HCl}(\text{aq})$
- B. $\text{NaOH}(\text{aq})$
- C. $\text{CaCl}_2(\text{s})$
- D. All of the above.

79. The multi-step industrial process for the production of nitric acid by oxidation of ammonia is known as the ... process.

- A. Haber-Bosch
- B. Ostwald
- C. thermite
- D. Hall-Hérout

80. Consider the reaction represented below:



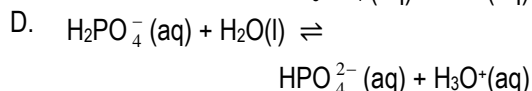
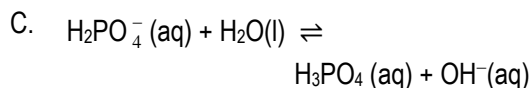
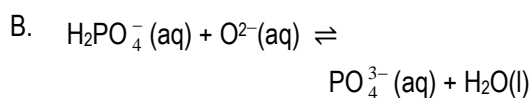
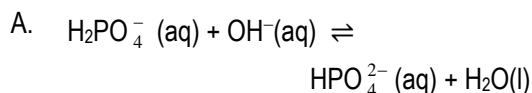
In the above reaction:

- A. H_2O is the acid and HCN is the base.
- B. HCN is the acid and CN^{-} is the conjugate base.
- C. H_3O^{+} is the acid and HCN is the conjugate base.
- D. HCN is the base and CN^{-} is the conjugate acid.

81. Molecules that are able to act either as a Brønsted-Lowry acid or base are called ...:

- A. amphiprotic.
- B. polyprotic.
- C. polyanionic.
- D. hydrophilic.

82. In which one of the following reactions does the dihydrogen phosphate ion act as a base according to the Brønsted-Lowry theory?



83. Element X reacts with hydrogen to produce HX , which when dissolved in water forms an acidic solution. Element X is:

- A. S
- B. N
- C. Mg
- D. Br

84. Which one of the following is the strongest acid?

- A. H_2SO_4
- B. HBr
- C. $\text{H}_2\text{F}[\text{SbF}_6]$
- D. NaHCO_3

85. Hydrochloric acid can be purchased from suppliers as a 33% solution (mass/mass). What mass of this solution contains 12,49 g of HCl ?

- A. 45 g
- B. 38 g
- C. 100 g
- D. 33 g

86. Water can be treated with chlorine to ensure that it is safe to drink.

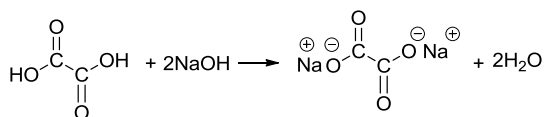
The presence of which active chlorine species is responsible for the important sterilising action of chlorine in water?

- A. Cl^{-}
- B. HClO
- C. HCl
- D. Cl_2

87. The colour change observed during a titration of an acetic acid solution (in conical flask) with a sodium hydroxide solution (in burette) using phenolphthalein as indicator is:

- A. Blue to yellow
- B. Pink to colourless
- C. Red to blue
- D. Colourless to pink

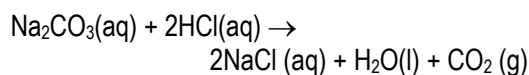
88. Oxalic acid can be neutralised by sodium hydroxide, as shown in the following scheme:



If 51,2 ml of an oxalic acid solution of concentration $0,15 \text{ mol}\cdot\text{l}^{-1}$ is used to neutralise 20 ml of a sodium hydroxide solution, what is the concentration of the sodium hydroxide solution?

- A. $0,547 \text{ mol}\cdot\text{l}^{-1}$ B. $0,384 \text{ mol}\cdot\text{l}^{-1}$
C. $0,768 \text{ mol}\cdot\text{l}^{-1}$ D. $0,200 \text{ mol}\cdot\text{l}^{-1}$

89. In Soda ash (Na_2CO_3) reacts with HCl according to the balanced equation below:



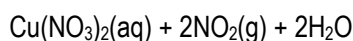
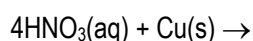
If 0,243 g of impure soda ash reacts with 21,14 ml of a $0,146 \text{ mol}\cdot\text{dm}^{-3}$ HCl solution, what is the percentage purity of the soda ash?

- A. 74,1% B. 49,8%
C. 67,3% D. 100%

90. If 0,617 g of an unknown monoprotic acid HA is neutralised by 42,15 ml of a $0,1055 \text{ mol}\cdot\text{dm}^{-3}$ NaOH solution, what is the molar mass of the unknown acid?

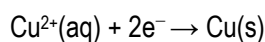
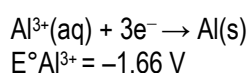
- A. $277,6 \text{ g}\cdot\text{mol}^{-1}$ B. $61,7 \text{ g}\cdot\text{mol}^{-1}$
C. $138,8 \text{ g}\cdot\text{mol}^{-1}$ D. $105,5 \text{ g}\cdot\text{mol}^{-1}$

91. In the reaction below, ... is the reducing agent and ... is the oxidising agent ... is reduced and ... is oxidised.



- A. H_2O ; Cu; Cu; H_2O
B. Cu; HNO_3 ; N; Cu
C. NO_3^- ; Cu; Cu; NO_3^-
D. NO_2 ; Cu^{2+} ; Cu; NO_3^-

92. The following half-reactions take place in a galvanic cell:



$$E^\circ \text{Cu}^{2+} = +0,34 \text{ V}$$

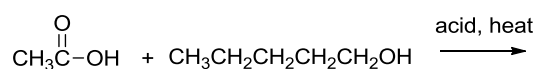
What is the balanced spontaneous cell reaction?

- A. $3\text{Cu}^{2+}(\text{aq}) + 2\text{Al}(\text{s}) \rightarrow 3\text{Cu}(\text{s}) + 2\text{Al}^{3+}(\text{aq})$
B. $2\text{Cu}^{2+}(\text{aq}) + 3\text{Al}(\text{s}) \rightarrow 2\text{Cu}(\text{s}) + 3\text{Al}^{3+}(\text{aq})$
C. $\text{Cu}(\text{s}) + \text{Al}^{3+}(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + \text{Al}(\text{s})$
D. $3\text{Cu}(\text{s}) + 2\text{Al}^{3+}(\text{aq}) \rightarrow 3\text{Cu}^{2+}(\text{aq}) + 2\text{Al}(\text{s})$

93. For the above cell reaction, what is the standard potential of the cell?

- A. $-1,32 \text{ V}$ B. $-2,00 \text{ V}$
C. $2,00 \text{ V}$ D. $1,32 \text{ V}$

Questions 94 and 95 refer to the incomplete chemical equation below.



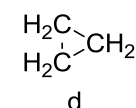
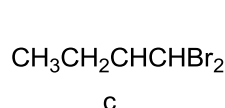
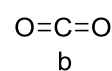
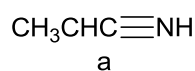
94. The product of the reaction shown is:

- A. pentyl ethanal B. ethyl pentanal
C. ethyl pentanone D. pentyl ethanoate

95. The reaction is an example of:

- A. Combustion B. Saponification
C. Esterification D. Hydrolysis

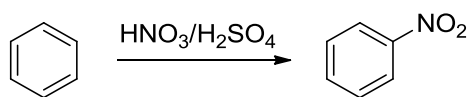
96. Structures of four compounds are shown below:



Which of these structures are possible, keeping in mind the number of bonds that various atoms can form?

- A. a and b B. c and d
C. b and d D. a, b, c and d

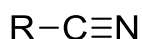
97. Consider the reaction represented below:



This reaction is an example of a(n) ... reaction.

- | | |
|--------------|-----------------|
| A. addition | B. substitution |
| C. oxidation | D. dehydration |

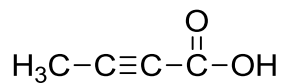
98. Consider a nitrile, RCN :



The $\text{R}-\text{C}-\text{N}$ bond angle in a typical nitrile is:

- | | |
|----------------|----------------|
| A. 180° | B. 120° |
| C. 109° | D. 90° |

99. The molecule below contains ... σ bonds and ... π bonds.



- | | |
|----------|---------|
| A. 8, 3 | B. 9, 3 |
| C. 10, 2 | D. 7, 5 |

100. The Nobel Prize in Chemistry for 2016 was won by Jean-Pierre Sauvage, Sir J. Fraser Stoddart and Bernard L. Feringa for the:

- A. Design and synthesis of molecular machines
- B. Discovery of mechanisms to explain how DNA is repaired
- C. Development of a solar cell
- D. Determining the structure of G-protein coupled receptors

The End

DATA FOR PHYSICS GEGEWENS VIR FISIKA

**TABLE 1: PHYSICAL CONSTANTS
TABEL 1: FISIESE KONSTANTES**

NAME/NAAM	SYMBOL SIMBOOL	VALUE / WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	9,8 m·s ⁻²
Speed of light in a vacuum <i>Spoe van lig in 'n vakuum</i>	c	3,0 x 10 ⁸ m·s ⁻¹
Planck's constant <i>Planck se konstante</i>	h	6,63 x 10 ⁻³⁴ J·s
Coulomb's constant <i>Coulomb se konstante</i>	k	9,0 x 10 ⁹ N·m ² ·C ⁻²
Charge on electron <i>Lading op elektron</i>	e	-1,6 x 10 ⁻¹⁹ C
Electron mass <i>Elektronmassa</i>	m _e	9,11 x 10 ⁻³¹ kg
Permittivity of free space <i>Permittiwiteit van vry ruimte</i>	ε ₀	8,85 x 10 ⁻¹² F·m ⁻¹

**TABLE 2: FORMULAE
TABEL 2: FORMULES**

MOTION/BEWEGING

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE / KRAAG

$F_{\text{net}} = ma$	$p = mv$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER / ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h \frac{c}{\lambda}$
$\sin \theta = \frac{m \lambda}{a}$	$E = W_o + E_k$ where/waar $E = hf$ and/en $W_o = hf_o$ and/en $E_k = \frac{1}{2} mv^2$

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1 Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$U = \frac{kQ_1 Q_2}{r}$	$V = \frac{W}{q}$
$C = \frac{Q}{V}$	$C = \frac{\epsilon_0 A}{d}$

ELECTRIC CIRCUITS / ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (\mathcal{E}) = $I(R + r)$ emk (\mathcal{E}) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I \Delta t$
$W = Vq$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms} I_{rms}$ / $P_{gemiddeld} = V_{wgk} I_{wgk}$ $P_{average} = I_{rms}^2 R$ / $P_{gemiddeld} = I_{wgk}^2 R$ $P_{average} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$
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THE PERIODIC TABLE OF ELEMENTS / DIE PERIODIEKE TABEL VAN ELEMENTE

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 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Al 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cl 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tl 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															
58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175				
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr				

KEY/SLEUTEL

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

