50th NATIONAL SCIENCE OLYMPIAD

PHYSICAL SCIENCE

6 MARCH 2014
12:00 – 15:00

INSTRUCTIONS

Please read the instructions carefully before answering the questions

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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. The student number allocated to you can be obtained from your teacher and consists of eight digits e.g. 08149701.

Do not fold the answer sheets.

Three hours are allowed to answer the questions

The SAASTA Education Unit wishes you the best of luck

National Science Olympiad
Physics 2014

1 Which one of the following has the same SI unit as acceleration?

A $\frac{\text{energy}}{\text{mass}}$ B $\frac{\text{velocity}}{\text{area}}$

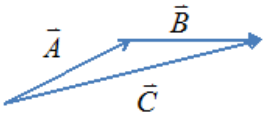
C $\frac{\text{weight}}{\text{mass}}$ D $\frac{\text{force}}{\text{length}}$

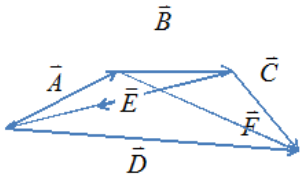
2 Thomas and Mary are doing a vector demonstration. Starting at the door of their physics classroom, they walk 2.0 m south. They then turn and walk 16.0 m west. They turn again and walk 24.0 m north and finally turn and walk 36.0 m, west. What is the magnitude of their overall displacement?

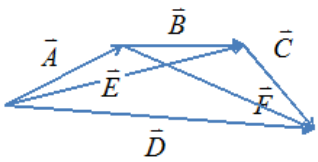
A 56.5 m
B 57.3 m
C 58.1 m
D 29.7 m

3 Consider the three vectors, $\vec{A}$, $\vec{B}$ and $\vec{C}$. These vectors can be shown to obey the laws of vector algebra, e.g. the associative law, $(\vec{A}+\vec{B})+\vec{C}=\vec{A}+(\vec{B}+\vec{C})$.

Which figure below best illustrates this law?

A 

B 

C 

D None of the above, as vectors D, E and F are not given

4 The world record for a high dive into deep water is 54 m. A diver of mass 65 kg dives into the water below him. If air resistance is insignificant, his velocity on entering the water is independent of his:

A Height above the water
B Weight
C Gravitational acceleration
D All of the above

5 A, B, C and D are four points on the same vertical line and are such that AB = BC = CD. If a particle falls freely from rest from point A, the times taken by it to move distances AB, BC and CD are in the ratio of:

A 1 : 3 : 5
B 1 : 4 : 6
C 1 : 4 : 9
D $1:\left(\sqrt{2}-1\right):\left(\sqrt{3}-\sqrt{2}\right)$

6 A boat can row with a speed of 10 km/h in still water. The river flows steadily at 5 km/h. In which direction, **relative** to the **direction** of the flow of the **river**, should the boatman row in order to reach a point on the other bank directly opposite to the point from where he started?

A 30°
B 45°
C 60°
D 120°

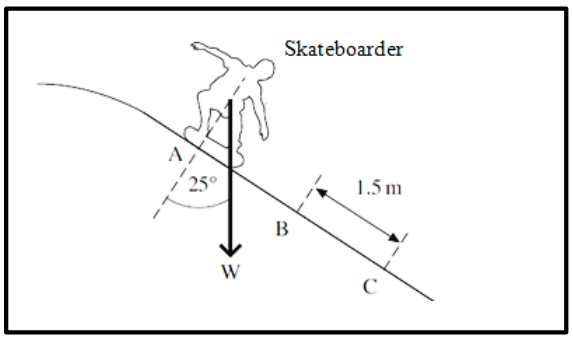
7 A body of mass M is thrown horizontally with a velocity of 60 km/h from the ledge of a tower from a height h. It strikes the level ground a distance of 400 m from the foot of the tower. Next, a body of mass 2M is thrown horizontally with a velocity of 30 km/h from another ledge of the tower, this time from a height 4h. At what distance from the foot of the tower would it strike the level ground?

A 200 m
B 400 m
C 600 m
D 800 m

8 A stone, of mass *m*, is thrown from the top of a cliff *H* metres above a lake at a speed of *u* m.s^{-1}. At what angle must it be thrown so that it hits the water at the maximum speed?

A Straight up
B Straight down
C Horizontally outwards
D The final speed is independent of the angle the stone is thrown.

9 A Skateboarder skates down a slope as shown below.



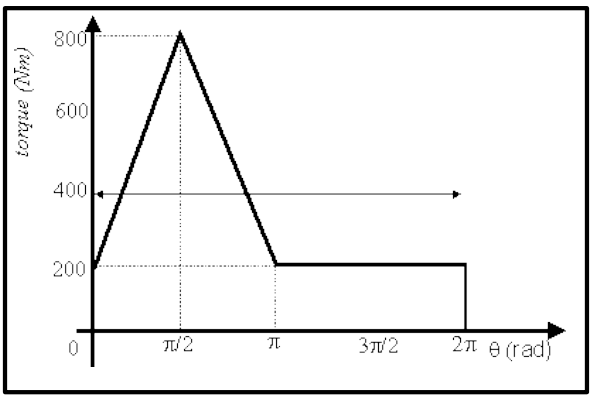
Between B and C his acceleration is constant and he travels the 1.5 m in 0.43 seconds reaching a speed of 5.0 m·s^{-1} at C. What was his speed when he was at B?

A 1.98 m·s^{-1}
B 3 m·s^{-1}
C 3.5 m·s^{-1}
D 3.9 m·s^{-1}

10 It takes a man 10 s to ride down an escalator. The same man takes 15 s to walk back up the escalator against its motion. How long will the man take to walk down the escalator at the same rate he was walking before?

A 2.5 s
B 5 s
C 7.5 s
D 10 s

11 A machine needs a variable torque to operate as shown in the graph below.



The work done per revolution is:

A 300 J
B 400 J
C 450 J
D 2 200 J

12 A train 100 m long travelling at 40 m/s overtakes another train 200 m long travelling at 30 m/s. The time taken by the first train to pass the second train is:

A 30 s
B 40 s
C 50 s
D 60 s

13 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 will be

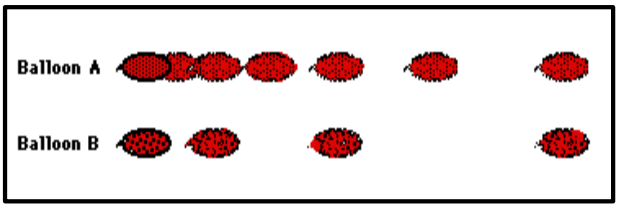
A E
B $E/\sqrt{2}$
C $E/2$
D Zero

14 Under the action of a force, a 2 kg body moves from rest on a smooth horizontal surface such that it reaches a velocity of 1 m·s^{-1} at the end of the first second. It then doubles its velocity each second after that. The work done by the force in the first two seconds is:

A 30 s
B 40 s

C 50 s
D 50 s

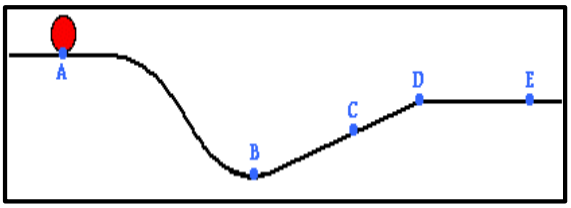
15 In a physics demonstration, two identical balloons (A and B) are propelled across the room on horizontal guide wires. The motion diagrams (depicting the relative position of the balloons at time intervals of 0.05 seconds) for these two balloons are shown below.



Which one of the balloons, A or B, has the greatest impulse?

A Balloon A
B Balloon B
C They have the same impulse.
D Need to know the mass of each balloon to work this out.

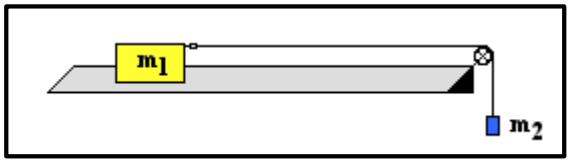
16 Consider the following diagram with a ball passing point A at a constant speed. It then rolls down the slope past B, and then up to C, D and E. Neglect the effect of resistant forces.



The ball's kinetic energy at point C is less than its kinetic energy:

A At point A only
B At points A, D & E
C At point B only
D At points D & E

17 Consider the two-body situation depicted in the accompanying illustration. A 20-g hanging mass (m_2) is attached to a 250-g air track glider (m_1).



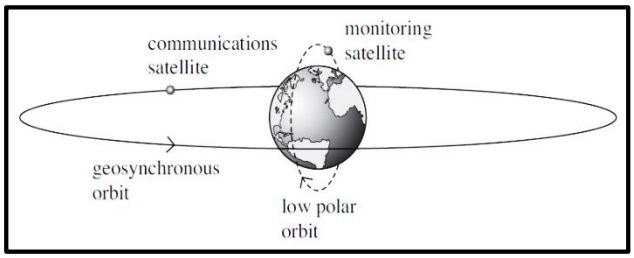
The acceleration of the system is:

A 0.18 m·s^{-2}
B 0.27 m·s^{-2}
C 0.73 m·s^{-2}
D 0.78 m·s^{-2}

18 Two bodies, X and Y, of masses M kg and 2M kg respectively are moving towards each other due to their mutual gravitational attraction. If the velocity of X is *u* and the velocity of Y is *v*, what is the velocity of their centre of mass?

A 0
B ½uv towards X
C ½uv towards Y
D $\sqrt{\frac{2u}{v}}$ towards Y

19 The diagram below shows the orbits of two Earth orbiting satellites: a monitoring satellite in a low polar orbit and a communications satellite in a geosynchronous orbit.



The period, T, of a satellite in a circular orbit around a planet is proportional to $r^{3/2}$, where r is the radius of its orbit measured from the centre of the planet. For a satellite in a low polar orbit, T is 105 minutes when r is 7 370 km. Calculate the height above the surface of the Earth of a satellite in a geosynchronous circular orbit. Radius of the Earth = 6 370 km

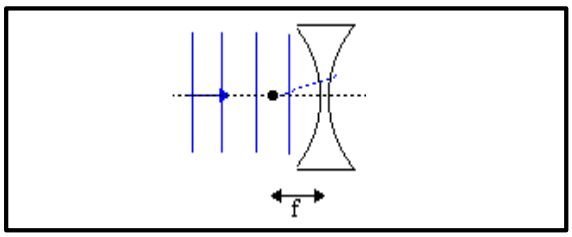
A 13 740 km
B 34 830 km

C 35 830 km
D 42 200 km

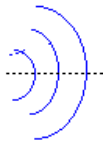
20 Which of the following waves do not exhibit polarization?

A X-rays
B Radio waves
C Sound waves
D Gamma radiation

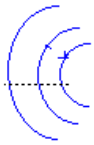
21 The diagram on the right shows plane waves approaching a concave lens. Which one of the following diagrams correctly shows what happens when the plane waves reach the lens? The plane waves will:



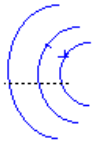
A Pass through the lens and emerge as shown



B Pass through the lens and emerge as shown



C Be reflected off the lens as shown

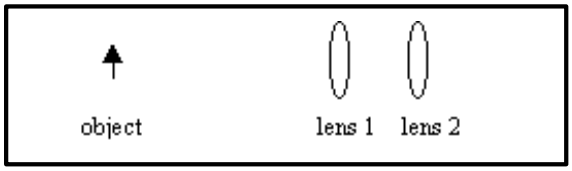


D Pass through the lens and changed as shown

22 Suppose you are standing on the platform of a railway station. As the train approaches the station, it gradually slows down. During this process of slowing down, the driver sounds the horn which emits sound waves at a constant frequency of 300 Hz. Which statement correctly describes the pitch, or changes in pitch, that you will you hear as the train approaches you? It will:

A Remain at 300 Hz
B Remain constant above 300 Hz
C Gradually increase from 300 Hz to above 300 Hz
D Gradually decrease from above 300 Hz to 300 Hz

23 An object is placed 75.0 cm in front of a converging lens of focal length f_1 = 15.0 cm. A second lens of focal length f_2 = 10.0 cm is placed 12 cm from the first lens on the opposite side from the object as shown in the diagram below.



The location of the image produced by these **two** lenses is:

A 32.50 cm beyond lens 1
B 22.50 cm behind lens 2
C 18.75 cm beyond lens 1
D 4.03 cm beyond lens 2

24 A child is blowing bubbles in the sunlight, and as the bubbles drift around in the air they show a wide range of different colours. What effect of light causes these differing colours?

A Reflection
B Diffraction
C Refraction
D Interference

25 Red light passes through a yellow filter, what colour is seen coming out of the filter?

A Orange
B Green
C Red

D Blue

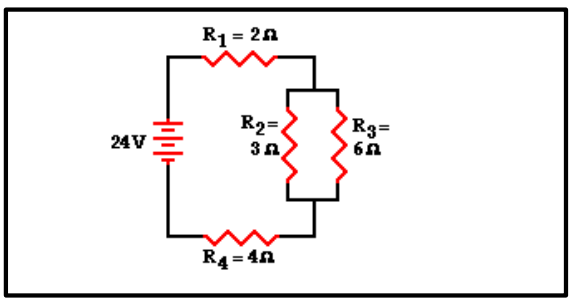
26 A source emits electromagnetic waves of wavelength 3 m with intensity *I*. One beam reaches the observer directly and the other after reflection from a water surface, and so traveling an extra distance of 1.5 m whilst its intensity is reduced to ¼ of the original intensity. The resultant intensity as seen by the observer is:

A ¼*I*
B ¾*I*
C $\frac{5}{4}I$
D $\frac{9}{4}I$

27 Three charges are placed along the X-axis. Charge A is a +18 nC charge placed at the origin, 0 cm mark. Charge B is a – 27 nC charge placed at the 60 cm mark. Where along the axis must a negative charge C be placed in order to be in equilibrium? At the:

A 2.67 cm mark
B 0.27 cm mark
C – 0.27 cm mark
D – 6.27 cm mark

28 The power dissipated in the 4Ω resistor, R_4, in the accompanying diagram, in watts (W), is



A 24
B 36
C 48
D 96

29 The older unit for magnetic strength is:

A Tesla
B Oersted
C Gauss
D Henry

30 At what frequency is AC generated by Eskom in South Africa?

A 120 Hz
B 110 Hz
C 60 Hz
D 50 Hz

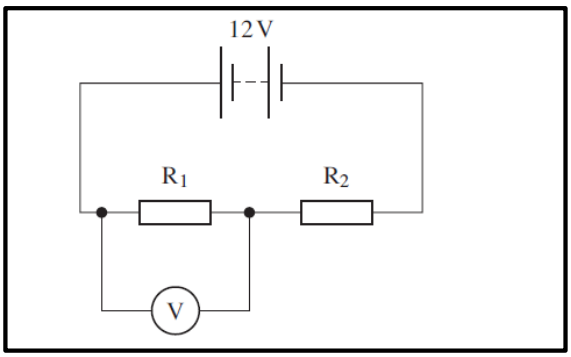
31 Which one of the following expressions will have the dimensions of time? Here L is inductance, R is resistance and C is capacitance.

A LC B R/L
C L/R D C/L

32 Which one of the following statements is correct?

A Inductance is a measure of the generated emf for a unit change in current
B A capacitor blocks the flow of DC and low frequency AC
C An inductor blocks high frequency AC, but passes low frequency AC and DC
D All of the above are correct.

33 In the circuit shown below, R_2 is replaced with a thermistor. How will the reading on the voltmeter be affected if the temperature of the thermistor increases.



A Increases
B Decreases
C Stays the same
D The reading drops to 0, as thermistors are not conductors.

34 A beam of electrons was produced from a heated filament and accelerated towards an anode. When the potential difference between the anode and the filament was 4200V, the speed of the electrons in the beam was $3.9 \times 10^7 ms^{-1}$. From this information, the value of the charge/mass $\left(\frac{e}{m}\right)$ ratio for the electron is:

A 1.9×10^{-19} C/kg
B 9.3×10^{4} C/kg
C 1.8×10^{11} C/kg
D 1.8×10^{-11} C/kg

35 Four (4) condensers each of capacity 8 μF are connected in parallel and then in series. The ratio of their equivalent capacities in two cases will be:

A 1/16 B 8
C 16 D 32

36 A flash of lightning discharged 60 C of charge at a potential difference of 10^9 V in 10^{-2} seconds. The current is:

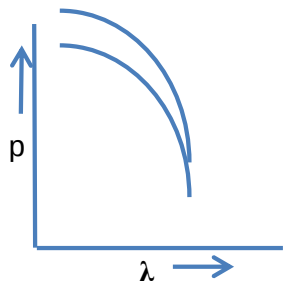
A 6 A B 36 A
C 6 000 A D 36 000 A

37 A galvanometer has a resistance of 3 663 Ω. A shunt S is connected across it such that (1/34) of the total current passes through the galvanometer. The resistance of the shunt is:

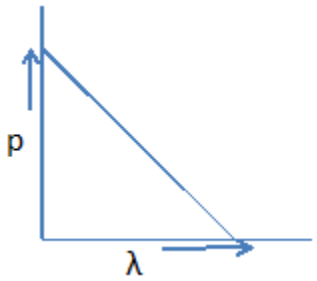
A 3 663 Ω B 111 Ω
C 107.7 Ω D 3 555 Ω

38 Which of the following graphs correctly represents the variation of momentum, p, of a particle and its de Broglie wavelength, λ?

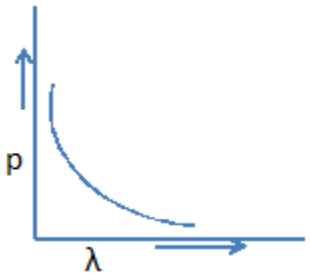
A



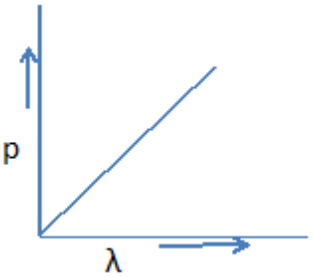
B



C



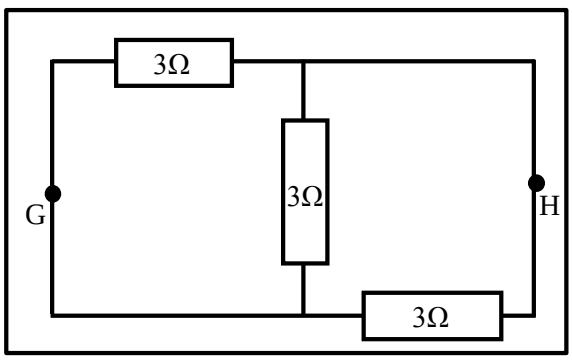
D



39 The RMS value of alternating current which produces heat in a given resistor at twice the rate as a direct current of 3A is in amperes:

A 1.5
B √6
C 2√3
D 3√2

40 The diagram below shows a circuit containing three resistors of 3 Ω each.



The resistance between points G and H is:

A 2/3 Ω B 1 Ω
C 3/2 Ω D 9 Ω

41 The cores used in transformers and other electromotive devices are laminated because it:

A increases the magnetic field
B increases the magnetic saturation level of the core
C decreases the residual magnetism of the core
D decreases the eddy-currents in the core

42 A transformer has 100 turns in the primary coil and 2 000 turns in the secondary coil. If an alternating potential difference of 12 V is applied across the primary, the potential difference across the secondary will be:

A 6 V
B 240 V
C 480 V
D 2 400 V

43 Three resistors, X, Y and Z are connected in parallel, with the resistance of X < Y < Z. The value of the equivalent resistance R of the parallel combination is:

A R > Z

B $R = \frac{1}{X} + \frac{1}{Y} + \frac{1}{Z}$

C R < X

D $R = \frac{X + Y + Z}{XYZ}$

44 If E is the emf of a cell, n the number of cells, r the internal resistance of each cell and R an external resistance, then the current, I, in a circuit where these components are connected in `series is:

A $\frac{nE}{(R + nr)}$

B $\frac{nE}{(R + r)}$

C $\frac{E}{(R + r)}$

D $\frac{E}{(R + nr)}$

45 What is another name for the Helium nucleus?

A Proton
B Neutron
C beta particle
D alpha particle

46 Radiation of frequency 10^{15} Hz shines on the surface of a metal whose work function is 1 eV (1.6×10^{-19} J). The retarding potential which just prevents the ejection of photo-electrons is:

A 1 V
B 3 V
C 3.84 V
D 5 V

47 Beta decay can occur when a neutron in a radioactive nucleus splits into a proton and an electron. What else is emitted in this process?

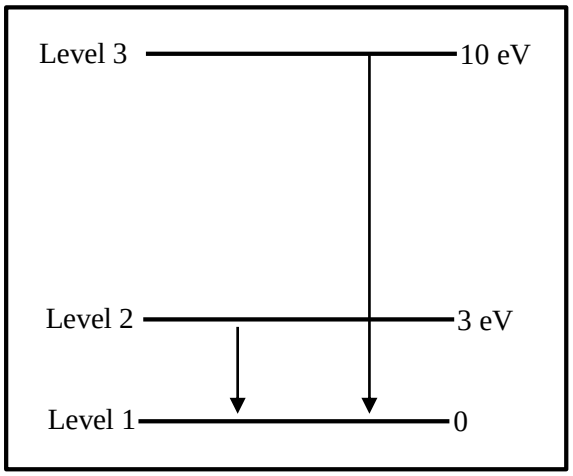
A Only a photon
B Only a neutrino
C A neutrino and a photon
D An anti-neutrino and a photon

48 The age of wood can be found by comparing the amount of carbon-14 a sample contains to the amount of carbon-14 in a fresh piece of wood. Such a piece of wood contains 8 times the amount of carbon-14 as a sample from an ancient campfire. How many years ago was the campfire burning if the half-life of carbon-14 is 5 600 years?

A 44 800
B 22 400
C 16 800

D 11 200

49 The diagram below shows three of the energy levels of an atom. A transition from level 2 to level 1 results in the emission of a photon of blue light. A transition from level 3 to level 1 could result in the emission of a photon of :



A γ-radiation
B X-rays
C ultra-violet light
D red light

50 For a "p" electron (quantum number *l* = 1) the possible values of the magnetic quantum numbers *m* are:

A –1, 0
B 0, +1
C –1, +1
D –1, 0, +1

Chemistry 2014

51. An element appearing in the top right hand corner of the periodic table will definitely be a

A metal.
B non-metal.
C metalloid.
D liquid.

52. Which electronic configuration is most likely to give a stable +1 ion?

A $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
B $1s^2 2s^2 2p^6 3s^2 3p^5$
C $1s^2 2s^2 2p^6 3s^2 3p^4$
D None of the above

53. The Heisenberg Uncertainty Principle states that it is not possible to know precisely both the momentum and the … of an electron.

A position
B velocity
C mass
D charge

54 Atoms of a particular element all have the same:

A Number of neutrons
B. Number of protons
C. Atomic mass
D. Number of protons and neutrons

55. There are… electrons, … protons and … neutrons in the ion $^{90}_{38}Sr^{2+}$.

A 36; 38; 52
B 38; 38; 90
C 38; 38; 52
D 36; 38; 90

56. Chlorine occurs naturally as two isotopes: ^{35}Cl and ^{37}Cl.

The atomic mass of ^{35}Cl is 34.969, whilst that of ^{37}Cl is 36.966. If 75.8% of chlorine occurs as ^{35}Cl and 24.2% occurs as ^{37}Cl, what is the average atomic mass of chlorine?

A 71.94
B 72.00
C 35.55
D 35.46

57. The SI unit for radioactivity is:

A Gray
B Rad
C Becquerel
D Curie

58. Gold and many platinum group metals are found in nature in metallic rather than ionic form. The reason for this is:

A They are not soluble in water.
B They are rather inert.
C They are rather reactive.
D They cannot exist in their ionic form.

59. 9. A metal is likely to have a:

A High first ionisation energy and a high electronegativity.
B Low first ionisation energy and a low electronegativity.
C High first ionisation energy and a low electronegativity.
D Low first ionisation energy and a high electronegativity.

60. Carbon and silicon are in the same group of the periodic table. Carbon forms different allotropes such as graphite. Silicon …

A does not form allotropes like those of carbon because of its high electronegativity.
B readily forms allotropes like those of carbon because of its high electronegativity.
C does not form allotropes like those of carbon because of its large size.
D readily forms allotropes similar to those of carbon because of its large size.

61. Which one of the following does not occur as a diatomic molecule in its elemental form?

A Sulphur
B Nitrogen
C Oxygen
D Bromine

62. Which one of the following is the most abundant element in the universe?

A Hydrogen
B Nitrogen
C Helium
D Oxygen

63. The most abundant element in the human body by mass is:

A Hydrogen
B Oxygen
C Carbon
D Nitrogen

64. In order for a compound to be classified as a peroxide, it must have:

A A ring in the structure
B An oxygen-oxygen bond
C An oxygen-hydrogen bond
D A minimum of 5 oxygen atoms

65. The transition metal titanium is found in the mineral:

A Molybdenite
B Rutile
C Cinnabar
D Magnetite

66. Iron pyrite, also known as fool's gold, has a pale yellow shiny appearance that amateurs may confuse with gold. This mineral has the formula:

A FeCl
B FeS_2
C Fe_2S
D $FeSO_4$

67. Cubic zirconia is used as a cheaper alternative to diamonds in jewellery manufacture. Cubic zirconia has the formula:

A ZrS_2
B ZrO_2
C $ZrSiO_4$
D CuZr

68. Emeralds are precious gemstones that are made of:

A $Al_2(SO_4)_3$
B $CaSO_4$

C Al_2O_3
D $Be_3Al_2(SiO_3)_6$

69. Perspex, the transparent material that resembles glass is an example of:

A A peptide
B A synthetic polymer
C Natural rubber
D A polypeptide

70. Which of the following statements about alloys is true?

A An alloy is a mixture of two or more non-metals.
B Brass is an alloy of copper and zinc.
C An alloy contains a mixture of isotopes of the same element.
D An alloy is always water-soluble.

71. The shape of a molecule of carbon tetrachloride (CCl_4) can be described as:

A Trigonal planar
B Tetrahedral
C Octahedral
D Pyramidal

72. Which of the following compounds is not ionic in nature?

A SiO_2
B NaCl
C Na_2SO_4
D KI

73. Colloidal systems are made up of a dispersed phase and a dispersing medium. Margarine is an example of a(n) …

A. water-in-oil emulsion.
B oil-in-water emulsion.
C oil-in-water suspension.
D solid-in-solid emulsion.

74. The process where a solid is directly converted into a gas without going through a liquid phase is called …

A distillation.
B condensation.
C sublimation.
D deposition.

75. A ball has a mass of 19.66 g. This ball will sink in liquid mercury (density = 13.6 $g \cdot cm^{-3}$) if it has a volume of less than … cm^3.

A 0.692
B 1.51
C 1.44
D 14.5

76. Which one of the following is the definition of molarity?

A Moles of solute per kilogram of solvent
B Moles of solute per litre of solvent
C Molar mass of solute per gram of solvent
D Mass of solute in grams per kilogram of solvent

77. Considering 4.965 mol of each of the following compounds, which one contains the largest number of atoms?

A H_2SO_4
B $C_{12}H_{14}N_2O_2$
C $NH_4Al(SO_4)_2$
D $Be_3Al_2(SiO_3)_6$

78. The percentage by mass of calcium in $Ca(H_2PO_4)_2$ is:

A 17.1%
B 34.2%
C 0.05%
D 0.17%

79. A beaker contains 23 ml of ethanol (CH_3CH_2OH). How many molecules of ethanol are present in the beaker? [The density of ethanol is 0.79 $g \cdot ml^{-1}$]

A 7.90×10^{23}
B 3.01×10^{23}
C 2.37×10^{23}
D 6.02×10^{23}

80. Sodium azide decomposes according to the following equation:

$2NaN_3\ (s) \rightarrow 2Na\ (s) + 3N_2\ (g)$

In which everyday process is this reaction used?

A Inflation of vehicle air bags in the case of collisions.
B Striking of a match to produce a flame.
C The reaction taking place inside a fluorescent bulb.
D Combustion in a car engine.

81. Industrially, ammonia is produced by reaction of nitrogen and hydrogen in the Haber process:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

How many moles of hydrogen need to react to produce 0.59 mol of NH_3?

A 0.443
B 0.590
C 0.885
D 1.77

82. Aluminium sulphate can be prepared using the following reaction:

$2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$

What is the maximum amount of $Al_2(SO_4)_3$ that can be made starting from 56 g of $Al(OH)_3$ and 85 g of H_2SO_4?

A 99 g
B 246 g
C 297 g
D 123 g

83. Lactic acid (M = 90 $g \cdot mol^{-1}$), the compound that gives milk a sour taste, was analysed and found to have the composition: 40.00% C, 53.29% O and 6.71% H. What is its molecular formula?

A $C_2H_4O_2$
B CH_2O
C $C_3H_6O_3$
D $C_4H_{10}O_2$

84. What does the vertical arrow represent in the following equation?

$CaCO_3 \rightarrow CaO + CO_2\uparrow$

A This is the compound that increases the pH of the solution.
B This means the reaction is exothermic.
C This compound precipitates out of solution.
D This compound is produced as a gas.

85. Consider the reaction

$2NO\ (g) + O_2\ (g) \rightleftharpoons 2NO_2\ (g)$
$\Delta H = -114$ kJ

An increase the temperature will:

A Favour the reverse reaction according Le Chatelier's principle
B Favour the forward reaction according to Le Chatelier's principle
C Favour the reverse reaction according Boyle's law
D Favour the forward reaction according to Boyle's law

86. Consider the reaction

$H^-(aq) + H_2O(l) \rightarrow H_2(g) + OH^-(aq)$

Which one of the following is true for the above reaction?

A $H^-(aq)$ acts as an acid.

B H^- is a weaker base than OH^-(aq).

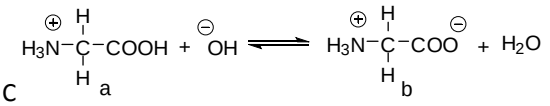
C H^-(aq) is a stronger base OH^-(aq).

D H_2O(l) acts as a base.

87. Using the Brønsted-Lowry definition, which one of the following reactions is not an acid-base reaction?

A $HCl + NaOH \rightarrow NaCl + H_2O$

B $HCN + H_2O \rightleftharpoons CN^- + H_3O^+$

C 

D $NH_3 + BCl_3 \rightarrow NH_3BCl_3$

88. What volume of a 0.53 M NaOH solution is needed to neutralise 37 ml of a 0.33 M H_2SO_4 solution according to the following reaction:

$2NaOH\ (aq) + H_2SO_4\ (aq) \rightarrow$
$Na_2SO_4\ (aq) + 2H_2O$

A 12.3 ml

B 23.0 ml

C 46.1 ml

D 460.0 ml

89. Acid rain resulting from pollution causes damage to wild life and corrodes buildings and infrastructure. The main contributing pollutant to acid rain is:

A NaCl

B $CaCO_3$

C MnO_2

D SO_2

90. The following equation shows the neutralisation reaction of arsenic acid with potassium hydroxide:

$H_3AsO_4 + 3KOH \rightarrow K_3AsO_4 + 3H_2O$

If 25 ml of an arsenic acid solution of concentration 0.32 $mol \cdot l^{-1}$ neutralises 35 ml of a potassium hydroxide solution, the concentration of the potassium hydroxide solution is:

A 0.229 $mol \cdot l^{-1}$

B 0.686 $mol \cdot l^{-1}$

C 0.457 $mol \cdot l^{-1}$

D 6.86 $mol \cdot l^{-1}$

91. Portland cement is made by initially heating limestone, sand and clay together. When water and additional sand are added, concrete is formed. The chemical composition of this cement is largely:

A $Al_2(SO_4)_3$ and $(CaSO_4)_2$

B Ca_2SiO_4 and $Ca_3Al_2O_6$

C $CuSO_4$ and $MgSO_4$

D $Fe(OH)_3$ and $Ca(OH)_2$

92. Consider the reaction below:

$4HNO_3\ (aq) + Cu\ (s) \rightarrow$
$Cu(NO_3)_2\ (aq) + 2NO_2\ (g) + H_2O$

In this reaction, … is the reducing agent and … is the oxidising agent. … is reduced and … is oxidised.

A HNO_3; Cu; Cu; N

B Cu; HNO_3; N; Cu

C Cu; HNO_3; Cu; N

D None of the above, as this is not a redox reaction.

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

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
$E°reduction^- = +1.33\ V$

$I_2 + 2e^- \rightarrow 2I^-$
$E°\ reduction^- = +0.54\ V$

Which one of the following is the balanced spontaneous cell reaction?

A $Cr_2O_7^{2-} + 14H^+ + 2I^- \rightarrow$
$2Cr^{3+} + I_2 + 7H_2O$

B $3I_2 + 2Cr^{3+} + 7H_2O \rightarrow Cr_2O_7^{2-} + 14H^+ + 6I^-$

C $3I_2 + Cr_2O_7^{2-} + 14H^+ \rightarrow 6I^- + 2Cr^{3+} + 7H_2O$

D $Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$

94. For the galvanic cell based on the cell reaction in QUESTION 43, the standard cell potential is:

A 0.29 V
B -0.79 V
C 0.79 V
D 1.87 V

95. Which of the following are both **always** unsaturated organic compounds?

A Carboxylic acids and alkenes
B Esters and alcohols
C Amides and thiols
D Alkynes and amines

96. Which one of the following reactions represents the process used in the petroleum industry known as cracking?

A $CH_3CH_2CH_2CH_3 \rightarrow CH_3CH_3 + CH_2{=}CH_2$

B $C_6H_2O_6 \rightarrow CH_3COCOOH \rightarrow CH_3CH_2OH$

C $CH_3CH_2OH \rightarrow CH_3CHO \rightarrow CH_3COOH$

D None of the above

97. The Nobel Prize in Chemistry for 2013 was won by Martin Karplus, Michael Levitt (born in South Africa) and Arieh Warshel for:

A Prostaglandin synthesis
B Ultraviolet spectroscopy
C Developing models for complex chemical systems
D Structural elucidation of taxol

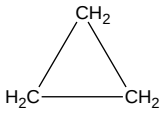
98. Consider the following statements about alcohols:

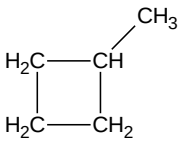
(i) *Alcohols generally have a higher boiling point than the corresponding alkanes.*
(ii) Alcohols contain an –OH group.
(iii) Alcohols cannot participate in hydrogen bonding.
(iv) Alcohols react with carboxylic acids to give aldehydes.

Which of the above statements are true?

A (ii) and (iv)
B (ii) and (iii)
C (i) and (ii)
D (i), (ii), (iii) and (iv)

99. Consider the structures of four organic compounds below:

(i) $CH_3CH{=}CHCH_2CH_3$
(ii) $CH_3CH_2BrCH_2CH_3$
(iii) 

(iv) 

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

A (ii) en (iii)
B (i) en (ii)
C (ii) en (iv)
D (iii) en (iv)

100. Penicillin antibiotics contain a distinctive structural feature. This feature is:

A An α-hydroxyketone
B A β-ketonitrile
C A δ-lactone ring
D A β-lactam ring

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 *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	8,85 x 10^{-12} $F \cdot m^{-1}$

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 / *KRAG*

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

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*** $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ **or/*of*** $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ **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*** $W_0 = hf_0$ **and/*en*** $E_k = \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$U = \frac{kQ_1Q_2}{r}$	$V = \frac{W}{q}$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$

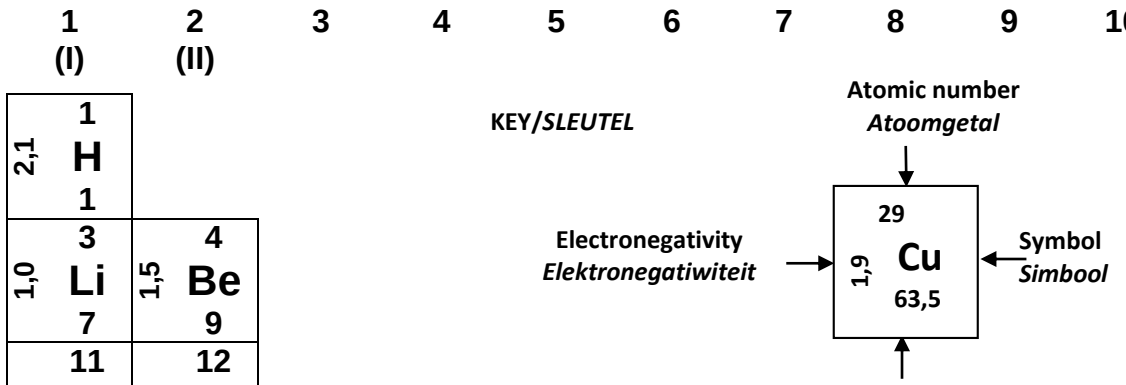
ELECTRIC CIRCUITS / *ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms} I_{rms}$ / $P_{gemiddeld} = V_{wgk} I_{wgk}$ $P_{average} = I^2_{rms} R$ / $P_{gemiddeld} = I^2_{wgk} R$ $P_{average} = \frac{V^2_{rms}}{R}$ / $P_{gemiddeld} = \frac{V^2_{wgk}}{R}$

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)
2,1 **1 H 1**																	**2 He 4**
1,0 **3 Li 7**	1,5 **4 Be 9**											2,0 **5 B 11**	2,5 **6 C 12**	3,0 **7 N 14**	3,5 **8 O 16**	4,0 **9 F 19**	**10 Ne 20**
0,9 **11 Na 23**	1,2 **12 Mg 24**											1,5 **13 Aℓ 27**	1,8 **14 Si 28**	2,1 **15 P 31**	2,5 **16 S 32**	3,0 **17 Cℓ 35,5**	**18 Ar 40**
0,8 **19 K 39**	1,0 **20 Ca 40**	1,3 **21 Sc 45**	1,5 **22 Ti 48**	1,6 **23 V 51**	1,6 **24 Cr 52**	1,5 **25 Mn 55**	1,8 **26 Fe 56**	1,8 **27 Co 59**	1,8 **28 Ni 59**	1,9 **29 Cu 63,5**	1,6 **30 Zn 65**	1,6 **31 Ga 70**	1,8 **32 Ge 73**	2,0 **33 As 75**	2,4 **34 Se 79**	2,8 **35 Br 80**	**36 Kr 84**
0,8 **37 Rb 86**	1,0 **38 Sr 88**	1,2 **39 Y 89**	1,4 **40 Zr 91**	**41 Nb 92**	1,8 **42 Mo 96**	1,9 **43 Tc**	2,2 **44 Ru 101**	2,2 **45 Rh 103**	2,2 **46 Pd 106**	1,9 **47 Ag 108**	1,7 **48 Cd 112**	1,7 **49 In 115**	1,8 **50 Sn 119**	1,9 **51 Sb 122**	2,1 **52 Te 128**	2,5 **53 I 127**	**54 Xe 131**
0,7 **55 Cs 133**	0,9 **56 Ba 137**	**57 La 139**	1,6 **72 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**	1,8 **81 Tℓ 204**	1,8 **82 Pb 207**	1,9 **83 Bi 209**	2,0 **84 Po**	2,5 **85 At**	**86 Rn**
0,7 **87 Fr**	0,9 **88 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**