51st NATIONAL SCIENCE OLYMPIAD

PHYSICAL SCIENCE

5 MARCH 2015
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 2015

1. Which one of the following is a unit of power?

   A. kWh B. J
   C. Nm D. W

2. If the velocity of an object changes, we can be certain that:

   A. A single force acted on the object
   B. A net external force acted on the object
   C. The momentum of the object has been conserved
   D. The direction of the object must have changed

3. The law which best explains why momentum is conserved in a collision is:

   A. Newton's 1st Law
   B. Newton's 2nd Law
   C. Newton's 3rd Law
   D. Newton's Law of Universal Gravitation

4. A cup of hot tea placed on a metallic table loses heat by

   A. Conduction only
   B. Radiation and evaporation only
   C. Convection only
   D. All of the above

Questions 5 and 6 refer to the following situation. A police car is parked at the side of a highway with its engine running. A car speeds past the police car at 30 $m.s^{-1}$. The police immediately give chase, moving with a constant acceleration, until they catch the speeding car after 50 seconds. The speeding car maintains a constant speed of 30 $m.s^{-1}$ throughout the chase.

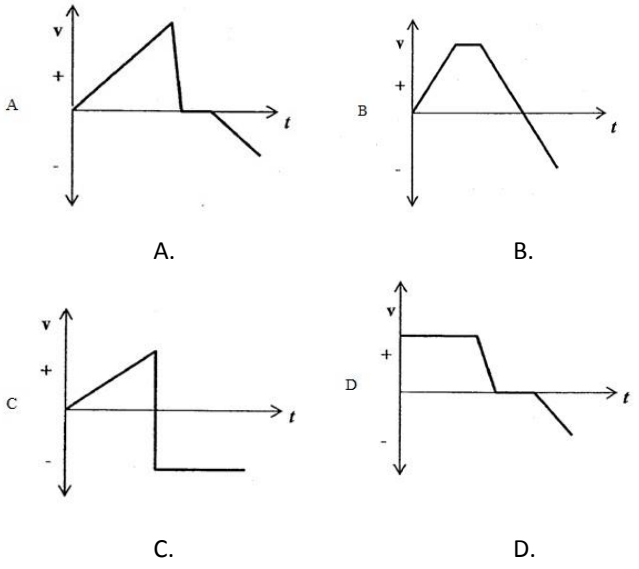
5. The speed of the police car at the instant it reaches the speeding car is:

   A. 15 $m.s^{-1}$ B. 50 $m.s^{-1}$
   C. 25 $m.s^{-1}$ D. 60 $m.s^{-1}$

6. The acceleration of the police car is:

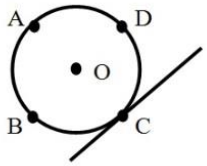
   A. 1.2 $m.s^{-2}$ B. 1.5 $m.s^{-2}$
   C. 12 $m.s^{-2}$ D. 15 $m.s^{-2}$

7. A car began accelerating from rest and then stopped quickly. After waiting a short time, it then moved off again in the opposite direction. Which velocity – time graph best describes the motion of the car?

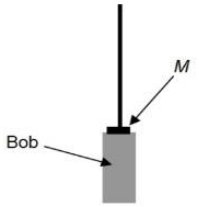


A. B. C. D.

8. A hoop is rolling down a slope as shown in the accompanying diagram. The points A, B and D are marks on the hoop, O is the axle and C is where the hoop touches the ground. Which one of the points, A, B, C or D, does not change speed as the hoop rolls down the slope?

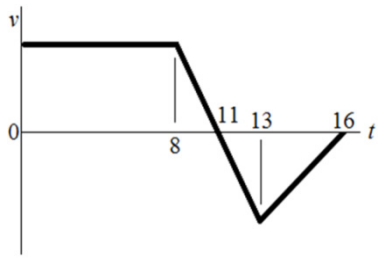


9. The diagram below shows a pendulum which is used to regulate a clock. The clock is running slow, so a physicist works out that if she were to place a ring with a pre-calculated mass M on the bob as shown, the clock would keep good time again. Which one of the following statements is true?



A. It wouldn't work as the bob would then be heavier and the clock would slow even more.
B. Adding the mass would make no difference since the period of a pendulum is independent of the mass of the bob.
C. It wouldn't work as the only way to change the period of the pendulum is to change the length of the pendulum shaft.
D. By placing the ring on the bob, the effective length of the pendulum is shortened, and so decreases the period allowing the clock to keep proper time.

10. In which interval on the following graph is the object speeding up?



A. 8 s – 11 s
B. 8 s – 13 s
C. 11 s – 13 s
D. 13 s – 16 s

11. A stone is thrown vertically upwards with a velocity of 29.4 $m.s^{-1}$ from the edge of a cliff 78.4 m high. The stone falls so that it just misses the edge of the cliff and hits the ground at the foot of the cliff. The time taken by the stone to reach the ground is: (assume the acceleration due to gravity, $g = 9.8\ m.s^{-2}$.)

A. 2 s
B. 8 s
C. 14.7 s
D. 88.2 s

12. A vehicle of mass 1 000 kg increases its velocity from 5 $m.s^{-1}$ to 10 $m.s^{-1}$ in 15 seconds. The increase in kinetic energy is:

A. 75 000 J
B. 37 500 J
C. 5 000 J
D. 2 500 J

13. The combined frictional force and air resistance on a cyclist has force F = kv, where v is the velocity and k is a constant of value 4 $N(m.s)^{-1}$. The maximum power the cyclist can generate is 600 W. What is the cyclist's maximum speed on a level road?

A. 12.2 $m.s^{-1}$
B. 6.12 $m.s^{-1}$
C. 17.3 $m.s^{-1}$
D. Unable to calculate unless the air resistance is known.

14. A vehicle of mass 800 kg is moving at 8 $m.s^{-1}$ is brought to rest in a distance of 40 m. The force exerted on the vehicle to do this is:

A. 6 400 N opposite to the direction of motion.
B. 640 N opposite to the direction of motion
C. 640 N in the direction of motion
D. 1 288 N opposite to the direction of motion

15. A soccer ball of mass 0.42 kg is moving horizontally at 10 $m.s^{-1}$ towards a footballer's boot, who kicks it and it returns along the same path as before. If the impulse on the ball is 11 Ns, what is its speed, in $m.s^{-1}$, afterwards?

A. 2.62
B. 6.8
C. 15.2
D. 16.2

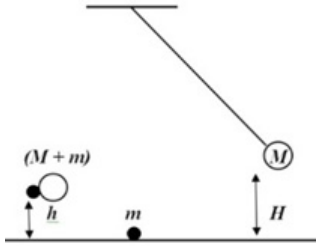
16. A 1 200kg car is travelling east along a curve at a constant speed of 20 $m.s^{-1}$. What is the magnitude of the change of velocity when it is travelling south? The radius of the curve is 30 m, and it takes 2.4 s to move around the curve.

A. 16.7 $m.s^{-1}$
B. 19.6 $m.s^{-1}$
C. 28.3 $m.s^{-1}$
D. 333 $m.s^{-1}$

17. Two cars have an inelastic collision at a T-junction. Before the collision car A of mass 500 kg was moving west at 20 $m.s^{-1}$ and car B of mass 650 kg was moving north at 25 $m.s^{-1}$. The total momentum of the cars after the collision is:

A. 1×10^4 Ns S31.6°E
B. 1.625×10^4 Ns N58.4°W
C. 1.908×10^4 Ns N31.6°W
D. 1.908×10^4 Ns S58.4°E

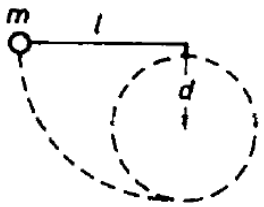
18. A pendulum with a bob of mass M is raised to a height H and released. At the bottom of its swing, it picks up a piece of putty with mass m. The combination (M + m) will rise height h equal to



A. $H\left(\frac{M}{M+m}\right)^2$ B. $2H\left(\frac{M}{M+m}\right)^2$

C. $H\left(\frac{M}{M+m}\right)$ D. $H\left(\frac{m}{M}\right)^2$

19. A pendulum of mass *m* and length *l* is released from rest in a horizontal position. A nail a distance d below the pivot causes the mass to move along the path indicated by the dotted line. Find the minimum distance d in terms of *l* such that the mass will swing completely round in the circle shown below.



A. 2l B. 3l

C. $\frac{3l}{5}$ D. $\frac{2l}{5}$

20. If a body of mass m has momentum ***P*** then its kinetic energy E is:

A. $\frac{P^2}{2m}$ B. $\frac{2P^2}{m}$

C. $\frac{mP^2}{2}$ D. $2mP^2$

21. The amount of work you have to do against gravity to push your car on a level road

A. depends on the local value of the acceleration due to gravity
B. is zero
C. depends on the mass of the car
D. depends on the force you apply

22. Two projectiles are launched simultaneously with the same initial speed and position and in the same vertical plane. One is launched at 70° to the horizontal, and the other at 20° to the horizontal. If the air resistance is neglected then which of the following statements are true?

(i) The projectiles will land at the same point.
(ii) The projectile launched at 20° to the horizontal will land first.
(iii) The projectiles will land at the same time.

A. Only (ii) B. (i) and (ii)
C. (i) and (iii) D. Only (i)

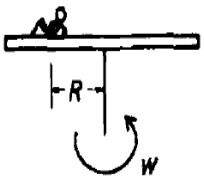
23. A particle is projected vertically upwards at a speed u. It is at a height h after time t and again after time T. The speed u is:

A. g (t + T) B. ½ g (t – T)
C. ½ g (t + T) D. 2g (T – t)

24. A car of mass 3600 kg is travelling in a circular path of radius 10 m at a speed of 30 km/h. What is the sideways force needed to keep the car moving in a horizontal circular path?

A. 0 N B. 10 800 N
C. 24 800 N D. 32 400 N

25. In an amusement park there is a rotating horizontal disk. A child can sit on it at any radius, see figure. As the disk begins to "speed-up" the child may slide off the disk if the frictional force is not enough. The mass of the child is 50 kg and the coefficient of friction is 0.4. What is the maximum radius R where the child can sit and still remain on the disk, when the angular velocity is 2 rad/s?



A. 0.98 m
B. 1.96 m
C. 7.84 m
D. 15.68 m

26. An astronaut in his space suit weighs 1 500 N on Earth. With the data given below, calculate the weight of the astronaut on the Moon. Mass of Moon = 0.0123 that of Earth Radius of Moon = 0.273 that of Earth.

A. 18.4 N
B. 50.4 N
C. 67.6 N
D. 248 N

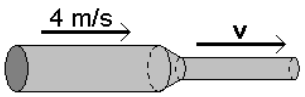
27. Consider a rotating spherical planet. The velocity of a point on its equator is v. The effect of rotation of the planet is to make g at the equator ½ of g at the pole. What is the escape velocity for a particle launched from the north pole of the planet expressed as a multiple of v?

A. 3v
B. 2v
C. v
D. 0.5v

28. In 1798 Cavendish investigated Newton's law by measuring the gravitational force between two unequal uniform lead spheres. The radius of the larger sphere was 100 mm and that of the smaller sphere was 25 mm with a mass of 0.74 kg. The mass of the larger sphere is estimated as:

A. 47 kg
B. 470 kg
C. 6.4 kg
D. 64 kg

29. Water flows from left to right through the pipe illustrated in the accompanying diagram. The cross-section of the pipe is circular. The diameter of the left half of the pipe is double the diameter in the right half of the pipe. If the speed of the water in the left half of the pipe is 4 $m.s^{-1}$, what is the speed of the water in the right half? (Assume the liquid is incompressible, and that there are no viscous or frictional forces.)



A. 2 $m.s^{-1}$
B. 4 $m.s^{-1}$
C. 8 $m.s^{-1}$
D. 16 $m.s^{-1}$

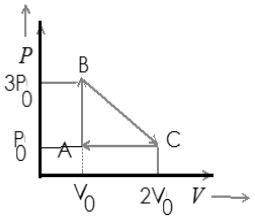
30. Which of the following is/are true for closed systems?

A. they are able to exchange energy (heat and work) with their environment
B. there is no transfer of mass with their surroundings
C. Both (A) and (B) are correct
D. Only (A) is correct

31. Which one of the following is true for a free expansion (i.e. expansion into a vacuum)

A. Work done is zero
B. Work done is positive
C. Work done is negative
D. None of the above

32. According to the figure if one mole of an ideal gas is taken in a cyclic process, the work done by the gas in the process will be:

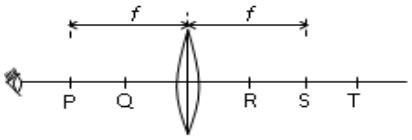


A. P_0V_0
B. $2P_0V_0$
C. $3P_0V_0$
D. $4P_0V_0$

33. A patient's eye is astigmatic. The type of lens used to correct astigmatism is:

A. Convex
B. Concave
C. Cylindrical
D. Polarized

34. An artist uses a magnifying glass to draw a picture on a grain of rice. The focal length of the magnifying glass is f.



At which one of the points, in the diagram shown above, must he place the rice so that he obtains an upright, magnified image?

A. Q B. R
C. S D. T

35. Optical fibres are used to transmit pulses of light and in telecommunications to transmit telephone conversations and data. This is possible due to:

A. Total internal reflection
B. Diffraction of light
C. Total internal refraction
D. Interference of light

36. A light passes through a flat slab of glass mounted in a frame standing in a laboratory. The angle of incidence of the ray of light on the glass is 30^{o}. What is the angle (with the normal) with which the light emerges on the other side of the slab?

A. 60° B. 30^{o} C. 45°

D. Could be any angle, depending on the thickness of the glass.

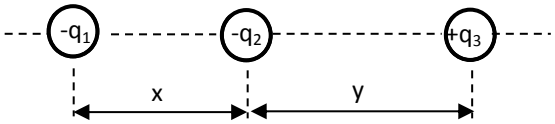
37. When a polythene rod is rubbed with a yellow duster, the rod becomes negatively charged. This charge is caused by the transfer of:

A. electrons from the duster to the rod
B. protons from the rod to the duster
C. electrons from the rod to the duster
D. protons from the duster to the rod.

38. Two identical insulated conductors are charged so that one has a charge of -6μC and the other a charge of 12μC. They experience a force of F N when placed a distance d m apart. They are now briefly brought into contact with each other and returned to their original positions. The magnitude of the force on each is now:

A. $\frac{9F}{8}$ B. F
C. $\frac{F}{4}$ D. $\frac{F}{8}$

39. The diagram (not drawn to scale) below shows three small metallic balls carrying charges of $-q_1$, $-q_2$ and $+q_3$. They are on an insulated stands in the same straight line. The magnitude of the net electrostatic force experienced by charge q2 due to the presence of the other two charges can be expressed as:



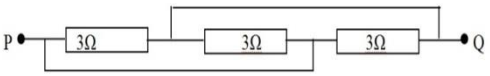
A. $kq_2(\frac{q_1 - q_3}{x^2y^2})$ B. $kq_2(\frac{q_1 + q_3}{x^2y^2})$

C. $kq_2(\frac{q_1y^2 - q_3x^2}{x^2y^2})$ D. $kq_2(\frac{q_1y^2 + q_3x^2}{x^2y^2})$

40. Electrons are accelerated through a small potential difference V and reach a velocity u. The ratio of the charge to mass of an electron $\left(\frac{e}{m}\right)$ is given by:

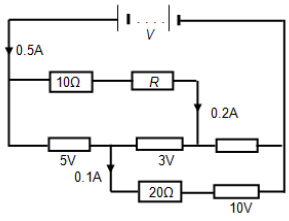
A. $\frac{u}{V}$ B. $\frac{V}{u}$
C. $\frac{2u}{V^2}$ D. $\frac{u^2}{(2V)}$

41. In the circuit shown below the resistance, in ohms (Ω) between points P and Q is:



A. $\frac{3}{2}$ B. 9
C. $\frac{2}{3}$ D. 1

Questions 42 and 43 refer to the circuit diagram on the right. The resistances of some of the resistors are indicated and the potential difference across some resistors is shown below them. The currents in the various parts are as indicated by the arrows.



42. The value of R is:

A. 40 Ω
B. 30 Ω
C. 20 Ω
D. 16.7 Ω

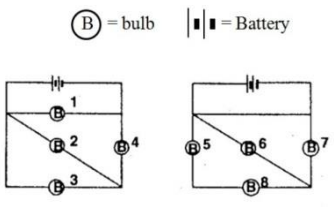
43. The potential difference V of the battery is:

A. 20 V
B. 18 V
C. 17 V
D. 15 V

44. A capacitance of 0.4 µF is connected to an alternating emf of frequency 100 Hz. What is the capacitive resistance?

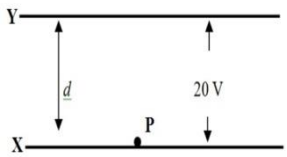
A. 398.1 Ω
B. 3 981 Ω
C. 25 000 Ω
D. 39 810 Ω

45. The circuits below have identical batteries and bulbs. Which of the bulbs burn equally brightly?



A. 2, 3, 6 and 8
B. 4 and 7
C. 2 and 3
D. 4, 5 and 8

Questions 46 and 47 refer to the diagram below. It shows two parallel plates a distance d apart and a potential difference of 20V between them with Y at the higher potential. A small particle P of mass 6 x 10^{-12} kg carrying a charge of –9 µC is released from plate X. Neglect gravitational effects.



46. The speed u with which P reaches plate Y is:

A. 7 746 $m.s^{-1}$
B. 1 225 $m.s^{-1}$
C. 30 $m.s^{-1}$
D. Impossible to calculate it unless d is known.

47. If the speed with which it reached plate Y above was u, and the distance between the plates is now increased to 2d, the speed with which it reaches plate Y after being released from X is now:

A. 2 u
B. u
C. u/2
D. $\sqrt{2u}$

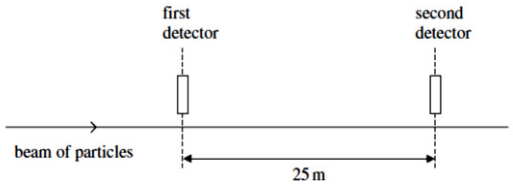
48. Which statement about electrical power is correct?

A. Power is a measure of the rate at which electrical energy is changed into other forms of energy.
B. Power measures how much electrical energy is used by an appliance each time it is used.
C. Power is a measure of the amount of energy a power supply can supply to an electrical circuit.
D. The power of an energy source is determined by its voltage.

49. A proton, a deuteron and an alpha particle with the same kinetic energy enter a region of uniform magnetic field moving at right angles to the field. What is the ratio of the radii of their circular paths?

A. $\sqrt{3}:2:1$
B. $1:2:3$
C. $1:\sqrt{2}:1$
D. $\sqrt{2}:1:1$

50. A beam of identical particles moving at a speed of 0.98c is directed along a straight line between two detectors 25 m apart.



The particles are unstable and the intensity of the beam at the second detector is a quarter of the intensity at the first detector. The half-life of the particles is:

A. 17×10^{-8} s
B. 1.7×10^{-8} s
C. 8.5×10^{-9} s
D. 4.25×10^{-9} s

Chemistry 2015

51. Consider the atom represented below:

$$^{222}_{86}\mathrm{Rn}$$

There are … electrons, … protons and … neutrons in the above atom.

A. 222; 86; 86
B. 136; 136; 222
C. 86; 86; 222
D. 86; 86; 136

52. Which ONE of the following electronic configurations is most likely to give a stable +2 ion?

A. $1s^2 2s^2 2p^6 3s^1$
B. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
C. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
D. $1s^2 2s^2 2p^6 3s^2 3p^4$

53. Which ONE of the following is an example of a metalloid?

A. Sn
B. Sb
C. V
D. In

54. One of the properties of metals is that they are malleable. This means that they:

A. Can melt at low temperatures
B. Can be drawn into wire
C. Are highly conductive
D. Can be hammered flat

55. Which ONE of the following elements does not occur in nature in its elemental form?

A. Zn
B. Ag
C. Na
D. Cu

56. Which of the following statements regarding steel is UNTRUE?

A. One of its forms is stainless steel that is able to resist rusting.
B. It is an alloy of iron and carbon, amongst other additives.
C. It is a polymer.
D. Its properties may be altered, depending on its method of manufacture.

57. Dioxygen (O_2) and ozone (O_3) are … of oxygen.

A. allotropes
B. enantiomers
C. isotopes
D. diastereomers

58. ONE of the following forms of pure carbon contains only sp^3 hybridied carbon atoms?

A. Carborundum
B. Charcoal
C. Graphite
D. Diamond

59. Sterling silver, which is used to make jewellery, is an alloy of silver and …

A. copper.
B. zinc.
C. gold.
D. titanium.

60. Teflon is a polymer used to coat pots and pans to make them non-stick. The monomer unit making up the Teflon polymer is:

A. $F_2C{=}CF_2$
B. $H_2C{=}CHCl$

C. $PhCH=CH_2$ D. $H_2C=CHCN$

61. Gold is often alloyed with other metals to increase its strength. If a piece of jewellery is made from 9 carat gold, the percentage of the jewellery that is actually gold is:

A. 50% B. 75%
C. 33% D. 38%

62. The compound that is used by marine organisms such as sea urchins, crustaceans and starfish to make their shells and exoskeletons is:

A. SiO_2 B. Al_2O_3
C. $MgSO_4$ D. $CaCO_3$

63. Which of all the following metals has the highest strength-to-weight ratio?

A. Tungsten
B. Copper
C. Iron
D. Titanium

64. Which ONE of the following explains why carbon monoxide is toxic to humans?

A. It binds strongly to haemoglobin, preventing the transport of oxygen.
B. It binds irreversibly to the adrenergic receptors.
C. It binds directly to oxygen, causing suffocation.
D. It causes kidney failure.

65. Tanzanite, a gemstone found only in Tanzania has the following composition:

A. $A\ell_2(SO_4)_3$
B. $(CaSO_4)_2 \cdot H_2O$
C. $Ca_2A\ell_3(SiO_4)(Si_2O_7)O(OH)$
D. $KA\ell(SO_4)_2 \cdot 12H_2O$

66. All molecules with the same molecular formula but with different bonding arrangements and therefore different structures are called …

A. structural diastereomers.
B. structural isomers.
C. structural enantiomers.
D. geometric isomers.

67. Copper occurs naturally as two isotopes: ^{63}Cu and ^{65}Cu. The atomic mass of ^{63}Cu is 62,9296, while that of ^{65}Cu is 64,9278. If 69,17% of copper occurs as ^{63}Cu and 30,83% occurs as ^{65}Cu what is the average atomic mass of copper?

A. 63,55 B. 65,00
C. 63,34 D. 64,09

68. A typical carbon-carbon triple bond…..

A. is longer than a double bond.
B. has two σ bonds and one π bond.
C. has one σ bond and two π bonds.
D. consists of three shared electrons.

69. In the reaction of a metal and a non- metal, the … usually gains electrons and the … loses electrons.

A. non-metal, metal
B. metal, non-metal
C. non-metal, non-metal
D. metal, metal

70. In a solution of NaCℓ in water, the force of attraction between Na^+ ions and H_2O molecules is called a(n)…..interaction.

A. hydrogen bonding
B. Van der Waals
C. ion-ion
D. ion-dipole

71. Analysis of a seawater sample shows that it contains $4,3 \times 10^{-8}$ g. l^{-1} of mercury. A teaspoon of sea water of volume 5,0 mℓ contains … atoms of Hg.

A. $5,62 \times 10^{35}$
B. $6,45 \times 10^{9}$
C. $6,44 \times 10^{11}$
D. $1,07 \times 10^{12}$

72. The percentage by mass of chromium in $(NH_4)_2Cr_2O_7$ is:

A. 41,3% B. 44,4%

C. 20,6% D. 25,3%

73. Which ONE of the following represents a combustion reaction?

A. $CH_3CH_2CH_2CH_2CH_2C\ell + KOH \rightarrow CH_3CH_2CH_2CHCH_2$

B. $CH_3CH_2OH \rightarrow CH_3CHO \rightarrow CH_3COOH$

C. $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

D. $C_6H_2O_6 \rightarrow CH_3COCOOH \rightarrow CH_3CH_2OH$

Questions 74 and 75 refer to the following balanced equation:

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

74. What is the maximum amount of Fe that can be produced from 253 g of CO and 550 g of Fe_2O_3?

A. 337,3 g B. 504,4 g

C. 192,3 g D. 384,7 g

75. What was the yield of the reaction if the amount of Fe actually obtained was 125 g?

A. 25% B. 37%

C. 33% D. 65%

76. Borax, a substance used in washing powder and other cleaning products, occurs naturally as a hydrate. This means a certain number of water molecules are always present in the structure. The formula may be represented as $Na_2B_4O_7 \cdot xH_2O$, where x represents the number of moles of water present per mole of $Na_2B_4O_7$. When a 245,5 g sample of borax was heated, all the water of crystallisation were lost, leaving 129,6 g of $Na_2B_4O_7$. Which ONE of the following is the value of x?

A. 10 B. 7

C. 2 D. 5

77. A 2,25 g sample of limestone rock was crushed and the sample was treated with an excess of HCℓ (35 mℓof a 1,45 mol·dm^{-3} HCℓ solution). The unreacted HCℓ was neutralised using 10,25 mℓ of a 1,25 mol·dm^{-3} NaOH solution. Assuming that of all the rock components, only $CaCO_3$ is able to react with HCℓ, what is the mass percentage of $CaCO_3$ in the limestone rock? Calcium carbonate and HCℓ react as follows:

$$2HC\ell(aq) + CaCO_3(s) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

A. 100% B. 72%

C. 57% D. 84%

78. Consider the balanced equation below:

$$CH_3CH_2COOH + NH_3 \rightleftharpoons CH_3CH_2COO^- + NH_4^+$$

In this reaction …

A. $CH_3CH_2COO^-$ is the base and NH_3 the conjugate acid.

B. NH_3 is the base and NH_4^+ the conjugate acid.

C. H_3CH_2COOH is the acid and NH_3 the conjugate base.

D. NH_3 is the acid and NH_4^+ the conjugate base.

79. Which ONE of the following is the weakest acid?

A. HCℓ B. HF

C. HI D. HBr

80. The half-reaction that occurs at the anode during the electrolysis of molten sodium bromide is:

A. $2\,Br^- \rightarrow Br_2 + 2e^-$

B. $Br_2 + 2e^- \rightarrow 2\,Br^-$

C. $Na^+ + e^- \rightarrow Na$

D. $Na \rightarrow Na^+ + e^-$

81. Magnesium hydroxide can be neutralised by HCℓ according to the following reaction:

$$Mg(OH)_2 + 2HC\ell \rightarrow MgC\ell_2 + 2H_2O$$

If it takes 308 mℓ of an HCℓ solution to neutralise 2,87 g of $Mg(OH)_2$, what is the concentration of the HCℓ solution?

A. 0,079 mol·l^{-1}
B. 0,479 mol·l^{-1}
C. 0,160 mol·l^{-1}
D. 0,320 mol·l^{-1}

82. Ethylene glycol, a compound that is used in car radiators to prevent freezing during winter, was analysed and found to have the composition:

C: 38,7%; O: 51,6%; H: 9,7%

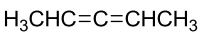
The molar mass of ethylene glycol is 62,1g·mol^{-1}. What is its molecular formula?

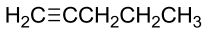
A. $C_2H_6O_2$ B. CH_3O
C. $C_3H_6O_3$ D. $C_2H_5O_2$

83. The general formula representing an ether is:

A. R-CO-R' B. R-O-R'
C. R-COOH D. R-OH

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


a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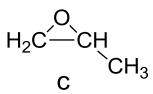
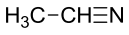
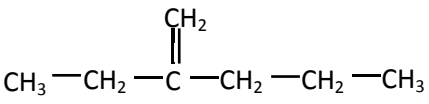

c


d

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

85. Consider the condensed structural formula of an organic compound below.



The best IUPAC name for this compound is:

A. 3-methylenehexane
B. 2-propyl-1-butene
C. 4-ethyl-4-pentene
D. 2-ethyl-1-pentene

86. The reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is known as the:

A. Hall-Héroult process
B. Haber-Bosch process
C. Thermite reaction
D. Solvay process

87. Consider the following reaction taking place in a closed container:

$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$
$\Delta H = -904$ kJ

The effect of reducing the volume of the container will be …
A. to favour the forward reaction.
B. no effect.
C. to make the reaction irreversible.
D. to favour the reverse reaction.

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

$Cd(s) + NiO_2(s) + 2H_2O(\ell) \rightarrow Cd(OH)_2(s) + Ni(OH)_2(s)$

A. Cd, NiO_2, NiO_2, Cd
B. NiO_2, Cd, Cd, NiO_2
C. H_2O, NiO_2, Cd, NiO_2
D. None of the above, as this is not a redox reaction.

89. Consider the following reaction:

$Cr_2(SO_4)_3(aq) + (NH_4)_2CO_3(aq) \rightarrow$
$Cr_2(CO_3)_3(s) + 3(NH_4)_2SO_4(aq)$

In this reaction, NH_4^+ and SO_4^{2-} are:

A. Spectator ions
B. Insoluble ions
C. Oxidising agents
D. reducing agents

Questions 90 and 91 refer to the following half-reactions taking place in a galvanic cell:

$AuBr_4^-(aq) + 3e^- \rightarrow Au(s) + 4Br^-(aq)$

$E°(AuBr_4^-) = -0,86\ V$

$IO^-(aq) + H_2O + 2e^- \rightarrow I^-(aq) + 2OH^-(aq)$

$E°(IO^-) = +0,49\ V$

90. Which ONE of the following is the balanced equation for the net cell reaction?

A. $2\,AuBr_4^-(aq) + 3I^-(aq) + 6OH^-(aq) \rightarrow 2Au(s) + 8\,Br^-(aq) + 3IO^-(aq) + 3H_2O(\ell)$

B. $Au(s) + 4\,Br^-(aq) + 3IO^-(aq) + 3H_2O(\ell) \rightarrow AuBr_4^-(aq) + 3I^-(aq) + 6OH^-(aq)$

C. $2Au(s) + 8\,Br^-(aq) + 3IO^-(aq) + 3H_2O(\ell) \rightarrow 2\,AuBr_4^-(aq) + 3I^-(aq) + 6OH^-(aq)$

D. $AuBr_4^-(aq) + I^-(aq) + 2OH^-(aq) \rightarrow Au(s) + 4\,Br^-(aq) + IO^-(aq) + H_2O(\ell)$

91. The standard cell potential of the galvanic cell is:

A. 0,37 V B. 1,35 V
C. –0,37 V D. –1,35 V

92. For a chemical reaction to occur, reactants must collide with each other. The rate of the reaction depends on …

A. the energy of the collisions.
B. the frequency of the collisions.
C. the orientation of the collisions.
D. all of the above.

93. Shown below are two reactions that aluminium oxide can undergo:

$A\ell_2O_3(s) + 6H^+(aq) + 9H_2O \rightarrow 2[A\ell(H_2O)_6]^{3+}(aq)$
$A\ell_2O_3(s) + 2OH^- + 7H_2O \rightarrow 2[A\ell(H_2O)_2(OH)_4]^-(aq)$

These two reactions show that aluminium oxide is a/an …

A. superoxide.
B. basic oxide.
C. amphoteric oxide.
D. acidic oxide.

94. If a solution of ethanol (CH_3CH_2OH) in water is 1,75 $mol{\cdot}dm^{-3}$, how many grams of ethanol are dissolved in 3 200 g of water?

A. 81 g B. 120 g
C. 560 g D. 258 g

95. An 8 g piece of magnesium was placed into 6 $mol{\cdot}dm^{-3}$ $HC\ell$. After 25 s, 3,5 g of unreacted magnesium remained. The average rate at which magnesium was consumed is:

A. 0,14 $g{\cdot}s^{-1}$ B. 0,18 $g{\cdot}s^{-1}$
C. 0,32 $g{\cdot}s^{-1}$ D. 4,50 $g{\cdot}s^{-1}$

96. Aluminium sulphate reacts with sodium hydroxide to produce aluminium hydroxide and sodium sulphate. The correct balanced equation for this reaction is:

A. $Al_2(SO_4)_3 + 3NaOH \rightarrow 2Al(OH)_3 + 2Na_2SO_4$
B. $Al(SO_4)_3 + 6NaOH \rightarrow Al(OH)_3 + 6NaSO_4$
C. $Al(SO_3)_4 + 6NaOH \rightarrow 2AlOH + 3Na_2SO_3$
D. $Al_2(SO_4)_3 + 6NaOH \rightarrow 2Al(OH)_3 + 3Na_2SO_4$

97. The following elements are essential to human life:

A. Se, V, Cr, Mo, Zn
B. Mg, Ge, Mn, Ca, Cu
C. Sn, Na, Ne, Pd, P
D. All of the above

98. Which ONE of the following statements regarding chemical equilibrium in INCORRECT?

A. All chemical reactions are, in principle, reversible.

B. Equilibrium is achieved when the forward reaction rate equals the reverse reaction rate.
C. Equilibrium is achieved when the concentrations of species become constant.
D. Equilibrium is achieved when reactant and product concentrations are equal.

99. The equilibrium constant for the reaction $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$ is given as K_c. The equation is now rewritten as

$CO(g) + ½O_2(g) \rightleftharpoons CO_2(g)$ with an equilibrium constant K_c'. What is the relationship between K_c and K_c'?

A. $K_c' = K_c$ (i.e. no change)
B. $K_c' = (K_c)^{½}$
C. $K_c' = ½(K_c)$
D. $K_c' = (K_c)^2$

100. The Nobel Prize in Chemistry for 2014 was won by Eric Betzig, Stefan Hell and William Moerner for the development of:

A. Super-resolution fluorescence microscopy
B. Nuclear fusion
C. A synthetic method for prostaglandins
D. The polymerase chain reaction

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*

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

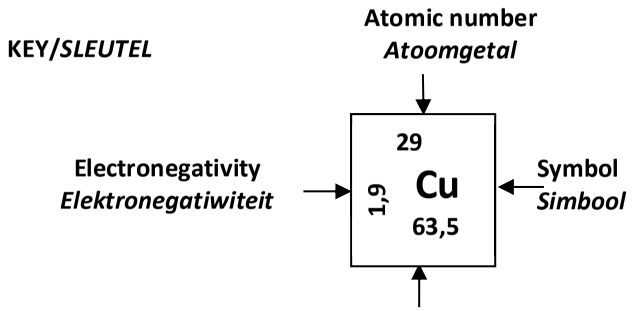
ELECTRIC CIRCUITS / *ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

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