SOUTH AFRICAN AGENCY FOR SCIENCE AND TECHNOLOGY ADVANCEMENT

PHYSICS OLYMPIAD

GRADE 10 - 12

2022

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 correct answer and shade the corresponding circle on the answer sheet completely, using an HB pencil.

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

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

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

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

This paper consists of 21 pages and 5 data sheets.

Three hours are allowed to answer the questions

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1. When water becomes overly enriched with nutrients, it contributes to the escalating problem of 'oxygen starved' or 'dead' zones in rivers and the sea. This is known as eutrophication and kills organisms such as fish, oysters and other marine creatures. Which one of the following is not associated with eutrophication?

A. Industrial discharge of waste
B. Plastic pollution
C. Untreated sewage
D. Excessive use of fertilizers

2. The temperature of a gas is a measure of the ... of the particles.

A. average potential energy
B. average kinetic energy
C. total kinetic energy
D. total potential energy

3. Consider an electrochemical cell based on the following reaction:
$Sn^{4+}(aq) + Sn(s) \rightarrow 2Sn^{2+}(aq)$

Which ONE of the following statements regarding this cell is CORRECT?

A. Sn is the anode of the cell.
B. Sn is the cathode of the cell.
C. $Sn^{4+}(aq)$ is the reducing agent.
D. Sn is the oxidizing agent.

4. Which ONE of the following substances can be used as an electrolyte?

A. Mercury
B. Molten copper
C. Sugar dissolved in distilled water
D. Table salt dissolved in distilled water

5. Which one of the following compounds is NOT present in crude oil?

A. Kerosene
B. Naphtha
C. Bitumen
D. Teflon

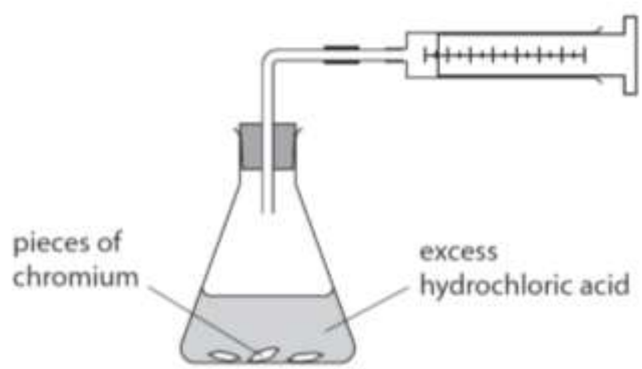
6. The reaction represented by the equation below reaches equilibrium.

$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$
yellow orange

Which ONE of the following changes to the reaction mixture will change its colour from yellow to orange?

A Add a catalyst.
B Add water to the reaction mixture.
C Add a few drops of sodium hydroxide solution to the reaction mixture.
D Add a few drops of concentrated hydrochloric acid to the reaction mixture.

7. Chromium metal reacts with dilute hydrochloric acid to form hydrogen gas.
This apparatus is used to investigate the reaction.



The equation for the reaction is:

$Cr(s) + 2HCl(aq) \longrightarrow CrCl_2(aq) + H_2(g)$

A student adds 0.26 g of a sample of chromium metal to excess dilute hydrochloric acid.
The maximum volume of hydrogen gas that the student could produce in this experiment at room temperature and pressure (25 °C and 101.3 kPa) is … dm^3

A. 0,005
B. 0,100
C. 0,112
D. 0,224

8. Consider the reaction represented by the following balanced chemical equation. The system is initially at equilibrium.

$H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$

The pressure is increased by decreasing the volume of the container at constant temperature. How will the amount of HBr and the concentration of HBr change due to this increase in pressure?

	Amount of HBr	Concentration of HBr
A	Increase	Decrease
B	Decrease	Increase
C	Remain the same	Decrease
D	Remain the same	Increase

9. Which of the following statements is/are TRUE regarding the neutralisation point of a reaction between ammonia and hydrochloric acid?

(i) It is the point where the acid and base have reacted so that neither is in excess
(ii) pH = 7
(iii) $[H_3O^+] = [OH^-]$

A. (i) only
B. (i) and (ii)
C. (i), (ii) and (iii)
D. (ii) and (iii)

10. The average rate of formation of CO_2 in the following reaction is 0,5 mol·min^{-1}.

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

The average rate of consumption (disappearance) of $HC\ell$ for this same reaction is:

A. 0,25 mol·min^{-1}
B. 0,5 mol·min^{-1}
C. 1 mol·min^{-1}
D. 2 mol·min^{-1}

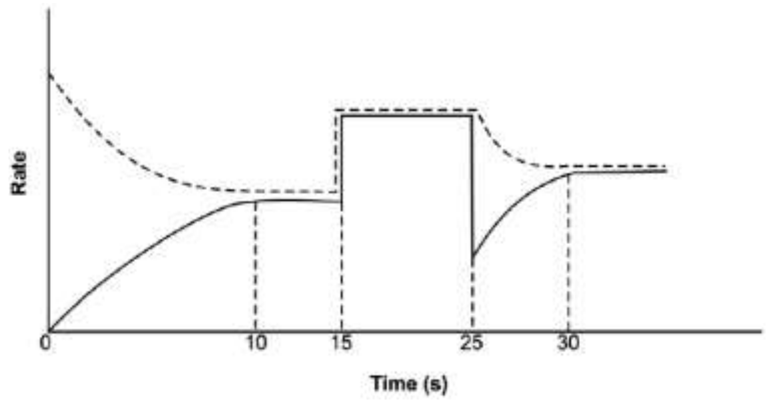
11. Which one of the following gives the number of methane molecules in 12 g of $CH_4(g)$?

A. $\frac{16 \times 6{,}02 \times 10^{23}}{12}$
B. $\frac{12 \times 6{,}02 \times 10^{23}}{16}$
C. $\frac{12}{16 \times 6{,}02 \times 10^{23}}$
D. $\frac{16}{12 \times 6{,}02 \times 10^{23}}$

12. A hypothetical chemical reaction in a closed container is represented by the following chemical equation:

$aA(s) + bB(aq) \rightleftharpoons cC(aq) + dD(g) \quad \Delta H < 0$

The graph below represents the rates of the forward and reverse reactions plotted as a function of time.



Which one of the following could describe the change in the rates of the reactions at t = 15 s and t = 25 s respectively?

	Disturbance at t =15 s	Disturbance at t =25 s
A	Surface area of A was increased	The pressure in the system was increased
B	A catalyst was added	The temperature of the system was decreased
C	The temperature of the system was increased	The surface area of A was decreased
D	The pressure of the system was decreased	The temperature of the system was increased

13. The bends, also known as decompression sickness (DCS) or Caisson disease, occurs in scuba divers. The risk of decompression illness is directly related to the depth of the dive, the amount of time under pressure, and the rate of ascent. Which of the following is correct?

	GASSES USED IN SCUBA TANKS	CAUSE OF DCS (THE BENDS)
A	Oxygen, hydrogen and helium	Expansion of oxygen in the bloodstream
B	Oxygen, hydrogen and helium	Expansion of nitrogen in the bloodstream
C	Oxygen, nitrogen and argon	Expansion of oxygen in the bloodstream
D	Oxygen, nitrogen and argon	Expansion of nitrogen in the bloodstream

14. A lead storage battery which is used in motor cars, involves two half-cell reactions as illustrated below:

	E^0 (volts)
$PbO_2(s)+HSO_4^-(aq)+3H^++2e^- \rightarrow PbSO_4(s)+2H_2O(\ell)$	(+ 1,69)
$PbSO_4(s)+H^+(aq)+2e^- \rightarrow Pb(s)+HSO_4^-(aq)$	(– 0,36)

Using this information, for a cell that involves these reactions under standard conditions, what is the overall reaction and the cell emf (in volts) when the cell is discharging?

	OVERALL CELL REACTION	Emf (V)
A	$PbO_2 + 4H^+ \rightarrow Pb + 2H_2O$	+1,33
B	$PbO_2 + Pb + 2SO_4^{2-} \rightarrow 2PbSO_4 + 2H_2O$	+2,05
C	$Pb + PbO_2 + 2HSO_4^- + 2H^+ \rightarrow 2PbSO_4 + 2H_2O$	+2,05
D	$2PbSO_4 + 2H_2O \rightarrow PbO_2 + Pb + 2HSO_4^- + 2H^+$	-2,05

15. The gases used in different types of welding would include:

A. oxygen and hydrogen
B. oxygen, hydrogen, acetylene and nitrogen
C. oxygen, hydrogen and argon
D. oxygen and acetylene

16. Galvanised iron sheets have a coating of:

A. chromium
B. lead
C. zinc
D. tin

17. Heavy water is a compound that is made up of oxygen and deuterium, a heavier isotope of hydrogen. Which of the following is NOT true? Heavy water …

A. has the chemical formula D_2O
B. has a molecular mass of 20.03 $g.mol^{-1}$
C. is found in the dead sea
D. is used in certain types of nuclear reactors

18. Liquid Petroleum Gas (LPG) consists of mainly of:

A. butane, propane and propene
B. methane, butane and pentane
C. ethane, propane and pentane
D. propane butane and hexane

19. Water is a good solvent of ionic salts because:

A. It has a high specific heat
B. It has a high boiling point
C. It has a low density
D. It is a polar molecule

20. Which of the following substances is a white salt and is colourless in solution?

A. Copper nitrate
B. Magnesium sulphate
C. Iron oxide
D. Cobalt chloride

21. Which of the following is a non-metal that remains liquid at room temperature?
A. Phosphorous
B. Bromine
C. Chlorine
D. Sulphur

22. Which ONE of the following statements regarding chemical equilibrium is INCORRECT?

A. Equilibrium is achieved when the rate of the forward reaction equals the rate of the reverse reaction.
B. Equilibrium is achieved when reactant and product concentrations are equal.
C. Equilibrium is achieved when the concentrations of all reactants and products become constant.
D. Equilibrium is possible in an open container.

23. Which of the following are NOT commonly used when manufacturing the frame of airplanes?

A. Lead
B. Aluminium
C. Titanium
D. Steel

24. Hard water can cause damage to your home and body. Water softening systems are used to remove the following metals to soften the water.

A. Aluminium and copper
B. Magnesium and calcium
C. Iron and copper
D. Chlorine and magnesium

25. With reference to the halogen family of elements, consider the following:

i) A deficiency causes enlargement of the thyroid and a bulge in the neck (goitre)
ii) The halogen with the smallest ionic radius
iii) The halogen that is most reactive chemically

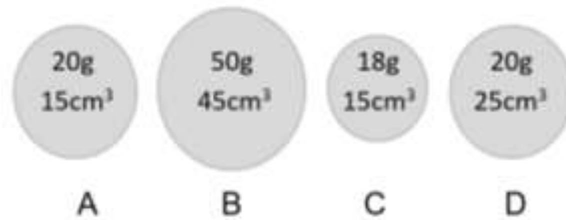
Which of the following is the correct set of elements denoting the above properties respectively?

A. Iodine, Iodine, Fluorine
B. Iodine, Fluorine, Fluorine
C. Fluorine, Fluorine, Chlorine
D. Iodine, Fluorine, Chlorine

26. Which of the following is the most common element used for batteries in electric cars?

A. Magnesium
B. Zinc
C. Lithium
D. Sodium

27. The following balls (A, B, C and D) are made from different materials. The mass and volume of each is indicated in the diagram below.



If the density of water is 1 g/cm^3, which one of these balls will be able to float in water?

A. A
B. B
C. C
D. D

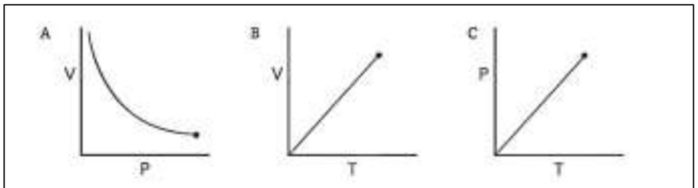
28. A Hydrochloric acid (HCl) solution of volume 15 cm^3 has a pH of 5. How much distilled water should be added to this solution to change the pH to 6?

A. 1,5 cm^3
B. 15 cm^3
C. 135 cm^3
D. 150 cm^3

29. In a chemical reaction 5 g magnesium reacts with 2,24 dm^3 oxygen gas at STP (standard temperature and pressure) until one of the reactants is used up. After completion of the reaction, the following reactant will be in excess:

A. 0,008 g magnesium
B. 0,192 g magnesium
C. 0,824 cm^3 oxygen
D. 2,032 cm^3 oxygen

30. The following graphs represents three gas laws.



Identify which gas law each graph depicts in the correct order.

A. Charles law, Boyle's law, Gay Lussac's law
B. Charles law, Gay Lussac's law, Boyle's law
C. Boyle's law, Gay Lussac's law, Charles law
D. Boyle's law, Charles law, Gay Lussac's law

31. Which one of the following is NOT a redox reaction?

A. $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
B. $C + O_2 \rightarrow CO_2$
C. $Na_2CO_3 + 2H_2O \rightarrow 2NaOH + H_2CO_3$
D. $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

32. The shape of a molecule of phosphorus pentafluoride, (PF_5) is:

A Octahedral
B Tetrahedral
C Trigonal planar
D Trigonal bipyramidal

33. The percentage by mass of aluminium in $Al_2(SO_4)_3$ is:
A. 1,58
B. 15,80
C. 0,79
D. 7,90

34. Approximately 99% of our body consist of the following six elements:

A. Oxygen, hydrogen, nitrogen, carbon, calcium, and phosphorus
B. Oxygen, hydrogen, chlorine, carbon, calcium, and sulphur
C. Oxygen, hydrogen, potassium, carbon, sodium, and phosphorus
D. Oxygen, hydrogen, chlorine, carbon, calcium, and zinc

35. Pure water freezes at 0 °C and boils at 100 °C under normal pressure conditions. Sea water will..

A. freeze below 0 °C and will boil above 100 °C
B. freeze below 0 °C and will boil below 100 °C
C. freeze above 0 °C and will boil above 100 °C
D. freeze above 0 °C and will boil below 100 °C

36. The worst nuclear power plant accident ever in terms of death toll and cost occurred in Ukraine in 1986. This disaster is known as the …..disaster

A. Kyshtym
B. Chernobyl
C. Three Mile Island
D. Windscale

USE THE FOLLOWING INFORMATION TO ANSWER QUESTIONS 37 TO 38.

"Green hydrogen is South Africa's next great export opportunity", says Gladys Nabagala, director of the energy transition advisory Group at Royal Haskoning DHV. Boegoebaai has the potential to produce up to 400 kilotons of hydrogen per annum, which will require renewable energy of 9 gigawatts or approximately 20% of South Africa's current installed energy capacity.

37. Hydrogen can be produced from electrolysis of water.

The reaction above is an …
A. Exothermic acid-base reaction
B. Endothermic acid-base reaction
C. Exothermic redox reaction
D. Endothermic redox reaction

38. To produce **green** hydrogen, the following energy source(s) can be used for electrolysis:

(i) Wind
(ii) Solar
(iii) Biofuel
(iv) Natural gas
(v) Coal

A. i, and ii only
B. i, ii and iii only
C. i, ii, iii and iv only
D. all of the above

39. Consider the reaction at equilibrium:

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

Which of the following changes will increase the rate of the forward reaction?

(i) Temperature is increased
(ii) NO_2 gas is added to the equilibrium mixture
(iii) Pressure is increased

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

USE THE FOLLOWING INFORMATION TO ANSWER QUESTIONS 40 TO 42.

The following graph illustrate the combined average results obtained from two similar investigations (1 and 2) done with different methods by two marine scientists.

Investigation 1:

Experiment 1.1: The conductivity of the same salt solution was determined at three different temperatures (23, 25 and 27 °C).

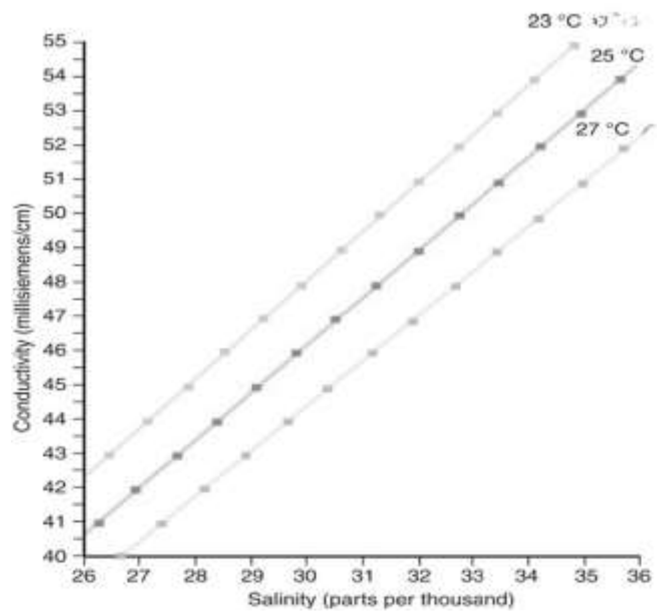
Experiment 1.2: The conductivity of a solution with higher salinity was then determined at three different temperatures (23, 25 and 27 °C).

Further similar experiments were done with solutions with increased salinity.

Investigation 2:

Experiment 2.1: The conductivity of salt solutions with different salinity (salt concentration) was determined at 23 °C.

Experiment 2.2: The experiment was then repeated with the same salt solutions at
25 °C (and again at 27 °C for Experiment 2.3).



40. Which of the following is the correct variables for Experiment 1.1 in Investigation 1?

	Independent Variable	Dependent Variable	Constant Variable
A	Temperature	Conductivity	Salinity
B	Conductivity	Temperature	Salinity
C	Salinity	Conductivity	Temperature
D	Salinity	Temperature	Conductivity

41. Which of the following is a correct conclusion from the results?

(i) An increase in the salt content of seawater increases the electrical conductivity of the water.
(ii) An increase in the salt content of seawater increases the temperature of the water.
(iii) An increase in the temperature of seawater increases the electrical conductivity of the water.

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

42. A temperature change of 4 °C will change the electrical conductivity of sea water by approximately … millisiemens/cm^3

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

43. Which ONE of the following is a CORRECT description for a 0,1 $mol \cdot dm^{-3}$ hydrochloric acid solution?

A. Dilute strong acid
B. Dilute weak acid
C. Concentrated weak acid
D. Concentrated strong acid

44. Which ONE of the following compounds is produced in the Haber process?

A. $N_2(g)$
B. $NH_3(g)$
C. $HNO_3(\ell)$
D. $NH_4NO_3(s)$

45. Real gases deviate from Ideal gas behaviour at:

A Low pressure and high temperature
B High pressure and low temperature
C Low pressure and low temperature
D High pressure and high temperature

46. The empirical formula of a certain carbon compound is CH_2O.
Which ONE of the following can be the molecular formula of this compound?

A. C_2H_6O
B. C_3H_6O
C. $C_2H_4O_2$
D. $C_2H_6O_2$

47. Each of the substances below is formed by attractive forces between two ions.
In which ONE of the substances do the constituent ions have the same electron configuration?

A. KBr
B. Na_2S
C. $MgCl_2$
D. $CaCl_2$

48. Which ONE of the following is a mixture?

A. Air
B. A diamond
C. Distilled water
D. Sodium chloride

49. The typical size of an atom is …

A. 0,1 mm
B. 0,1 cm
C. 0,1 µm
D. 0,1 nm

50. Which of the following substances would have the lowest boiling point?

A. Ethanol
B. Benzene
C. Water
D. Nitrogen

51. What is the approximate mass of an alpha particle?

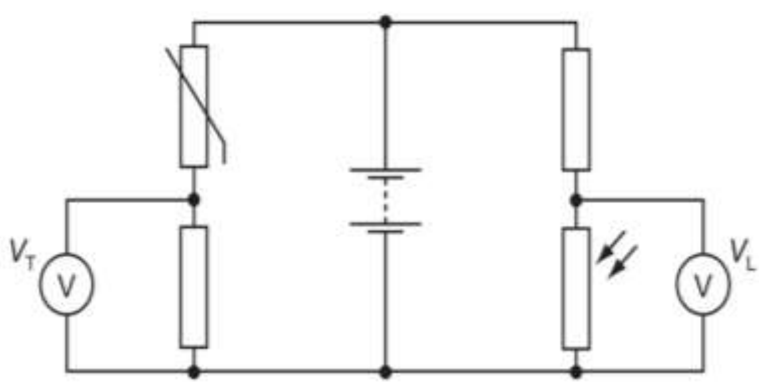
A. 10^{-28} kg
B. 10^{-26} kg
C. 10^{-24} kg
D. 10^{-22} kg

52. An actinium nucleus has a nucleon number of 227 and a proton number of 89. It decays to form a radium nucleus, emitting a beta particle and an alpha particle in the process.

What are the nucleon number and the proton number of this radium nucleus?

	nucleon number	proton number
A.	223	87
B.	223	88
C.	224	87
D.	225	86

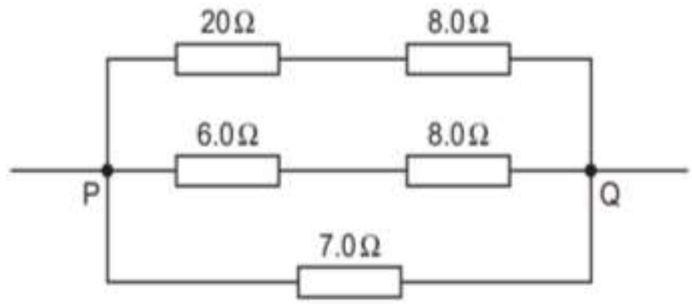
53. In the circuit below, the reading V_T on the voltmeter changes from high to low as the temperature of the thermistor changes. The reading V_L on the voltmeter changes from high to low as the level of light on the light-dependent resistor (LDR) changes.



The readings V_T and V_L are both high. What are the conditions of temperature and light level?

	Temperature	Light level
A.	low	low
B.	low	high
C.	high	low
D.	high	high

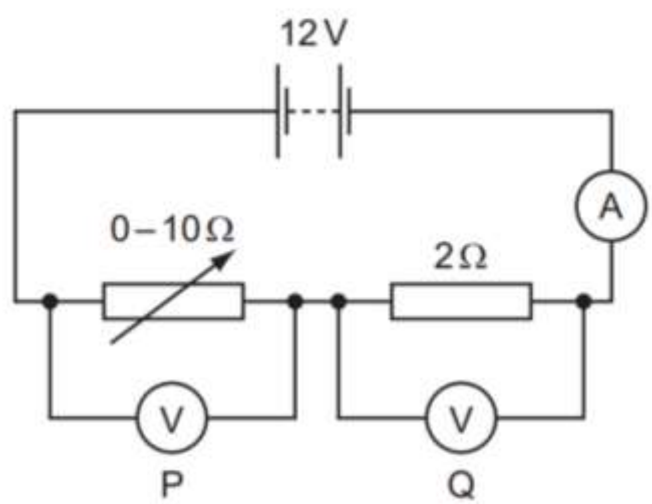
54. Five resistors are connected as shown.



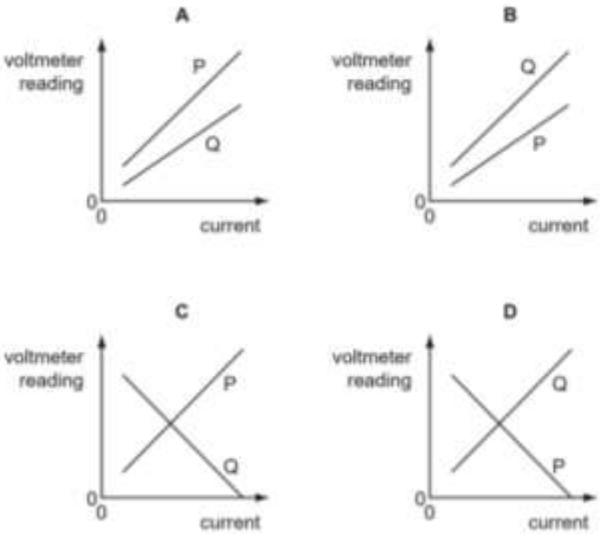
What is the total resistance between P and Q?

A. 0.25Ω
B. 0.61Ω
C. 4.0Ω
D. 16Ω

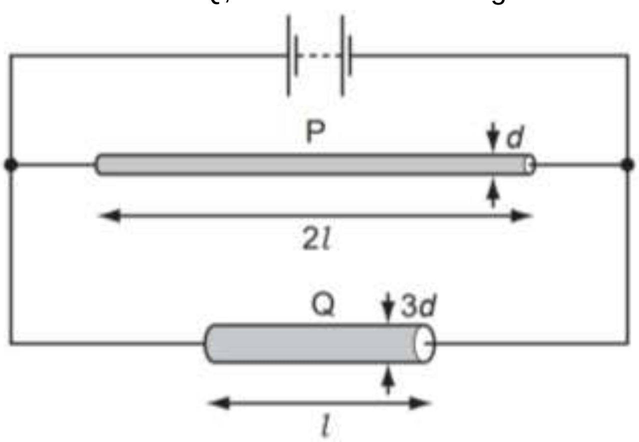
55. A 12 V battery is in series with an ammeter, a 2 Ω fixed resistor and a 0 –10 Ω variable resistor. High-resistance voltmeters P and Q are connected across the variable resistor and the fixed resistor respectively, as shown.



The resistance of the variable resistor is changed from its maximum value to zero. Which graph shows the variation with current of the voltmeter readings?



56. Two wires P and Q, made of the same material, are connected to the same electrical supply. P has twice the length of Q and one-third of the diameter of Q, as shown in the diagram.



What is the ratio $\frac{current\ in\ P}{current\ in\ Q}$?

A $\frac{2}{3}$ B. $\frac{2}{9}$ C. $\frac{1}{6}$ D. $\frac{1}{18}$

57. A filament lamp has a resistance of 180 Ω when the current in it is 500 mA.

What is the power transformed in the lamp?

A. 45 W B. 50 W C. 90 W D. 1400 W

58. A low-voltage supply with an e.m.f. of 20 V and an internal resistance of 1.5 Ω is used to supply power to a heater of resistance 6.5 Ω in a fish tank.

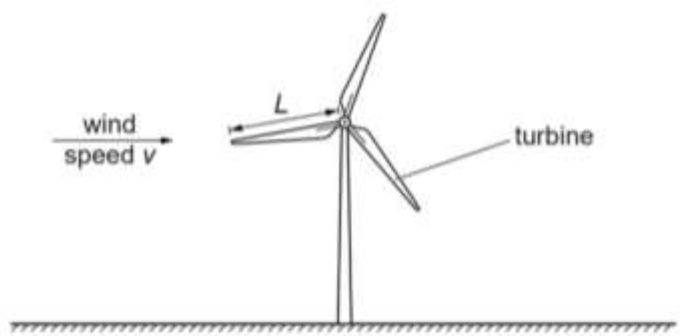
What is the power supplied to the water in the fish tank?

A. 41 W B. 50 W C. 53 W D. 62 W

59. What are the SI base units of power?

A. kg m^4 s^{-1}
B. kg m^3 s^{-2}
C. kg m^2 s^{-3}
D. kg m s^{-4}

Questions 60 – 62 are based on the figure below which depicts a turbine that is used to generate electrical power from the wind.



The power *P* available from the wind is given by:

$P = CL^2\rho v^3$

where *L* is the length of each blade of the turbine,
ρ is the density of air,
v is the wind speed,
C is a constant.

60. Determine the units of the constant C.

A. kg m^4 s^{-1}
B. kg m^3
C. The constant C has no units
D. kg m s^{-4}

61. The length L of each blade of the turbine is 25.0 m and the density ρ of air is 1.30 in SI units. The constant C is 0.931. The efficiency of the turbine is 55% and the electric power output P is 3.50 × 105 W.

Calculate the wind speed.

A. 583 km h^{-1}
B. 9.4 m s^{-1}
C. 76.5 m s^{-1}
D. 19.4 kg m s^{-4}

62. Suggest why the electrical power output of the turbine is less than the power available from the wind.

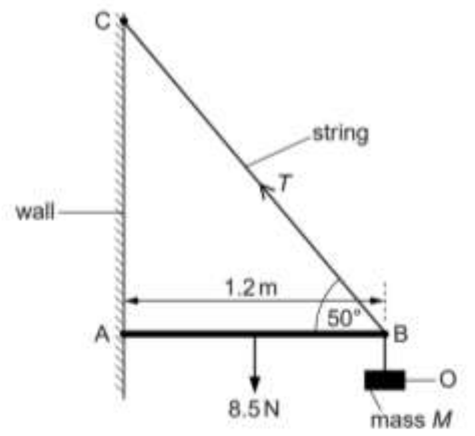
A. Not all kinetic energy of the wind is converted to kinetic energy of the blades.
B. Conversion to electrical energy is not 100% efficient
C. Heat is produced in the generator / bearings
D. All of the above.

63. What is the centre of gravity?

A. the point where the weight of the body is symmetrical
B. the point where all the weight of the body is considered/seems to act
C. the point where the weight is least acting on the body
D. the point where all the weight of the body is considered zero.

Questions 64 – 67 refer to the diagram below.

A uniform rod AB is attached to a vertical wall at A. The rod is held horizontally by a string attached at B and to point C, as shown in figure below.



The angle between the rod and the string at B is 50°. The rod has length 1.2 m and weight 8.5 N. An object O of mass M is hung from the rod at B. The tension T in the string is 30 N.

Using the figure above, answer the following questions.

64. Use the resolution of forces to calculate the vertical component of T.

A. 35 N
B. 23 N
C. 67 N
D. 44 N

65. The principle of moments states that……...

A. The sum of the clockwise moments about a point equals the sum of the anticlockwise moments about the same point.
B. The sum of the clockwise and anticlockwise moments equals the mean of the sum of the anticlockwise moments about the same point
C. Clockwise moments about a point are opposite the sum of the anticlockwise moments about the same point.
D. There are no moments about a point on an object.

66. Use the principle of moments and take moments about A to determine the weight of the object O.

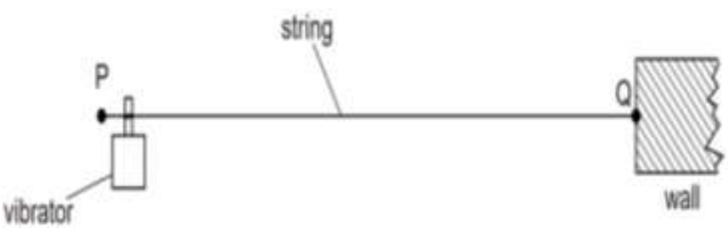
A. 27 N
B. 8.5 N
C. 19 N
D. 21 N

67. Which of the following is true about the concept of equilibrium to explain why a force must act on the rod at A?

A. For forces in equilibrium, the resultant force (and moment) = 0
B. Upward force does not equal downward force
C. Horizontal component of T not balanced by forces shown
D. All of the above.

Questions 68-70 refer to the diagram below.

The figure below shows a string stretched between two fixed points P and Q



A vibrator is attached near end P of the string. End Q is fixed to a wall. The vibrator has a frequency of 50 Hz and causes a transverse wave to travel along the string at a speed of 40 m s^{-1}.

68. Calculate the wavelength of the transverse wave on the string.

A. 1.9 m
B. 0.8 m
C. 2.5 m
D. 1.2 m

69. How would the arrangement in the figure above be explained to produce a stationary wave on the string?

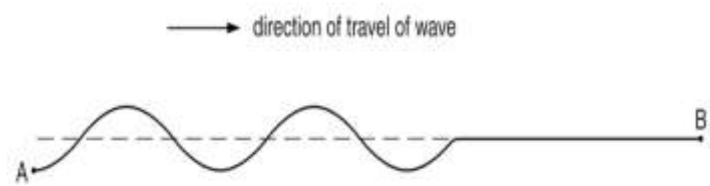
A. Waves travel perpendicular to the string and reflect at Q.
B. Waves travel transversely towards a fixed end.
C. Incident and reflected waves cancel each other.
D. Incident and reflected waves interfere / superpose.

70. Choose the length that the string PQ in the figure above must have so that a stationary wave can exist in the string.

A. 1.2 m
B. 2.4 m
C. 3.5 m
D. 4.2 m

Questions 71 – 74 refer to the diagram below.

A long rope is held under tension between two points A and B. Point A is made to vibrate vertically and a wave is sent down the rope towards B as shown in the figure below.



The time for one oscillation of point A on the rope is 0.20 s. The point A moves a distance of 80 mm during one oscillation. The wave on the rope has a wavelength of 1.5 m.

71. Displacement may be explained as

A. displacement is the distance moved by the wave or particle after a disturbance.
B. displacement is the sum of the height of disturbance of a wave.
C. displacement is the time taken for a wave or particle to traverse similar points in the propagation of the wave.
D. displacement is the distance the rope or particles are above or below from the equilibrium undisturbed position.

72. Calculate the amplitude for the wave on the rope in the figure above.

A. 20 mm
B. 600 mm
C. 80 mm
D. 120 mm

73. Calculate the speed of the wave on the rope in the figure above.

A. 15 m s^{-1}
B. 7.5 m s^{-1}
C. 5.0 m s^{-1}
D. 22 m s^{-1}

74. The motion of the wave in the figure above may be described as…………

A. transversal as particles/rope movement is perpendicular to direction of travel.
B. progressive as energy OR peaks OR troughs are cancelled.
C. the velocity of the wave changes as the wave propagate.
D. there is no conservation of the energy of propagation.

75. Charge may be defined as……………

A. Charge is the amount of voltage flowing per unit time.
B. Charge is the power of an electric current.
C. The amount of charge that flows per unit time is equal to the electric current.
D. Charge is the potential difference between terminals.

Questions 76 -79 refer to the information below:
A heater is made from a wire of resistance 18.0 Ω and is connected to a power supply of 240 V. The heater is switched on for 2.60 ms.

76. Calculate the power transformed in the heater

A. 4820W
B. 11600W
C. 3200W
D. 620W

77. Calculate the current in the heater

A. 15.2A
B. 13.3A
C. 32.5A
D. 14.8A

78. Calculate the charge passing through the heater in this time

A. 3.47×10^{7} C
B. 1.65×10^{11} C
C. 2.08×10^{5} C
D. 4.49×10^{3} C

79. Calculate the number of electrons per second passing a given point in the heater

A. 7.44×10^{12}
B. 8.35×10^{19}
C. 3.58×10^{22}
D. 4.62×10^{34}

Questions 80 – 81 refer to the information below.

A polonium nucleus ${}^{210}_{84}\mathrm{Po}$ is radioactive and decays with the emission of an α-particle. The nuclear reaction for this decay is given by

$${}^{210}_{84}\mathrm{Po} \longrightarrow {}^{W}_{X}\mathrm{Q} + {}^{Y}_{Z}\alpha.$$

80. Which of the following set of values is correct?

W	X		Y	Z
A.	208	80	2	4
B.	206	82	4	2
C.	214	86	4	2
D.	212	88	2	4

81. Why does the mass seem not to be conserved in the reaction?

A. Because energy is absorbed
B. Because mass is broken down
C. Because mass-energy is conserved
D. Because photons are matter

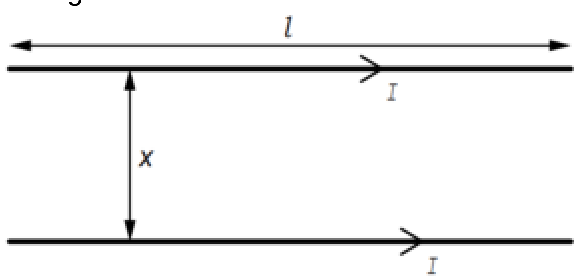
82. When a reaction is spontaneous, this means the reaction is…………..

A. not affected by external conditions of temperature and pressure
B. very slow that it need energy to be added
C. fast but with no explosion
D. explosive after adding heat

83. What is the SI units of force?

A. $kg^2\ m\ s^{-2}$
B. $kg\ m^2\ s^{-2}$
C. $kg\ m\ s^{-2}$
D. $kg^2\ m^2\ s^{-2}$

84. Two wires each of length l are placed parallel to each other a distance x apart, as shown in the figure below



Each wire carries a current I. The currents give rise to a force *F* on each wire given by

$F = \frac{KI^2 l}{x}$ where K is a constant.

Determine the SI units of the constant K.

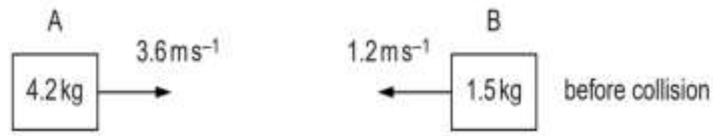
A. $kg^2\ m\ s^{-2}\ A$
B. $kg\ m\ s^{-2}\ A^{-2}$
C. $kg\ m^2\ s^{-2}\ A^{-2}$
D. $kg^2\ m^2\ s^{-2} A^2$

85. State the difference between an elastic and an inelastic collision.

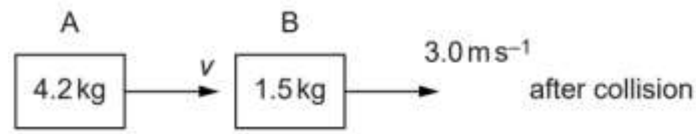
A. elastic: relative speed of approach is faster than the relative speed of separation
B. inelastic: kinetic energy is summative with mass.
C. Kinetic energy is constant in both elastic and inelastic collisions.
D. elastic: total kinetic energy is conserved, inelastic: loss of kinetic energy

Question 86 and 87 refer to the diagram below.

An object A of mass 4.2 kg and horizontal velocity 3.6 m s^{-1} moves towards object B as shown in the figure below. Object B of mass 1.5 kg is moving with a horizontal velocity of 1.2 m s^{-1} towards object A.



The objects collide and then both move to the right, as shown in figure below. Object A has velocity *v* and object B has velocity 3.0 m s^{-1}.



86. Calculate the velocity *v* of object A after the collision.

A. 13.3 ms^{-1}
B. 2.1 ms^{-1}
C. 15.2 ms^{-1}
D. 4.6 ms^{-1}

87. Calculate a set of values that determine whether the collision is elastic or inelastic

	Initial $_{KE}$	Final $_{KE}$
A.	28	16
B.	16	42
C.	24	18
D.	12	26

88. Stress may be defined as………

A. the size of an area multiplied by the force applied.
B. force acting in all directions on an object.
C. force per unit cross-sectional area.
D. the distance along which a force is acting.

Questions 89 – 90 refer to the information below:
The Young modulus of the metal of a wire is 0.17 TPa. The cross-sectional area of the wire is 0.18 mm^2. The wire is extended by a force *F*. This causes the length of the wire to be increased by 0.095 %.

89. Calculate the stress in the wire.

A. 1.6×10^8 Pa
B. 3.0×10^{11} Pa
C. 0.025×10^{29} Pa
D. 7.32×10^{19} Pa

90. Then what is the value of the force *F* from the information above.

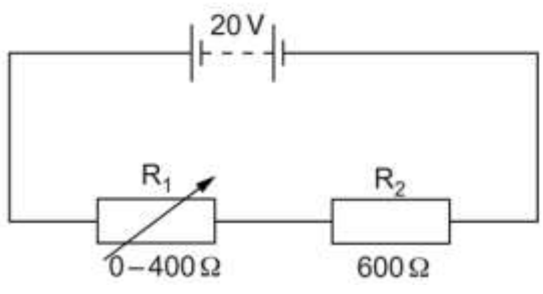
A. 29 N
B. 350 N
C. 25 N
D. 7.0 N

91. What is potential difference (p.d.)?

A. different forms of electricity.
B. force acting in generating electricity.
C. total energy transferred.
D. work done per unit charge transferred.

Questions 92 – 93 refer to the diagram below:

A battery of electromotive force 20 V and zero internal resistance is connected in series with two resistors R_1 and R_2, as shown in the figure below.



The resistance of R_2 is 600 Ω. The resistance of R_1 is varied from 0 to 400 Ω.

92. Calculate the maximum p.d. across R_2

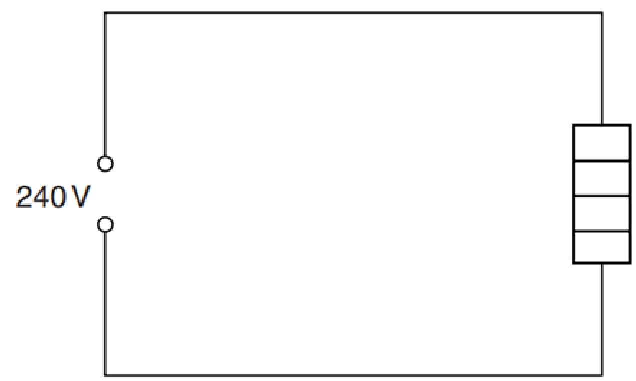
A. 28 V
B. 20 V
C. 45 V
D. 72 V

93. Calculate the minimum p.d. across R_2

A. 12 V
B. 56 V
C. 200 V
D. 18 V

Questions 94 – 97 refer to the diagram and information below:

A power supply of e.m.f. 240 V and zero internal resistance is connected to a heater as shown in the figure below.



The wires used to connect the heater to the power supply each have length 75 m. The wires have a cross-sectional area 2.5 mm^2 and resistivity 18 nΩ m. The heater has a constant resistance of 38 Ω.

94. Calculate the resistance of the wire in the figure above.

A. 540 Ω
B. 18 Ω
C. 38 Ω
D. 0.54 Ω

95. Calculate the current in the wires in the figure above.

A. 2.84 A
B. 6.14 A
C. 17.4 A
D. 0.22 A

96. Calculate the power loss in the wires in the figure above.

A. 18 W
B. 210 W
C. 41 W
D. 64 W

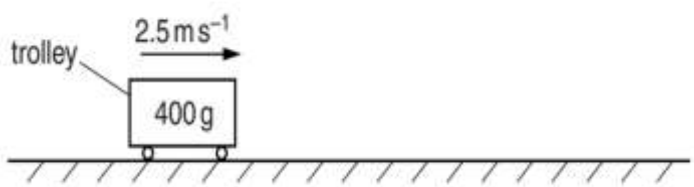
97. The wires to the heater are replaced by wires of the same length and material but having a cross-sectional area of 0.50 mm^2. What effect does this have on the power loss in the wires?

A. R = 1/A therefore R is greater.
B. Current is increased as cross sectional area decreases.
C. Area of wire is less (1/5) hence resistance greater (×5)
D. p.d. across wires greater so power loss in wires decreases

98. What is meant by work done?

A. displacement in the direction of the force.
B. force moves perpendicular to the direction of the force.
C. work done = force × time over which the force is applied.
D. the pressure applied over a unit area.

99. A trolley of mass 400 g is moving at a constant velocity of 2.5 m s^{-1} to the right as shown in the figure below.



Calculate the kinetic energy of the trolley.

A. 0.40 J
B. 2.50 J
C. 1.25 J
D. 1.30 J

100. A ball is thrown vertically down towards the ground with an initial velocity of 4.23 m s^{-1}. The ball falls for a time of 1.51 s before hitting the ground. Air resistance is negligible.

Determine the downwards velocity of the ball when it hits the ground.

A. 32.4 m s^{-1}
B. 19.0 m s^{-1}
C. 21.7 m s^{-1}
D. 4.23 m s^{-1}

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m\cdot s^{-2}$
Universal gravitational constant	G	$6{,}67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Radius of Earth	R_E	$6{,}38 \times 10^6\ m$
Mass of Earth	M_E	$5{,}98 \times 10^{24}\ kg$
Speed of light in a vacuum	c	$3{,}0 \times 10^8\ m\cdot s^{-1}$
Planck's constant	h	$6{,}63 \times 10^{-34}\ J\cdot s$
Coulomb's constant	k	$9{,}0 \times 10^9\ N\cdot m^2\cdot C^{-2}$
Charge on electron	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass	m_e	$9{,}11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE

MOTION

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

WORK, ENERGY AND POWER

$W = F\Delta x\cos\theta$	$U = mgh$ or $E_P = mgh$
$K = \frac{1}{2}mv^2$ or $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

FORCE

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or $g = G\frac{M}{r^2}$

WAVES, SOUND AND LIGHT

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

ELECTRIC CIRCUITS

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

ALTERNATING CURRENT

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

ELECTROSTATICS

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

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard temperature	T^{θ}	273 K
Charge on electron	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE

$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$c=\frac{n}{V}$ or $c=\frac{m}{MV}$	$n=\frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b}=\frac{n_a}{n_b}$	$pH = -log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ or $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ or $E^{\theta}_{cell} = E^{\theta}_{oxidising agent} - E^{\theta}_{reducing agent}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY

Atomic number	29
Electronegativity	1,9
Symbol	Cu
Approximate relative atomic mass	63,5

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

TABLE 4A: STANDARD REDUCTION POTENTIALS

Half-reactions			E^{θ} (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(l) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(l)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	$\rightleftharpoons$	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Al^{3+} + 3e^-$	$\rightleftharpoons$	Al	− 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05

Increasing oxidising ability

Increasing reducing ability

TABLE 4B: STANDARD REDUCTION POTENTIALS

Half-reactions			E^{θ} (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	− 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$Al^{3+} + 3e^-$	$\rightleftharpoons$	Al	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$2H^+ + 2e^-$	$\rightleftharpoons$	$H_2(g)$	0,00
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(l)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(l) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

Increasing oxidising ability

Increasing reducing ability