LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL

SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1) AND CHEMISTRY (P2)

PRE-TRIAL EXAM

22 AUGUST 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 5 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of 7 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

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QUESTION 1 (Start on a new page)

1.1 If $X = \frac{\Delta n}{\Delta t}$ applies to chemical reactions, where Δn = change in number of moles and Δt = time interval, then X probably represents …

A equilibrium constant.

B yield of products.

C heat of reaction.

D rate of reaction. (2)

1.2 Consider the following hypothetical reaction which is at equilibrium:

$$2XY(s) \rightleftharpoons 2X(\ell) + Y_2(g)$$

The pressure of the system is INCREASED.

How will the CONCENTRATION of $Y_2(g)$ and the value of K_C be affected (**at constant temperature**) when the new equilibrium is established?

	CONCENTRATION of $Y_2(g)$	**K_C VALUE**
A	Unchange	Unchange
B	Decrease	Decrease
C	Increase	Increase
D	Decrease	Unchange

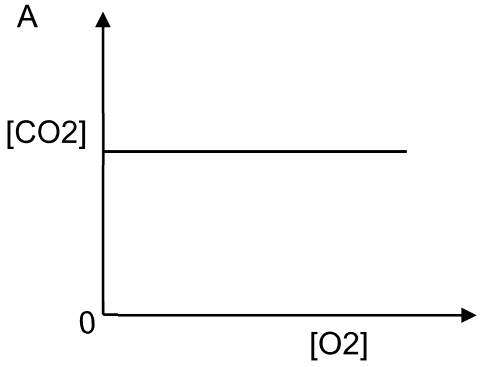
(2)

1.3 Consider the following equilibrium reaction equation:

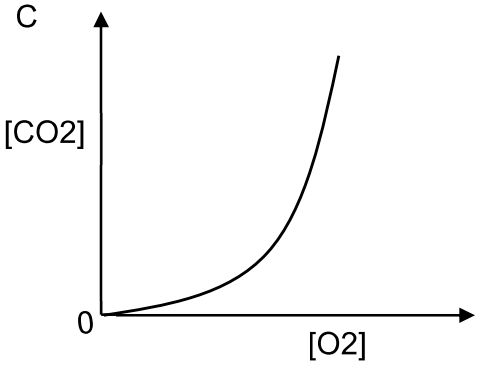
$$C(s) + O_2(g) \rightleftharpoons CO_2(g)$$

Which ONE of the following graphs BEST represents the relationship between $[CO_2]$ and $[O_2]$ at CONSTANT TEMPERATURE?

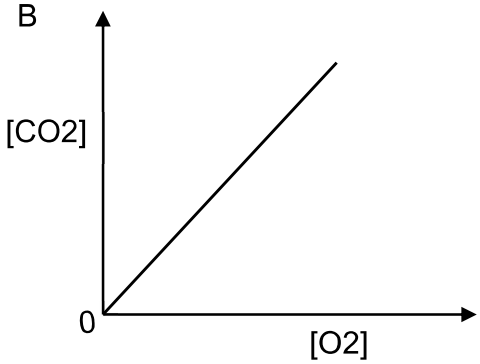
A



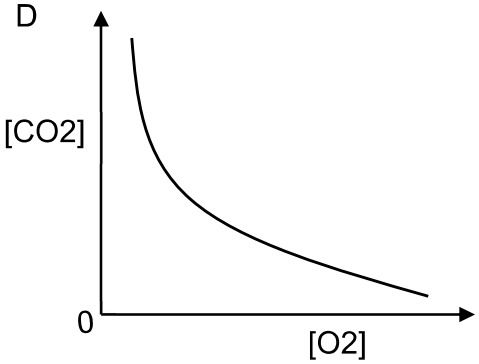
C



B



D



(2)

1.4 The engine of a car does work, W, to increase the velocity of the car from v to 2v. The work done by the engine of the same car to increase the velocity from 2v to 4v, is …

A W

B 2W

C 3W

D 4W (2)

[8]

QUESTION 2 (Start on a new page)

2.1 Two experiments are performed, with everything the same EXCEPT that one experiment is done at 20°C, and the other is done at 60°C. It is found that the experiment at 20°C takes 320 s and the experiment at 60°C takes 80 s. For each question, write down the LETTER from the LIST below which represents the BEST possible answer.

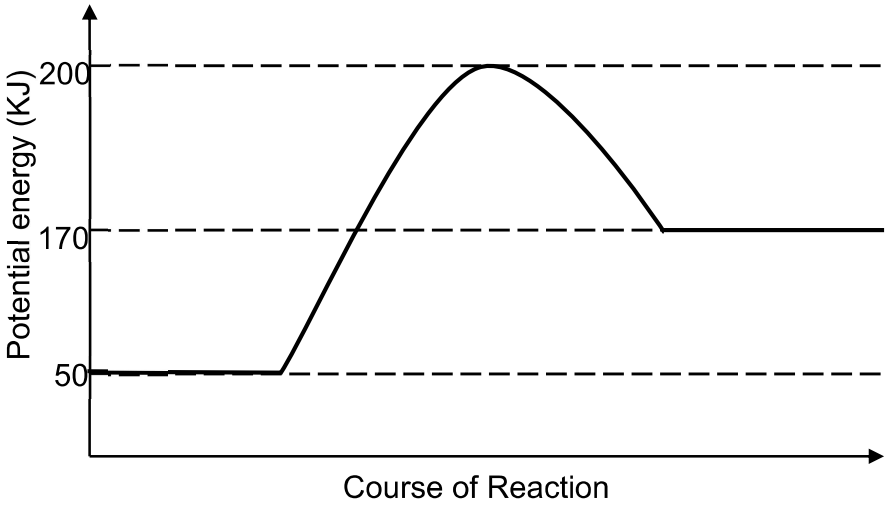
V	The rate of reaction increases when temperature is increased.
W	The rate of reaction is higher at 60°C than at 20°C.
X	Is the rate of a reaction higher at 60°C than at 20°C?
Y	How does increasing temperature affect the rate of a reaction?
Z	The rate of reaction is 4 times faster at 60°C than at 20°C.

2.1.1 Investigative question. (1)

2.1.2 Hypothesis. (1)

2.1.3 Conclusion. (1)

2.2 A learner conducts a practical investigation in order to test whether the dissolution of solid ammonium chloride is **exothermic** or **endothermic.** The apparatus used include a beaker, a salt and a *certain measuring instrument*. The graph below shows the energy changes that occur when ammonium chloride dissolves in water.



2.2.1 Name the measuring instrument that must be used during this investigation. (1)

2.2.2 Will the reading on the instrument used in QUESTION 2.2.1 INCREASE, DECREASE or REMAIN THE SAME during the course of the reaction? Explain the answer with reference to the graph. (2)

For this reaction, calculate:

2.2.3 The heat of reaction (2)

2.2.4 Activation energy (1)

In another experiment, a learner adds a catalyst. On addition of a catalyst, state whether the following will INCREASE, DECREASE or REMAIN THE SAME:

2.2.5 Potential energy of the products (1)

2.2.6 Activation energy (1)

[11]

QUESTION 3 (Start on a new page)

A group of chemistry learners use the reaction between magnesium and sulphuric acid to investigate one of the factors that affects reaction rates.

3.1 Define the term *reaction rate* in words. (2)

They add 2,4 g of magnesium ribbon to EXCESS dilute sulphuric acid and measure the mass of magnesium used per unit time.

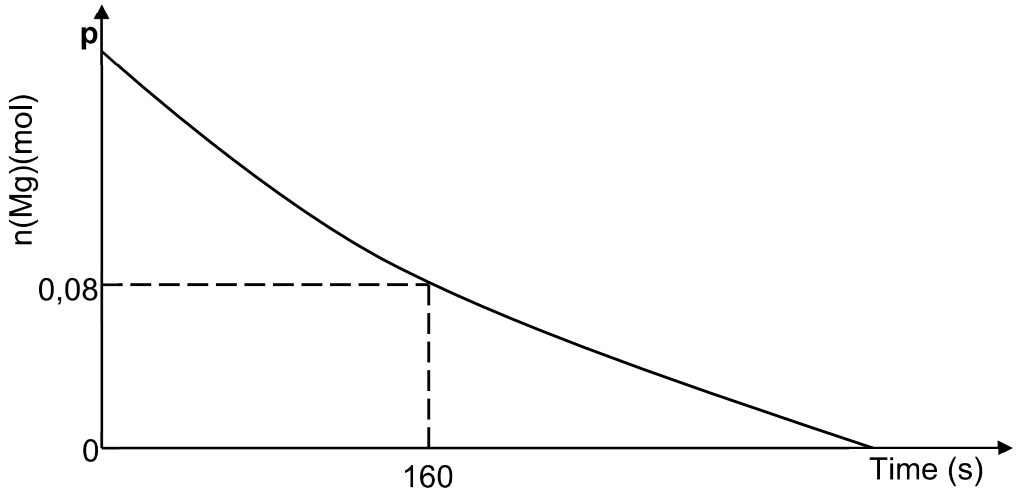
$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

3.2 Suggest a reason as to why the acid must be in excess. (1)

The learners repeat the experiment using EXCESS **concentrated sulphuric acid**.

3.3 Provide a reason why the learners use the SAME amount (in grams) of magnesium ribbon in BOTH experiments. (1)

The results obtained for the reaction using DILUTE sulphuric acid are represented in the graph below.



3.4 Determine the value of **p** (shown in the graph). (3)

3.5 Using the graph, calculate the mass of magnesium used from t = 0 s to t = 160 s. (3)

3.6 Hence, find the average reaction rate (in $g \cdot s^{-1}$) during the FIRST 160 s. (2)

3.7 Copy the graph above in the ANSWER BOOK (Label it **R**). On the same set of axes, use a dotted line to show the curve that will be obtained when CONCERNTRATED sulphuric acid is used. (Label it **S**). No numerical values needed. (2)

3.8 Use the collision theory to explain the difference in the two graphs. (3)
[17]

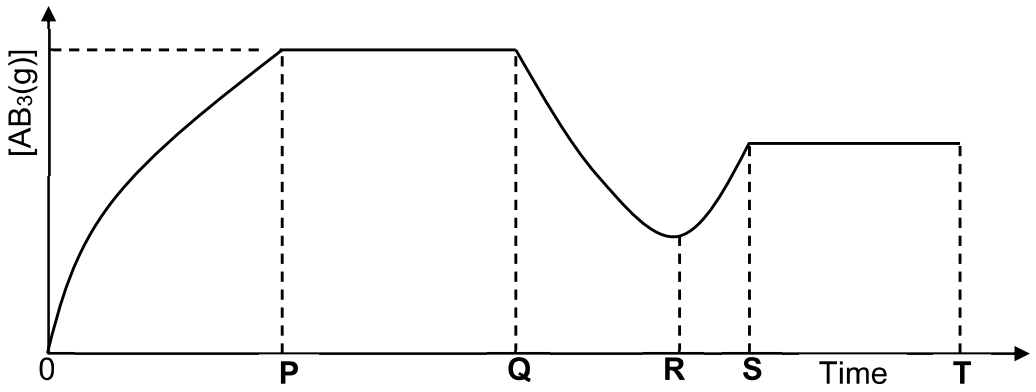
QUESTION 4 (Start on a new page)

4.1 Consider the following equilibrium reaction equation:

$$A_2(g) + 3B_2(g) \rightleftharpoons 2AB_3(g), \Delta H<0$$

4.1.1 Write down ONE condition necessary for a chemical system to be in equilibrium. (1)

A graph showing the concentration of $AB_3(g)$ produced versus time is plotted below.



How does the rate of the FORWARD REACTION compare to the rate of the REVERSE REACTION during the following intervals? (Write down only: GREATER THAN, EQUAL TO or LESS THAN).

4.1.2 OP (1)

4.1.3 QR (1)

4.1.4 ST (1)

Changes are made to the graph from **Q** to **S** due to changes in the temperature.

4.1.5 At which point (**Q**, **R** or **S**) will the temperature be GREATEST? Justify the answer. (2)

4.1.6 At which point (**Q**,**R** or **S**) will the value of K_C be the SMALLEST? (1)

4.1.7 If the changes in the graph from **Q** to **S** are due to pressure changes, at which point (**Q**,**R** or **S**) will the pressure be the HIGHEST? Explain the answer. (2)

4.2 Initially, 0,086 mol of Br_2 is placed in a 1,26 dm^3 flask and heated to 1 680 K, a temperature at which the halogen dissociates to atoms according to the following equation:

$$Br_2(g) \rightleftharpoons 2Br(g),\ \Delta H>0$$

$Br_2(g)$ is 4,8% dissociated at 1 680 K.

Calculate the equilibrium constant for this reaction at 1 680 K. (6)

[15]

QUESTION 5 (Start on a new page)

5.1 Hydrochloric acid (HCℓ) is added to distilled water.

5.1.1 Write down the balanced equation for the ionisation of hydrochloric acid in water. (2)

5.1.2 Classify hydrochloric acid as a STRONG acid or WEAK acid. (1)

5.2 Calculate the concentration of the hydroxide (OH^-) ions in a sulphuric acid solution with a pH = 3,5 at 25°C. (3)

5.3 A standard solution of oxalic acid ($(COOH)_2$) is prepared by dissolving 3,8 g of the acid in 250 cm^3 of distilled water. The acid is titrated against an impure solution of sodium hydroxide (NaOH). The impure solution of sodium hydroxide is prepared by dissolving 5,0 g of the impure mixture in 250 cm^3 of distilled water. (Assume that the impurities do not react). In a titration, 25,0 cm^3 of the impure sodium hydroxide is neutralized by 30 cm^3 of the acid.

$$(COOH)_2\,(aq) + 2NaOH(aq) \rightarrow (COONa)2(aq) + 2H_2O(\ell)$$

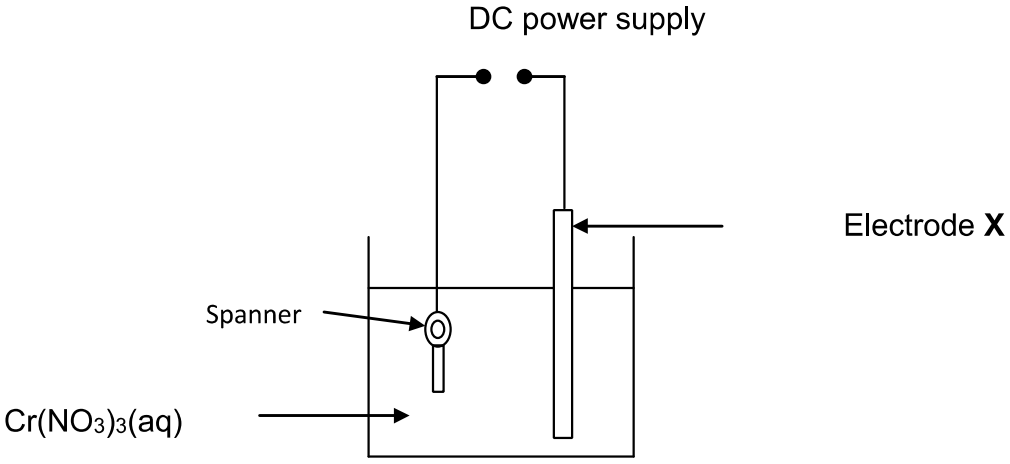
5.3.1 Is an aqueous solution of $(COONa)_2$ *acidic, basic* or *neutral*? Explain the answer with the aid of a chemical reaction equation. (3)

5.3.2 Calculate the concentration of the oxalic acid solution. (3)

5.3.3 Calculate the mass of the impurities contained in the 5,0 g of the impure sodium hydroxide. (6)
[18]

QUESTION 6 (Start on a new page.)

The diagram below represents a simplified electrolytic cell used to electroplate a spanner with chromium. The spanner is continuously rotated during the process of electroplating.



A constant current passes through the solution and the concentration of $Cr(NO_3)_3(aq)$ remains constant during the process. In the process, a total of 0,03 moles of electrons is transferred in the electrolytic cell.

6.1 Define the term *electrolysis*. (2)

6.2 State the energy conversion that takes place in the above cell. (1)

6.3 Write down the:

6.3.1 Half-reaction that occurs at the spanner (2)

6.3.2 NAME or FORMULA of the metal of which electrode **X** is made (1)

6.3.3 NAME or FORMULA of the oxidising agent (1)

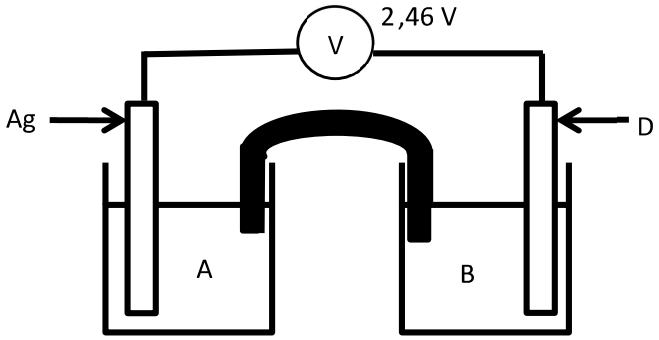
6.4 Give a reason why the concentration of the $Cr(NO_3)_3(aq)$ remains constant during the process. (2)

6.5. State on reason why the spanner is electroplated. (1)

[10]

QUESTION 7(Start on a new page)

A standard electrochemical cell is set up, using silver and an unknown electrode, D, as shown in the sketch below,. The initial reading on the voltmeter is 2,46 V. After the cell was connected for some time, the mass of the silver electrode increased.



7.1 What process takes place at the silver electrode? Choose from OXIDATION or REDUCTION. (1)

7.2 Define an *oxidising agent* in terms of electron transfer. (2)

7.3 Write down the NAME of a solution which can be used in beaker A. (1)

7.4 Determine the standard electrode potential for electrode D and identify D from the standard potential table. (5)

7.5 Write down the cell notation for this cell. (3)

[12]

QUESTION 8 (Start on a new page)

During an investigation to verify the speed of sound, Mr Chiv use a siren with a single frequency of 400 Hz, mounted on a remote-controlled toy car. With the siren activated, he move the car along a 5 m track at a constant velocity of 7,50 $m \cdot s^{-1}$. One of the learners stands halfway down the track and records the sound emitted by the siren for the duration of the motion on the cellphone. They are expecting to record two different pitches of the sound emitted by the siren.

8.1 For this investigation, write down the:

8.1.1 Independent Variable (1)

8.1.2 Dependent Variable (1)

8.1.3 ONE control Variable (1)

8.2 Write down the NAME of and state in words, the phenomenon on which the learners depends in order to calculate the speed of sound. (3)

When playing back the sound recorded on the cellphone in the presence of a frequency meter, two different notes were registered: One with a frequency of 409 Hz and the other with a frequency lower than 400 Hz.

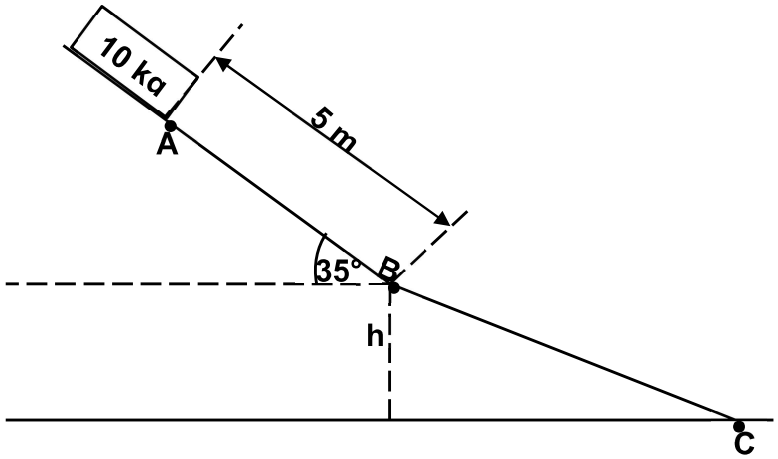
8.3 Using the frequency of one of the recorded notes, calculate the speed of sound in air. (3)

One of the uses of this phenomenon is in ultrasound.

8.4 State ONE application of ultrasound in the medical field. (1)
[10]

QUESTION 9 (Start on a new page)

9.1 A crate of mass 10 kg slides FROM REST down path **ABC**, as shown in the diagram below.



Along the portion **A** to **B**, the coefficient of kinetic friction between the crate and the surface is 0,16. The distance from **A** to **B** is **5 m**.

9.1.1 Define the term *conservative force*. (2)

9.1.2 Draw a labelled free-body diagram for the crate as it slides along portion **AB**. (3)

9.1.3 Write down the work-(kinetic) energy theorem in words. (2)

9.1.4 Use the work-(kinetic) energy theorem to calculate the speed of the crate as it reaches point **B**. (5)

The crate reaches point **C** with a speed of 8,5 $m \cdot s^{-1}$.

9.1.5 Assume portion **BC** is smooth (frictionless) and calculate the vertical height, **h**, of **B** above **C**, **using energy principles**. (4)

9.2 Water is pumped from a borehole 100 m deep. A pump with a power output of 2,3 kW (2 300 W) is used.

9.2.1 Define the term *power* as applied in physics. (2)

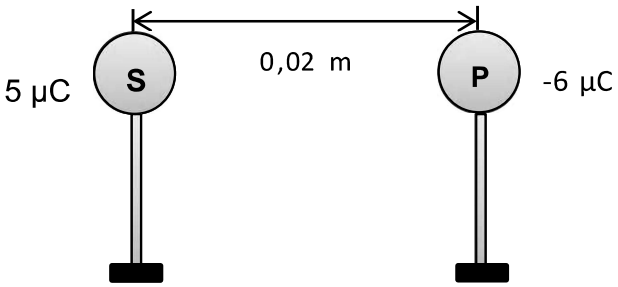
9.2.2 Calculate the time (in seconds) taken for the pump to bring the 500 kg of water to the surface. (3)

[21]

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QUESTION 10 (Start on a new page)

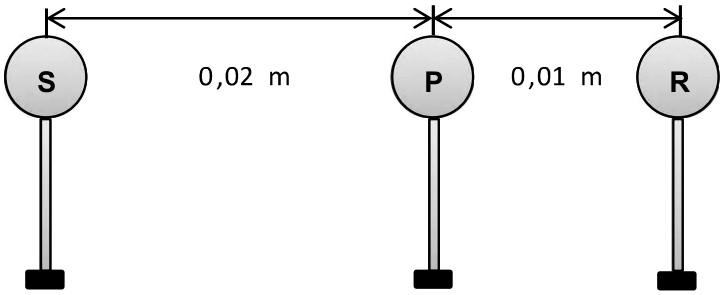
Two charged spheres, **S** and **P**, on insulated stands, with charges of 5 µC and -6 µC respectively, are placed 0,02 m apart, as shown in the diagram below.



10.1 State *Coulombs' Law* in words. (2)

10.2 Calculate the magnitude and direction of the electrostatic force that sphere **S** exerts on sphere **P**. (4)

Spheres **S** and **P** are brought into contact with each other and then returned to their original positions. A third, negatively charged, sphere **R** with an UNKNOWN charge is now placed 0,01 m to the right of sphere **P** as shown below.



10.3 Calculate the magnitude of the NEW charge on **S** after being in contact with **P**. (1)

10.4 Draw a free-body diagram showing ALL the electrostatic forces experienced by **P**. (2)

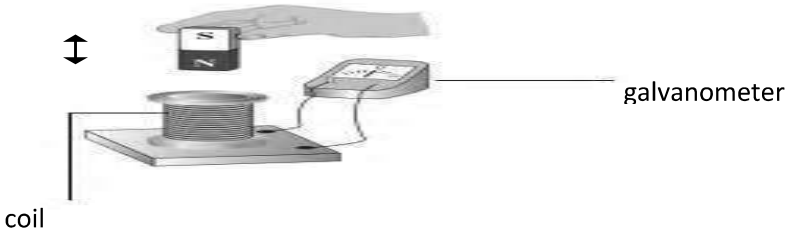
10.5 The magnitude of the net electrostatic force experienced by **P** due to **S** and **R** is 84,375 N. Calculate the magnitude of the charge on **R**. (5)

10.6 Calculate the magnitude of the net electric field at a point 0,01 m to the LEFT of **R** due to the charges on **S** and **R**. (3)
[17]

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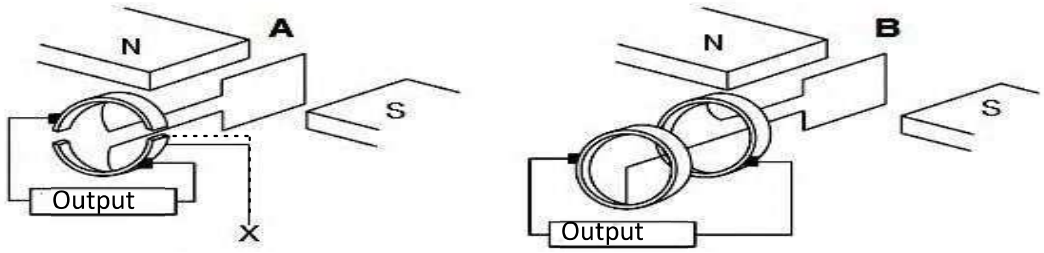
QUESTION 11 (Start on a new page.)

11.1 A teacher demonstrates how current can be obtained using a bar magnet, a coil and a galvanometer. The teacher moves the bar magnet up and down, as shown by the arrow in the diagram below.



11.1.1. Briefly describe how the magnet must be moved in order to obtain a LARGE deflection on the galvanometer. (2)

The two devices, **A** and **B**, below operate on the principle described in QUESTION 11.1.1 above.



11.1.2 Write down the name of the principle. (1)

11.1.3 Write down the name of part **X** in device **A**. (1)

11.2 A 240 V, AC voltage is supplied from a wall socket to an electric kettle of resistance 40 Ω. Wall sockets provide rms voltages and currents.

Calculate the:

9.2.1 Electrical energy consumed by the kettle per second (4)

9.2.2 Maximum (peak) current through the kettle (3)
[11]

Total Marks: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS*:*

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

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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/*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

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

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $p_{gemid} = Fv_{gemid}$	

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/*of* $E = \frac{hf}{\lambda}$

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ELECTROSTATICS

$F = \frac{K_{Q1}K_{Q2}}{r^2}$	$E = \frac{KQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	Emf (ε) = I(R + r)
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\Delta t$

$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $\mathbf{W = \frac{V^2 \Delta t}{R}}$	$P = \frac{W}{\Delta t}$ $P = Vi$ $P = I^2R$ $P = \frac{V^2}{R}$

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ATERNATING CURRENT

$I_{rms} = \frac{1_{max}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ $P_{ave} = I_{rms}^2R$ $P_{ave} = \frac{v_{rms}^2}{R}$

PAPER 2 (CHEMISTRY)

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{C_bV_b}{C_aV_a} = \frac{n_b}{n_a}$	$pH = -log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	

NAME	SYMBOL	VALUE
Avogadro's constant	N_A	$6,02X10^{23}$ mol^{-1}

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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 He 4
2,1 1 H 1																	
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	1.8 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	1.8 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

KEY/SLEUTEL

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

29
1,9 Cu
63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa