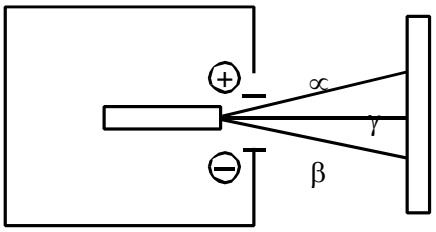
PART A

This part of the examination comprises questions 1 to 9.
Each question is worth 4 marks.
Answer all the questions in your answer booklet by blackening the letter of the answer chosen.

1 When radiation emitted from the element polonium passes between the positive and negative plates of an electrical field, the gamma rays pass straight through, unaffected by the field.



Which of the following best explains this phenomenon?

A) The electrical field is not strong enough.

B) The gamma rays are very penetrating.

C) The gamma rays are moving at extremely high speeds.

D) The gamma rays are not attracted by either plate.

2 Thomson's atomic model is represented as a positive sphere with electrons embedded on the surface.

Which of the following statements are *TRUE* according to Thomson's model?

1. Matter is electrically neutral.
2. Atoms have positive and negative charges.
3. Atoms are almost completely empty.
4. Electrons move around the nucleus.
5. Atoms cannot gain or lose electrons.
6. Matter can produce static electricity.

A) 1, 2 and 6

B) 1, 2 and 3

C) 3, 4 and 5

D) 4, 5 and 6

3 Element X has three stable isotopes and an atomic number of 10.

Isotope	Number of Neutrons	Relative abundance (%)
1	10	95.92
2	11	0.26
3	12	?

Which of the following represents the atomic mass of element X?

A) 10.0 μ

B) 20.0 μ

C) 20.1 μ

D) 20.8 μ

4 **Which of the following statements defines a one-ampere current?**

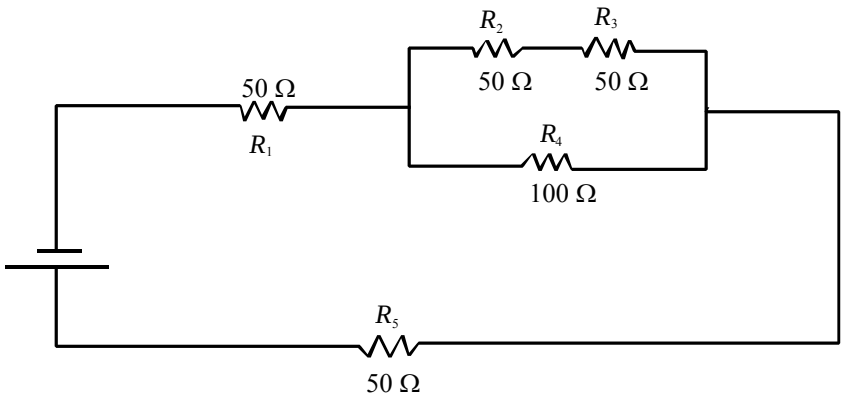
A) The energy of one joule used to move one coulomb of charge

B) The energy of one joule that flows through an electric circuit in one second

C) The rate that energy is used per second

D) The flow of one coulomb of electrons in one second

5 The following circuit consists of a power supply and five resistors (R_1, R_2, R_3, R_4 and R_5).



What is the equivalent resistance of the entire circuit (R_{eq})?

A) 150 Ω

B) 200 Ω

C) 250 Ω

D) 300 Ω

6 A cellular phone, operating on a 7.2 volt battery, is used for 8 minutes and 20 seconds.

Which of the following is a measure of the electrical current intensity the phone requires if it consumes 2.88 kJ of electrical energy?

A) 4.0×10^{-1} A

B) 8.0×10^{-1} A

C) 4.9×10^{-2} A

D) 8.0×10^{-4} A

7 **Which of the following substances, when dissolved in water, *WILL NOT* form ions?**

1.	$C_6H_{12}O_6$	4.	LiCl
2.	H_2SO_4	5.	O_2
3.	$Ca(OH)_2$	6.	CH_3OH

A) 1, 2 and 3

B) 1, 5 and 6

C) 2, 3 and 4

D) 4, 5 and 6

8 You are given 1 mole of $CaCO_3$, NaOH and O_2.

Which of the following quantities is the *SAME* for all three chemicals?

A) Mass

B) Number of atoms

C) Number of molecules

D) Volume

9 Iron ore, Fe_2O_3, reacts with carbon, C, to produce iron, Fe, according to the balanced chemical equation:

$$Fe_2O_3 + 3\,C \rightarrow 2\,Fe + 3\,CO$$

What mass of carbon is required for every 6 moles of Fe_2O_3 used?

A) 2 g

B) 18 g

C) 216 g

D) 670 g

PART B

This part of the examination comprises questions 10 to 15.
Each question is worth 4 marks.
Answer all these questions in the answer booklet provided.

10 **What is the correct molecular formula of a compound formed by an element "Y" from group IV A (4) and an element "Z" from group VI A (16)?**

Give the correct molecular formula for this compound.

Explain your answer by taking into account the bonding ability and/or valence electrons of an element "Y" from Group IV A (4) and an element "Z" from Group VI A (16).

Show all your work.

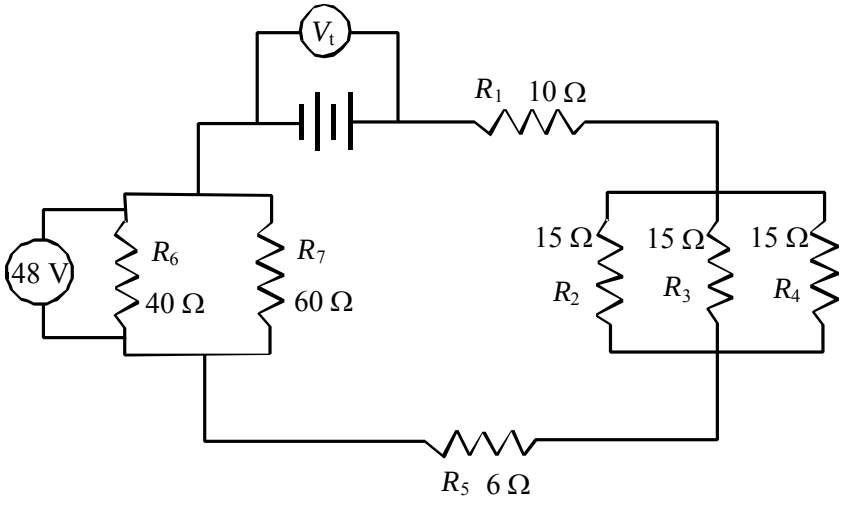
11 It took four minutes to boil (100°C) 900 mL of water in a kettle. The kettle was connected to a 120-V power source, with a current of 12.5 A.

What was the initial temperature of the water?

(Assume there was no energy loss: 100 % efficiency).

Show all your work.

12 **What is the total voltage V_t (voltage at source) of the following circuit?**



Show all your work.

13 A solution of potassium hydroxide, KOH, has a pH of 13.

What is the hydroxide ion, OH^-, concentration of this KOH solution?

Show all your work.

14 Using 300 mL of a 2.0 mol/L solution of copper sulfate, $CuSO_4$, a student must prepare a 0.50 mol/L solution of copper sulfate.

What volume of H_2O must be added to prepare the 0.50 mol/L solution?

Show all your work.

15 In a car battery, lead, Pb, lead oxide, PbO_2, and sulfuric acid, H_2SO_4, react to produce lead sulfate, $PbSO_4$, and water according to the following balanced equation:

$$Pb + PbO_2 + 2\ H_2SO_4 \rightarrow 2\ PbSO_4 + 2\ H_2O$$

What mass of Pb would react to produce 28.71 g of $PbSO_4$?

Show all your work.

2- CORRECTION KEY

Part A

4 marks or 0 marks

1 D

2 A

3 C

4 D

5 A

6 B

7 B

8 C

9 C

Part B
Questions 10 to 15

10 **Examples of an appropriate and complete explanation**

Explanation based on bonding:

Element Y from Group IV A (4) can form 4 bonds. Element Z from Group VI A (16) can form 2 bonds. In order to fulfill bonding potential of Y and Z, the formula should be YZ_2.

Explanation based on valence electrons:

Element Y has 4 valence electrons and can donate 4 electrons. Element Z has 6 valence electrons and can receive 2 electrons. In order to fulfill bonding potential of Y and Z, the formula should be YZ_2.

Explanation using any acceptable diagram.

(example: Lewis diagram)

Answer **The molecular formula of the compound is YZ_2.**

4 marks	Appropriate explanation and formula
3 marks	Appropriate explanation, incomplete formula with minor errors (e.g. wrote the formula Y_2Z_4)
2 marks	Incomplete explanation and correct formula (ex. crossover rule with no explanation)
1 mark	Correct formula only
0 marks	Inappropriate explanation and incorrect formula (e.g. Y_2Z)

11 **Examples of an appropriate and complete procedure**

E_{used} = VIt

= (120 V) (12.5 A) (4 min × 60 sec/min)

= 3.6×10^5 J

$Q_{absorbed}$ = $mc\Delta T$

= $(900\text{ g})\left(4.19\ \frac{\text{J}}{\text{g} \bullet °\text{C}}\right)(100°\text{C} - T_{initial})$

Assume $E_{used} = Q_{absorbed}$ (given 100% efficiency)

$3.6 \times 10^5\text{ J} = (900\text{ g})\left(4.19\ \frac{\text{J}}{\text{g} \bullet °\text{C}}\right)(100°\text{C} - T_{initial})$

$\frac{3.6 \times 10^5\text{ J}}{3.77 \times 10^3\ \frac{\text{J}}{°\text{C}}} = 100°\text{C} - T_{initial}$

$95.49°\text{C} = 100°\text{C} - T_{initial}$

$T_{initial} = 100°\text{C} - 95.49°\text{C}$

$T_{initial} = 4.51°\text{C}$

Answer **The initial temperature was 4.5°C.**

4 marks The student chose an appropriate procedure and applied it correctly; the final answer is correct.

3 marks The student chose an appropriate procedure, but made minor errors in applying it (calculation or transcription errors, incorrect or missing unit of measurement, number rounded off incorrectly); the final answer is incorrect, or it is correct purely by chance.

2 marks The student chose an appropriate procedure, but made major errors in applying it (errors related to methods, rules, laws, systems, or theories); the final answer is incorrect, or it is correct purely by chance.

1 mark The student's procedure was partially appropriate (i.e. it does not lead to the correct answer, but at least one of the steps is relevant and presented correctly); the answer is missing or incorrect, or it is correct purely by chance.

0 marks The student showed no work or chose an inappropriate procedure; the answer is missing or incorrect, or it is correct purely by chance.

12 **Example of an appropriate and complete procedure**

1. Equivalent resistance at R_6 and R_7

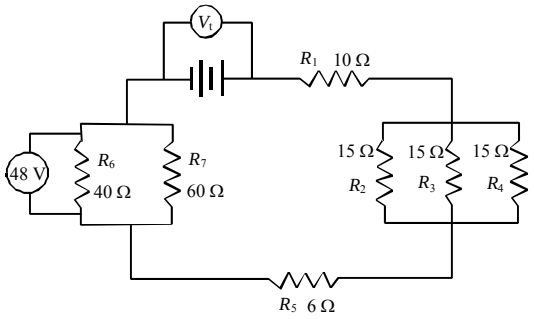
$$\frac{1}{R_{eq1}} = \frac{1}{R_6} + \frac{1}{R_7} = \frac{1}{40\,\Omega} + \frac{1}{60\,\Omega} = 24\,\Omega$$

2. Current intensity through R_{eq1} (Voltage in parallel is equal)

$$I = \frac{V_6}{R_{eq1}} = \frac{48\text{ V}}{24\,\Omega} = 2\text{ A}$$ (Current Intensity in series is equal)

3. Equivalent resistance at R_2, R_3, R_4

$$\frac{1}{R_{eq2}} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{15\,\Omega} + \frac{1}{15\,\Omega} + \frac{1}{15\,\Omega} = 5\,\Omega$$



4. Total resistance

$$R_t = R_{eq1} + R_{eq2} + R_1 + R_5 = 24\,\Omega + 5\,\Omega + 10\,\Omega + 6\,\Omega = 45\,\Omega$$

5. Total Voltage

$$V_t = IR = 2\text{ A} \times 45\,\Omega = 90\text{ V}$$

Answer **The total voltage, V_t, is 90 V.**

4 marks	The student chose an appropriate procedure and applied it correctly; the final answer is correct.
3 marks	The student chose an appropriate procedure, but made minor errors in applying it (calculation or transcription errors, incorrect or missing unit of measurement, number rounded off incorrectly); the final answer is incorrect, or it is correct purely by chance.
2 marks	The student chose an appropriate procedure, but made major errors in applying it (errors relating to methods, rules, laws, systems or theories); the final answer is incorrect, or it is correct purely by chance.
1 mark	The student procedure was partially appropriate (i.e. it does not lead to the correct answer, but at least one of the steps is relevant and presented correctly); the answer is missing or incorrect, or it is correct purely by chance.
0 marks	The student showed no work or chose an inappropriate procedure; the answer is missing or incorrect, or it is correct purely by chance.

13 **Examples of an appropriate and complete procedure**

pH	=	13
pOH	=	14 – pH
pOH	=	14 – 13
pOH	=	1
OH^- concentration	=	1.0×10^{-1} mol/L

Answer **The OH^- concentration is 1.0×10^{-1} mol/L.**

4 marks The student chose an appropriate procedure and applied it correctly; the final answer is correct.

2 marks The student chose an appropriate procedure, but made major errors in applying it (errors related to methods, rules, laws, systems or theories); the final answer is incorrect, or it is correct purely by chance.
(e.g. Student gives pOH instead of OH^- concentration.)

1 mark The student's procedure was partially appropriate (i.e. it does not lead to the correct answer, but at least one of the steps is relevant and presented correctly); the answer is missing or incorrect, or it is correct purely by chance.
(e.g. Student gives correct answer, but no explanation.)

0 marks The student showed no work or chose an inappropriate procedure; the answer is missing or incorrect, or it is correct purely by chance.

14 **Example of an appropriate and complete procedure**

Calculations:

$$c_1V_1 = c_2V_2$$

$$\therefore V_2 = \frac{c_1V_1}{c_2} = \frac{2.0\ \text{mol/L} \times 300\ \text{mL}}{0.50\ \text{mol/L}}$$

$$= 1200\ \text{mL or } 1.2\ \text{L}$$

The resulting solution having a concentration of 0.50 mol/L will be 1200 mL (1.2 L).

Since 300 mL of initial solution (V_1) was used, (1200 mL – 300 mL), represents the amount of H_2O that must be added to the initial solution.

1200 mL – 300 mL = 900 mL

Answer **The volume of water to be added is 900 mL.**

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer because of minor errors such as a calculation or transcription error, or an incorrect or missing unit of measurement
2 marks	Appropriate procedure, but incorrect answer because of major errors such as the incorrect application of a law, formula or rule (e.g. Forgetting to subtract the original 300 mL.)
1 mark	Partially appropriate and correctly completed procedure
0 marks	Procedure inappropriate or missing, regardless of the final answer

15 **Example of an appropriate and complete procedure**

1 mol 2 mol

$$\frac{Pb}{x} + PbO_2 + 2\,H_2SO_4 \rightarrow \frac{2\,PbSO_4}{28.71\,g} + 2\,H_2O$$

207.2 g 606.4 g

$$\frac{Pb}{x} + PbO_2 + 2\,H_2SO_4 \rightarrow \frac{2\,PbSO_4}{28.71\,g} + 2\,H_2O$$

207.2 g of Pb reacts with 606.4 g $PbSO_4$
x reacts with 28.71 g $PbSO_4$

x = 9.81 g of Pb

Answer **9.81 g of Pb would react to produce 28.71 g of $PbSO_4$.**

4 marks Appropriate procedure and correct answer

3 marks Appropriate procedure, but incorrect answer because of minor errors such as an error in calculation or transcription or missing units of measurement

2 marks Appropriate procedure, but incorrect answer because of major errors (e.g. all the necessary work done properly, but based on an incorrect molar mass)

1 mark Partially appropriate and correctly completed procedure
(e.g. only calculated molar masses)

0 marks Procedure inappropriate or missing, regardless of the final answer