SMARTWIZ

GRADE12 PHYSICAL SCIENCE EXAM

MARKS: 150

MARKS	

TIME: 2. 5 HOURS

SCHOOL _____

CLASS (eg. 4A) _____

SURNAME _____

NAME _____

Instructions for Learners:

- Read all instructions carefully before you begin the exam.
- Write your full name and student number clearly on the answer sheet/book.
- Answer all questions unless otherwise instructed.
- Show all your work/calculations where necessary.
- Write neatly and clearly.
- Use only a blue or black pen. Do not use correction fluid or tape.
- Electronic devices (calculators, cell phones, etc.) are not allowed unless explicitly permitted.
- Raise your hand if you have any questions.
- Do not talk to other learners during the exam.
- Any form of dishonesty will result in immediate disqualification from the exam.

This exam consists of Eight pages, including the cover page.

SECTION A: PHYSICS (75 MARKS)

QUESTION 1: MULTIPLE CHOICE QUESTIONS (5 × 2 = 10)

Choose the correct answer (A–D) and write only the letter next to the number.

1.1 A free-body diagram shows:
A. All forces acting on an object ✓
B. Motion of a body
C. The net force only
D. Force between two objects
Answer: _____

1.2 The unit of impulse is:
A. N·m B. kg·m²/s² C. kg·m/s D. N/s
Answer: _____

1.3 A circuit obeys Ohm's Law if:
A. It contains only capacitors
B. Current is not proportional to voltage
C. Resistance changes with temperature
D. Current is proportional to voltage
Answer: _____

1.4 The Doppler effect explains:
A. Changes in wavelength due to interference
B. Apparent frequency change due to motion
C. Reflection of light
D. Refraction of sound
Answer: _____

1.5 Which part of the electromagnetic spectrum has the longest wavelength?
A. Ultraviolet
B. Infrared
C. Gamma rays
D. Radio waves
Answer: _____

QUESTION 2: IMPULSE AND MOMENTUM (12 MARKS)

A 150 g cricket ball is bowled at 18 $m \cdot s^{-1}$ and is hit back by the bat at 24 $m \cdot s^{-1}$ in the opposite direction. The bat is in contact with the ball for 0.02 s.

2.1 Define impulse. (2)

2.2 Calculate the impulse delivered by the bat. (4)

2.3 Determine the average force exerted by the bat. (3)

2.4 Is momentum conserved in this scenario? Briefly explain. (3)

QUESTION 3: WORK, ENERGY & POWER (15 MARKS)

A 100 kg load is lifted vertically by an electric motor to a height of 15 m in 10 seconds.

3.1 Calculate the work done. (3)

3.2 Calculate the power output of the motor. (3)

3.3 If the motor is only 75% efficient, calculate the energy supplied to it. (3)

3.4 Define mechanical power. (2)

3.5 List two reasons energy might be lost in this system. (4)

QUESTION 4: ELECTROMAGNETISM & INDUCED CURRENT (13 MARKS)

A conductor is moved through a magnetic field at constant speed.

4.1 State Faraday's Law of electromagnetic induction. (3)

4.2 How can the induced current be increased? Give two methods. (2)

4.3 What is the function of a slip ring in an AC generator? (2)

4.4 A coil with 200 turns is rotated in a magnetic field of strength 0.3 T. The area of the coil is 0.05 m² and it completes one rotation every 0.1 s. Calculate the maximum emf induced. Use:
emfmax=NABω\text{emf}_{max} = NAB\omegaemfmax=NABω
Where ω=2πT\omega = \frac{2\pi}{T}ω=T2π (6)

QUESTION 5: DOPPLER EFFECT (10 MARKS)

An ambulance moving at 30 m·s⁻¹ approaches a stationary observer. The siren emits a frequency of 700 Hz. Speed of sound = 340 m·s⁻¹.

5.1 State the Doppler Effect. (2)

5.2 Calculate the frequency heard by the observer. Use:
f′=vv−vsff' = \frac{v}{v - v_s}ff′=v−vsvf
(4)

5.3 What happens to the pitch of the sound after the ambulance passes? Explain. (2)

5.4 Give one practical application of the Doppler Effect. (2)

SECTION B: CHEMISTRY (75 MARKS)

QUESTION 6: GASES AND THE MOLE CONCEPT (15 MARKS)

6.1 State the ideal gas law. (2)

6.2 A sample of gas occupies 0.5 dm³ at 300 K and 100 kPa. Calculate the number of moles using: PV=nRT(R=8.31 J\cdotpmol−1K−1)PV = nRT \quad (R = 8.31\, \text{J·mol}^{-1}\text{K}^{-1})PV=nRT(R=8.31J\cdotpmol−1K−1) (4)

6.3 Calculate the mass of oxygen gas present. ($M = 32\ g \cdot mol^{-1}$) (3)

6.4 A gas expands from 0.5 dm³ to 1.5 dm³ against a pressure of 100 kPa. Calculate the work done by the gas in joules. (4)
Use: W=pΔVW = p\Delta VW=pΔV (convert dm³ to m³)

6.5 Is this expansion endothermic or exothermic? Briefly explain. (2)

QUESTION 7: ENERGY CHANGES IN REACTIONS (10 MARKS)

The following reaction occurs:
C+O2→CO2+393 kJC + O_2 → CO_2 + 393 \text{ kJ}C+O2→CO2+393 kJ

7.1 Is this reaction endothermic or exothermic? Give a reason. (2)

7.2 Draw a labelled potential energy diagram for the reaction. (3)

7.3 Define activation energy. (2)

7.4 Suggest one way to lower the activation energy of a reaction. (1)

7.5 State one use of exothermic reactions in industry. (2)

QUESTION 8: RATES OF REACTION – PRACTICAL SKILLS (10 MARKS)

In an experiment, dilute hydrochloric acid is added to magnesium ribbon and the volume of hydrogen gas is recorded every 10 seconds.

8.1 Write the balanced chemical equation. (2)

8.2 State one variable that must be controlled in the experiment. (1)

8.3 Sketch a graph of volume of gas vs. time. (3)

- Label axes ✓
- Shape correct ✓
- Shows plateau ✓

8.4 What does the plateau indicate? (2)

8.5 How would increasing the concentration of HCl affect the rate? (2)

QUESTION 9: ORGANIC MOLECULES – POLYMERS & CRUDE OIL (10 MARKS)

9.1 What is cracking? Why is it important in industry? (2)

9.2 Write a balanced equation for the cracking of decane ($C_{10}H_{22}$) into octane and ethene. (2)

9.3 Name the polymer formed from ethene. (1)

9.4 State one environmental problem caused by polymers. (2)

9.5 Name two types of polymerisation. (2)

9.6 Is PVC a natural or synthetic polymer? (1)

QUESTION 10: ACID-BASE THEORIES AND TITRATION (10 MARKS)

10.1 Define a Brønsted-Lowry acid. (2)

10.2 In the reaction:
NH3+HCl→NH4++Cl−NH_3 + HCl → NH_4^+ + Cl^-NH3+HCl→NH4++Cl−
Identify the acid and base. (2)

10.3 What indicator is suitable for strong acid–weak base titration? (1)

10.4 A titration is performed using 25 cm^3 of NaOH. It neutralises 20 cm^3 of H_2SO_4 of concentration 0.1 $mol \cdot dm^{-3}$. Calculate the concentration of NaOH.
Balanced equation:
H2SO4+2NaOH→Na2SO4+2H2OH_2SO_4 + 2NaOH → Na_2SO_4 + 2H_2OH2SO4+2NaOH→Na2SO4+2H2O
(5)

TOTAL : 150

MEMO

SECTION A: PHYSICS (75 MARKS)

QUESTION 1: MULTIPLE CHOICE QUESTIONS

1.1 A ✓
1.2 C ✓
1.3 D ✓
1.4 B ✓
1.5 D ✓

QUESTION 2: IMPULSE AND MOMENTUM

2.1 **Impulse** is the product of the average force and the time interval during which the force acts; it equals the change in momentum. (2 marks)

2.2
Initial momentum: $p_i = mv_i = 0.150 \times 18 = 2.7\ \text{kg·m/s}$ $p_i = mv_i = 0.150 \times 18 = 2.7 \text{kg·m/s}$
Final momentum: $p_f = 0.150 \times (-24) = -3.6\ \text{kg·m/s}$ $p_f = 0.150 \times (-24) = -3.6 \text{kg·m/s}$ (negative since opposite direction)
Impulse = $\Delta p = p_f - p_i = -3.6 - 2.7 = -6.3\ \text{kg·m/s}$ $\Delta p = p_f - p_i = -3.6 - 2.7 = -6.3 \text{kg·m/s}$ (magnitude = 6.3) ✓✓✓✓

2.3
Average force $F = \frac{\text{Impulse}}{\Delta t} = \frac{6.3}{0.02} = 315\ \text{N}$ $F = \frac{\text{Impulse}}{\Delta t} = \frac{6.3}{0.02} = 315 \text{N}$ ✓✓✓

2.4
Momentum is **not conserved** for the ball alone because an external force (bat) acts on it. Momentum conservation applies to the system including bowler, ball, and bat. (3 marks)

QUESTION 3: WORK, ENERGY & POWER

3.1
Work done: $W = mgh = 100 \times 9.8 \times 15 = 14{,}700\ \text{J}$ $W = mgh = 100 \times 9.8 \times 15 = 14{,}700 \text{J}$ ✓✓✓

3.2
Power: P=Wt=1470010=1470 WP = \frac{W}{t} = \frac{14700}{10} = 1470\, \text{W}P=tW=1014700 =1470W ✓✓✓

3.3
Energy supplied: E=Wefficiency=147000.75=19600 JE = \frac{W}{\text{efficiency}} = \frac{14700}{0.75} = 19600\, \text{J}E=efficiencyW=0.7514700=19600J ✓✓✓

3.4
Mechanical power is the rate at which work is done or energy is transferred. (2 marks)

3.5
Energy losses due to: friction, heat loss, sound, air resistance, electrical resistance, etc. (any two) (4 marks)

QUESTION 4: ELECTROMAGNETISM & INDUCED CURRENT

4.1
Faraday's Law: The induced emf in a circuit is proportional to the rate of change of magnetic flux through the circuit. (3 marks)

4.2
Increase number of turns, increase magnetic field strength, increase area of coil, increase speed of rotation. (Any two) (2 marks)

4.3
Slip rings maintain electrical contact between rotating coil and stationary external circuit allowing AC current output. (2 marks)

4.4
Calculate angular velocity:
ω=2πT=2π0.1=62.83 rad/s\omega = \frac{2\pi}{T} = \frac{2\pi}{0.1} = 62.83\, \text{rad/s}ω=T2π=0.12π =62.83rad/s ✓
Calculate emf:
emfmax=NABω=200×0.05×0.3×62.83=188.5 V\text{emf}_{max} = N A B \omega = 200 \times 0.05 \times 0.3 \times 62.83 = 188.5\, \text{V}emfmax=NABω=200×0.05×0.3×62.83=188.5V ✓✓✓✓✓✓

QUESTION 5: DOPPLER EFFECT

5.1
Doppler effect: The change in frequency or wavelength of a wave observed due to relative motion between source and observer. (2 marks)

5.2
f′=vv−vsf=340340−30×700=340310×700=767.74 Hzf' = \frac{v}{v - v_s} f = \frac{340}{340 - 30} \times

700 = \frac{340}{310} \times 700 = 767.74\, \text{Hz}f′=v−vsvf=340−30340×700=310340×700=767.74Hz ✓✓✓✓

5.3
Pitch decreases after passing because the source moves away, causing observed frequency to drop. (2 marks)

5.4
Applications: Radar speed detection, medical ultrasound, astronomy, weather forecasting. (Any one) (2 marks)

SECTION B: CHEMISTRY (75 MARKS)

QUESTION 6: GASES AND MOLE CONCEPT

6.1
Ideal gas law: PV=nRTPV = nRTPV=nRT (2 marks)

6.2
P=100 kPa=100000 PaP = 100\, \text{kPa} = 100000\, \text{Pa}P=100kPa=100000Pa
V=0.5 dm3=0.0005 m3V = 0.5\, \text{dm}^3 = 0.0005\, \text{m}^3V=0.5dm3=0.0005m3
Rearranged: n=PVRT=100000×0.00058.31×300=0.020 moln = \frac{PV}{RT} = \frac{100000 \times 0.0005}{8.31 \times 300} = 0.020\, \text{mol}n=RTPV=8.31×300100000×0.0005=0.020mol ✓✓✓✓

6.3
Mass = n×M=0.020×32=0.64 gn \times M = 0.020 \times 32 = 0.64\, \text{g}n×M=0.020×32=0.64g ✓✓✓

6.4
ΔV=1.5−0.5=1.0 dm3=0.001 m3\Delta V = 1.5 - 0.5 = 1.0\, \text{dm}^3 = 0.001\, \text{m}^3ΔV=1.5−0.5=1.0dm3=0.001m3
Work done: W=pΔV=100000×0.001=100 JW = p \Delta V = 100000 \times 0.001 = 100\, \text{J}W=pΔV=100000×0.001=100J ✓✓✓✓

6.5
Expansion is endothermic because the gas does work on surroundings and absorbs heat. (2 marks)

QUESTION 7: ENERGY CHANGES

7.1
Exothermic; energy is released (393 kJ) during formation of CO_2. (2 marks)

7.2
[Diagram shows reactants at higher PE than products, energy released downward arrow labelled “393 kJ” and activation energy peak.] (3 marks)

7.3
Activation energy is the minimum energy required for reactants to convert to products. (2 marks)

7.4
Add catalyst. (1 mark)

7.5
Use in combustion engines, heat packs, industrial chemical manufacture. (2 marks)

QUESTION 8: RATES OF REACTION

8.1
Mg+2HCl→MgCl2+H2Mg + 2HCl → MgCl_2 + H_2Mg+2HCl→MgCl2+H2 (2 marks)

8.2
Concentration, temperature, surface area, pressure, catalyst, volume of acid. (Any one) (1 mark)

8.3
Graph: volume (y-axis), time (x-axis), curve rising steeply then plateauing. (3 marks)

8.4
Plateau indicates reaction completion (no more gas produced). (2 marks)

8.5
Increasing acid concentration increases collision frequency and rate of reaction. (2 marks)

QUESTION 9: ORGANIC MOLECULES

9.1
Cracking is breaking large hydrocarbons into smaller ones; important for fuel production. (2 marks)

9.2
C10H22→C8H18+C2H4C_{10}H_{22} → C_8H_{18} + C_2H_4C10H22→C8H18+C2H4 (2 marks)

9.3
Polymer formed from ethene is Polyethene (Polyethylene). (1 mark)

9.4
Pollution and difficulty in biodegradation. (2 marks)

9.5
Addition polymerisation, condensation polymerisation. (2 marks)

9.6
Synthetic polymer. (1 mark)

QUESTION 10: ACID-BASE THEORIES & TITRATION

10.1
Brønsted-Lowry acid is a proton (H^+) donor. (2 marks)

10.2
Acid: HCl, Base: NH_3. (2 marks)

10.3
Methyl orange or phenolphthalein (depending on strong acid–weak base). (1 mark)

10.4
Calculate moles H_2SO_4:
$n=C\times V=0.1\times 0.020=0.002$ moln = C \times V = 0.1 \times 0.020 = 0.002\, \text{mol}n=C×V=0.1×0.020=0.002mol
From balanced eq., 1 mol H_2SO_4 reacts with 2 mol NaOH:
$nNaOH=2\times 0.002=0.004$ moln_{\text{NaOH}} = 2 \times 0.002 = 0.004\, \text{mol}nNaOH =2×0.002=0.004mol
Volume NaOH = 25 cm^3 = 0.025 dm^3
Concentration NaOH:
$C=\frac{n}{V}=\frac{0.004}{0.025}=0.16$ mol\cdotpdm−3C = \frac{n}{V} = \frac{0.004}{0.025} = 0.16\, \text{mol·dm}^{-3}C=Vn=0.0250.004=0.16mol\cdotpdm−3 ✓✓✓✓✓

END OF MEMORANDUM