GRADE 11 EXAMINATION
NOVEMBER 2007

PHYSICAL SCIENCE: PAPER II
(CHEMISTRY FOCUS)

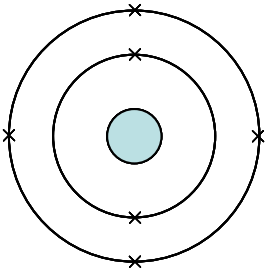
MARKING GUIDELINES

Time: 3 hours 150 marks

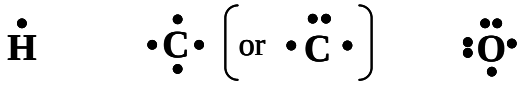
The marking guide is a working document prepared for use by teachers as they assess the Grade 11 externally set examinations.

There may be different interpretations of the marking guidelines but the teacher should keep as closely as possible to the suggested way of assessing. When in doubt, a teacher should check with another member of the cluster or with the relevant Assessment Specialist.

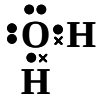
QUESTION 1

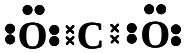
1.1 

Electron configuration of a C atom where X represents an electron (1)

1.2  (3)

For q 1.3 : 2 marks if correct, 0 if not completely correct.

1.3 (a)  (2)

(b)  (2)

1.4 (a) Polar molecule - a molecule with a distinct region ✓of +ve and - ve charge asymmetrically distributed✓
Non polar - a molecule that does not have a distinct region of +ve and –ve charge distributed asymetrically✓✓ (2)

(b) CO_2 is a symmetric ✓molecule, thus although the bonds are polar, the regions of ✓+ve and –ve charge are symmetrically distributed

δ- δ+ δ-
O == C == O

(2)

1.5 Gases that absorb ✓infrared radiation, trapping✓ heat in the Earth's atmosphere (2)

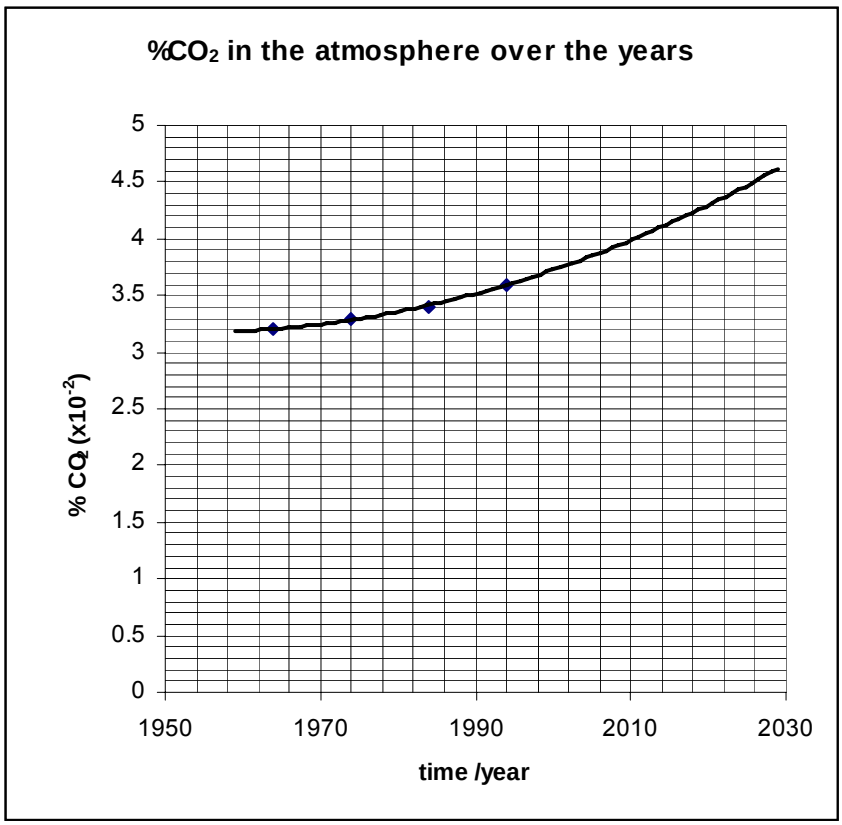
[14]

QUESTION 2

2.1 Year✓ - We choose✓✓ the time (in years) in which to read the %CO_2. (3)

2.2

Year	1964	1974	1984	1994	2004
%CO_2 by volume	0,032	0,033	0,034	0,036	0.038



Appropriate Scale ✓time; appropriate Scale✓ %CO_2; plot of points✓; curved line ✓; (4)

For 1 mark: ANY TWO OF:
- horizontal axis – label and units (years)
- vertical axis – label and units (% CO_2)
- heading to graph (1)

2.3 The increase of %CO_2 in the atmosphere per year or the time rate of increase in %CO_2 in the atmosphere. (2)

2.4 The slope is increasing with time (2)

2.5 Approximately 0.045 % in 2030 (2)

[14]

QUESTION 3

3.1

	Equation
1	$O_2 \xrightarrow{hf} O + O$ ✓
2	$O_2 + O \rightarrow O_3$ ✓
3	$2O_3 \xrightarrow{hf} 3O_2$ ✓

(3)

3.2 Ozone absorbs high energy ultraviolet light from the sun. ✓✓
Depletion would cause the high energy UV light to reach earth and cause harmful✓✓ effects such as cancers in humans. (4)
[7]

QUESTION 4

4.1 Q1 - Does the quantity of light falling on the absorbing surface affect the change in temperature of the air in the bottle ? ✓

Q2 - Does the absorbing surface affect the change in temperature of the air in the bottle ? ✓ (2)

4.2

	Independent variable	Dependent variable	Control variable
Q1	Quantity of light ✓	Temperature change✓	Absorbing surface✓
or			
Q2	Absorbing surface✓	Temperature change✓	Quantity of light✓

(3)

4.3 ✓✓The absorbing surface affects the rise in temperature of the air in the bottle (2)

4.4 ✓✓The bottles were placed at different positions relative to the lamp or the amount of light received changed (2)

4.5

(a) Clouds✓ (2)

(b) B, D and F would be cooler. ✓ Much of the light is reflected by the white paint.✓ (2)

(c) B, D and F would be warmer. ✓ The radiated heat would be reflected downwards by the white paint✓ (2)

[15]

QUESTION 5

5.1 A : Combustion✓ (or oxidation)
B : Elimination✓
C : Substitution✓
D : Addition✓ (4)

5.2 (a) Alkenes✓
(b) Unsaturated✓ (2)

5.3 (a)

-4 ✓ 0 ✓ ✓+4 -2✓
$CH_4 + 2O_2 \rightarrow CO_2 + H_2O$ (4)

(b) oxidation ✓ CH_4
Reduction ✓ O_2 (2)

[12]

QUESTION 6

6.1 (a) Liquid✓ - room temperature (approx. 20^0C) lies between✓ the melting point and boiling point, thus will be found in the liquid phase (2)

(b) Bonds✓ between the atoms in the molecule are strong✓ and stable (2)

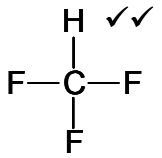
(c) Ultraviolet light breaks up the CFC. Cl atom is released which reacts with the O_3 molecule, ✓breaking the molecule down to form O_2 and ClO. The ClO molecule now combines with an O atom to release another Cl atom which repeats✓✓ the cycle of destroying the O_3 molecules. (3)

6.2 (a) The amount of energy required to break✓ a chemical bond OR the amount of energy✓ released when a chemical bond is formed. (for 2 marks give both) (2)

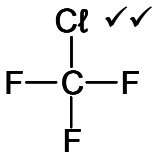
(b) The C – Cl bond requires only 330 kJ/mol of energy which is✓ less than the 400 kJ/mol of the UV light, thus UV light will cause the bond to break. The C – F bond✓ requires 450 kJ/mol of energy to break which is more than that of UV light and thus will not break. (2)

(c) The C – C✓ bond will also break as bond energy required to break it is less than that of UV light. ✓ (2)

(d) (4)



trifluoromethane



chlorotrifluoromethane

(4)

(e) Exothermic - chemical reaction during which energy is transferred to the surroundings✓ so that the temperature of the surroundings increase✓

Endothermic - chemical reaction during which energy is transferred from the surroundings✓ so that the temperature of the surroundings decrease ✓ (4)

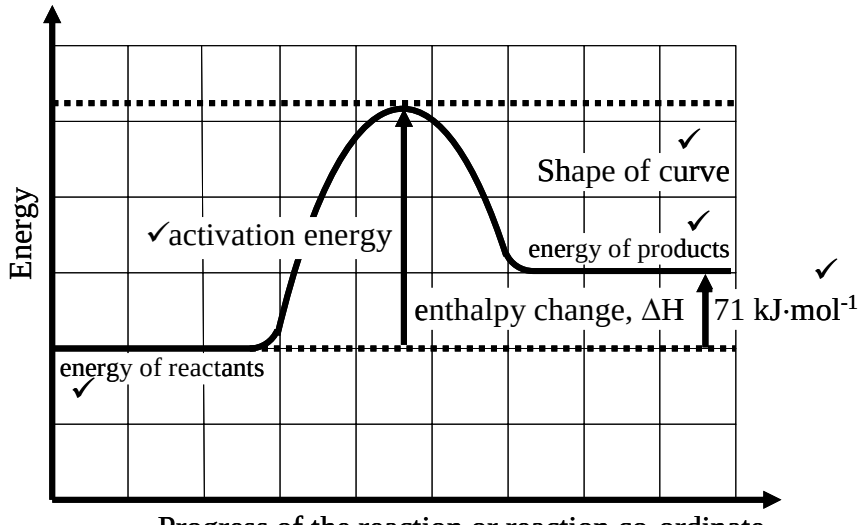
(f) (i) Endothermic✓
(ii) Exothermic✓ (2)

(g) (i) Reactants
3 x C – F bonds = 1350 kJ/mol ✓
1 x C – H bond = 435 kJ/mol✓
1 x Cl – Cl bond = 397 kJ/mol✓
2182 kJ/mol (3)

(ii) Products
3 x C – F bonds = 1350 kJ/mol
1 x C – Cl bond = 330 kJ/mol✓
1 x H – Cl bond = 431 kJ/mol✓
2111 kJ/mol (2)

(iii) Heat of reaction = $E_{reactants}$ - $E_{products}$ ✓
= 2182 – 2111
= + 71 kJ/mol✓ thus endothermic (2)

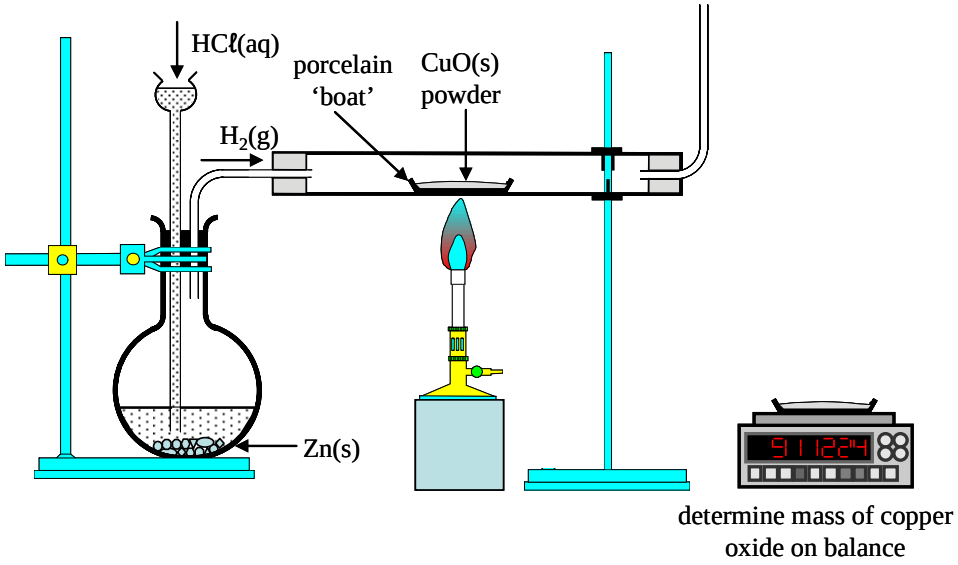
(h)



(5)
[35]

QUESTION 7

7.1



Copper oxide in the porcelain boat✓
Boat and copper oxide placed inside the horizontal tube. ✓
Hydrogen passed from the hydrogen generator through the tube✓
Burner beneath the boat containing the copper oxide✓ (4)

7.2

1. Find the mass of the boat. ✓
2. Find the mass of the boat and some copper oxide✓
3. Set the apparatus up as in the sketch✓
4. Generate hydrogen✓
5. Heat the copper oxide✓
6. Measure the mass of boat and copper✓
7. Complete the table✓
8. Calculate the formula ✓ (8)

7.3

	Mass / g
Mass of empty porcelain boat	15,00
Mass of boat and copper oxide before heating	18,97
Mass of copper oxide before heating	**3.97**✓
Mass of boat and copper after heating	18.17
Mass of copper after heating	**3.17**✓
Mass of oxygen removed	**0.80**✓

(3)

7.4 Mass of Cu = 3.17g

$\frac{3,17}{63,5}$ ✓ = 0.05 mol

Mass of O = 0,8g

✓ $\frac{0,80}{16}$ = 0,05 mol ✓

Ratio Cu : O = 1 : 1

Thus formula is **CuO** (3)

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QUESTION 8

8.1 Acid – base reaction ✓ Transfer of protons✓✓ (3)

8.2 Oxonium / hydronium ion✓ (1)

8.3 H_2SO_3 and HSO_4^- ✓
H_2O and H_3O^+ ✓ (2)

8.4 (a) $SO_2 + CaO \longrightarrow CaSO_3$

$M(CaSO_3) = 40 + 32 + 3 \times 16 = 120\ g \cdot mol^{-1}$ ✓

$$n(CaSO_3) = \frac{900\ 000\ g}{120\ g \cdot mol^{-1}} = 7500\ mol$$ ✓

From mole ratio: $SO_2 : CaSO_3 :: 1 : 1$ ✓

7500 mol $CaSO_3 \Rightarrow$ 7500 mol SO_2

Alternately

SO_2	+	CaO	$CaSO_3$
64 g			120g ✓
Xg			900 000g

$$X = \frac{900\ 000 \times 64\ g}{120}$$

X = 480 000 g of SO_2 used up ✓

$$n = \frac{m}{M}$$

$$= \frac{480\ 000}{64}$$ ✓

= 7500 mols of SO_2 used up (3)

(b) 1 mol occupies $22,4 dm^3$(l) at STP ✓

Thus. 7 500 mol will occupy 7500 x 22,4 ✓

= 168 000 l of SO_2 at STP (2)

[11]

QUESTION 9

9.1

Human activity	Chemical Processes on which the human activity is based	List of greenhouse gases emitted
Transport	Combustion of hydrocarbons✓	
Electric power generation	Combustion of coal and/or oil✓	
Manufacturing (e.g. blast furnace, refineries, …)	Reduction of ore, fractional distillation, production of refrigerants✓	
Waste Disposal	Decomposition of organic vegetable matter✓	

(4)

9.2

Human activity	Chemical Processes on which the human activity is based	List of greenhouse gases emitted
Transport	Combustion of hydrocarbons	CO NO_2 H_2O N_2O CO_2 ✓✓
Electric power generation	Combustion of coal and/or oil	CO_2 SO_2 H_2O ✓✓
Manufacturing (e.g. blast furnace, refineries, …)	Reduction of ore, fractional distillation, production of refrigerants	HFC's PFC's CO_2 SO_2 CH_4 ✓✓
Waste Disposal	Decomposition of organic vegetable matter	CH_4 H_2O✓✓

(8)

9.3 Advantages
- At this stage, resources readily available – coal is plentiful and cheap✓
- Mining coal provides jobs✓
- Electricity is clean in the home✓
- Electricity is a very easy and efficient way to transfer energy✓
- Electrical appliances take the drudgery out of life
- Preserve food (refrigeration) ✓
- Pleasure entertainment – movies, ✓
- Make work more efficient - computers ✓
- ONE FOR EACH UP TO A MAXIMUM OF 3

Disadvantages
- Production of Greenhouse gases ✓
- SO_2 and CO_2 are soluble and form acid rain ✓
- Gradual using up of natural resources ✓
- Electricity is dangerous and people are accidentally electrocuted from time to time ✓
- Reduced manual labour means people get less exercise, less healthy✓
- Coal mining is dangerous ✓
- Coal mines damage the environment – open pits where grassland or even farms ✓
- ONE FOR EACH UP TO A MAXIMUM OF 3

9.4 Take steps to reduce the emissions like smoke and pollutants like sulphur dioxide
Pay more attention to safety and health issues in mining.
Pay more attention to issues of efficiency to reduce waste and pollute unnecessarily.
Give one mark for any single piece of sensible advice up to a maximum of 2. (2)

9.5 Positive: lighter, less fuel required✓, reduction in carbon dioxide emissions per✓ kilometre per passenger, positive for reducing global warming✓.
Negative: Cheaper flights, more fly, more flights✓, increased carbon dioxide emissions, negative for global warming. ✓
Production: Disadvantages greater than advantages. Therefore increases global warming.
Marking: Give up to (3) for positives and negatives and (1) for connecting production to the stronger argument. (4)
[24]

Answers to Optional Questions

QUESTION 10

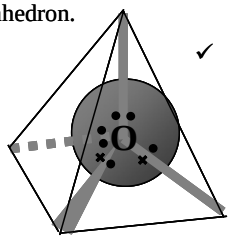
10.1 (a) A water molecule is bent✓ (1)

(b) A carbon dioxide molecule is linear✓ (1)

10.2 From the Lewis diagram of the water molecule we can see there are 4 electron pairs in the valence shell of the oxygen atom, two shared pairs and two lone pairs. VSEPR theory says that these valence shell electron pairs repel each other.

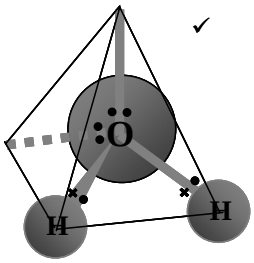
4 valence shell electron pairs around the central O-atom

The four negatively charged electron pairs repel each other . To be as far apart as possible in three dimensions the electron pairs are orientated as if to the vertices of a terahedron.



✓

Since only two of the electrons pairs are shared pairs (or bonding pairs) two hydrogen-atoms bond with the oxygen resulting in a bend shape



✓

(2)
[4]

QUESTION 11

11.1 (a) "a half life of 1600 years" means half of the number of atoms of the parent isotope decay into the daughter isotope after 1600 years ✓ (1)

(b) 4800 years represents 4800/1600 = 3 x half life ✓⇒ ½ x ½ x ½ x✓100 = 12.5% (2)

(c) 20% corresponds to 2.4 x the half life ✓= 2.4 x 1600 years ✓ = 3840 years (2)

11.2 $^{212}_{82}Pb$ ✓$\rightarrow$ $^{212}_{83}Bi$ ✓+ $^{0}_{-1}e$ ✓ (3)

11.3 (a) Reaction 2✓

(b) It is the nuclear reaction that powers the sun and supplies the Earth with virtually all its energy✓

(c) Reaction 1 is currently used on Earth to generate electricity✓

(d) Disadvantages: ✓

1. Reaction 2 produces radioactive waste that has a half life of thousands of years therefore cannot be disposed of and is very dangerous to humans and damages the environment.
2. Nuclear plants are expensive and potentially very dangerous.

Advantages:

1. They do not produce greenhouse gases and cause global warming.
2. the quantity of waste is small
3. they do not produce pollutants in the atmosphere like smoke.

ONE mark for any one of the above or any other advantage or disadvantage of generating electricity using nuclear fission. (4)

[12]

Grand total: 150 marks