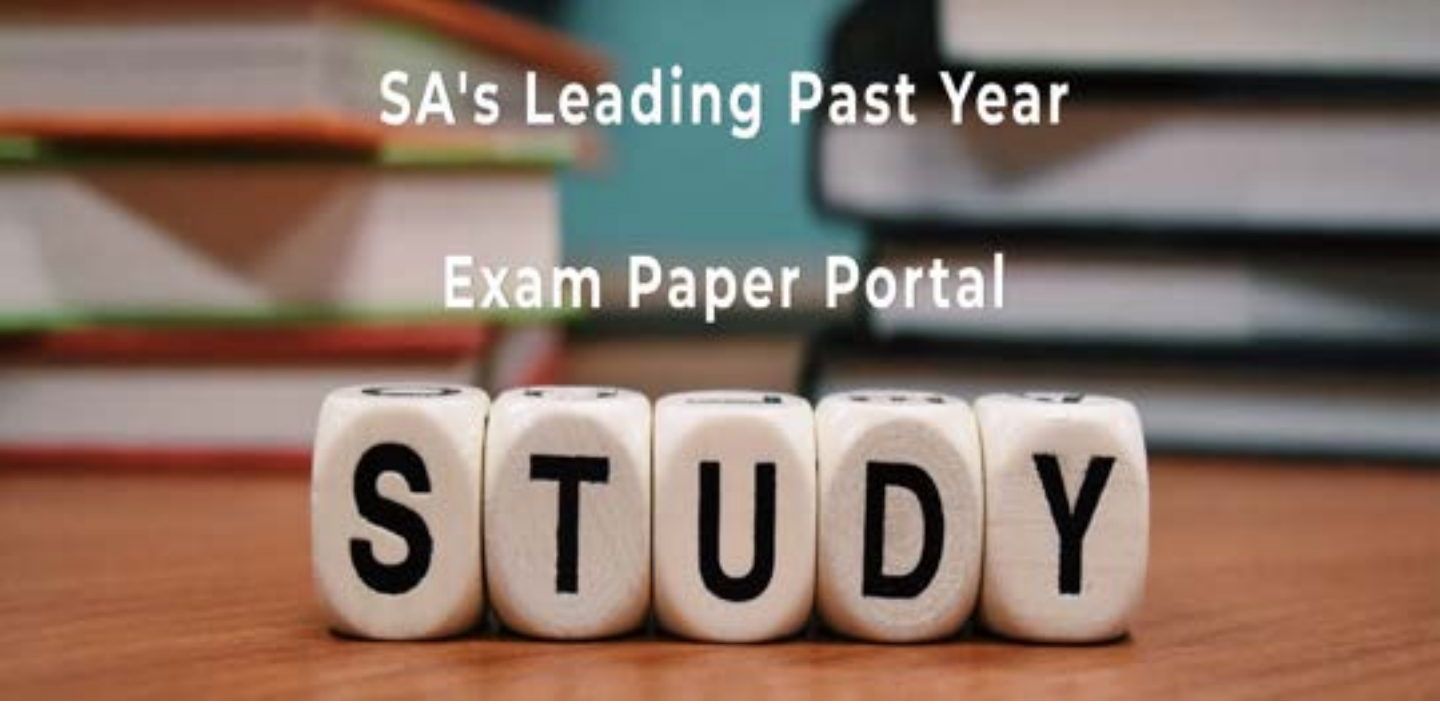

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GRADE 12

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

22 AUGUST 2022

MEMORANDUM

MARKS: 100

These marking guidelines consist of 10 pages.

QUESTION 1

1.1 D✓✓ (2)

1.2 A✓✓ (2)

1.3 B✓✓ (2)

1.4 D✓✓ (2)

[8]

QUESTION 2

2.1.1 Y✓ (Ask general question) (1)

2.1.2 V✓ (Predict) (1)

2.1.3 V ✓ (State) (1)

2.2.1 Thermometer✓ (1)

2.2.2 Decrease✓

- One mark the first bullet
  OR
- One mark for the second bullet

(2)

- The potential energy for the products is higher than that of the reactants/. The potential energy for the reactants is lower than that of products. ✓
- This shows that the reaction is endothermic/heat absorbing. ✓

2.2.3 $\Delta H = E_P(P) - E_P(R)$
$= 170 - 50$✓
$= 120$ KJ✓ (2)

2.2.4 $E_a = E_P(Ca) - E_P(R)$
$= 200 - 50$
$= 150$ KJ✓ (1)

2.2.5 Remain the same. ✓ (1)

2.2.6 Decrease. ✓ (1)
[11]

QUESTION 3

3.1 The change in concentration of products or reactants per unit time. ✓✓
OR:
The change in number of moles/ mass/ volume of reactants/products per unit time. ✓✓ (2)

3.2 To ensure that all the magnesium gets used up. ✓ (1)

3.3 To make it a fair comparison/test. ✓ (1)

3.4

$n_i(Mg) = \frac{m}{M}$✓
$= \frac{2,4}{24}$✓
$= 0,10$ mol
$\therefore P = 0,10$✓

(3)

3.5 **Positive marking from 3.4**

$n(Mg)_{used} = n_i - n_f$
$= 0,10 - 0,08$ ✓
$= 0,02$ mol

m(Mg)used= nM
$= (0,02)(24)$ ✓
$= 0,48$ g✓

Option 2: $\boldsymbol{m(Mg) = n.M}$
$= (0,1)(24)$
$= 2,4\ g \quad (it\ is\ given\ in\ the\ preamble)$
$\boldsymbol{m(Mg) = (0,08).(24)}$ ✓
$\boldsymbol{= 1,92\ g}$
$\boldsymbol{m(Mg)_{used} = 2,4}$ ✓ $\boldsymbol{- 1,92}$
$\boldsymbol{= 0,48\ g}$ ✓ ✓

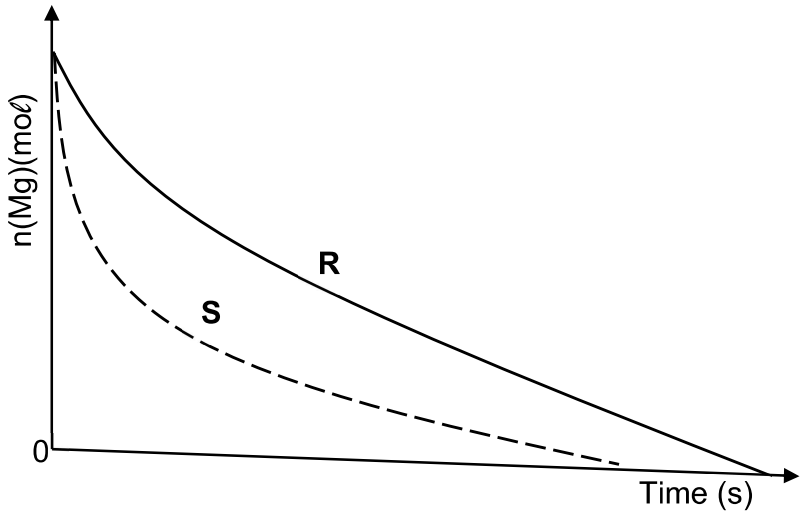
(3)

3.6 **Positive marking from 3.4 & 3.5**

Average rate = $\frac{m(Mg)_{used}}{Time\ taken}$
= $\frac{0,48}{160}$✓
= 3 x 10^{-3} g·s^{-1}✓

(2)

3.7



- Steeper gradient✓
- X – intercept for **S** smaller than for graph **R**✓

(2)

3.8

Higher concentration for curve **S** means:
• More reactant particles will be present in a given volume / More particles will have the correct orientation. ✓ • More effective collisions per unit time/Higher frequency of effective collisions. ✓ • Increased reaction rate. ✓
OR: Lower concentration for graph **R** means:
• Less reactant particles will be present in a given volume / Less particles will have the correct orientation. ✓ • Less effective collisions per unit time/ Lower frequency of effective collisions. ✓

• Decreased reaction rate. ✓

(3)
[17]

QUESTION 4

4.1.1 ANY ONE:
- Closed system✓
- Reversible reaction✓
- Accept isolated system✓

(1)

4.1.2 Greater than✓ (1)

4.1.3 Less than✓ (1)

4.1.4 Equal to✓ (1)

4.1.5 **R**✓
- The reverse reaction is endothermic and so the temperature is greatest where [AB_3 (g)] is lowest. ✓

(2)

4.1.6 **R**✓ (1)

4.1.7 **Q**✓
- An increase in pressure will the favour the forward reaction, resulting in the [AB_2] increasing.

Therefore, high pressure corresponds to a high [AB_3]. ✓ (2)

4.2

Equation	$Br_2(g)$	$\rightleftharpoons$ 2Br(g)
Ratio	1	2
Initial amount (mol)	0,086	0
Change in amount (mol)	$-4,128x10^{-3}$	$+8,256x10^{3}$✓
Equilibrium amount (mol)	0,081872	$8,256x10^{-3}$✓
$C = \frac{n}{v}$ (mol·dm^{-3})	0,06498	$6,5524x10^{-3}$✓

$$kc =$$

$n(Br_2)_{decomposed} = \frac{4,8}{100}(0,086)$

$= 4,128x10^{-3}$ mol

$kc = \frac{[Br]^2}{[Br_2]}$✓

$= \frac{(6,5524\times10^{-3})^2}{(0,06498)}$✓ (6)

$=6,61 \times 10^{-4}$✓

[15]

QUESTION 5

5.1.1 $HCl(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + Cl^-(aq)$ ✓✓ **Accept single arrow** (2)

5.1.2 Strong acid✓ (1)

5.2

OPTION 1:	**OPTION 2:**
$pH = -log[H_3O^+]$ 3,5 ✓$= -log[H_3O^+]$ $-3,5 = log[H_3O^+]$ $[H_3O^+]= 10^{-3,5}$ $[H_3O^+]= 3,1622 \text{ X } 10^{-4}$ mol·dm^{-3} $K_w = [H_3O^+][OH^-]$ $1 \text{ X } 10^{-14} = (3,16228 \text{ X } 10^{-4})[OH^-]$✓ $[OH^-]= 3,16228 \text{ X } 10^{-11}$ mol·dm^{-3}✓	$pH + pOH = 14$✓ pOH= 14 - pH = 14 ✓- 3,5 = 10,5 $pOH = -log[OH^-]$ 10,5 ✓$= -log[OH^-]$ $[OH^-] = 10^{-10,5}$ $[OH^-] = 3,16228 \text{ x } 10^{-11}$ ✓mol·dm^{-3}

(3)

5.3.1 Basic✓

- $(COO^-)_2(aq) + 2H_2O(l) \rightleftharpoons (COOH)_2(aq) + 2OH^-(aq)$ ✓
- Excess OH^- ions are formed✓
- Therefore the solution is basic
- Hence the pH > 7

(3)

5.3.2

$c = \frac{m}{MV}$✓

$=\frac{3,8}{(90)(0,25)}$✓

$=0,169$ mol·dm^{-3}✓

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

$=\frac{3,8}{90}$

$= 0,0422222$ mol

$\therefore c = \frac{n}{V}$ ✓

$= \frac{0,0422222}{0,25}$✓

$= 0,169$ mol·dm^{-3}✓

(3)

5.3.3

OPTION 1:	**OPTION 2:**
$P_aC_aV_a = P_bC_bV_b$ OR $\frac{C_bV_b}{C_aV_a} = \frac{n_b}{n_a}$ $(2)(0,169)(30) = (1)C_b(25)$ ✓ $C_b = 0,4056\ mol\cdot dm^{-3}$ $n(NaOH) = cV$ $= (0,4056)(0,25)$ ✓ $= 0.1014\ mol$ $m(NaOH) = nM$ ✓ $= (0,1014)(40)$ ✓ $= 4,056\ g$ $m(impurities) = 5,0 - 4,056$ $= 0,944\ g$✓	1 mol $(COOH)_2$ reacts with 2 mol NaOH $n_a = cV = (0,169)(0,03)$ ✓ $= 5,07x10^{-3}\ mol$ $P_bn_b = P_an_a$ $(1)n_b = (2)(5,07x10^{-3})$ $\therefore n_b = 0,01014\ mol\ in\ 25\ cm^3$ $\therefore n_b = (10)(0,01014)$ ✓ $= 0,1014\ mol\ in\ 250\ cm^3$ $\therefore m(NaOH) = Nm$ ✓ $= (0,1014)(40)$ ✓$= 4,056\ g$ $\therefore m(impurities) = 5,0 - 4,056 = 0,944\ g$✓

(6)

[18]

QUESTION 6

6.1 A process that converts electrical energy to chemical energy ✓ ✓ (2)

6.2 Electrical to Chemical ✓ (1)

6.3.1 $Cr^{3+}_{(aq)} + 3e^- \longrightarrow Cr_{(s)}$ ✓ ✓ (2)

6.3.2 Chromium / Cr ✓ (1)

6.3.3 Cr^{3+} / Chromium (III) ion (1)

6.4 Rate of oxidation is equal to Rate of reduction ✓ ✓ (2)

6.5 To improve the properties / Add value ✓ (1)

[10]

QUESTION 7

7.1 Reduction ✓ (1)

7.2 A substance that gains ✓ electrons ✓ (2)

7.3 Silver nitrate ✓ (1)

7.4 $E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ ✓

$2,46$ ✓ $= (+0,80)$ ✓ $- E^\theta_{anode}$

$E^\theta_{anode} = -1,66\ V$ ✓

D is Al / Aluminium ✓ (5)

7.5 $Al_{(s)} \mid Al^{3+}_{(aq)} (1\ mol.dm^{-3}) \parallel Ag^{+}_{(aq)} (1\ mol.dm^{-3}) \mid Ag_{(s)}$ ✓ (3)

[12]

QUESTION 8

8.1.1 The direction of the car with the siren relative to the observer/listener.✓ (1)

8.1.2 The observed/detected frequency of the siren. ✓ (1)

8.1.3 ANY ONE:
- The actual frequency of the siren.✓ (1)
- The velocity of the car.✓

8.2 The Doppler Effect.✓
- The apparent change in frequency (or pitch/wavelength) of the sound detected by the listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓ (3)

8.3

$f_L = \left(\frac{v \pm v_L}{v \pm v_s}\right) f_s$ ✓

$409 = \left(\frac{v + 0}{v - v_s}\right)(400)$ ✓

$(409)(v-7,5) = (v)(400)$

$V = 340,83\ m \cdot s^{-1}$ ✓ (3)

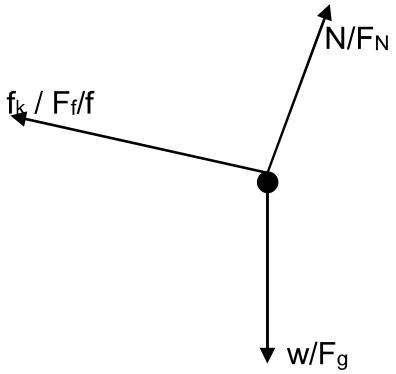
8.4 ANY ONE:
- To monitor blood flow.✓ (1)
- To detect the heartbeat of a foetus.✓

[10]

QUESTION 9

9.1.1 A force for which the work done (in moving an object between two points) is independent of the path taken. ✓✓
OR: A force for which the work done on a particle moving through any closed path is zero.✓✓ (2)

9.1.2



f:	Frictional force/friction✓
N:	Normal force✓
Fg/w:	Gravitational force/weight✓

(3)

9.1.3 The net/ total work done on an object is equal to the change in the object's kinetic energy.✓✓
OR: The work done on an object by the net force is equal to the change in the object's kinetic energy.✓✓ (2)

9.1.4

$W_{net} = \Delta E_k$
$W_N + W_{f_k} + W_w = \Delta E_k$
$0 + f_k \cdot \Delta x \cdot \cos\beta + mg \cdot \Delta x \cdot \cos\alpha = \frac{1}{2}m(v_f^2 - v_i^2)$
$\mu_k \cdot N \cdot \Delta x \cdot \cos\beta + mg \cdot \Delta x \cdot \cos\alpha = \frac{1}{2}m(v_f^2 - v_i^2)$
$\mu_k \cdot mg\cos\theta \cdot \Delta x \cdot \cos\beta + mg \cdot \Delta x \cdot \cos\alpha = \frac{1}{2}m(v_f^2 - v_i^2)$ — Any one✓
$(0,16)(10)(9,8)(\cos 35°)(5)(\cos 180°) + (10)(9,8)(5)(\cos 55°/305°) = \frac{1}{2}(10)(v_f^2 - 0^2)$
$-64,22152027 + 281,0524538 = 5v_f^2$
$216,8309335 = 5v_f^2$
$v_f^2 = 43,36618671$
$v_f = 6,5853\ m \cdot s^{-1}$✓
∴The speed is $6,5853\ m \cdot s^{-1}$ ✓ (5)

- *W_w can also be calculated by using* 1) $W_w = Fg_{||} \times \Delta x \times cos\theta$

2) $W_w = -\Delta E_p = -mg(h_f - h_i)$

9.1.5

$(E_P + E_K)_B = (E_P + E_K)_C$
$(mgh + \frac{1}{2}mv^2)_B = (mgh + \frac{1}{2}mv^2)_C$ } Any one✓

$(10)(9,8)h + \frac{1}{2}(10)(6,5853)^2$✓ $= (10)(9,8)(0) + \frac{1}{2}(10)(8,5)^2$
$(98)h + 216,8308805 = 0 + 361,25$✓
$(98)h = 144,4191195$
$\therefore h = 1,4737$ m✓
∴The height is 1,4737 m

(4)

9.2.1 The rate at which work is done.✓✓
OR: The rate at which energy is expended/transferred.✓✓ (2)

9.2.2 $W = E_P$
$= mgh$
$= (4500)(9,8)(100)$ ✓
$= 4410000$ J

$P = \frac{W}{\Delta t}$
$2300 = \frac{4410000}{\Delta t}$✓
$\Delta t = \frac{4410000}{2300}$
$= 1917,39$ s✓ (3)

[21]

QUESTION 11

11.1.1 In and Out of the coil ✓
- Very high speed ✓ (2)

11.1.2 Faraday's law of electromagnetic Induction ✓ (1)

11.1.3 Split ring / Commutator ✓ (1)

11.2.1 $W = \frac{V_{rms}^2 \Delta t}{R}$ ✓

$= \frac{(220)^2(1)}{40,33}$ ✓ ✓

$= 1200,10 J$ ✓ (4)

11.2.2 $W = V_{rms} I_{rms} \Delta t$

$1200,10 = (220)(I_{rms})(1)$ ✓

$I_{rms} = 5,455 A$

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$

$I_{max} = 5,455 \times \sqrt{2}$ ✓

$= 7,715 A$ ✓ (3) [11]

GRAND TOTAL: 150 MARKS

QUESTION 10

10.1 Electrostatic Force is directly proportional to the product of magnitude of the charges, inversely proportional to the square of the distance between them ✓✓ (2)

NB Deduct one mark for any underlined key word omitted

10.2 $F = \frac{kQ_1Q_2}{r^2}$ ✓ $\Rightarrow$ $F = \frac{(9\times10^9)(5\times10^{-6})(6\times10^{-6})}{(0,02)^2}$ ✓ ✓ (4)

$= 675N$ towards S / attractive ✓

10.3 $Q_s = \frac{5\mu C + -6\mu C}{2}$ OR $\frac{5\times10^{-6}C + -6\times10^{-6}C}{2}$

$= -0,5\mu C$ ✓ $= -5\times10^{-7}C$ ✓ (1)

10.4 ✓ F_{RP} ← ● → F_{SP} ✓ (2)

10.5 Taking Right as +ve

$F_{net} = F_{SP} + F_{RP}$ ✓

$F_{net} = \frac{kQ_SQ_P}{r^2} + \frac{kQ_RQ_P}{r^2}$

$-84,375$ ✓ $= \frac{(9\times10^9)(5\times10^{-7})(5\times10^{-7})}{(0,02)^2} + \frac{(9,0\times10^9)(5\times10^{-7})Q_R}{(0,01)^2}$ ✓

$Q_R = 2\times10^{-6}C$ ✓ (5)

10.6 $E_{net} = \frac{F_{net}}{Q_P}$ ✓ $\Rightarrow$ $\frac{84,375}{5\times10^{-7}}$ ✓ $= 1,6875\times10^8 NC^{-1}$ ✓ (3)

[17]