KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

CURRICULUM GRADE 10 -12 DIRECTORATE

NCS (CAPS) SUPPORT

SOLUTIONS

LAST PUSH REVISION TEACHER DOCUMENT

PHYSICAL SCIENCES: PAPER 1 & 2

GRADE 12

2025

VERTICAL PROJECTILE MOTION
SOLUTIONS
MULTIPLE CHOICE QUESTIONS

1.1 B ✓✓ (2)
1.2 C ✓✓ (2)
1.3 D ✓✓ (2)
1.4 A ✓✓ (2)
1.5 C ✓✓ (2)

LONG QUESTIONS

QUESTION 1

1.1 $9{,}8\ m\cdot s^{-2}$ ✓ (1)

1.2.1 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$2 = v_i(0{,}125) + \frac{1}{2}(9{,}8)(0{,}125)^2$ ✓

$v_i = 15{,}39\ m.s^{-1}$

$v_f^2 = v_i^2 + 2a\Delta y$

$(15{,}39)^2 = (0)^2 + 2(9{,}8)(\Delta y)$ ✓

$\Delta y = 12{,}08\ m$

$h = 12{,}08 + 2$ ✓

$= 14{,}08\ m$ ✓ (5)

1.2.2 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$14{,}08$ ✓ $= 0(\Delta t) + \frac{1}{2}(9{,}8)(\Delta t)^2$ ✓

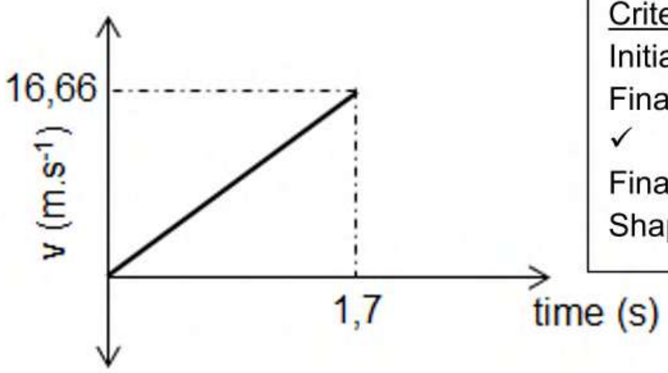
$\Delta t = 1{,}7\ s$ ✓ (4)

1.2.3 $v_f = v_i + a\Delta t$ ✓

$= 0 + (9.8)(1{,}7)$ ✓

$= 16{,}66\ m\cdot s^{-1}$ downwards ✓ (3)

1.3



Criteria
Initial velocity = $0\ m\cdot s^{-1}$ ✓
Final velocity = answer to 1.2.3 ✓
Final time = answer to 1.2.2 ✓
Shape: Straight line ✓

(4)
[17]

QUESTION 2

2.1 An object which has been given an initial velocity and then it moves under the influence of the gravitational force only. ✓✓ (2)

2.2 Distance = area under graph OR ½bh ✓

$= \frac{1}{2} \times 0{,}8$✓ $\times 7{,}84$✓

$= 3{,}14$ m ✓ (4)

2.3 0,2 seconds ✓ (1)

2.4 $F_{net} = \frac{\Delta p}{\Delta t}$

$F_{net} = \frac{m\Delta v}{\Delta t}$ ✓

$F_{net} = \frac{0{,}175(1{,}53 - 7{,}84)✓}{0{,}2✓}$

$= -5{,}52$ N

$= 5{,}52$ N upwards ✓ (4)

2.5 $v_f = v_i + a\Delta t$ ✓

$0 = 1{,}53 + (9{,}8)(0{,}7)$ ✓

$= 8{,}39 \text{ m·s}^{-1}$ ✓

$a = \frac{y_2 - y_1}{x_2 - x_1}$ ✓

$9{,}8 = \frac{v_f - 1{,}53}{1{,}7 - 1}$ ✓

$V_f = 8{,}39 \text{ m·s}^{-1}$ ✓ (3)

2.6 Equal to ✓ (1)

[15]

QUESTION 3

3.1 **BALL B**

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓

$12 = 18\Delta t + \frac{1}{2}(-9{,}8)\Delta t^2$ ✓

$\Delta t = 0{,}88$ s or $2{,}8$ s

Select $\Delta t = 0{,}88$ s since Ball B is moving upwards when they meet at P

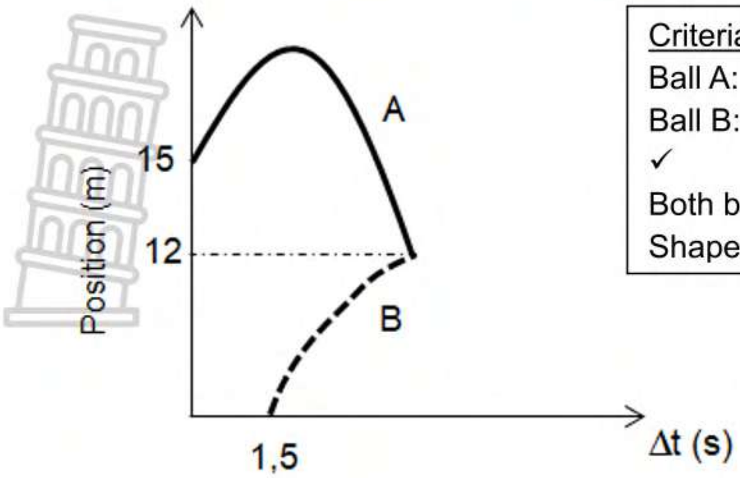
BALL A

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

-3 ✓ $= v_i(0{,}88+1{,}5$✓$) + \frac{1}{2}(-9{,}8)(0{,}88+1{,}5)^2$ ✓

$v_i = 10{,}4 \text{ m·s}^{-1}$ upwards ✓ (6)

3.2



Criteria
Ball A: Start at 15 m ✓
Ball B: Start from x-axis at 1,5 s ✓
Both balls meet at 12 m ✓
Shape: Graph A ✓

(5)
[11]

QUESTION 4

4.1 Motion in which the only force acting is gravitational force.✓✓ (2)

4.2 No ✓ (1)

4.3.1
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$15 = 3,4(\Delta t) + \frac{1}{2}(9,8)(\Delta t)^2$ ✓
$\Delta t = 1,44$ s ✓ (3)

4.3.2
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= 3,4(1,44) + \frac{1}{2}(0)(1,44)^2$ ✓
$= 4,896$ m
Height = 15 – 4,896 ✓
= 10,1 m ✓ (4)

4.4
$v_f = v_i + a\Delta t$ ✓
$0 = -7,2 + (9,8)\Delta t$ ✓
$\Delta t = 0,73$ s
$t_3 = 1,44 + 0,2 + 0,73$ ✓
= 2,37 s ✓ (4)
[14]

QUESTION 5

5.1.1
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(0$✓$)^2 = v_i^2 + 2(-9,8)(\frac{1}{4}H)$ ✓
$v_i = \sqrt{4,9H}$ ✓ (4)

5.1.2
$v_f = v_i + a\Delta t$ ✓
$\underline{0 = v_i + (-9,8)(2,33 - T}$ ✓$\underline{)}$ ✓ (3)

$v_i = 22{,}834 - 9{,}8T$ ✓

5.2 $\sqrt{4{,}9H} = 22{,}834 - 9{,}8$

$H = \frac{(22{,}834 - 9{,}8T)^2}{4{,}9}$

Criteria

Graph A: v =19 $m.s^{-1}$ at t = 0 s and v = 0 $m.s^{-1}$ at t =1,94 s ✓

Graph B: Starts at t = 3,30 s and v = 0 $m.s^{-1}$ ✓

5.3 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$-H$ ✓ $= 5(T) + \frac{1}{2}(-9{,}8)(T)^2$ ✓

$H = 4{,}9T^2 - 5T$ ✓ (4)

5.4 $4{,}9T^2 - 5T$ ✓ $= \frac{(22{,}834 - 9{,}8T)^2}{4{,}9}$ ✓

T = 1,76 s or T = 4,11 s (Reject 4,11s since T is less than 2,33 seconds)

T = 1,76 s ✓ (3)

[15]

QUESTION 6

6.1 Weight / Gravitational force ✓ (1)

6.2.1 t = 0,67 – 0,64 ✓

= 0,03 s ✓ (2)

6.2.2

$t = \frac{1{,}9 - 0{,}67}{2}$ ✓

= 0,62 s ✓ (2)

6.2.3 $v_f = v_i + a\Delta t$ ✓

$0 = v_i + (-9{,}8)(0{,}62)$ ✓

$v_i = 6{,}08\ m.s^{-1}$ ✓ (3)

6.2.4 $v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(0)^2 = v_i^2 + 2(-9{,}8)(1{,}2)$ ✓

$v_i = 4{,}85\ m.s^{-1}$

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$1{,}2 = 4{,}85\Delta t + \frac{1}{2}(-9{,}8)\Delta t^2$ ✓

$\Delta t = 0{,}49$ s

t = 1,97 + 2 x 0,49 ✓

= 2,95 s ✓ (6)

[14]

SOLUTIONS – WORK, ENERGY & POWER

QUESTION 1

1.1 B ✓✓ (2)
1.2 C ✓✓ (2)
1.3 A ✓✓ (2)
1.4 B ✓✓ (2)
[8]

QUESTION 2

2.1 Backwards/behind him✓ (1)

2.1.2 Newton's third Law of ✓motion
When one body exerts a force on a second body, the second body exerts a force of equal magnitude ✓ in the opposite direction on the first body. ✓ (3)

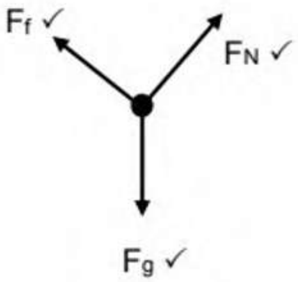
2.3 $W_{net} = \Delta K$ ✓
$W_g + W_f = \Delta K$
$F_g\Delta x\cos\theta + f\Delta x\cos\theta = \Delta K$
$(57)(9,8)(4)\cos180°$ ✓ $+ 40\Delta x\cos180°$ ✓ $= 0 - \frac{1}{2}(57)(6^2)$ ✓
$\Delta x = -30,21$ m
$\sin\theta = \frac{4}{30.21}$
$\theta = 7,61°$ ✓ (5)

2.4 $W_{net} = \Delta K$ ✓
$W_T + W_g + W_f = \Delta K$
$(80)(5)(4)\cos0°$ ✓$+(15)(5)\cos180°$ ✓ $=$
$(4)(9,8)\sin30°(5) - (4)(9,8)(0)$ ✓ $+ \frac{1}{2}(4)v_f^2 - \frac{1}{2}(4)(3)^2$ ✓
$v_f = 11,07\ m\cdot s^{-1}$ ✓ (6)
[15]

QUESTION 3

3.1 The net work done on an object by a force is equal to the change in the object's kinetic energy. ✓✓ (2)

3.2



Accepted labels	
F_g ✓	W/Fw/weight/mg / gravitational force
F_f ✓	(Kinetic) friction / f/fk
F_N ✓	Fnormal/Normal/N

(3)

3.3 $W_{net} = (W_{Fnormal}) + W_{friction} + W_{Fgravity}$ ✓
$W_{net} = (0) + \mu_k N.\Delta x.\cos\theta + mg.\Delta x.\cos\theta$

$W_{net}=0+(0,42)(850)(9.8)(\cos30°)$✓$(200)(\cos180°)$✓$(850)(9,8)(200)(\cos 60°)$✓

$W_{net} = (-605\ 975,2955) + 833\ 000$
$W_{net} = 227\ 024,7045$ (or $227\ 024,7$) J ✓
(5)

3.4 $\Delta E_{K\text{ from B to C}} = E_{Kf} - E_{Ki}$ (7)

$-108\ 950 = E_{Kf} - 227\ 024,\ 7045$ ✓

$E_{Kf\text{ at C}} = 118\ 074,\ 7045$

$W_{net} = \Delta E_K$ ✓

$W_{Fnormal} + W_{Fgravity} + W_{friction} + W_{Fbrakes} = \Delta E_K$

$0 + 0 + \mu_k N.\Delta x.\cos\theta + F_{brakes}.\Delta x.\cos\theta = E_{Kf\text{ at D}} - E_{Ki\text{ at C}}$

$0 + 0 + (0{,}42)(850)(9.8)$✓$(50)(\cos 180°)$✓$+ F_{brakes}.(50)(\cos 180°)$ ✓$= 0 - 118$ 074, 7045 ✓

$F_{brakes} = -1137{,}106$ N

magnitude of $F_{brakes} = 1137{,}106$ N ✓

[21]

QUESTION 4

4.1 $\Delta U + \Delta K = 0$ ✓

$(5)(9{,}8)(5) + 0$✓ $+ (0 + ½ (5v_f^2)$ ✓ g = 0

$v_f = 2\sqrt{\ } \times 9{,}8 \times 5$

$= 9{,}90\ m\cdot s^{-1}$✓ $(9{,}899\ m\cdot s^{-1})$ (4) (4)

4.2

$W_{nc} = \Delta U + \Delta K$ ✓ $F\ \Delta x \cos\theta = \Delta U + \Delta K$

$(18\ \Delta x \cos 180$✓$) = (5)(9{,}8)(3-0)$ ✓ $+ ½ (5)(0 - 9{,}90^2)$✓

$\Delta x = 5{,}4458$m✓

$\theta = \sin^{-1}$ ✓$\frac{3}{5.4458}$

$\theta = 33{,}43°$ ✓ (7)

QUESTION 5

5.1 A system on which the net external force is zero. ✓✓ (2)

5.2 $(U + K)_A = (U + K)_B$✓

$mgh + ½ mv^2 = mgh + ½ mv^2$

$gh + ½ (v_i)^2 = gh + ½ vf^2$

$(9{,}8)(0{,}67) + ½ (0)^2$ ✓ $= 0 + ½ vf^2$ ✓

$v_f = 3{,}6238\ m.s^{-1}$

$m_b v_{is} + m_c v_{ic} = m_b v_{fs} + m_c v_{fc}$ ✓

$5(3.6238) + 0$ ✓ $= 5v_{fs} + 2(4.95)$ ✓

$V_{fs} = 1.6438 m.s^{-1}$ ✓ (6)

5.3 $(U + K)_{before} = (U + K)_{after}$✓

$mgh + ½ mv^2 = mgh + ½ mv^2$

0✓ $+ ½ (5)(1{,}6438)^2$ ✓ $= (5)(9{,}8)h + 0$ ✓

$h = 0{,}138$ m ✓

5.4 Some of the ball's mechanical energy is transferred to the block. ✓ ✓

5.5 The net/total work done on an object is equal to the change in the object's kinetic energy. ✓ ✓

5.6 $W_{nc} = \Delta EK + \Delta U$ ✓

$W_{nc} = \Delta E_K + \Delta E_P$

$W_f = \frac{1}{2}(2)(2^2 - 4{,}95^2)$ ✓ $+ (2)(9{,}8)(0{,}5 - 0)$ ✓

$= -10{,}7$ J ✓

[22]

QUESTION 6

6.1 A force is non-conservative if the work it does/done on an object which is moving between two points depends on the path taken. ✓ ✓ (2)

6.2 $W_{net} = \Delta K$ ✓

$mg\sin\theta\Delta x\cos\theta + W_f + W_F = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$(20)(9{,}8)(\sin 18^\circ)(15{,}6)\cos 180^\circ$ ✓ $+ (13{,}5)(15{,}6)\cos 180^\circ) + (96{,}8)(15{,}6)\cos 0^\circ$ ✓

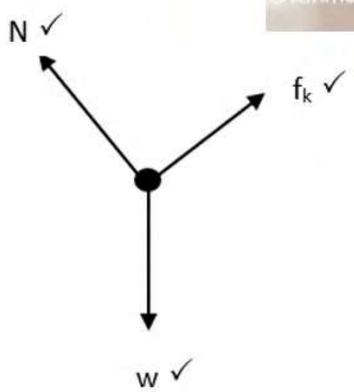
$= \frac{1}{2}(20)(v_f^2 - 0)^2$ ✓

$v_f = 5{,}96 \text{ m·s}^{-1}$ ✓ (5)

6.3 $P_{ave} = Fv_{ave}$ ✓

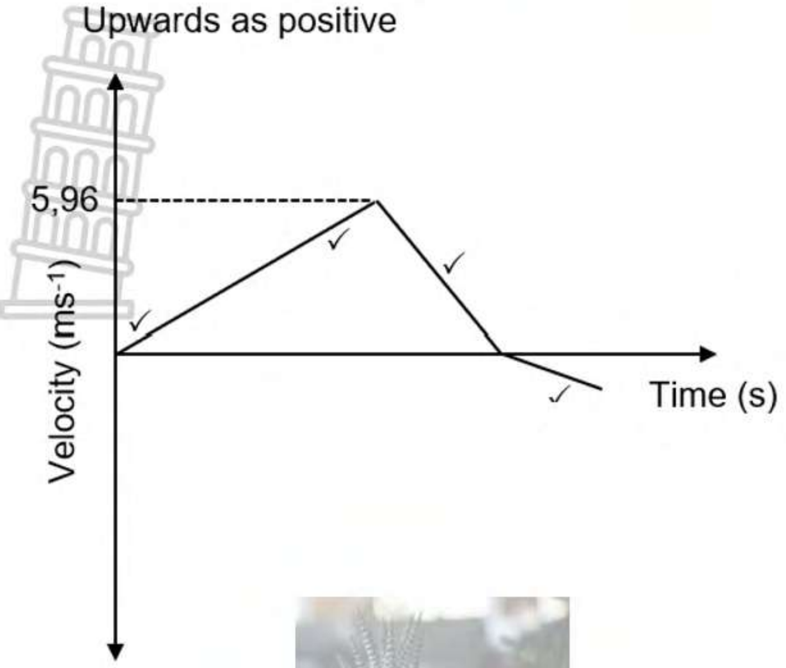
$= 96{,}8(\frac{(0)+(5{,}96)}{2})$ ✓

$= 288{,}46$ W ✓ (3)



(3)

6.4 (4)

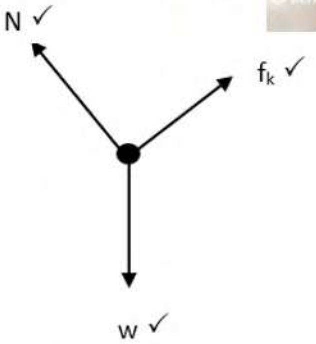


[17]

QUESTION 7

7.1 A force for which the work done in moving an object between two points depends on the path taken. ✓ ✓ (2)

7.2



(3)

7.3 The net workdone on an object is equal to the change in the object's kinetic enegy. ✓ ✓ (2)

7.4.1 $W_{nc} = \Delta E_K + \Delta E_P$ ✓

$W_f = \Delta E_K + \Delta E_P$

$W_f = ½ mv_f^2 - ½ mv_i^2 + mgh_2 - mgh_1$

$2{,}5 \times \frac{5}{\sin 10}\cos180^o$ ✓ $= ½ \times 2 \times v_f^2 - 1{,}5^2$ ✓ $+ 2 \times 9{,}8 \times 0 - 2 \times 9{,}8 \times 5$ ✓

$v_f = 5{,}32\ m.s^{-1}$ ✓ (5)

7.4.2 $f_k = \mu_k N$

$2{,}5 = \mu k \times 2 \times 9{,}8\cos10^o$

$\mu k = 0{,}13$

$W_f = \Delta E_k + \Delta E_p$

$W_f = W_f = ½ mv_f^2 - ½ mv_i^2 + mgh_2 - mgh_1$

$0{,}13\ (2 \times 9{,}8)\ x\cos180^o$ ✓ $= ½ x\ 2 \times 0^2\ ½ x\ 2 \times 5{,}32^2$ ✓ $+ 0$

$\Delta x = 11{,}11$ m ✓ (5)

[14]

SOLUTIONS
CHEMICAL EQUILIBRIUM
QUESTION 1

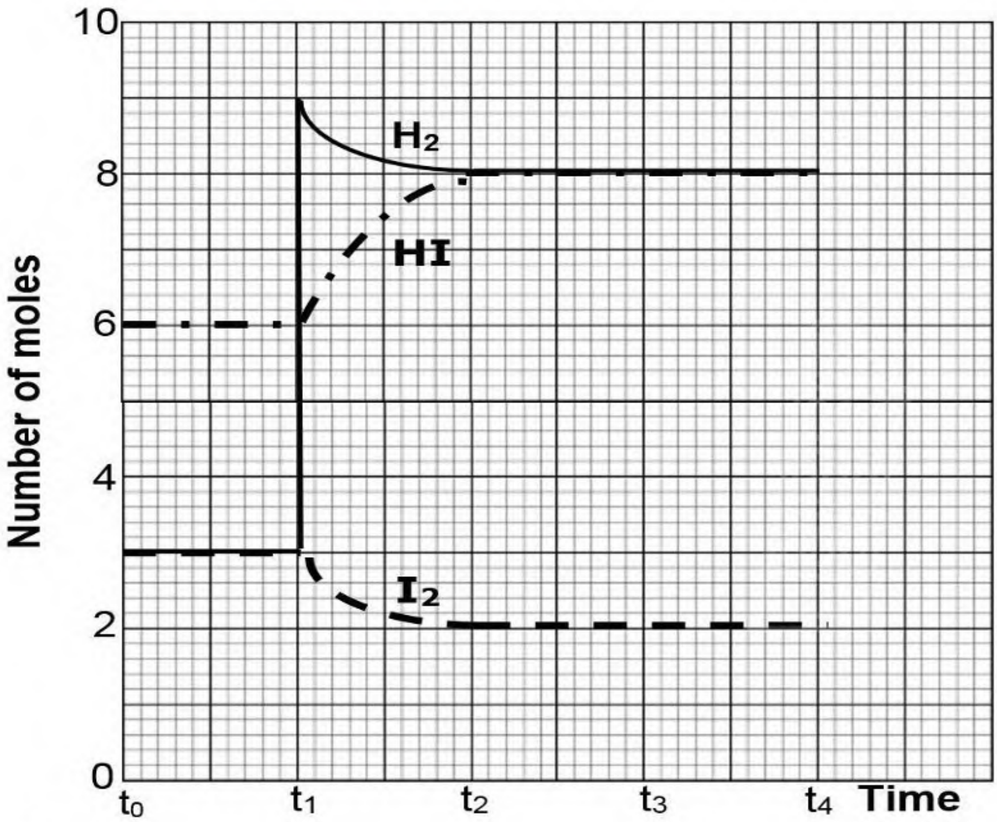
1.1 B✓✓
1.2 C✓✓
1.3 C✓✓
1.4 D✓✓
1.5 B✓✓
1.6 A✓✓
1.7 A✓✓
1.8 A✓✓
1.9 B✓✓
1.10 C✓✓

[20]

QUESTION 2

2.1 (6 moles of) H2 was added. ✓✓ (2)

2.2



Criteria

- t_0 to t_1 all correct and constant✓

- At t_1, H_2 increases to 9✓
- Between t_1 and t_2, H_2 gets to 8✓, HI gets to 8✓, I_2 gets to 2✓
- t_2 to t_3 all constant✓

Note: If the transitions from t_1 to t_2 are incorrectly shown, take off max 1 mark. (6)

2.3
- The reaction that removes H_2 or decreases $[H_2]$ is favoured✓
- i.e. the forward reaction is favoured✓
- The amounts of (H_2 and) I_2 decrease✓
- and the amount of HI increases✓ (4)

2.4 $K_c = \frac{[HI]^2}{[H_2][I_2]}$ ✓ correct Kc expression

Divide all moles by 2 to get concentration✓

Before t_1

$K_c = \frac{3^2}{(1,5)(1,5)} = 4$

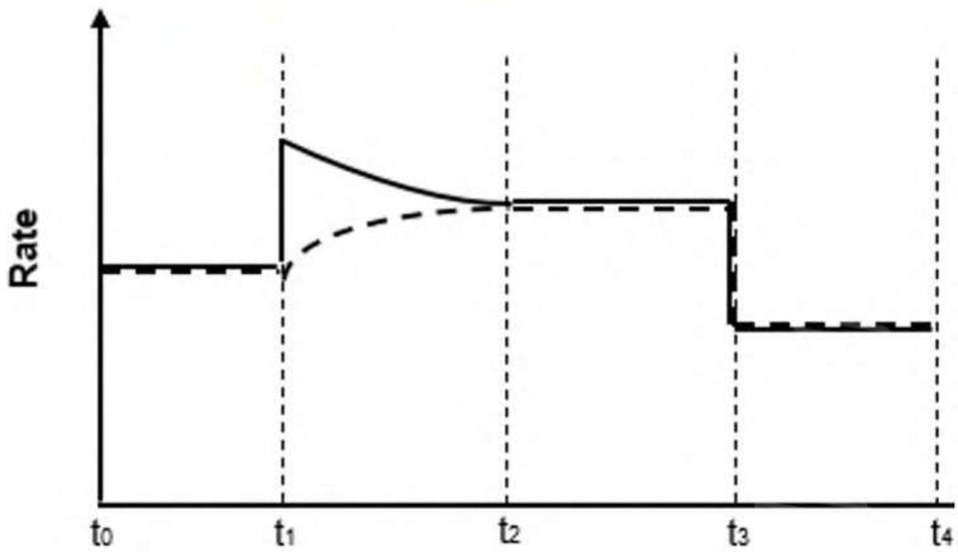
Before t_1

$K_c = \frac{4^2}{(1)(4)} = 4$

- Substitute (concentration values) × 2✓
- Same correct answer (4) ✓
- Kc does not change ∴ not a temperature change✓ (5)

2.5 No change to number of moles at t_3✓✓ (2)

2.6



- $t_0 - t_1$ rates equal✓
- At t_1, rate of forward increases✓
- $t_2 - t_3$ both rates equal and higher than between t_0 and t_1✓
- At t_3 both rates decrease by same amount✓
- Then continue equal and lower✓ (5)

[25]

QUESTION 3

3.1 False✓ (1)

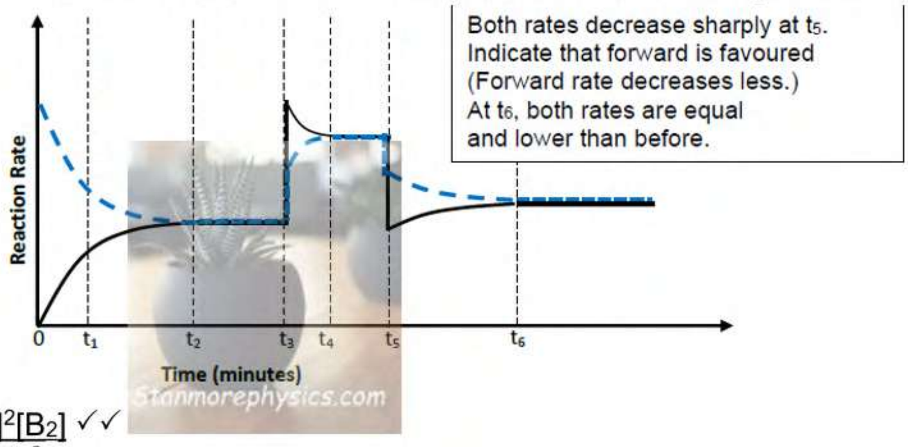
3.2 The rate of the forward reaction✓✓ (2)

3.3 Constant✓ (1)

3.4 A temperature increase causes an endothermic reaction to be favoured because it will absorb heat and thereby reduce the temperature✓
The graph shows that the reverse reaction is favoured✓
The forward reaction is exothermic✓ (3)

3.5.1 The system favours the reaction towards more gas moles.✓
The forward reaction is favoured✓
Concentration of AB decreases and concentration of A and B_2 increase✓ (3)

3.5.2



(3)

3.6.1 $K_c = \frac{[A]^2[B_2]}{[AB]^2}$ ✓✓ (2)

3.6.2 $1{,}56 \times 10^{-3}$ ✓ $= \frac{(0{,}05)^2(0{,}025)}{[AB]^2}$ ✓
$[AB] = 0{,}2\ mol \cdot dm^{-3}$ (2)

3.6.3

R(ratio)	2AB(g)	⇌	2A(g)	+	B_2(g)
I(initial)	X		0		0
C(change)	-0,05		+0,05		+0,025
E(equilibrium)	0,2		0,05		0,025

X – 0,05 = 0,2✓
X = $[AB]_{initial}$ = 0,25 $mol \cdot dm^{-3}$ ✓✓ (3)

[20]

QUESTION 4

4.1 That there is a much larger amount of reactants than products✓✓ (2)

4.2
- Internal combustion engines have extremely high temperatures✓
- Le Châtelier's principle predicts the system will respond in order to decrease the temperature✓
- Thus, the forward reaction is (initially) favoured as it is endothermic and thus consumes heat✓

- Increasing the amount of nitrogen monoxide✓ (4)

4.3 Remains the same✓✓ (2)

4.4 Increase✓✓ (2)

4.5.1 $K_c = \frac{[NO]^2}{[O_2][N_2]}$ ✓ (1)

4.5.2

R	N_2	+	O_2	⇌	2NO	
I	$4{,}5 \times 10^{-3}$		$4{,}5 \times 10^{-3}$		0	
C	$(-x$		$-x)$		$+2x$	✓
E	$4{,}5 \times 10^{-3} - x$		$4{,}5 \times 10^{-3} - x$		$2x$	
[ ]	$\frac{4{,}5 \times 10^{-3} - x}{0{,}2}$		$\frac{4{,}5 \times 10^{-3} - x}{0{,}2}$		$\frac{2x}{0{,}2}$	✓

$K_c = \frac{[NO]^2}{[O_2][N_2]}$ ✓

$$1{,}11 \times 10^{-5} = \frac{\left(\frac{2x}{0{,}2}\right)^2}{\left(\frac{4{,}5 \times 10^{-3} - x}{0{,}2}\right)\left(\frac{4{,}5 \times 10^{-3} - x}{0{,}2}\right)}$$ ✓ ✓

$X = 7{,}45 \times 10^{-6}\ mol \cdot dm^{-3}$ ✓ (6)

4.6 $2NO + O_2$ ✓ ⇌ $2NO_2$✓ ✓(balancing) (3)

4.7
- Le Châtelier's principle predicts the system will respond in order to increase the pressure
- The reverse reaction is (initially) favoured as it produces more gas particles
- Decreasing the amount of NO_2
- Causing the brown colour to fade

(4)

[24]

QUESTION 5

5.1 When the equilibrium in a closed system is disturbed, the system will reinstate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓✓ (2)

5.2.1 Adding more CH_4 will increase the concentration of CH_4✓
The forward reaction is favoured✓
The yield of H_2 will increase✓ (3)

5.2.2 An increase in pressure favours the reaction that produces the lower number of moles/number of molecules✓
The reverse reaction is favoured✓
The yield of H_2 decreases✓ (3)

5.3.1 The reaction is in (dynamic/chemical) equilibrium✓/ the rates of the forward and reverse reactions are equal✓ (2)

5.3.2 MARKING CRITERIA:

a) Mole at equilibrium 0,6✓
b) Use mole ratio 1 : 1 : 1 : 3✓
c) Subtract CH_4 , H_2O and add H_2✓
d) Divide by 2 dm^3✓
e) Correct Kc expression (formulae in square brackets) ✓
f) Substitution of concentrations into correct Kc expression✓
g) Final answer (range 1,82 – 1,83) ✓
Option with concentration can also be used.

	CH_4 +	H_2O	CO	H_2
Initial amount (moles)	1,4	1,2	0	0
Change in amount (moles)	0,6	0,6	0,6	1,8✓ratio
Equilibrium amount (moles)	0,8	0,6✓	**0,6**	1,8✓
Concentration at equilibrium	0,4	0,3	0,3	0,9✓

$$K_c = \frac{[CO][H_2]^3}{[CH_4][H_2O]} ✓$$

$$= \frac{(0,3)(0,9)^3}{(0,4)(0,3)} ✓$$

$$= 1,82 ✓$$

No Kc expression, correct substitution: Max. $^6/_7$
No square brackets: Max. $^6/_7$
Wrong Kc expression: Max $^4/_7$ (7)

[17]

QUESTION 6

6.1 A system that is isolated from its surroundings. A system where substances cannot leave/escape the container.✓✓ (2)

6.2 **CALCULATIONS USING NUMBER OF MOLES**

Marking criteria

a) Change n(H_2) = equilibrium n(H_2) = 0,02
b) **USING** ratio HI:H_2:I_2 = 2:1:1
c) Equilibrium mole of I_2 = Change mole I_2 ✓
d) Divide 0,02 by 5 AND multiplying 0,0316 by 5 ✓
e) Correct K_c expression (formulae in square brackets) ✓
f) Substitution of K_c 0,016
g) Substitution of concentrations into K_c expression ✓
h) Initial mole of HI = Equilibrium + Change = 0,198 mol ✓

	HI	H_2	I_2
Initial amount (moles)	0,198✓		0
Change in amount (moles)	0, 04	0,02	0,02✓
Equilibrium amount (moles)	0,158	0,02✓	0,02
Concentration at equilibrium	0,0316	0,004	0,004

$Kc = \frac{[I_2][H_2]}{[HI]^2}$✓

$0,016$✓ $= \frac{(0,004)^2}{[HI]^2}$✓

$[HI] = 0,0396\ mol.dm^{-3}$

$n(HI) = 5 \times 0,0316$✓

$= 0.198\ mol$✓ (8)

6.3.1 Decreases✓ (1)

6.3.1 Remains the same✓ (1)

6.4 Endothermic✓

- K_c decreases with a decrease in temperature ✓
- Reverse reaction is favoured/concentration of reactants increases/ concentration of products decreases/yield decreases ✓

Decrease in temperature favours an exothermic reaction ✓ (4)

[16]

QUESTION 7

7.1.1 Increases ✓ (1)

7.1.2 Forward ✓ (1)

7.1.3 Reactants and products are all in the (same) gaseous phase ✓✓ (2)

7.1.4 Increase in temperature increases K_C. ✓
Increase in K_C indicates that the forward reaction has been favoured. ✓
Increase in temperature favours the endothermic reaction. ✓ (4)
Therefore, the forward reaction is endothermic. ✓

7.1.5 Add a catalyst. ✓ Decrease pressure OR Increases the volume of the container. ✓ (2)

7.2

	$2SO_2$	O_2	$2SO_3$
Initial mol	8	y	0
Mol reacted	-2x	-x	+2x ✓
Mol at equil.	2	y-3 ✓	6
[ ] at equil.	1	$\frac{y-3}{2}$	3 ✓ (÷2)

$Kc = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$ ✓ correct Kc expression

$9 = \frac{(3)^2}{(1)^2\frac{(y-3)}{2}}$ ✓ correct substitution

y = 5 mol ✓ (6)

[16]

QUESTION 8

8.1.1 The reaction is in a state of dynamic equilibrium/ Rate of the forward reaction equals the rate of the reverse reaction.✓✓ (2)

8.1.2 Less than✓ (1)

8.1.3 t_1 ✓
the concentration of N_2 (g) was increased✓ (2)

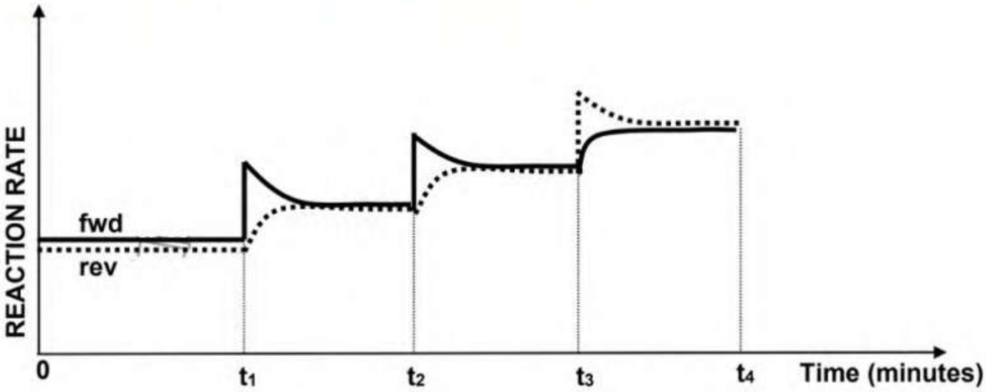
8.1.4 When an equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance✓✓ (2)

8.1.5 Temperature ✓ (1)

8.1.6 INCREASED✓
According to the graph the concentration of the reactants increases OR the concentration of the products decrease.✓
Therefore the reverse reaction / endothermic reaction is favoured.✓ (According to Le Chatelier's Principle) an increase in temperature favours the endothermic reaction✓ (4)

8.1.7 **Marking criteria**

- At t_1, forward reaction is favoured (vertical upward climb of solid line) ✓
- At t_2, forward reaction is favoured (vertical upward climb of solid line) ✓
- At t_3, reverse reaction is favoured (vertical upward climb of broken line) Vertical upward increase in rates at t_2, t_3 and t_4. ✓
- Equilibrium rate at t_4 .> equilibrium rate at t_3 > equilibrium rate at t_2✓✓ (5)



8.2

	AO_2	A_2O_3	O_2
Initial concentration	2	0	0
Change concentration	-4x = - 0.2✓	+2x = +0.1✓	+x = +0.05✓
Equilibrium concentration (mol.dm^{-3})	1.8✓	0.1✓	0.05✓

At equilibrium, AO_2, is 10% decomposed.
10% of 2 = 0.2 (6)

[23]

QUESTION 9

9.1 The stage in a chemical reaction when the rate of the forward equals the rate of the reverse reaction. ✓✓ (2)

9.2.1 2✓ (1)

9.2.2 1✓ (1)

9.2.3 3✓ (1)

9.3

OPTION 1

$[A] = \frac{8✓}{3} = 2{,}67\ mol\cdot dm^{-3}$

$[B] = \frac{4✓}{3} = 1{,}33\ mol\cdot dm^{-3}$ Divide by 3 dm^3 ✓

$[C] = \frac{12✓}{3} = 4\ mol\cdot dm^{-3}$

$K_c = \frac{[C]^3}{[A]^2[B]}$ ✓ $= \frac{(4)^3}{(2{,}67)^2(1{,}33)}$ ✓ = 6,75 ✓

OPTION 2

	A	B	C	
Initial quantity (mol)	16	8	0	
Change (mol)	8	4	12	
Quantity at equilibrium (mol)	8 ✓	4 ✓	12 ✓	
Equilibrium concentration (mol·dm^{-3})	$\frac{8}{3}$	$\frac{4}{3}$	$\frac{12}{3}$	Divide by 3 dm^3 ✓

$$K_c = \frac{[C]^3}{[A]^2[B]} \checkmark = \frac{(4)^3}{(2{,}67)^2(1{,}33)} \checkmark = 6{,}75 \checkmark$$

(7)

9.4 Endothermic ✓

- (an increase in temperature) favours the reverse reaction.✓
- An increase in the temperature favours an endothermic reaction.✓ (3)

[15]

QUESTION 10

10.1

10.1.1 Remains the same✓ (1)

10.1.2 Decreases ✓ (1)

10.1.3 Remains the same✓ (1)

10.2

- When the volume is increased, the pressure decreases.
- According to Le Chatelier's principle, the system will favour the reaction that produces more moles of gas. ✓
- The forward reaction produces more moles of gas
- The forward reaction is favoured. ✓

(2)

10.3

- Mass of CO_2 reacted:
  - Δm(C) = Initial mass - Equilibrium mass
  - Δm(CO_2) = 14.0 g – 4.44 g✓ = 9.56 g
- Moles of C reacted:
  - n = m / M
  - n(C) = 9.56 g / 12 g·mol^{-1} ✓= 0.797 mol
- Moles of C reacted (from mole ratio C:CO_2 is 1:1):
  - n(CO_2) reacted = 0.797 mol✓
- Mass of C reacted:
  - m = n × M
  - m(C) = 0.797 mol × 44 g·mol^{-1}✓ = 35.07 g
- Initial mass of C (X):
  - X = Initial mass - Mass reacted
  - X = 41.2 – 35.07 ✓ = 6.13 g✓ (6)

10.4
- Equilibrium moles:
  - $n(CO_2)$ = 6.13g / 44 g·mol⁻¹ =0.139 mol
  - n(CO) formed = 2 × $n(CO_2)$ reacted ✓= 2 × 0.797 mol = 1.594 mol
- Equilibrium concentrations (V = 3 dm^3):
  - $[CO_2]$ = n / V = 0.139mol / 3 dm^3 = 0.046 $mol{\cdot}dm^{-3}$
  - [CO] = n / V = 1.594 mol / 3 dm^3 = 0.53 $mol{\cdot}dm^{-3}$ ✓

OR

	CO_2	2CO
Initial amount (moles)	0.936	0
Change in amount (moles)	0.797	1.594
Equilibrium amount (moles)	0.139	1.594
Concentration at equilibrium	0.046	0.53

- Kc calculation:
  - Kc = $[CO]^2 / [CO_2]$✓
  - Kc = $(0.53^2 / (0.046)$ ✓
  - Kc = 6.10✓ (5)

10.5 Y✓✓ (2)

10.6 Remains the same✓ (1)

[19]

QUESTION 11

11.1

Marking criteria*:*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark. The underlined phrases must be in the correct context.

(2)

When the <u>equilibrium in a closed system is disturbed</u>, the system will re-instate a <u>new equilibrium by favouring the reaction that will cancel/oppose the disturbance</u>.✓✓

11.2 (Chemical) equilibrium/Concentrations of reactants and products remain constant./Rate of the forward and reverse reactions are equal. ✓ (1)

11.3 Exothermic✓ (1)

11.4
- With an increase in temperature the endothermic reaction is favoured.✓
- The reverse reaction is favoured./ Equilibrium shifts to the left. / Reactants / $[P_2Q]$ increases OR Products / $[PQ_2]$ decreases.✓ (2)

11.5 Less than✓ (1)

11.6 **Marking criteria**

- Correct Kc expression
- Substitute 0.49 into the Kc expression
- Substitute equilibrium concentration (0.35) into the correct Kc expression
- Change in concentration/mole
- **USE** ratio P_2Q : $2PQ_2$ = 1 : 2
- Substitute 2 dm3 in n = cV
- Final answer = 0.85 mol

	P_2Q	$2PQ_2$
Initial concentration ($mol.dm^3$)	X	0
Change in concentration($mol.dm^3$)	0.175✓	0.35
Equilibrium concentration ($mol.dm^3$)	X- 0175✓	0.35

$Kc = [PQ_2]^2 / [P_2Q]$ ✓✓

✓$0.49 = (0.35^2 / (x - 0.175)$ ✓

$X= 0425\ mol.dm^{-3}$

$n\ (P_2Q) = cV$

= 0.425 x 2 ✓

= 0.85 mol✓ (8)

11.7 Pressure was decreased/ volume of the container was increased✓ (1)

11.8 Favours the reaction that produces more number of gas moles✓ (2)

$[P_2Q]$ increased✓

[18]

QUESTION 12

12.1

12.1.1 (The dynamic equilibrium when) the rate of the forward reaction equals the rate of the reverse reaction. ✓✓ (2 or 0) (2)

12.1.2 x✓ (1)

12.1.3 Decreased✓ (1)

12.1.4 The concentrations of (all) the gases decreased./The reverse reaction was favoured.✓ (1)

12.1.5 CO(g)/carbon monoxide (1)

12.1.6 The concentration of Z (CO) decreased with a decrease in the concentration of X (O_2). ✓

OR (1)

The concentration of Z (CO) increased with an increase in the concentration of X (O_2)

12.1.7 Decreased✓ (1)

12.1.8
- Concentration of products/Y/CO_2 increases. ✓
  OR
  Concentration of reactant/Z/X/CO/O_2 decreases. **OR**
  The forward reaction is favoured. (3)
- The forward reaction is exothermic. ✓
- A decrease in temperature favours the exothermic reaction. ✓

12.2 **Marking criteria**

(a)USING ratio: $n(H_2O) : n(CO) : n(H_2) : n(CO_2) = 1 : 1 : 1 : 1$ ✓

(b) $n(CO)eq = n(CO)initial – \Delta n(CO)$, $n(H_2O)_{eq} = n(H_2O)initial – \Delta n(H_2O)$, $n(CO_2)eq = n(CO_2)initial + \Delta n(CO_2)$ AND $n(H_2)_{eq} = n(H_2)initial + \Delta n(H_2)$ ✓

(c) Divide n_{eq} by the volume 2 dm^3 ✓

(d) Correct Kc expression. ✓

(e) Substitute Kc value 4. ✓

(f) Substitute concentrations in Kc expression. ✓

(g) Substitute numerical values of x in n(CO)initial – Δn(CO)change ✓

(h) Substitute of 28 in n = m/M ✓

(i) Final answer: 6,44 g ✓

Range: 6,44 – 6,72 g (9)

	CO	**H_2O**	**H_2**	**CO_2**
Initial concentration ($mol \cdot dm^{-3}$)	0,3	0,3	0,05	0,05✓
Change ($mol \cdot dm^{-3}$)	x	X	x	x✓
Equilibrium concentration ($mol \cdot dm^{-3}$)	0,3 + x	0,3 + x	0,05 - x	0,05–x ✓

$$Kc = \frac{[CO_2][H_2]}{[CO][H_2O]}\ ✓$$

$$✓ 4 = \frac{[(0,05-x)\ (0,05-x)]}{[(0,3+x)\ (0,3+x)]}\ ✓$$

x = -0,18 (0,183)

[CO] = 0,3 + (-0,18) ✓ = 0,12 $mol \cdot dm^{-3}$

n(CO)eq = cV

= (0,12)(2) ✓
= 0,24 mol

$n(CO) = \frac{m}{M}$

$0,24 = \frac{m}{28}$ ✓

m(CO)eq = **6,72 g** ✓

OR

	CO	**H_2O**	**CO_2**	**H_2**
Initial amount (moles)	0,6	0,6	0,1	0,1
Change in amount (moles)	x	X	x	x
Equilibrium amount (moles)	0,6 + x	0,6 + x	0,1 - x	0,1 - x✓
Equilibrium concentration ($mol \cdot dm^{-3}$)	(0,6 + x)/2	(0,6 + x)/2	(0,1- x)/2	(0,1- x)/2 ✓

$Kc = \frac{[CO_2][H_2]}{[CO][H_2O]}$ ✓

4 ✓= $\frac{\{[(0,1 - x)/2] * [(0,1 - x)/2]\}}{\{[(0,6 + x)/2] * [(0,6 + x)/2]\}}$ ✓

x = -0,37

n(CO)eq = 0,6 + (-0,37) ✓
= 0,23 mol

$n(CO)eq = \frac{m}{M}$

$0,23 = \frac{m}{28}$ ✓

m(CO)eq = 6,44 g ✓

[20]

GALVANIC CELLS: SOLUTIONS

QUESTION 1

1.1. D ✓✓

1.2. B ✓✓

1.3. C ✓✓

1.4. A ✓✓

1.5. D ✓✓

[10]

QUESTION 2

2.1	Chemical to Electrical ✓	(1)
2.2	Zn(g) | Zn^{2+}(aq) || Ag+(aq) | Ag(s) ✓✓✓	(3)
2.3	The electrode where oxidation takes place. ✓✓	(2)
2.4	Silver ions. ✓	(1)
2.5	Zn(s) + $2Ag^+$(aq) → Zn^{2+}(aq) + 2Ag(s) ✓✓✓	(3)
2.6	Concentration of the electrolyte 1mol.dm^{-3}✓	
	Temperature 25^{0}C / 273K ✓	(2)
2.7	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓	
	= (0,80) – (- 0,76) ✓✓	
	E^{θ}_{cell}= 1, 56 V ✓	(4)

[16]

QUESTION 3

3.1.1	Gold (III) ions✓ or Au^{3+}	(1)
3.1.2	$2Cl^-$ → Cl_2(g) + $2e^-$ ✓✓	(2)
3.1.3	Pt (s) | Cl^- (aq) | Cl_2 (g) || Au^{3+}(aq) | Au (s) ✓✓✓	(3)
3.2	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓	
	0, 14 = $E^{\theta}_{cathode}$ - (1, 36) ✓✓	
	= 1, 50 V ✓	(4)
3.5.1	Smaller than. ✓	
	Decreases in potential difference due to internal resistance✓	(2)

[12]

QUESTION 4

4.1 Temperature: 25 °C / 298 K ✓

Pressure: 101,3 kPa / 1,013 x 10^5 Pa / 1 atm / 100 kPa ✓

Concentration: 1 mol·dm^{-3} ✓

(3)

4.2.1 Cd(s) ✓ or Cadmium (1)

4.2.2 $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓

0, 13✓ = $E^{\theta}_{cathode}$ - (- 0, 4) ✓

= - 0, 27 V ✓

Q is Nickel ✓

(5)

4.3.1 Cd(s) → Cd^{2+}(aq) + $2e^-$ ✓✓ (2)

4.3.2 Pt ✓ or Platinum (1)

4.4 Cd^{2+}; Q^{2+}; R_2 ✓

Compare Q^{2+} & Cd^{2+}	Q^{2+} is reduced / Cd is oxidised, therefore Q^{2+} is a stronger oxidising agent than Cd^{2+} ✓
Compare R_2 & Cd^{2+}	R_2 is reduced / Cd is oxidised, therefore R_2 is a stronger oxidising agent than Cd^{2+} ✓
Compare R_2 & Q^{2+}	The cell potential of combination II is higher than that of combination I; therefore, R_2 is a stronger oxidising agent than Q^{2+}. ✓

(4)

[16]

QUESTION 5

5.1 Chemical energy to electrical energy. ✓ (1)

5.2 Concentration of the electrolyte 1mol.dm^{-3}✓

Temperature 25^0C / 273K ✓

(2)

5.3 Mg ✓ or Magnesium (1)

5.4 Mg (s) → Mg^{2+} + $2e^-$ ✓✓ (2)

5.5 $n_{Mg} = \frac{m}{M} = \frac{0,96}{24}$ ✓ = 0, 04 mol

$n_{Fe} = n_{Mg} \times \frac{2}{3}$ ✓

= 0, 027 mol ✓

m_{Fe} = n x M

= 0, 027 x 56 ✓

= 1, 51g ✓ (5)

5.6 $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓

= (- 0, 04) - (- 2, 37) ✓✓

= 2, 33V ✓

Yes✓, Bulb will light up. (5)

5.7 Increase. ✓ (1)

5.8 Decrease✓

An increase in the concentration of Magnesium ions (Mg^{2+}) will favour the reverse reaction (the reaction that decreases the Mg^{2+} concentration). ✓ (2)

[19]

QUESTION 6

6.1.1 Increases ✓

The reaction is exothermic. /Energy (or heat) is released /ΔH < 0. ✓ (2)

6.1.2 Aluminium is a strong reducing agent/stronger reducing agent ✓ than copper and will reduce the copper (||) ions to copper. ✓ (2)

6.1.3 $2Al(s) + 3Cu^{2+}(aq)$ ✓ $\rightarrow 2Al^{3+} + 3Cu(s)$ ✓ bal. ✓ (3)

6.2.1 Aluminium ✓ (1)

6.2.2 $Al(s)\ Al^{3+}\ (1\ mol \cdot dm^{-3}) \| Cu^{2+}\ (1\ mol \cdot dm^{-3})\ | Cu(s)$ ✓✓✓ (3)

6.2.3 $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓

= 0.34 – (-1.66) ✓✓ = 2.00V ✓ (4)

6.2.4 zero V / 0V ✓ The circuit is open ✓ (2)

[17]

ELECTROLYTIC CELLS: SOLUTIONS

QUESTION 1

1.1. A ✓✓

1.2. C ✓✓

1.3. C ✓✓

1.4. D ✓✓

1.5. C ✓✓

1.6. C ✓✓

[12]

QUESTION 2

2.1 Oxidation is a loss of electrons ✓✓ (2)

2.2 A ✓ Cr^{3+} ions moves Towards A ✓
Or Reduction is taking place
Or Oxidation is taking place at B, B is positive, so A must be negative. (2)

2.3 Cr^{3+} (aq) + $3e^{-}$ → Cr(s) ✓✓ (2)

2.4 Cr is a stronger reducing agent than Ag (Silver) ✓✓
Or Ag^{+} is a stronger oxidizing agent. (2)

[8]

QUESTION 3

3.1.1 Battery ✓ or Power source (1)

3.1.2 Chlorine ✓ (1)

3.1.3 $2H_2O$ (l) + $2e^{-}$ → H_2(g) + $2OH^{-}$ (aq) ✓✓ (2)

3.1.4 Cl^{-} ✓ (or NaCl) (1)

3.2 [H_3O^{+}] > $1x10^{-7}$ ✓
Solution is alkaline ✓ (2)

3.3 Cu^{2+} is a stronger oxidizing agent ✓than Na^{+} and will be reduced✓ to Cu ✓ (3)

[10]

QUESTION 4

4.1 A cell in which electrical energy is converted into chemical energy ✓✓ (2)

4.2 B ✓ (1)

4.3.1 n (Cu) $=\frac{m}{M}$

$= \frac{32}{63.5}$ ✓

= 0.504 mol of Cu ✓ (2)

4.3.2 n (Cu)**:** n (e^{-}) = 1: 2 Therefore; n (e^{-}) = 0.504x 2 = 1.008 mol ✓

n (Cu) = $\frac{N}{NA}$

$1.008 = \frac{N}{6.02x10^{23}}$ ✓

N = 6.068×10^{23} electrons

$n = \frac{Q}{qe}$

$6.068x10^{23} = \frac{Q}{1.6X10^{-19}}$ ✓

Q = 97090,56 C ✓

Q = I x Δt

97090,56 = I (3600) ✓ (6)

I = 26,97 A ✓

4.4 Cu^{2+} is a stronger oxidizing agent ✓ than Zn^{2+}.

Cu^{2+} is reduced ✓ to Cu. ✓ (3)

[14]

QUESTION 5

5.1 DC ✓ (1)

5.2 Cathode ✓

$Cu^{2+}(aq) + 2e^- \rightarrow Cu$ ✓✓ (3)

5.3 Cu^{2+} is a stronger oxidising agent ✓ than Zn^{2+} ions ✓; therefore Zn^{2+} ions will not be reduced (to Zn). ✓ (3)

5.4.1 (Chlorine) gas/ bubbles is/ are formed. ✓✓ (2)

5.4.2 Decreases ✓✓ (2)

[11]

ELECTRODYNAMICS: SOLUTIONS

MULTIPLE CHOICE SOLUTIONS

1.1 C✓✓ (2)

1.2 D✓✓ (2)

1.3 A✓✓ (2)

QUESTION 1

1.1 Generator ✓

No external power source✓ (2)

1.2 Coil✓ (1)

1.3 Good conductor of electricity✓ (1)

1.4 A to B✓✓ (2)

1.5.1 $f = \frac{1}{T}$ ✓ (3)

$f = \frac{1}{0.02}$ ✓

$= 50Hz$ ✓ Type equation here.

1.5.2 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{rms} = \frac{250}{\sqrt{2}}$

$= 176.78V$

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

$= \frac{2}{\sqrt{2}}$

$= 1.41$ A✓

$P_{av} = V_{rms}I_{rms}$ ✓ (5)

$= (176.78)(1.41)$ ✓

$= 249.26W$ ✓

QUESTION 2

2.1 AC (generator) ✓ the ends of the coil are attached to slip rings✓ (2)

2.2 From mechanical energy to electrical energy✓ (1)

2.3.1 Brushes✓ (1)

2.3.2 They conduct current from the slip rings to the external circuit. ✓ (1)

2.4 From X to Y✓ (1)

2.5.1 0 V✓ (1)

2.5.2 The rms current is the alternating current✓ which dissipates/produces the same amount of energy as an equivalent direct current (DC) ✓ (2)

2.5.3 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{rms} = \frac{120}{\sqrt{2}}$

$= 60\sqrt{2}\ V$

$P_{av} = V_{rms}I_{rms}$ ✓ (4)

$= (60\sqrt{2})(1.41)$ ✓

$= 101.82W$ ✓

[13]

QUESTION 3

3.1.1 X✓

3.1.2 Change the direction of the magnetic field (turn magnet upside down). (1)
Change the direction of the current (turn the battery around). ✓

3.1.3 Increase the strength of the magnetic field (use stronger magnet). ✓ Increase the current in the conductor. ✓ (2)

Increase the thickness of the magnet to increase the length of the magnetic field.

(Any of the above)

3.2.1 The AC potential difference ✓which dissipates/produces the same amount of energy as an equivalent DC potential difference. ✓ (2)

3.2.2 AC-slip rings ✓

DC- commutator ✓ (2)

3.2.3 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{rms} = \frac{460}{\sqrt{2}}$

$= 325.27\ V$

3.2.4 $I_{rms} = \frac{V_{rms}}{R}$ ✓ (4)

$= \frac{325{,}27✓}{40✓}$

$= 8{,}13A$✓

[11]

QUESTION 4

4.1 Slip-rings✓ (1)

4.2 B✓ (1)

4.3 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ (3)

$V_{rms} = \frac{320}{\sqrt{2}}$ ✓

$= 220.62\ V$ ✓

4.4.1 P$_{av}$ = $\frac{V_{rms}^2}{R}$ ✓ (3)

$= \frac{(220.62)^2}{40}$ ✓

=1216.83W✓

4.4.2 $I_{max} = \frac{V_{max}}{R}$ ✓ (4)

$= \frac{320}{40}$ ✓✓

$= 7.8A$ ✓

[12]

QUESTION 5

5.1.1 From electrical energy to mechanical energy. ✓ (1)

5.1.2 DC motor . ✓ external power source (1)

5.1.3 (carbon) brush✓✓ (2)

5.1.4 It reverses the direction of the current in the coil after each half-cycle✓ (1)

5.1.5 Increases. ✓ The current increases✓ (2)

5.2.1 The rms potential difference is the AC potential difference which dissipates/produces the same amount of energy as an equivalent DC potential difference✓✓ (2)

5.2.2 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ (3)

$200 = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{max} = 282.82V$ ✓

[12]

PHOTOELECTRIC EFFECT: SOLUTIONS

QUESTION 1

1.1 D ✓✓ (2)

1.2 C ✓✓ (2)

1.3 D ✓✓ (2)

1.4 A ✓✓ (2)

1.5 D ✓✓ (2)

1.6 A ✓✓ (2)

[12]

QUESTION 2

2.1.1 Metal (cathode)/ work function/threshold frequency✓ (1)

2.1.2 (maximum) kinetic energy✓ (1)

2.2 Photoelectric effect✓ (1)

2.3 The minimum energy that an electron in the metal needs to be emitted from the metal surface. ✓✓ (2)

2.4.1 $W_0 = hf_0$ ✓

$= (6.63 \times 10^{-34})(1.75 \times 10^{15})$ ✓

$= 1.16 \times 10^{-18} J$ ✓ (3)

2.4.2 $E = W_0 + E_{K(MAX)}$ ✓

$$(6.63 \times 10^{-34})f ✓ = 1{,}16 \times 10^{-18} + \frac{1}{2}(9.11 \times 10^{-31})(5{,}23 \times 10^5)^2 ✓$$

$f = 1.94 \times 10^{-19} Hz$ ✓ (4)

2.5 Increases✓

The number of photons per unit time increases✓ when the intensity of the light increase. Therefore, the number of photo-electrons per unit time increases. ✓ (3)

[15]

QUESTION 3

3.1 Light has a particle nature/is quantized✓ (1)

3.2 The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓ (2)

3.3 $E = W_0 + E_{K(MAX)}$ ✓

$(6{,}63 \times 10^{-34})(5{,}96 \times 10^{14}) = 3{,}42 \times 10^{-19} + E_{k(max)}$ ✓✓

$E_{k(max)} = 5{,}30 \times 10^{-20}$ J ✓ (4)

3.4 $q = I\Delta t$

$= (0{,}012)(10)$ ✓

$= 0{,}12$ C

$n = \frac{Q}{e}$

$n = \frac{0{,}12 ✓}{1{,}6 \times 10^{-19} ✓}$

$n = 7{,}5 \times 10^{17}$ (electrons) (4) number of photons = n = 7,5 x 10^{17}✓✓

3.5 Increases ✓

More photons strike the surface of the metal per unit time/ at a higher rate ✓ hence more (photo) electrons ejected per unit time✓ (resulting in increased current). (3)

[14]

QUESTION 4

4.1 The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓ (1)

4.2 1✓✓

4.3.1 $E_{k(max)} = \frac{1}{2}mv_{max}{}^2$✓

$2{,}99 \times 10^{-19} = (\frac{1}{2}(9.11 \times 10^{-31})v_{max}{}^2$✓

$v^2{}_{max} = 8{,}10 \times 10^5\ m.s^{-1}$✓

(3)

4.3.2 $E = W_0 + E_{K(MAX)}$✓

$E = (3.68 \times 10^{-19}) + 2{,}99 \times 10^{-19}$ ✓✓

$E = 6{,}67 \times 10^{-19} J$✓ (4)

4.4 Remain the same ✓

The energy of the incident photon is not changing✓ (2)

[13]

QUESTION 5

5.1 The minimum energy (of incident photons) that can eject electrons from a metal/surface. ✓✓ (2)

5.2 E = $\frac{hc}{\lambda}$✓

E= $\frac{(6{,}63 \times 10^{-34})(3 \times 10^8)}{400 \times 10^{-9}}$✓

E= $4{,}97 \times 10^{-19} J$✓ (3)

5.3 $E = W_0 + E_{K(MAX)}$✓

4.97×10^{-19}✓ $= (2{,}46 \times 10^{-19}) + \frac{1}{2}(9.11 \times 10^{-31})v_{max}{}^2$✓

$v_{(max)}$= 742322,57 m.s^{-1}✓ (4)

5.4 No✓

The work function of platinum is higher than the energy of the photon✓ (2)

[11]

QUESTION 6

6.1.1 E=hf ✓ (4)

$E=(6.63\times10^{-34})(2.8\times10^{16})$ ✓

$E=1.86\times10^{-17}$ J ✓

$E>W_0$ electrons will be ejected ✓

6.1.2 $F=\frac{kQ_1Q_2}{r^2}$ ✓

$0,027=\frac{(9\times10^9)(5.4\times10^{-6})Q_2}{(0.1)^2}$ ✓✓

$Q_2=5.56\times10^{-9}$ C

$n=\frac{Q}{e}$ ✓

$n=\frac{5.56\times10^{-9}}{1.6\times10^{-19}}$ ✓

$n=3.47\times10^{10}$ electrons

number of photons $= n = 3.47\times10^{10}$ ✓ (6)

6.2.1 Absorption ✓ (1)

6.2.2 Continuous spectrum of white light, with dark lines replacing frequency. ✓✓ (2)

6.2.3 Diagram B ✓ (1)

[14]

ORGANIC MOLECULES: SOLUTIONS

MULTIPLE CHOICE QUESTIONS

1.1. A ✓✓ (2)

1.2. B ✓✓ (2)

1.3. C ✓✓ (2)

1.4. B ✓✓ (2)

1.5. B ✓✓ (2)

1.6. D ✓✓ (2)

1.7. D ✓✓ (2)

1.8. C ✓✓ (2)

1.9. A ✓✓ (2)

1.10. C ✓✓ (2)

LONG QUESTIONS

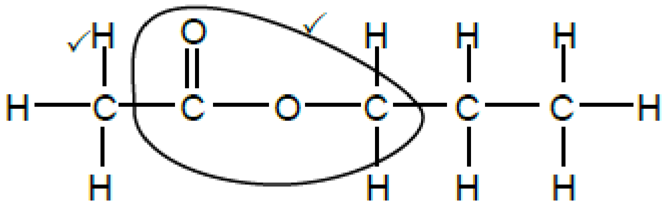
QUESTION 1

1.1.1 D✓ (1)

1.1.2 A✓ (1)

1.1.3 E✓ (1)

1.2.1 Butanal✓✓ (2)
1.2.2 4,4-dimethylpent-2-yne✓✓✓ (3)
1.3.1 Compounds with the same molecular formula,✓ but different functional groups/homologous series.✓ (2)
1.3.2 A and C✓ (1)
1.4.1 H_2SO_4/Sulphuric acid ✓ (1)
1.4.2 Esterification/Condensation✓ (1)
1.4.3



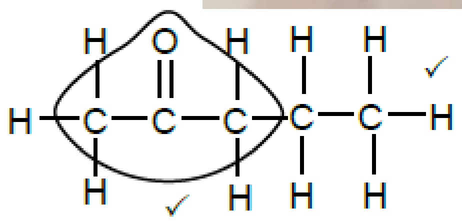
(2)

1.4.4 Propan-1-ol ✓✓ (2)

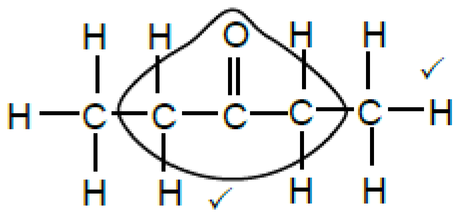
[17]

QUESTION 2

2.1. Organic compounds that consist of hydrogen and carbon only.✓✓ (2)
2.2.1 C and E✓ (1)
2.2.2 D and H✓✓ (2)
2.2.3 A✓ (1)
2.3.1

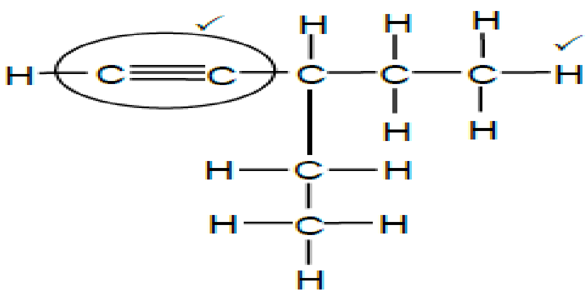


OR/OF



(2)

2.3.2 C_nH_{2n+2} ✓ (1)
2.3.3



(2)

2.4.1 3-ethylhex-3-ene ✓✓✓ (3)
2.4.2 2,5-dichloro-2,4-dimethylhexane ✓✓✓ (3)
2.4.3 2,2-dimethyl✓propanal✓ (2)
2.5 $C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$ ✓✓✓ (3)

[22]

QUESTION 3

3.1 A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds. ✓✓ (2)

3.2.1 E✓ (1)

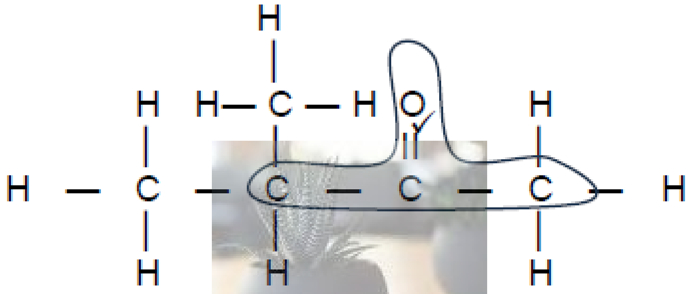
3.2.2 A✓ (1)

3.2.3 C✓ (1)

3.3 EQUAL TO✓

Compound **E** and ethyl methanoate are functional isomers / structural isomers / have the same molecular formula / same number and type of atoms/same number of C, H and O atoms. ✓✓ (3)

3.4.1

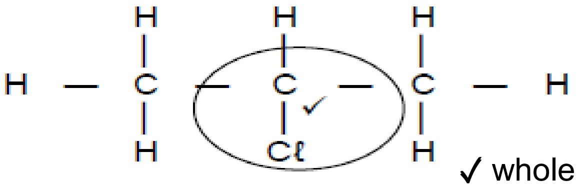


✓ whole structure (2)

3.4.2 Propanoic acid ✓✓ (2)

3.4.3 4-methylhex-2-yne ✓✓✓ (3)

3.5



✓ whole structure (2)

3.6 C_7H_{12} + 10 O_2 ✓→ 7 CO_2 + 6 H_2O ✓ Bal. ✓ (3)

[20]

QUESTION 4

4.1. Compounds with one or more multiple bondsbetween C atoms in the hydrocarbon chain✓✓ (2)

4.2.1 D✓ (1)

4.2.2 2,4-dimethyhexane✓✓✓ (3)

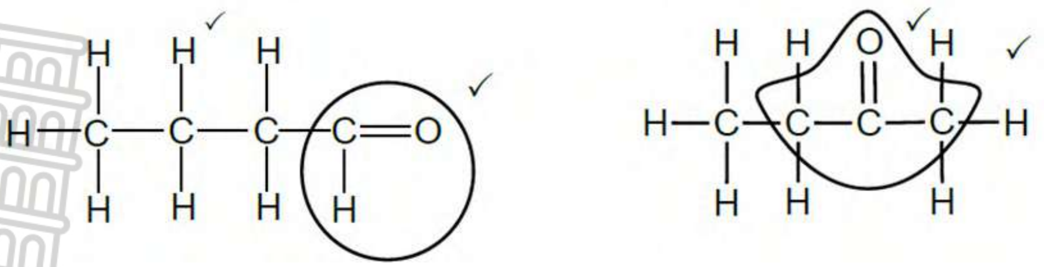
4.2.3 Propan-2-ol✓✓ (2)

4.2.4 Hept-1-ene✓✓ (2)

4.2.5 $2C_8H_{18}$ + $25O_2$ ✓ → $16CO_2$ + $18H_2O$✓ Balancing✓ (3)

4.3.1 Compounds with the same molecular formula but different functional groups/homologous series✓✓ (2)

4.3.2



(4)

4.4

	C	H	O
Mass	1,09	0,18	2-(1,09 +0,18) =0,73✓
Moles	$n = \frac{m}{M}$ $=\frac{1,09}{12}$✓ =0,0908	$n = \frac{m}{M}$ $=\frac{0,18}{1}$✓ =0,18	$n = \frac{m}{M}$ $=\frac{0,73}{16}$✓ =0,046
Simplest ratio	2	4	1
Empirical formula	C_2H_4O✓		
$M(C_2H_4O)$ x n = 88 ($g.mol^{-1}$) 4n = 88 n = 2 Molecular formula of compound X: $C_4H_8O_2$ ✓			

(6)
[25]

QUESTION 5

5.1 The pressure exerted by a vapour at equilibrium with its liquid in a closed system.✓✓ (2)

5.2.1 146 (kPa) ✓✓ (1)

5.2.2 Comparing compound C/2,2-dimethylpropane with compounds A/pentane and B/2-methylbutane

• Structure: Compound C is more branched than compounds A and B/Shorter chain length/most compact most spherical/smallest surface area (over which intermolecular forces act). ✓

• Intermolecular forces: Compound C has weaker/less intermolecular forces/Van der Waals forces/London forces than A and B. ✓

• Energy: Lesser energy needed to overcome or break intermolecular forces/Van der Waals force in compound C than A and B. ✓ (3)

5.3.1 E/butanal ✓ (1)

5.3.2 • Compound D/Propanoic acid has hydrogen bonding (dipoledipole and London forces) between molecules. ✓

• Compound E/Butanal has dipoledipole forces (and London forces) between molecules.✓
• Intermolecular forces between molecules of compound D/propanoic acid are stronger than intermolecular forces between molecules of compound E/butanal.✓
• More energy is needed to overcome/break intermolecular forces between molecules of compound D/propanoic acid than in compound E/butanal ✓ (4)

[11]

QUESTION 6

6.1 The temperature at which the vapour pressure of a substance equals atmospheric/external pressure. ✓✓ (2)

6.2 C ✓ (1)

6.3 A/$CH_3CH_2CH_2CH_2C\ell$ /1-chlorobutane

• Structure: Longer chain length/larger surface area (over which intermolecular forces act). ✓

• Intermolecular forces: Stronger/more intermolecular forces/Van der Waals forces/London forces/dipole-dipole forces.✓

• Energy: More energy needed to overcome or break intermolecular forces/Van der Waals forces/dipole-dipole forces. ✓

OR

B/$CH_3CH(CH_3)CH_2C\ell$/1-chloro-2-methylpropane

• Structure: Shorter chain length / branched / compact / more spherical / smaller surface area (over which intermolecular forces act). ✓

• Intermolecular forces: Weaker/less intermolecular forces/Van der Waals forces/London forces/ dipole-dipole forces. ✓

• Energy: Less energy needed to overcome or break intermolecular forces/Van der Waals forces/dipole-dipole forces.✓

(3)

6.4.1 75 (°C) ✓✓ (2)

6.4.2 • Intermolecular forces: C ($CH_3CH_2CH_2CH_2OH$/butanol) has stronger intermolecular forces than D ($CH_3CH_2CH_2CHO$/butanal). ✓ (2)

• Energy: More energy needed to overcome or break intermolecular forces. ✓

Accept: Boiling point of C will be more (in relation to C and D/118°C vs 75°C).

6.5 Decreases ✓ (1)

[10]

QUESTION 7

7.1.1 The temperature at which the vapour pressure of a substance / liquid equals the atmospheric pressure✓✓ (2)

7.1.2 All are primary alcohols ✓ (1)

7.1.3 London forces/dispersion forces/induced-dipole forces ✓ (1)

7.1.4 Pentan-1-ol ✓✓ (2)

7.2.1 Compound **C/**propanoic acid ✓ (1)

7.2.2 Compound A/butanone has dipole-dipole forces ✓ (and London forces / dispersion forces/induced-dipole forces)

Compound B/butan-1-ol and C/propanoic acid has hydrogen bonds ✓ (and London forces/dispersion forces/induced-dipole forces)
Compound B/butan-1-ol has one site for hydrogen bonding and C/propanoic acid has two sites for hydrogen bonding ✓
Strength of the intermolecular forces increases from compound A / butanone to compound B / butan-1-ol to compound C / propanoic acid ✓
More energy is needed to overcome the intermolecular forces in compound C / propanoic acid than compounds A/ butanone and B/butan-1-ol ✓ (5)

[12]

QUESTION 8

8.1. The temperature at which the vapour pressure of a liquid equals the atmospheric pressure ✓✓ (2)

8.2.1 Molecular size/ Surface area / Chain length✓ (1)

8.2.2 Functional group / Homologous series✓ (1)

8.3 London forces / induced dipole forces / dispersion forces ✓ (1)

8.4 129 °C ✓ (1)

8.5
- 2-methylbutan-1-ol has a larger molar mass/molecular size than butan-1-ol ✓
- London forces/induced dipole forces/dispersion forces of 2-methylbutan-1-ol is stronger than that butan-1ol ✓
- The boiling point will higher than that of butan-1-ol
- 2-methyl butan-1-ol has a shorter chain length than pentan-1-ol✓
- London forces of 2-methyl butan-1-ol is weaker than that of pentan-1-ol ✓
- The boiling point will be lower than that of pentan-1-ol

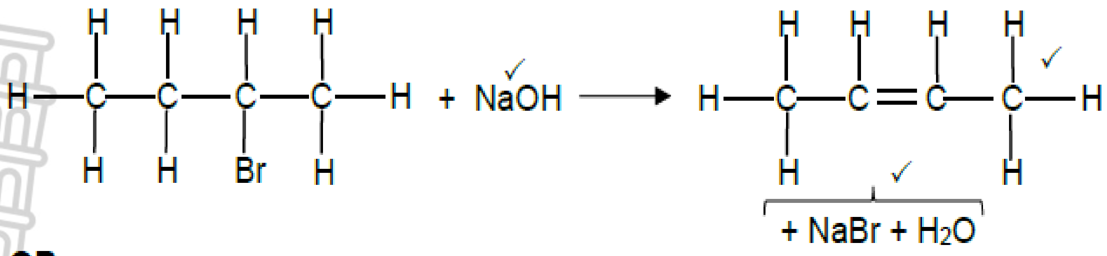
(4)

8.6.1 The pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓ (2)

8.6.2 Q ✓ (1)

8.6.3
- Propan-1-ol has hydrogen bonds ✓(and London forces/induced dipole forces/dispersion forces
- Propanal has dipole-dipole forces ✓(and London/induced dipole forces/dispersion forces
- Hydrogen bonds are stronger than dipole-dipole forces ✓
- The stronger the intermolecular forces the lower the vapour pressure

(4)



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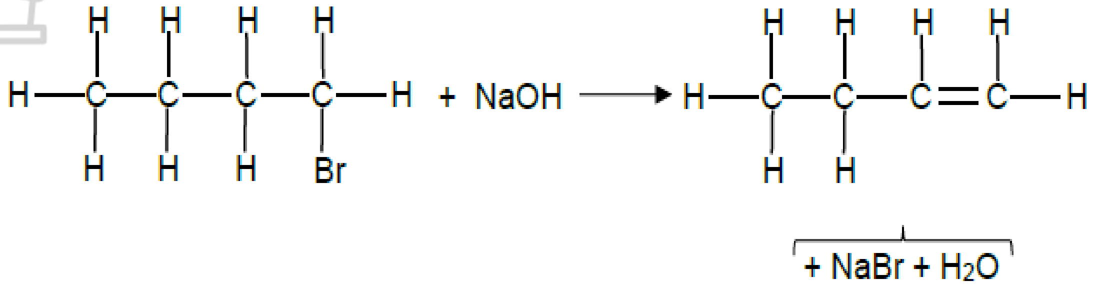


(3)

[17]

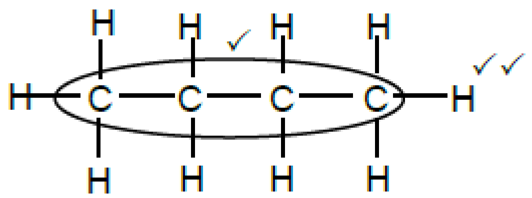
QUESTION 9

9.1. The chemical process/reaction in which longer chain hydrocarbon/alkane molecules/are broken down to shorter (more useful) molecules. ✓✓ (2)

9.2 Primary ✓

The halogen/bromine/functional group (-X) is bonded to a C atom that is bonded to one other C atom.✓ (2)

9.3.1



(3)

9.3.2 C_8H_{18} ✓ (1)

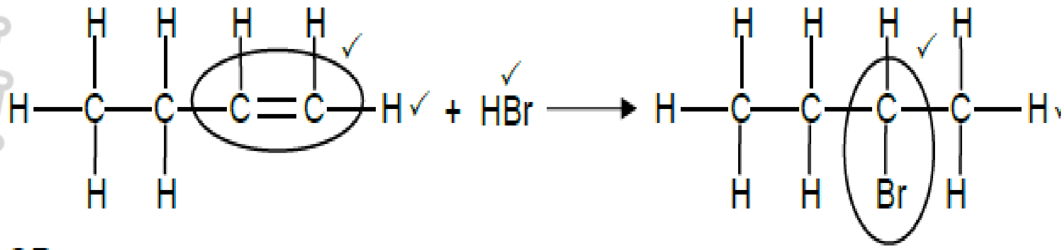
9.4.1 Br_2/Bromine✓ (1)

9.4.2 Substitution ✓ (1)

9.4.3 UV/(Sun)light/Heat ✓ (1)

9.5 Dehydrohalogenation/Dehydrobromination✓ (1)

9.6.1



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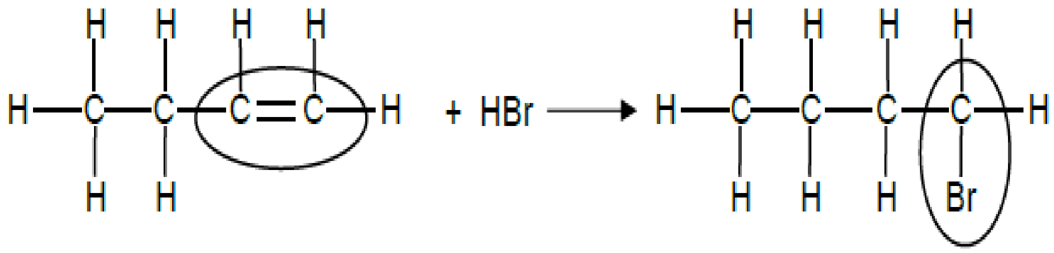
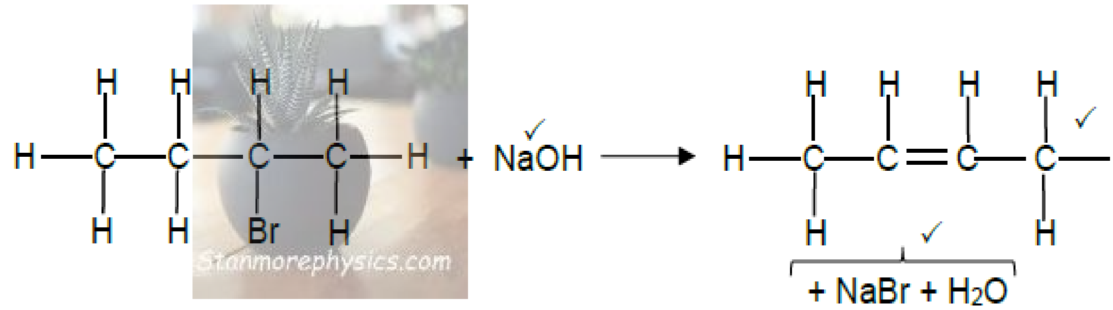


(5)

9.6.2



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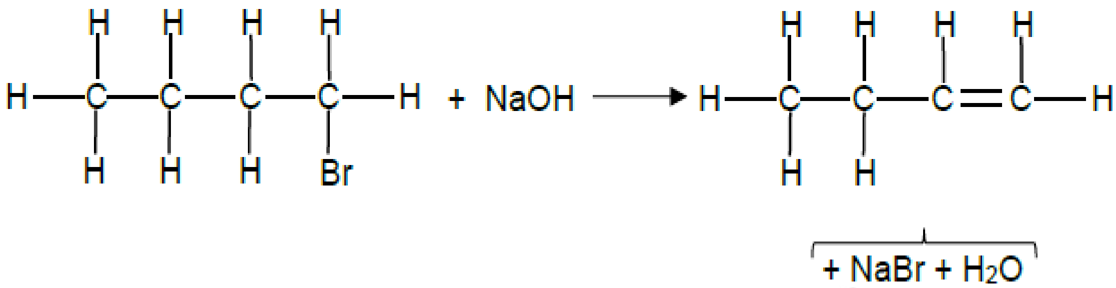


(3)

9.6.3 But-2-ene /but-1-ene ✓✓ (2)

[22]

QUESTION 10

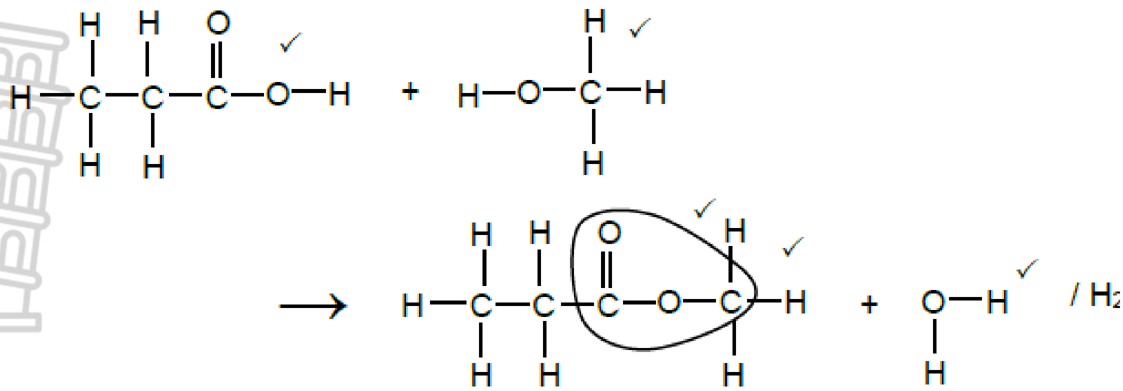
10.1.1 Concentrated) sulphuric acid/H2SO4(aq) ✓ (1)

10.1.2 Esterification / Condensation ✓ (1)

10.1.3
- Alcohol/methanol/reactant is flammable/catches fire easily. ✓
- To heat evenly/A steady/controlled/gradual increase in temperature. ✓

(2)

10.1.4



(5)

10.1.5 Methyl propanoate ✓✓ (2)

10.2.1 Hydrogen/H_2 ✓ (1)

10.2.2 3,3-dimethyl✓but-1-ene✓ (2)

10.2.3 elimination **OR** dehydrohalogenation ✓ (1)

10.2.4 H_2SO_4/H_3PO_4 **OR** Sulphuric acid/Phosphoric acid ✓ (1)

10.2.5 3,3-dimethyl ✓butan-2-ol ✓ (2)

10.2.6 Addition/hydration ✓ (1)

10.2.7 Secondary ✓ (1)

[20]

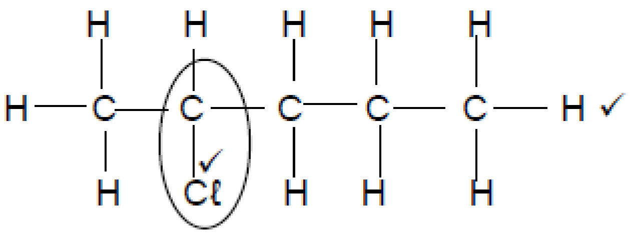
QUESTION 11

11.1 UNSATURATED✓ It contains a double bond between its carbon-carbon atoms in the hydrocarbon chain. ✓ (2)

11.2 Substitution/Hydrolysis of a haloalkane✓ (1)

11.3 Elimination/dehydrohalogenation of haloalkanes ✓ (1)

11.4



(2)

11.5 Pentan-2-ol ✓✓ (2)

11.6 Dilute strong base/NaOH✓ and mild heat ✓ (2)

11.7 Positional isomers ✓✓ (2)

[12]

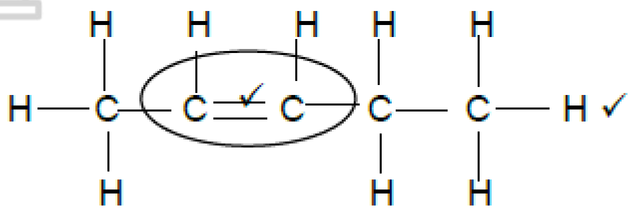
QUESTION 12

12.1.1 Hydrolysis ✓ (1)

12.1.2 Pentan-2-ol ✓✓ (2)

12.1.3 Concentrated strong base/ NaOH/ KOH/ LiOH✓ (1)

12.1.4 (2)



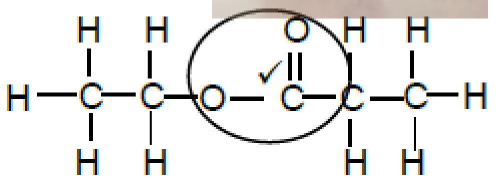
12.1.5 Sulphuric acid ✓ (1)

12.1.6 Dehydration ✓ (1)

12.2.1 Esterification / Condensation ✓ (1)

12.2.2 Alcohols are flammable✓ (1)

12.2.3



✓ whole structure

ethyl ✓propanoate ✓ (4)

[14]

REACTION RATE: SOLUTIONS

Question 1

1.1	C	✓✓	(2)
1.2	C	✓✓	(2)
1.3	D	✓✓	(2)
1.4	A	✓✓	(2)
1.5	B	✓✓	(2)

LONG QUESTIONS **[10]**

Question 1

1.1 Exothermic ✓

$\Delta H < 0$/Energy is released ✓ (2)

1.2 Rate = $-\frac{\Delta m}{\Delta t}$

$= -\frac{(0,25-2)✓}{30\ ✓}$

= 0,06 g.s^{-1}✓ (3)

1.3 m($CaCO_3$)= $\frac{40}{100}$ x2 ✓=0,8 g

n = $\frac{m}{M}$ = $\frac{0,8}{100}$ ✓ = 8X10^{-3} mol

n(CO_2) = n($CaCO_3$) ✓=8X10^{-3} mol

V(CO_2) = 8X10^{-3}x22,4✓ = 0,18 dm^3✓ (5)

1.4 **Any one :**

- Concentration (of acid) ✓
- Size/mass of tablet/Identical tablet /Type of tablet. ✓
- State of division / Surface area✓ (1)

1.5 **Any one:**

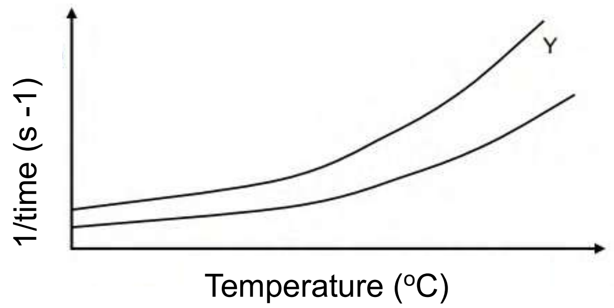
- Reaction rate increases with increase in temperature. ✓
- Reaction rate decreases with decrease in temperature. ✓
- Time taken for reaction decreases when temperature increases. (2)

1.6

- Increase in temperature increases the average kinetic energy/molecules move faster. ✓
- More molecules have enough/sufficient kinetic energy/More molecules have $E_k > E_a$. ✓
- More effective collisions per unit time/second. /Frequency of effective collisions increases. ✓ (3)

1.7 **Marking guideline:**

- For each value of temperature, the CURVE Y must be above the given CURVE. ✓
- CURVE Y must have an increasing rate with an increase in temperature. ✓



(2)
[18]

Question 2

2.1.1 Exothermic. Energy of products is less than energy of reactants ✓✓ (2)

2.1.2 Number of particles with enough energy to react. Kinetic energy greater than activation energy ✓ (1)

2.1.3 24.8-208.2=32.6(KJ)✓✓ (2)

2.2.1 Decrease ✓ (1)
2.2.2 Remains the same ✓ (1)
2.2.3 Remains the same✓ (1)
2.3.1 Concentration ✓ (1)
2.3.2 More particles per unit Volume ✓, more effective collision per unit time✓, higher reaction rate✓ (3)
2.3.3 $rate = {}^{\Delta V}/_{\Delta t} ✓ 40 = \frac{\Delta v}{(2.6)(60)} ✓ = 6240 cm^3$ $n = {}^{V}/_{V_m} = {}^{6240}/_{27000} ✓$

$n(Al) = \frac{2}{3}(0.23)✓ = 0.15 \text{ mol}$ $0.15 = \frac{m}{27}✓$ $\%\text{purity} = \frac{4.05}{5}(100)✓$

$= 81\%✓$ (6)

[18]

Question 3

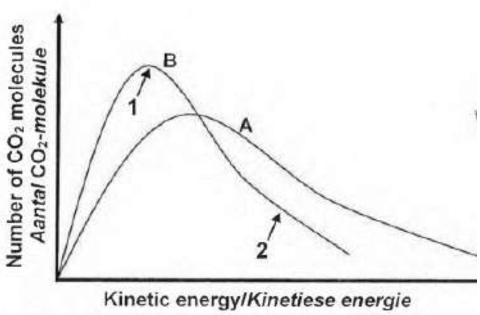
3.1 Change in concentration of reactant or product per (unit) time. ✓✓ (2)
3.2 Surface area✓ (1)
3.3 Higher kinetic energy , higher speed ✓. More molecules with enough energy✓. More effective collision per unit time✓. Rate of reaction also increase✓ (2)
3.4 (1)

3.4.1 $n = {}^{m}/_{M} ✓ = \frac{5}{84} ✓$ $n(CO_2) = n(MgCO_3)✓ = 0.06\, mol$

$0.06 = \frac{m}{44} ✓ \; 0.5✓ = \frac{2.64}{\Delta t}$ $\Delta t = 5.28\, min✓$ (6)

3.4.2 $n = \frac{V}{V_m} ✓$ $0.06 = \frac{1.5}{V_m}$ $V_m = 25\, dm^{-3} ✓$ (2)

3.5



(2)

[17]

Question 4

4.1 B ✓ (4)

Catalyst provides an alternative path of lower activation energy✓, more particles with enough energy to react or higher than activation energy✓, more collision per unit time ✓

4.2 Y. ✓✓ (2)

4.3

4.3.1 $0.56 dm^3$ or $560 (cm^3)$✓✓ (2)

4.3.2 $n = \frac{V}{V_m}$✓ $= \frac{560}{24000}$ ✓ $n(H_2O) = 2n(O_2)$ $n = 2(0.023)$✓ $= (0.046)(18)$ $= 0.83g$✓ (4)

4.4.1 Zero ✓ (1)

4.4.2 Greater ✓ (1)

4.6 $n = \frac{m}{M}$ $n(O_2) = \frac{0.9}{32}$ ✓ = 0,028mol

M 32

$n(H_2O_2) = 2n(O_2) = 2(0.028)$✓ 0.056

$2.1 \times 10^{-3} = \frac{0.056 - 0}{\Delta t}$ $\Delta t = 26.67$ (5)

[15]

Question 5

5.1 Temperature ✓ (1)

5.2 Change in concentration of reactant or product per (unit) time. ✓✓ (2)

5.3 14 (min) ✓ (1)

5.4.1 Graph B ✓(Experiment 3) has the highest (acid) concentration/more particles/higher number of moles. ✓ (2)

5.4.2 Graph C ✓(Experiment 5) is at highest temperature/more particles with sufficient kinetic energy/HCℓ is at 35° C ✓ (2)

5.5.1 Speeds up the reaction/Increases the reaction rate/ Provides alternate pathway/Lowers the (net) activation energy. ✓ (2)

5.5.2 Equal to ✓ (1)

5.3 $n(Zn) = \frac{m}{M} = \frac{1.5}{65}$✓ $= 0.023$ mol (4)

Rate = $-\frac{\Delta n}{\Delta t} = -\frac{(0-0.023)}{(14-0)}$✓✓= $1,65X10^{-3}$ $mol.min^{-1}$✓

[15]

Question 6

6.1.1 Temperature ✓ (1)

6.1.2 Reaction rate ✓ (1)

6.2
- Larger surface area. ✓
- More particles with enough energy and collide with correct orrientation. ✓

More effictive collisions per unit time. ✓ (3)

6.3 C ✓

Exp 1 and 2

- Reaction in Exp 1 is faster than Exp 2 due to higher concentration of the acid. ✓
- The gradient in Exp 1 is steeper than in Exp 2✓

Exp 1,3 and 4

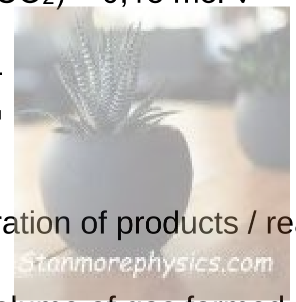
- Reaction in Exp 3 is faster than Exp 1 due to higher temperature. ✓
- Reaction in Exp 4 is faster than Exp 1 due to higher temperature/larger surface area. ✓ (6)
  Therefore, the gradient of graphs of Exp 3 and 4 is steeper than in Exp 1 ✓

6.4

$n(CO_2) = \frac{V}{V_m} = \frac{4,5}{25,7}$ ✓ = 0,18 mol

$n(CaCO_3) = n(CO_2)$ = 0,18 mol ✓

$n(CaCO_3) = \frac{m}{M}$



(5)

Question 7

7.1 Change in concentration of products / reactants perunit time ✓✓ (2)

7.2.1 Temperature ✓ (1)

7.2.2 Rate of reaction / volume of gas formed per unit time ✓ (1)

7.3 High temp / high concentration ✓ more effective collision/more molecules with enough energy,✓ more collision per unit time ✓ (4)

7.4 Exp 1 is faster than exp 2 due higher concemtration✓ steeper gradient ✓ (4)
Exp 4 faster than exp 1 due to higher temp✓✓
Final **C**

7.5

$$n = \frac{V}{V_m} = \frac{4.5}{25.7}✓ = 0.18\ mol$$

N(CO_2)=0.18 mol ✓ $0.18 = \frac{m}{100}$✓ m = 18g (5)

M=28-18=7.00g✓

DOPPLER EFFECT: SOLUTIONS

MULTIPLE CHOICE QUESTIONS

1	A	(2)
2	B	(2)
3	A	(2)
4	D	(2)
5	C	(2)

QUESTION 1

1.1.1 Radar cameras-used identify/scanning over speeding cars.✓ (1)

1.1.2 Burglar alarms. ✓ (1)

1.1.3 Sonar technology– used to locate objects under water. ✓ (1)

1.2 Directly proportional✓ (1)

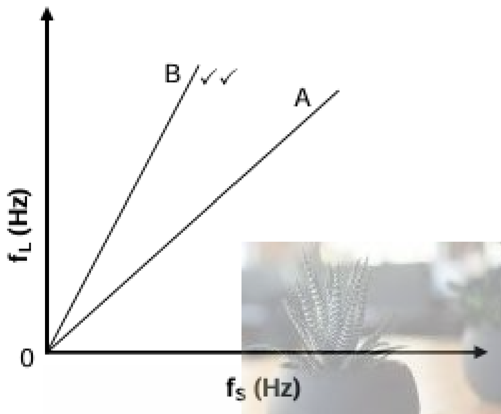
1.3 $f_l = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_s$ ✓ (5)

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

$1{,}06$ ✓✓ $= \frac{340 + v_L}{340}$ ✓

$v_L = 20{,}4 \, m.s^{-1}$ ✓

1.4 (2)



- Graph is a straight line starting from origin
- Gradient of B is greater than gradient of A

QUESTION 2

2.1 As the ambulance is moving away from the scene/detector, the wavelength become longer resulting in less waves reaching detector per unit time hence the frequency decreases. (2)

2.2 $f_l = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_s$ ✓ (5)

$0{,}9 f_s$ ✓ $= \left(\frac{340}{340 + v_S}\right) f_s$ ✓

$340 = 306 + v_s$ ✓

$v_s = 37{,}78 \, m.s^{-1}$ ✓

2.3

2.3.1 Red shift- shift in spectra of a distant galaxies towards longer wavelengths, towards the red end of the spectrum.✓✓ (2)

2.3.2 The shift is to a longer wavelength (lower frequency), therefore the star is moving away from the earth. ✓ (1)

2.3.3 A greater shift shows that the distant star is moving away at a greater speed than a nearby star.✓✓ (2)

QUESTION 3

3.1 Ambulance approaching : (6)

$f_l = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_s$ ✓

$450 = \frac{340 + 0}{340 - v_s} f_S$

$450(340-v_S)$✓$=340f_S$ ………………(i)✓

Ambulance moving away

$385=\frac{340-0}{340+v_s}f_S$

$385(340+v_S)=340f_S$ ………………(ii) ✓

$450(340-v_S)=385(340+v_S)$✓

$v_S = 26.46 m.s^{-1}$✓

3.2 $450(340-v_S)=340f_S$ (2)

$450(340-26.46)=340f_S$

$f_S = 414.98\ Hz$

3.3 414.98 Hz (1)

QUESTION 4

4.1 Ambulance ✓ (1)

4.2 fire engine ✓ (1)

4.3 (Fire engine) (6)

$f_L=\frac{v \pm v_L}{v \pm v_s}f_s$✓

850 ✓$=\frac{v+0}{v+20}$✓(900)✓

$v= 340\ m.s^{-1}$

(ambulance)

$1030=\frac{340}{340-v_S}(920)$✓

$v_S= 36,31\ m.s^{-1}$✓

4.4 When a distant star emits light, its spectrum can be observed on earth✓. The spectral lines for certain elements do not correspond to that of the same elements when the light source is stationery✓. The shift in the spectral lines (towards red)✓ implies that the frequency observed is lower than actual frequency. Hence the star is moving away from the earth or earth is expanding✓. (4)

QUESTION 5

5.1 Doppler effect✓. It is the change in frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation✓✓. (3)

5.2 $\lambda=\frac{v}{f}$ ✓ (3)

$\lambda=\frac{340}{30\ 000}$ ✓

$\lambda=0,0113\ m$ ✓

5.3 Increases (1)

5.4 Incident waves (6)

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$f_L = \frac{340 - v_L}{340}$ ✓(30 000)✓

Reflected waves

29 500 ✓$= (\frac{340}{340+v})(\frac{340-v}{340})$(30 000)✓

v=2,86 m.s^{-1} ✓(away from the device)

QUESTION 6

6.1 The change in frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation.✓✓ (2)

6.2 $\lambda = \frac{v}{f}$✓ (3)

$\lambda = \frac{340}{5000}$✓

$\lambda = 0{,}068\ m$✓

6.3 Shift 1 (6)

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$f_L = \frac{340+v}{340}$✓(5 000) ✓

Shift 2

5104✓$= (\frac{340}{340-v})(\frac{340+v}{340})$(5 000)✓

v=3,46 m.s^{-1}✓ towards the source

6.4 To measure heartbeat of the unborn foetus in the womb. (2)

To measure blood flow rate.✓✓

QUESTION 7

7.1 1,25 or 1 ¼ ✓ (1)

7.2 $14 \times 10^{-4}\ s$✓✓ (2)

7.3 (3)

$$f = \frac{1}{T} ✓$$

$$f = \frac{1}{14 \times 10^{-4}} ✓$$

f=714,29 Hz ✓

7.4 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$✓ (5)

(714,29)✓$= (\frac{340}{340 - v_s})$✓(600)✓

$v_s = 54{,}40\ m.s^{-1}$ ✓(accept 54,28 to 54,40)

QUESTION 8

8.1 Away from✓. Observed frequency lower.✓ (2)

8.2 v=fλ ✓ (3)

340=f (0,34)✓

f=1 000 Hz ✓

8.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ Distance=vΔt (6)

$950✓ = \frac{340 - v_L}{340 + 0}$ ✓(1000) ✓

$v_L = 17\ m.s^{-1}$

Distance=(17)(10) ✓

Distance=170 m✓

QUESTION 9

9.1 (Doppler) blood flow meter✓ (1)

9.2 $f_L = 954,3 + (954,3 \times \frac{3,25}{100})$✓ (2)

$f_L = 985,31\ Hz$ ✓

9.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ (4)

985,31 ✓= $\frac{v + 0}{v - 10,6}$ ✓(954,3)✓

$v = 336,80\ m.s^{-1}$✓

9.4 Decreases ✓ (1)

9.5 For a constant velocity or speed of sound, if the frequency increases, then the wavelength decreases.✓✓ (2)

QUESTION 10

10.1 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ **OR** $v = \frac{d}{t} = \frac{300}{10}$ ✓$= 30 m.s^{-1}$✓ (2)

300= v_i(10)✓

$v_i = 30\ m.s^{-1}$✓

10.2 The change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of sound propagation. (2)

10.3 Car/source (just) passes observer. (1)

10.4 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ (4)

932 ✓= $\frac{340}{340-30} f_s$✓

$\therefore f_s = 849,76\ Hz$ ✓

10.5 **ANY TWO:** Doppler / Blood flow meter/Measuring the heartbeat of a foetus/Radar/Sonar/Used to determine whether stars are receding or approaching earth.✓✓ (2)

ACIDS AND BASE: SOLUTIONS

MULTIPLE CHOICE QUESTIONS

1.1. D✓✓

1.2. D✓✓

1.3. B✓✓
1.4. B✓✓
1.5. D✓✓
1.6. C✓✓ (12)

QUESTION 1

1.1. An acid that can donate 2 (two) protons per molecule. ✓✓ (2)

1.2. 1.2.1. H_3O^+ ✓hydronium ion✓ (2)

1.2.2. SO_4^{2-} ✓✓ (2)

1.2.3. OH^- ✓ (1)

1.3 1.3.1. NaOH + HCℓ ✓ → NaCl + H_2O ✓ ✓Bal (3)

1.3.2. $c = \frac{n}{V}$ ✓ (3)

n=(0,5)(1) ✓

n=0,5mol✓

1.3.3. NaOH: HCℓ (1)

1:1

∴n=0,5mol✓

1.3.4. HCℓ✓ (1)

1.3.5. Initial n HCℓ =0,5 mol (6)

NaOH n = 0,06mol

HCℓ excess= 0,5 – 0,06✓ = 0,44mol✓

pH=-log[H_3O^+]✓

pH=-log 0,44✓

pH=0,36✓

Question 2

2.1. A solution with a known concentration. ✓✓ (2)

2.2.1. A= Pipette✓ (1)

2.2.2. B= Funnel ✓ (1)

2.3. Because the first trial is discarded. ✓/ (1)

2.4. $\frac{na}{nb} = \frac{caVa}{cbVb}$ ✓ (4)

$\frac{Ca \times 25}{0,2 \times 14,25} = ½$ ✓✓

Ca=0,228 mol.dm^{-3}✓

2.5. 2.5.1. H_2SO_4 ionises completely✓ in solution and forms a high concentration of H_3O^+✓ (2)

2.5.2. a) H_2SO_4 ✓ (2)

b) SO_4^{2-}✓

2.5.3. Ampholyte✓ (1)

2.5.4. H_2O✓ (1)

2.6. 2.6.1. A substance that produces hydroxide ions in solution. ✓✓ (2)

2.6.2. $CaSO_4$ ✓ (1)

2.6.3. Water ✓ (1)

[23]

Question 3

3.1. 3.1.1. HSO_4^-✓ (do not accept : hydrogen sulphate ion) (1)

3.1.2. CN^-✓ (1)

3.2. 3.2.1. $Na_2CO_3.10H_2O$ + 2HCℓ ✓→ 2NaCl + $11H_2O$ +CO_2 ✓ ✓bal (3)

3.2.2. Methyl orange ✓ (1)

3.2.3. Strong acid is titrated with a weak base✓✓/ he equivalence point is in the pH range (3 – 4,4) / Low pH / Acidic solution after titration end point. Any ONE answer will be correct (2)

3.2.4. Red to Yellow ✓ (1)

3.2.5.

Option 1: cHCℓ = = $\frac{n}{V}$ ✓ = 0,1 x $\frac{24,8}{1000}$ = 2,48 x 10^{-3} mol HCℓ ✓ 1 mol Na_2CO_3 reacts with 2 mol HCℓ n (Na_2CO_3) in 500 cm^3: ✓ = $\frac{2,48 \times 10^{-3}}{2}$X 500/25 ✓ = 2,48 x 10^{-3} mol Na_2CO_3 n = Mm m = nM = 2,48 x 10^{-3} x 286 $gmol^{-1}$ = 7,092 g ✓	**Option 2** $\frac{c_aV_a}{C_bV_b} = \frac{n_a}{n_b}$ $\frac{(0,1)(24,5\times10^{-3})}{(C_b(25\times10^{-3})} = \frac{2}{1}$ Cb = 0,0496 mol·dm-3 ✓ C = Vn n = (0,0496)(0,5) ✓ = 0,0248 mol Na_2CO_3 ✓ n = Mm m = nM = (0,0248) (286) = 7,093 g Na_2CO_3 ✓✓ **Marking guidelines**: Calculate n(HCℓ) ✓ Use formula C = n/V ✓ Use ratio, 1 : 2 ✓ Calculate n Na2CO3) ✓ Calculate m of Na_2CO_3 ✓

3.2.6. Positive marking from question above

% Na_2CO_3 in commercial washing soda= $\frac{actual\ mass}{\text{theorectical mass}}$X 100%✓

= $\frac{7,092}{7,6}$X 100✓ (3)

= 93,32 % ✓
If answer of 7,093 g is used then the answer is 93,33 %

Question 4

4.1. An acid is a proton donor. ✓✓ (2)

4.2. $NaOH \rightarrow Na^+ + OH^-$
0,75 $mol.dm^{-3}$ (NaOH) gives 0,75 $mol.dm^{-3}$ OH^- (Ratio 1:1) ✓ (1)

4.3. OPTION 1
pOH = -log [OH^-]
POH = - log[0,75] ✓
POH = 0,1249

pH + POH = 14
pH+ 0,1249 = 14 ✓
pH = 13,88 ✓

OPTION 2
[H^+][OH^-] = 10^{-14}
[H^+][0,75] = 10^{-14} ✓
[H^+] = 1,3333 x 10^{-14} $mol.dm^{-3}$

pH = -log [OH^-]
pH = - log[1,3333 x 10^{-14}] ✓
[H = 13,88 ✓

$N_{initial}$ (HCℓ) (9)
$c = \frac{n}{V}$ ✓
$N_{initial}$ = cV
= (0,5)(0,075) ✓
= 0,0375 moles

For the reaction between HCℓ (excess) and NaOH
N(NaOH) reacted n = cV
n = 0,75 x 0,022 ✓
n = 0,0165 moles
n(NaOH) : n(HCℓ) = 1 : 1
n_{excess} (HCℓ) = 0,0165 moles (Ratio) ✓
$n_{reacted}$ (HCℓ) = with $CaCO_3$
n = 0,0375 – 0,0165 ✓
n = 0,021 moles✓

use ratio:
n(reacted)($CaCO_3$) = 0,0105mol✓

m = n x M

m = (0,0105)(100) ✓

m = 1,05 g

% $CaCO_3$ = $\frac{1,05}{5} x\ 100$ ✓

= 21 % ✓

Question 5

5.1. 5.1.1. A substance that produces hydronium ion in solution. ✓✓ (2)

5.1.2. An acid that donate 2one proton per molecule. ✓✓ (2)

5.1.3. Strong acid. ✓ It ionise completely in solution. ✓ (2)

5.1.4. a) $K_w=[H_3O^+][OH^-]$ ✓ (3)

$1\times10^{-14} = [H_3O^+][1\times10^{-11}]$ ✓

$[H_3O^+] = 0,001 mol.dm^{-3}$ ✓

b) $pH = -\log[H_3O^+]$ ✓ (3)

$pH = -\log 0,001$ ✓

$pH = 3$ ✓

5.2. 5.2.1. $CO_3^{2-} + H_2O$ ✓→ $HCO_3^- + OH^-$ ✓✓bal. (3)

5.2.2. HCO_3^- ✓ (1)

Question 6

6.1. $pH = -\log[H_3O^+]$ ✓ (3)

$2 = -\log[H_3O^+]$ ✓

$[H_3O^+] = 10^{-2} mol.dm^{-3}$ ✓

6.2. $n(HC\ell) = cV$ ✓ (7)

$n = (0.03)(0,200) = 0.006mol$ ✓

$HC\ell$: NaOH 1:1 and pH is 2 ∴ H_3O^+ is excess

∴ n H_3O^+(final solution)=0,01)(0,150+0,200) = 0,01mol✓

N(reacted)=0,006- 0,0035=0,0025mol✓

NaOH: $HC\ell$ 1:2✓

∴n(initial NaOH)=0,0025mol

$c = \frac{n}{V}$ $c = \frac{0,0025}{0,150}$ ✓

$C = 0,0167 mol.dm^{-3}$ ✓

Question 7

7.1. HSO_4^- ✓✓ **(2)**

7.2.1. A substance that produces hydronium ions in solution. ✓✓ **(2)**

7.2.2. $pH = -\log[H_3O^+]$ ✓ **(2)**

$pH = -\log(0,1)$ ✓

$pH = 1$

7.3.3. NaOH $n = cV$ **(7)**

$n = (0,1) \times (0,2)$ ✓

$n = 0,02mol$

in $20cm^3$ …..= $\frac{0{,}02 \text{ mol}}{250}$ X $200cm^3$ = 0,0016 mol✓

$Ba(OH)_2$
Let $[Ba(OH)_2]$=x
n=(x)(0,05)
n=0,05x mol

$Ba(OH)_2$: $[OH^-]$ 1:2✓
∴in $250cm^3[OH^-]$ = 0,1xmol /$250cm^3$ X $20cm^3$ = 0,008x mol✓
Total n of OH^-= 0,0016 + 0,008x mol✓

n H_3O^+ from HCℓ = (0,1)(30/1000) = 0,003mol✓

at neutralisation moles of OH^-in $20cm^3$ = moles of H_3O^+ from HCℓ
0,0016+0,008x = 0,003
x=0,175 $mol.dm^{-3}$✓

Question 8

8.1.1. A substance that can act as either acid or base. ✓✓ **(2)**

8.1.2. HSO_3^- ✓ **(1)**

8.1.3. H_2SO_3, HSO_3^-✓✓ and **(2)**
H_2O, H_3O^+ ✓✓

8.3. Bromothymol blue ✓
Is most suitable for a solution with a pH = 7✓

8.4.1. n(NaOH) = cV **(2)**
= (1,2)(0,2) ✓
= 0,24 mol ✓

8.4.2. POSITIVE MARKING FROM QUESTION 8.4.1 **(9)**
Therefore (4 × 0,040239 mol) = 0,160956 mol in 200 cm^3 ✓ (d)
nused(HNO^3) = ninitial(HNO_3) – n excess(HNO_3)
n used(HNO_3) = 0,24 − 0,160956 ✓ ✓ (e)
nused(HNO_3) = 0,079 mol

m n(KOH) = M
m 0,079044 = 56 ✓ (f)
m = 4,426464 g

<u>4,426464</u>

%purity = 13 × 100(g) ✓
= 34,05% ✓ (h)

Question 9

9.1. Ionise incompletely in solution to form a low concentration oh hydronium ions. ✓ ✓ **(2)**

9.2. H_2O /H_3O+ and $H_2C_2O_4$ / HCO_4^-

9.3. Oxalic acid can donate two protons (H^+) during its ionisation in an aqueous solutions/It ionises to form 2 protons. ✓✓ **(2)**

9.4. A substance that can act as either an acid or a base.+ Accept: a substance✓✓ **(2)**

9.5.1.

$c = \frac{m}{MV}$ ✓ = 2,25 90(0, 25) ✓ C=0,1 mol.dm^{-3}✓	

9.5.3. Phenolphthalein✓ is a suitable indicator for the titration of oxalic acid and sodium hydroxide because the reaction involves a strong base (NaOH) and a weak acid ($H_2C_2O_4$). The endpoint of the titration occurs when the pH is greater than 7. ✓

OR

Because the salt of the titration will undergo hydrolysis and form a basic salt solution✓

9.6.1. $c = \frac{m}{\mathrm{MV}}$ ✓ **(4)**
0.2 ✓ =m/(58)(0.5) ✓
m = 5.8 g ✓

9.6.2. [OH^-] =2(O.20) ✓ **(2)**
[OH^-] = 0.4 mol.dm^{-3} ✓

9.6.3. [H_3O^+][OH^-] = 1 x 10^{-14} ✓ **(5)**
[H_3O^+](0.4) = 1 x 10^{-14} ✓
[H_3O^+] = 2,5 x 10^{-14}
pH= [H_3O^+] ✓
pH=([2,5 x 10^{-14}) ✓
pH = 13.60 ✓ NO, NOT SUITABLE for consumption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MOMENTUM AND IMPULSE: SOLUTIONS

MULTIPLE CHOICE

1.1 D✓✓ (2)

1.2 B✓✓ (2)

1.3 A✓✓ (2)

1.4 D✓✓ (2)

[8]

LONG QUESTIONS

QUESTION 2

2.1 In an isolated system the total (linear) momentum is conserved/remains constant✓✓ (2)

2.2
$\sum p_i = \sum p_f$ ✓

$m_A v_{iA} + m_B v_{iB} = m_A v_{fA} + m_B v_{fB}$

0 ✓ $= (3,2)(-0,4) + (2,6)v_f$ ✓

$\therefore v_f = 0,49\ m \cdot s^{-1}$

$v = \frac{\Delta x}{\Delta t}$

$0,49 = \frac{\Delta x}{1,3}$ ✓ $= 0.64\ m.s^{-1}$ ✓ (5)

2.3 $F_{net}\Delta t = \Delta p$✓

$F_{net}\Delta t = m(v_f - v_i)$ (3)

$(4,2)\Delta t = 2,6(0,49 - 0)$✓

$\Delta t = 0,3\ s$✓

2.4 LESS THAN ✓

Final momentum/change in momentum/impulse remains constant.✓

If mass/inertia increases, velocity decreases/velocity inversely proportional to mass ✓ (3)

[13]

QUESTION 3

3.1 The total mechanical energy/sum of gravitational potential energy and kinetic energy, in an isolated system remains constant/is conserved.✓✓ (2)

3.2

Total $E_{mech(top)}$ = Total $E_{mech(bottom)}$ ✓

$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$

$(mgh + \frac{1}{2}mv^2)_{top} = (mgh + \frac{1}{2}mv^2)_{bottom}$

$(2)(9,8)(1,5) + 0$✓ $= 0 + \frac{1}{2}(2)v^2$ ✓

(4)

$v = 5,42\ m \cdot s^{-1}$✓

3.3.1 $\Delta p = mv_f - mv_i$ ✓

$F_{net}\Delta t = \Delta p$

$= 2(5,42 - 0)$ ✓

$= \underline{10,84\ kg \cdot m \cdot s^{-1}\ right}$ ✓ (3)

3.3.2

10,84 kg·m·s-1 left /opposite direction ✓ (1)

3.4 $\Delta p_A = mv_f - mv_i$

$\Sigma p_i = \Sigma p_f$

$10,84 = 1,5(v_f - 0)$ ✓ OR $0 = 1,5v_f + (2)(5,42)$ ✓

$v_f = -7,23\ m \cdot s^{-1}$ $v_f = -7,23\ m \cdot s^{-1}$

$v = 7,23\ m \cdot s^{-1}$ ✓ $v = 7,23\ m \cdot s^{-1}$ ✓ (2)

[12]

QUESTION 4

4.1 In an isolated system the total (linear) momentum is conserved/remains constant. ✓✓ (accept closed system) (2)

4.2.1 $\sum p_i = \sum p_f$ ✓

$m_A v_{Ai} + m_B v_{Bi} = (m_A + m_B)v_f$

$(7,2)(0,4) + (0) = (7,2 + 5,3)v_f$ ✓ (3)

$v_f = 0,23\ m \cdot s^{-1}$ ✓

4.2.2 2 $F_{net}\Delta t = \Delta p$ ✓ Any one/

$F_{net}\Delta t = m(v_f - v_i)$ Enige een

$F_{net}(0,02) = 7,2(0,23 - 0,4)$ ✓

$F_{net} = -61,2$ ✓

$F_{net} = 61,2\ N$ (60,95 N to/tot 61,2 N) (3)

[8]

QUESTION 5

5.1 The total linear momentum of an isolated system remains constant. (2)

5.2 **OPTION 1** $\sum p_i = \sum p_f$ ✓

$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$

$\{0,45(9) + 0,20(0)\}$ ✓ $= (0,45 + 0,20)v$ ✓

$v = 6,23\ m \cdot s^{-1}$ ✓

OPTION 2

$\Delta p_{ball} = -\Delta p_{cont}$ ✓

$0,45(v - 9)$ ✓ $= -0,2(v - 0)$ ✓

$v = 6,23\ m \cdot s^{-1}$ ✓ (4)

[11]

QUESTION 6

6.1 $m_A v_{Ai} + m_B v_{Bi} = (m_A + m_B)v_f$ ✓

$(87)v_{im} + 0$ ✓ $= (87+22)(2,4)$ ✓

(4)

v_{im}= 3,01 m.s^{-1}✓

6.2 **Option1**

K(before) = ½mv^2 ✓

= ½(87)(3,01)2 + 0 ✓

= 394,11 J ✓

= (391,5 if 3 m·s-1)

K(after/na) = ½mv2

= ½(109)(2,4)2 ✓

= 313,92 J ✓

Collision is inelastic / No ✓

Option 2

ΔK = K(after) - K(before)

= ½mv^2(after) - ½mv^2(before) ✓

= ½(109)(2,4)2✓ – (½(87)(3,01)2 + 0) ✓

= 313,92 - 394,11

= - 80,19 J ✓

Collision is inelastic / No ✓

(6)

6.3 Wnet = ΔEk✓

Fnet Δxcosθ✓= ½m(vf ^{2} -vi ^{2})

Fnet(2)(-1)✓= ½(87+22)(0^2-2,4^2)✓ (5)

Fnet = 156,96N✓

[15]

QUESTION 7

7.1 Isolated system is a system on which the resultant/net external force is zero.✓✓ (2)

7.2 p = mv ✓

24 = m (480) ✓ (3)

m = 0,05 kg ✓

7.3 FnetΔt = Δp✓

Fnet(0,01)✓ = (0,05)(80) - 24✓

Fnet = -2 000 N (5)

Fnet = 2 000 N✓ west✓

[10]

QUESTION 8

8.1 West ✓ (1)

8.2 **(Newton's) Third Law (of Motion)** ✓

When object A exerts a force on object B, object B exerts a force equal in magnitude on object A ✓, but opposite in direction. ✓ (3)

8.3 $\Sigma p_i = \Sigma p_f$ ✓

0 ✓= (60)v_f + (5)(4) ✓

∴ v_f = - 0,33 ✓ (5)

∴ v_f = 0,33 m·s^{-1}✓

8.4.1 Increases✓ (1)

8.4.2 Increases✓, Δp package increases, thus Δp boy increases✓.
• For the same mass of the, v will be greater. ✓ (3)

[13]

QUESTION 9

9.1 Momentum is the product of the mass and velocity of an object. ✓✓ (2)

9.2 Δp = 0 ✓

$F_{net} = \frac{\Delta p}{\Delta t} = 0$✓

OR Δp = 0✓ Δv = 0

∴a = 0 ∴ Fnet = ma ✓ (2)

9.3

OPTION 1	OPTION 2
$F_{net}\Delta t = \Delta p$ ✓ = -120 – 50 ✓ = -170 ∴ FnetΔt = 170 N·s / kg·m·s^{-1} ✓	$F_{net} = \frac{\Delta p}{\Delta t}$✓ $= \frac{-120-50}{50-20}$ ∴Fnet = -5,67 FnetΔt = (-5,67)(30) ✓ = -170 ∴ FnetΔt = 170 N·s / kg·m·s^{-1} ✓

(3)

9.4

OPTION 1	OPTION 2
1 Σpi = Σpf ✓ -120 + 70 ✓ = 50 + p_{Bf} ✓ ∴ p_{Bf} = -100 ∴ p_{Bf} = 100 kg·m·s^{-1}✓west✓	$\Delta p_A = -\Delta p_B$ ✓ 50 – (-120) ✓ = -(p_{Bf} – 70) ✓ ∴ p_{Bf} = -100 ∴ p_{Bf} = 100 kg·m·s^{-1} west✓

(5)

[12]

QUESTION 10

10.1 Impulse is the product of the (net/average) force and the time during which the force acts. ✓ ✓ (2)

10.2 FnetΔt = Δp ✓

= m(vf – vi)

= 0,15(3,62 - (-6,2)) ✓

= 1,473 N·s / kg·m·s^{-1} ✓ upward (3)

10.3 $(U + K)_{top} = (U + K)_{bottom}$ ✓ ✓

$mgh_f + \frac{1}{2} m v_f^2 = mgh_i + \frac{1}{2} m v_i^2$ $(0,15)(9,8)h + 0$ ✓

$= 0 + \frac{1}{2}(0,15)(6,2)^2$ ✓

$\therefore h = 1,96$ m ✓

$\frac{1.96}{3} = 0,65$ m Yes/Meets requirements ✓ (5)

[10]

ELECTRIC CIRCUITS: SOLUTIONS

MULTIPLE CHOICE QUESTIONS

1.1 A✓✓ (2)

1.1 C✓✓ (2)

1.1 D ✓✓ (2)

1.2 C✓✓ (2)

LONG QUESTIONS

QUESTION 2

2.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓ (2)

2.1.2 Graph X, ✓

Graph X is a straight line, therefore potential difference is directly proportional to current. ✓ (2)

2.2.1 $\frac{1}{R_P} = \frac{1}{R_{10}} + \frac{1}{R_{15}}$

$= \frac{1}{10} + \frac{1}{15}$ ✓

$= 6\ \Omega$

$\therefore R = (10+6+2)$ ✓

$= 18\ \Omega$

$R = \frac{V}{I}$ ✓

$18 = \frac{6}{I}$ ✓

$I = 0,33$ A ✓ (5)

2.2.2 Decrease ✓

The total resistance of the circuit increases. ✓ (2)

2.2.3 Increase ✓ (1)

2.2.4 The total resistance in the external circuit increases ✓

Current decreases ✓

"Lost" volts decreases ✓ (3)

[15]

QUESTION 3

3.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓ (2)

3.1.2 **Diagram 1:**

$R_Y = \frac{V}{I}$ ✓

$= \frac{6}{2}$ ✓

$= 3\ \Omega$ ✓

Diagram 2:

$V_Y = \varepsilon - V_X$

$= 6 - 4$

$= 2\ V$

$R_Y = \frac{V}{I}$

$3 = \frac{2}{I}$ ✓

$I_Y = 0,67\ A$

$R_X = \frac{V}{I}$

$= \frac{4}{0,67}$ ✓

$= 5,97\ \Omega$ ✓

3.2.1 12,6 V ✓

3.2.2 $\varepsilon = I(R+r)$ ✓

12,6✓$= I(5+0,08)$ ✓

$I = 2,48\ A$

$V_{ext} = IR$

$= (2,48)(5)$ ✓

$= 12,4\ V$ ✓ (5)

3.2.3 Decrease ✓

Resistance decreases and I_T increases ✓

V_{int} will increase and V_{ext} will decrease (with emf constant) ✓

$\left(\text{According to } P = \frac{V^2}{R}\right)$, power will decrease ✓ (4)

[18]

QUESTION 4

4.1 3,11 J of energy is transferred per one coulomb of charge ✓✓ (2)

4.2.1 **OPTION 1**

$V = IR_2$ ✓

$1,6 = 0,2R_2$ ✓

$R_2 = 8\ \Omega$

$V = IR$

$= 0,2(4+8)$ ✓

$= 2,4\ V$ ✓

OPTION 2

$V_{ext} = V_{4\Omega} + V_{R2}$ ✓

$= IR_1 + V_2$

$= 0,2(4)$✓$+1,6$✓

$= 2,4\ V$ ✓ (4)

4.2.2 **OPTION 1**

$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$

$= \frac{1}{2} + \frac{1}{(4+8)}$✓

$R_P = 1,71\ \Omega$

$V_P = IR$

$2,4 = I(1,71)$ ✓

OPTION 2

$V = IR$

$2,4 = I(2)$ ✓

$I = 1,2\ A$

$I_{Tot} = 1,2 + 2$ ✓

$= 1,4\ A$ ✓ (3)

$I_P=1,4$ A ✓

4.2.3 OPTION 1

$\varepsilon=I(R+r)$

$3,11$✓$=1,4(1,71+r)$ ✓

$r=0,51\ \Omega$ ✓

OPTION 2

$V_{lost}=\varepsilon-V_{ext}$

$=3,11-2,4$ ✓

$=0,71$ V

$V_{lost}=IR$

$0,71=1,4r$ ✓

$r=0,51\Omega$ ✓ (3)

4.2.4 **OPTION 1**

$P=VI$ ✓

$=0,714(1,4)$ ✓

$=0,9996$ W ✓

OPTION 2

$P=I^2R$ ✓

$=(1,4)^2(0,51)$ ✓

$=0,9996$ W ✓

OPTION 3

$P=\frac{V^2}{R}$ ✓

$=\frac{(0,714)^2}{(0,51)}$ ✓

$=0,9996$ W✓ (3)

[15]

QUESTION 5

5.1 The maximum energy provided by a battery per unit charge passing through it✓✓ (2)

5.2 $\frac{1}{R_P}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$ ✓

$=\frac{1}{5}+\frac{1}{10}+\frac{1}{20}$ ✓

$\therefore R=2,86\ \Omega$ ✓ (3)

5.3 **OPTION 1**

Diagram B

- The total resistance of the circuit increase✓
- Total current decrease✓
- The $V_{internat}$ decreases✓
- Therefore V_{ext} increases

OPTION 2

Diagram A

- The total resistance of the circuit decreases✓
- Total current increases✓
- The $V_{internal}$ increases
- Therefore V_{ext} decreases

(3)

5.4.1 $R=\frac{V}{I}$ ✓

$2,86=\frac{10}{I}$ ✓

$\therefore I=3,50$ A ✓ (3)

5.4.2 **Diagram A**

$\varepsilon=I(R+r)$ ✓

$=3,5(2,86+r)$ ✓ ------------ (1)

Diagram B

$V=IR$

$12=\frac{I}{5,5}$

$I=2,18$ A

$\varepsilon=I(R+r)$

$=2,18(5,5+r)$ ✓ ------------- (2)

Equation 1=Equation 2

$3,5(2,86+r)=2,18(5,5+r)$ ✓

$r=1,5\ \Omega$ ✓ (5)

5.4.3 $\varepsilon = I(R+r)$
$= 3{,}5(2{,}86+1{,}5)$ ✓
$= 15{,}26$ V ✓ (2)

5.4.4 **OPTION 1**
$P = I^2R$ ✓
$= (2{,}18)^2(5{,}5)$ ✓
$= 26{,}14$ W ✓

OPTION 2
$P = \frac{V^2}{R}$ ✓
$= \frac{(12)^2}{5{,}5}$ ✓
$= 26{,}18$ W ✓

OPTION 3
$P = VI$ ✓
$= (12)(2{,}18)$ ✓
$= 26{,}16$ W ✓ (3)

5.5
- The voltmeter reading INCREASES ✓
- Total resistance increases and total current decreases ✓
- V_{int} decreases ✓ (3)

[24]

QUESTION 6

6.1.1 To change/vary the external resistance in the circuit in order to change/vary the (total) current through the battery. ✓✓ (2)

6.1.2 Current ✓ (1)

6.1.3 Internal resistance ✓ (1)

6.1.4 6 V ✓ (1)

6.1.5 $V_{int} = 6-2$ ✓ $= 4\ V$ ✓ (2)

6.2.1 The maximum energy provided by a battery per unit charge passing through it ✓✓ (2)

6.2.2
$P = VI$ ✓
$12 = V(2)$ ✓
$V_{12W} = 6$ V

$R_{6\Omega} = \frac{V}{I}$
$6 = \frac{18}{I}$ ✓
$I_{6\Omega} = 3$ A

$V_{6\Omega} = IR$
$= (2)(6)$ ✓
$= 12$ V

$I_{Tot} = 3+2$ ✓ $= 5$ A

$V_S = IR$
$= (5)(2)$ ✓
$= 10$ V

$V_P = 12+6 = 18$ V

$P = \frac{V^2}{R}$
$12 = \frac{6^2}{R}$ ✓
$R_{12W} = 3\ \Omega$

$V_{ext} = V_P + V_S$
$= 18+10$
$= 28$ V ✓ (8)

6.2.3 **OPTION 1**
$r = \frac{V_{int}}{I}$ ✓
$= \frac{30-28}{5}$ ✓
$= 0{,}4\ \Omega$ ✓

OPTION 2
$\varepsilon = I(R+r)$ ✓
$30 = 5(5{,}6+r)$ ✓
$r = 0{,}4\ \Omega$ ✓ (3)

6.2.4 Increase ✓

Total resistance in circuit increase and the total current decrease ✓
$V_{internal}$ will decrease. ✓
Therefore: $V_{external}$ will increase because emf stays constant ✓ (4)

[24]

QUESTION 7

7.1.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓ (2)

7.1.2
$$\frac{1}{R_P}=\frac{1}{R_1}+\frac{1}{R_2}✓$$
$$\frac{1}{R_P}=\frac{1}{(7+6)}✓+\frac{1}{(4+6)}✓$$
$$R_P=5{,}65\ \Omega\ ✓$$
(4)

7.1.3 **OPTION 1**

$\varepsilon=I(R+r)$✓
$15=I(5{,}65+0{,}45)$ ✓
$I=2{,}46$ A ✓

OPTION 2

$R_T=\frac{V_T}{I}$✓
$(5{,}65+0{,}45)=\frac{15}{I}$✓
$I=2{,}46$ A ✓

(3)

7.1.4

OPTION 1		**OPTION 2**	
$r=\frac{V}{I}$ $0{,}45=\frac{V}{2{,}46}$ ✓ $V_{int}=1{,}11$ V $V_T=V_{ext}+V_{int}$ $15=V_{ext}+1{,}11$ $V_{ext}=13{,}89$ V	$R=\frac{V}{I}$ $5{,}56=\frac{V}{2{,}46}$ ✓ $V_{ext}=13{,}89$ V	$r=\frac{V}{I}$ $0{,}45=\frac{V}{2{,}46}$ ✓ $V_{int}=1{,}11$ V	$R=\frac{V}{I}$ $5{,}56=\frac{V}{2{,}46}$ ✓ $V_{ext}=13{,}89$ V
↓	↓	↓	↓
Current through 7 Ω and 6 Ω $R=\frac{V}{I}$ $13=\frac{13{,}89}{I}$ ✓ $I=1{,}07$ A	**Current through 4 Ω and 6 Ω** $R=\frac{V}{I}$ $10=\frac{13{,}89}{I}$ ✓ $I=1{,}39$ A	**Current through 7 Ω and 6 Ω** $R=\frac{V}{I}$ $13=\frac{13{,}89}{I}$ ✓ $I=1{,}07$ A	**Current through 4 Ω and 6 Ω** $R=\frac{V}{I}$ $10=\frac{13{,}89}{I}$ ✓ $I=1{,}39$ A
↓	↓	↓	↓
Potential difference across 7 Ω $R_{7\Omega}=\frac{V}{I}$ $7=\frac{V}{1{,}07}$ ✓ $V=7{,}49$ V	**Potential difference across 4 Ω** $R_{4\Omega}=\frac{V}{I}$ $4=\frac{V}{1{,}39}$ ✓ $V=5{,}56$ V	**Potential difference across 6 Ω** $R_{6\Omega}=\frac{V(B)}{I}$ $R_{6\Omega}=\frac{V}{1{,}39}$ ✓ $V=8{,}34$ V	**Potential difference across 6 Ω** $R_{7\Omega}=\frac{V(A)}{I}$ $6=\frac{V}{1{,}07}$ ✓ $V=6{,}42$ V

V_A=13,89-7,49 =6,40 V	V_B=13,89-5,56 =8,33 V		
↓	↓	↓	↓
$V_2=V_B-V_A$ V_2=8,33-6,40 V_2=1,93 V ✓		$V_2=V_B-V_A$ V_2=8,34-6,42 V V_2=1,92 V ✓	

7.2 Increases ✓ (1)

7.3 Total resistance increases and total current decreases. ✓

V lost decreases ✓

7.4 Cost=energy×tariff

300✓=(P×8×30)×2,59 ✓

P=482,625 W✓

No. of bulbs=$\frac{482,625}{80}$✓ (5)

=6 ✓

[24]