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Complete, fold and seal
(see note 2 below)

SURNAME: NOLAN

FORENAME(S): CONOR JAMES

Examination Answer Books

12 Pages

Instructions to Candidates

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can check your answers or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

1	Student Number	2427110
2	Title of Examination Paper	OME CHEMISTRY BEng
3	Module Code	ACDB4011
4	Date and Time of Examination	06/05/25 9:00
5	Examination Venue	FR 310
6	Seat Number	16
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
ALL 1	9
2	11
3	9
4	10
5	14
6	4.5
7	11
8	5
9	4
10	3.5
Total	81.5

(Gweler yr ochr arall am y fersiwn Cymraeg)

81.5

Q1

a) T ✓

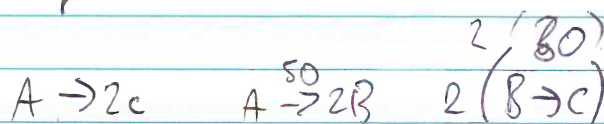
b) F ✓ (# of protons)

c) ~~T~~

d) T ✓

e) F ✓ $\frac{3}{2}$ mol O_2 $2Al + 3O_2 \rightarrow 2Al_2O_3 \therefore \frac{3}{2}$ mol O_2 ~~f)~~

f) T ✓

g) F ✓ NH_3 smaller, effuses quicker. *h) ~~T~~

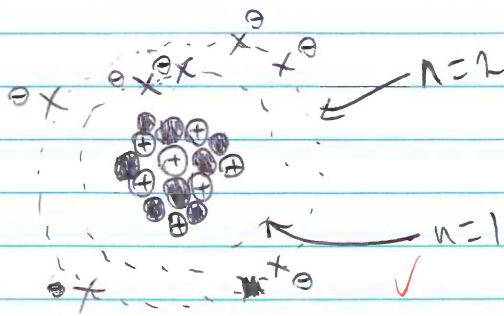
i) T ✓

j) F ✓ (lowering E_a)

9p

2

a)



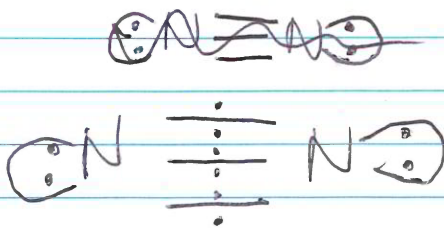
x = electron (-) ✓
 ⊕ = proton (+) ✓
 ● = neutron (neutral) ✓

3p

b) 3- ✓

2p

c)



3x bonding pairs
 2x lone pairs ✓

3p

The triple bond present is extremely strong, producing a large amount of energy when formed and requiring a lot of energy to break. ✓

d) $N \equiv N$ releases a lot of energy upon formation, so nitrogen containing explosives exploit this. ✓

3p

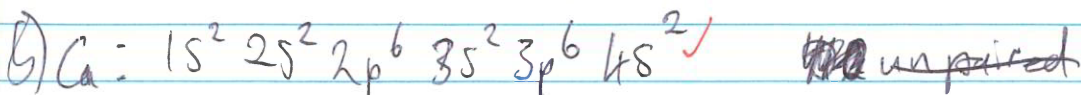
$N \equiv N$ is significantly stronger than $O=O$ and has shorter bond length. ✓

3) a) $E = \frac{hc}{\lambda}$ $E = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{616 \times 10^{-9}}$

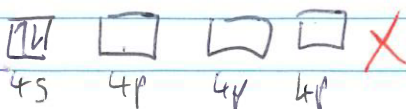
4p

$$E = 3.214 \dots \times 10^{-19} \text{ J}$$

$$E = 3.2 \times 10^{-19} \text{ J} \quad 2\text{sf. (lowest given precision)} \quad \checkmark$$



2p



0 unpaired ✓

1p

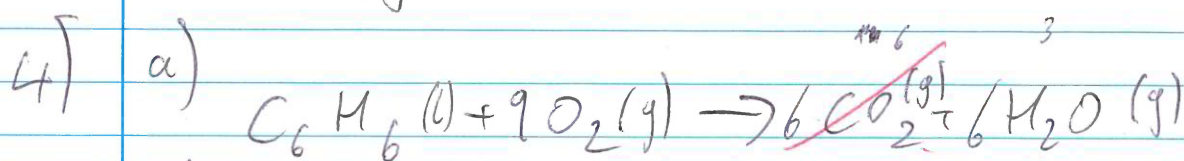
c) Electrons can absorb photons and use the energy to promote to a higher energy orbital. ✓ 3p

An excited electron can then deexcite to a lower energy level, emitting a photon. ✓

The photon energy will be exactly equal to the orbital gap in emission/absorption. ✓

The energy of the photon will determine the colour via $E = \frac{hc}{\lambda}$, where λ is the wavelength. ✓

Selecting a substance with a particular electron config can allow colour selection for pyrotechnics. ✓



b) $n = \frac{m}{M_r}$ $n(O_2) = \frac{27}{6(12)+6} = 0.3461... \text{ mol}$ ✓ 5p

12 moles of gas for 1 mol C_6H_6
 ~~$\frac{m(O_2)}{M_r} \times 12 = 4.1538... \text{ mol}$~~

~~$m = n \times M_r$ $m(\text{gas}) =$~~

$m(CO_2) = n(O_2) \times 6 \times (12+32) = 91.4 \text{ g } CO_2$ ✓

$m(H_2O) = n(O_2) \times 6 \times (11+2) = 37.4 \text{ g } H_2O$ ✓

128.8 g total of gas ✓ 30R

~~d?) use AKT~~

Is there is part c)? not on paper

4 cont.)
part c)
not present
in exam
script.

$$d) \quad pV = nRT$$

$$V = \frac{nRT}{p}$$

$$p = 101325 \text{ Pa} \quad T = 273 \text{ K}$$

$$R = 8.314$$

$$n = (0.34615 \dots) \times 12$$

$$= 4.1538 \dots \text{ mol}$$

$$V = \frac{4.1538 \dots \times 8.314 \times 273}{101325}$$

$$V = 0.09304 \dots \text{ m}^3$$

$$V = 0.0930 \text{ m}^3 \quad 3 \text{ sf}$$

alt method:

$$\frac{V_1}{n_1} = \frac{V_2}{n_2} \Rightarrow V_2 = \frac{V_1 n_2}{n_1}$$

$$e) \quad \frac{V_1 P_1}{T_1} = \frac{V_2 P_2}{T_2} \Rightarrow V_2 = \frac{V_1 \frac{P_1}{P_2}}{\frac{T_1}{T_2}}$$

$$0.0930 \times \frac{101325}{\frac{700}{760} \times 101325}$$

DO NOT USE IDE!

$$V_2 = \frac{0.0930 \times \frac{101325}{700}}{\frac{273}{373}} = 0.13795 \dots \text{ m}^3$$

$$= 0.138 \text{ m}^3 \quad 3 \text{ sf}$$

5) a) For complete combustion there must be enough moles of O_2 to fully oxidise an explosive and (undergo) complete combustion.

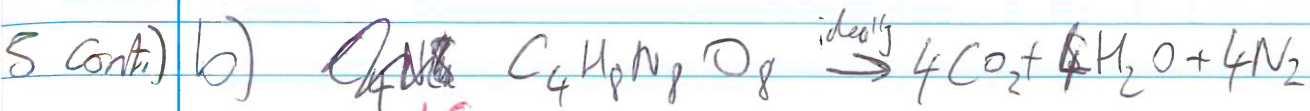
Oxygen balance tells you your ratio of O_2 to the desired amount for complete combustion.

4p

2p

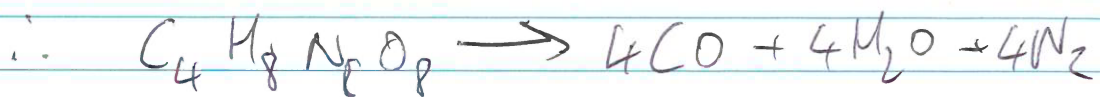
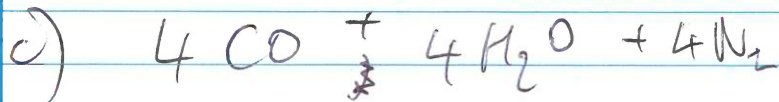
2p

6



$$\Delta = \frac{3216}{296.15} (8 - 8 - 4) \times 100$$

$$\Delta = -43.2\% \quad 3\text{f}$$



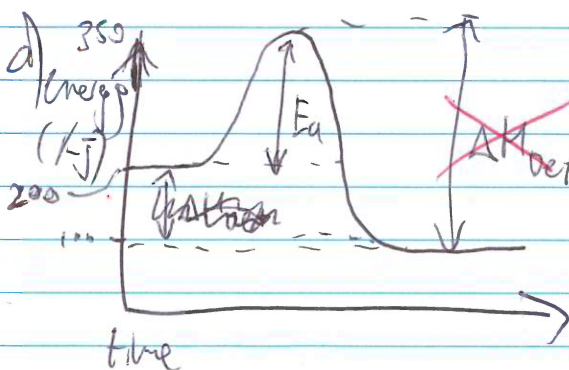
d) $75 - 4(110.5) - 4(241.8) = -1334.2 \quad 4\text{f}$
 kJ mol^{-1}

$\therefore$ exothermic

e) $\frac{2.8}{\left(\frac{1}{227.13}\right)} = 635.964$

MMX provides $698.2 \text{ kJ mol}^{-1}$
 more energy

6)



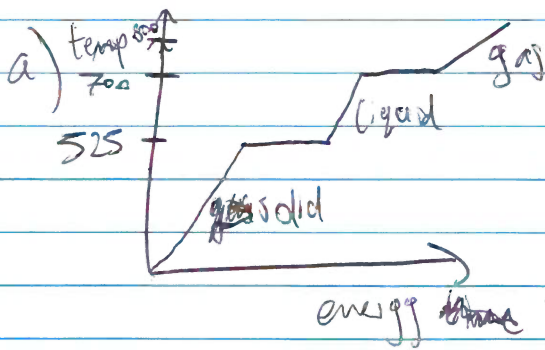
$E_a = 150 \text{ kJ} \quad \checkmark \quad *$

$\Delta H_{\text{act}} = 50 \text{ kJ}$

b) The reaction is endothermic, reaction is driven to products to maintain equilibrium.
 $E_a > \Delta H$ for forward reaction

correct

7



525°C melting
700°C ~~boiling~~ boiling

3p

b) ~~500°C 35 atm Triple point.~~

2p

Wording is ambiguous so... 500°C 35 atm.
Evaporation, ~~can~~ evaporation, condensation, melting, fusion, deposition, sublimation → is triple point

67 atm 852°C is super critical point.
Phase transitions - evaporation →
- condensation

c) Increased intermolecular forces can ~~low~~ raise the melting and boiling points of a compound, so area d's boundary with B would move to a higher temp, and same with B/C boundary.

3p

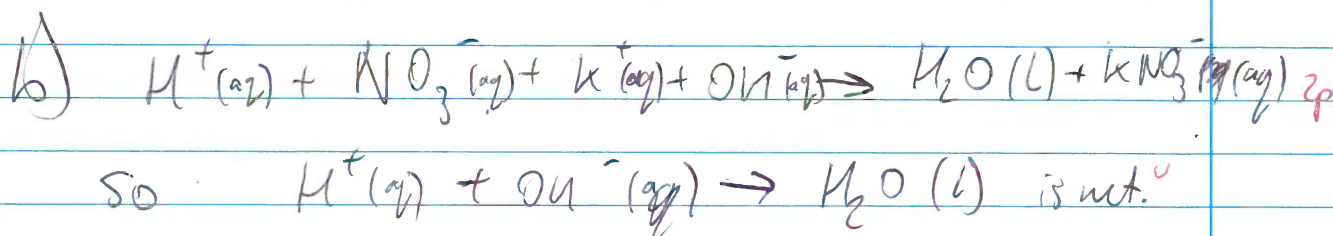
d) Compounds can be more dangerous in certain phases, so it's important to know exactly what conditions need to be met in order to maintain a certain phase.

3p

8) a) $c = \frac{n}{V}$ $n = cv$ $n = 9.00084 \times 10^{-3} \text{ mol}$ 3p

$C_{\text{HNO}_3} = \frac{n}{V} = \cancel{0.1800168} 0.1800168$

$= 0.1800 \text{ mol dm}^{-3}$



9) $q = mc\Delta T$ 4p

metal:

water:

$q_m = 100.0 \text{ g} (-115)^\circ\text{C}$ ✓

$q_w = 200 \text{ g} (4.18) (10)^\circ\text{C}$ ✓

$q_m = -q_w$

$100.0 \times 115^\circ\text{C} = 8360$

$C_m = 0.7269 \dots$

$C_m = 0.727 \text{ J g}^{-1} \text{K}^{-1}$ ✓

10) a) before: after: 1.5p

Al: +0

Al: +3 ✓

Cl: +7

Cl: -1 ✓

N: -3

N: +2 ✓

b) NH_4ClO_4 was an ~~reducing~~ ^{oxidising} agent as ClO_4^- ✓ 2p

was massively reduced. NH_4^+ was oxidised ~~but~~ so

it was technically a reducing agent. ✓

Al was oxidised so it acted as a reducing agent. ✓