1.2 PRACTICE EXAMINATION QUESTIONS MARK SCHEME

1. (a) (i) Avogadro's number/constant of molecules/particles/species / 6×10^{23} 1

[Not 'atoms']

Or same number of particles as (there are atoms)

[Not molecules]

in 12.(00)g of ^{12}C 1

(ii) Moles $O_2 = \frac{0.350}{32}$ (= 1.09×10^{-2} mol) 1

= 29 ($\times 1.09 \times 10^{-2}$) 1

[Accept answers via 4 separate mole calculations]

= 0.316 – 0.317 mol [answer to 3+ sf] 1

[Mark conseq on errors in M1/M2] (1)

(iii) Moles of nitroglycerine = $4 \times 1.09 \times 10^{-2}$ (= 0.0438 mol) 1

[Mark conseq on their moles of O_2]

M_r of nitroglycerine = 227 or number string 1

Moles of nitroglycerine = 227 × 0.0438 = 9.90 – 9.93(g)

[answer to 3+ sf]

[If string OK but final answer wrong then allow M6 but AE for M7]

[Mark conseq on error in M_r] [Penalise wrong units]

[Penalise sig. fig. errors once only in whole question]

(b) pV = nRT **or** $pV = \frac{mRT}{V}$ **or** $p = \frac{nRT}{V}$ 1

$p = \frac{nRT}{V} = \frac{0.873 \times 8.31 \times 1100}{1.00 \times 10^{-3}}$ 1

= 7980093 **or** 7980 **or** 7.98 1

[ignore s.f.]

units = Pa **or** kPa **or** MPa (as appropriate) 1

[If error in conversion from Pa, treat as a contradiction of the units mark]

[If transfer error, mark conseq but penalise M2]

[If data from outside of above used, penalise M2 and M3]

[If pV expression incorrectly rearranged, penalise M2 and M3]

[if T = 1373 K used, penalise M2]

[11]

2.

(a)

	Na	Cl	O	
	$\frac{21.6}{23}$	$\frac{33.3}{35.5}$	$\frac{45.1}{16}$	1
	0.9(39)	0.9(38)	2.8(2)	
Hence:	1	1	3	1

Accept backwards calculation, i.e. from formula to % composition, and also accept route via M_r to 23; 35.5; 48, and then to 1:1:3

[If % values incorrectly copied, allow M1 only]

[If any wrong A_r values/atomic numbers used = CE = 0}

(b) $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$ 1

[3]

3. (penalty for sig fig error =1mark per question)

(a) (i) moles $KNO_3 = 1.00/101.1 = 9.89 \times 10^{-3}$ (mol) 1

(ii) pV = nRT *or* n = pV/RT 1

moles O2 = n = $\frac{pV}{RT}$ = **(1)** $\frac{100000 \times 1.22 \times 10^{-4}}{8.31 \times 298}$ **(1)** 2

= 4.93 × 10-3 (mol) 1

(mark answer first – check back if wrong)
(transcription error lose M3, mark M4 conseq on error)
(if 'untraceable' figures used M3=M4=0)
(if wrong temp conversion – lose M3 – conseq M4)
(if n = RT/pV CE, lose M3 and M4)

(b) (i) simplest/lowest ratio of atoms of each / element/s in a compound / substance / species / entity / molecule 1

(ii)

K	*N*	*O*			
$\frac{45.9}{39.1}$	$\frac{16.5}{14}$	$\frac{37.6}{16}$ (1)			
1.17	1.18	2.35			
1	1	2	KNO^2	(1)	3

(M3 tied to M2), (M3 can be transferred from equation if ratio correct but EF not given) (if calc inverted, lose M2 and M3), (if used At N_1 / wrong No for Ar then CE, lose M2 and M3) (if % of O missing, award M2 only)

(c) $2KNO^3 \rightarrow 2KNO^2 + O^2$ or fractions/multiples 1

(accept $2KNO^3 \rightarrow K^2N^2O^4 + O^2$)
(do NOT accept 'Y' in equation)

[10]

4. *(penalty for sig fig error =1mark per question)*

Mr $(Mg(NO_3)_2$ = 58(.3) *(if At N° used, lose M1 and M2)* 1

moles $Mg(OH)_2$ = 0.0172 (conseq on wrong M^2) (answer to 3+ s.f.) 1

moles HCl = 2 × 0.0172 = 0.0344 *or* 0.0343 (mol) *(process mark)* 1

vol HCl = $\frac{0.0343 \times 1000}{1}$ = 34.3 – 34.5 (cm_3) *(unless wrong unit)* 1

*(if candidate **used** 0.017 or 0.0171 lose M2)*
(just answer with no working, if in range = (4). if, say, 34 then =(2))
(if not 2:1 ratio, lose M3 and M4)
(if work on HCl, CE = 0/4)

[4]

5. 2A1+ $3CuCl_2$ → $2A1C1_3$ + 3Cu;
(accept multiples/fractions)

OR

2A1+ $3Cu^{2+}$ → $2A1^{3+}$ + 3Cu; 1

[1]

6. (a) moles $HN0_3$ = 175 X 10^{-3} × 1.5 = (0.2625 mol); 1
moles $Pb(NO_3)_2$ = ½ × 0.2625 = (0.131 mol); 1
M_r $Pb(NO_3)_2$ = 331(.2); 1
mass $Pb(NO_3)_2$ = 331.2 x 0.131=43.5 g; 1

(accept 43.2 - 43.8)

(M1 & M2 are process marks. If error in M1, or in M2, do not mark M4
consequentially, i.e. do not award M4)
(if atomic numbers used in M3, do not award M4)

(b) (i) pV = nRT; 1

$n = \frac{pV}{RT} = \frac{100000 \times 1.5 \times 10^{-4}}{8.31 \times 500}$; 1

= 3.61 X 10^{-3} ; 1

(If pressure not converted to Pa, max 2)

(If $n = \frac{RT}{pV}$ used = CE; M2 = M3 = 0)

(ii) moles$N0_2$ = 4/5 × 3.61 × 10^{-3}; 1

[mark is for use of 4/5]

= 2.89 × 10^{-3} *OR* 1.78×10^{-3}; 1

M_r NO_2 = 46; 1

massNO_2 = 46 ×2.89×$l0^{-3}$ = 0.1.33(g) *OR* 0.0821 (g); 1

(if atomic numbers used, M3 = M4 = 0)

[11]

7. (a) $2Na + 2NH_3 \rightarrow 2NaNH_2 + H_2$ *(or multiples)* 1

(b) (i) <u>Simplest ratio of atoms of each element</u> in a compound / substance / species / entity / molecule 1

(ii)

	Mg	N	O	
				1
$\frac{16.2}{(24)}$	$\frac{16.2}{24.3}$	$\frac{18.9}{14}$	$\frac{64.9}{16}$	
(0.675)	0.667	1.37	4.06	1
	1	2	6	MgN_2O_6

(Mark M1 first. If any wrong A_r used = CE = 0)
(Accept $Mg(NO_3)_2$ for M3 if above working shown)

[4]

8. (a) (i) $100 \times 10^{-3} \times 0.500 = 5.00 \times 10^{-2}$ (mol) accept 5×10^{-2} / 0.05 1

(ii) $27.3 \times 10^{-3} \times 0.600 = 1.64 \times 10^{-2}$ / 1.638×10^{-2} (mol) <u>only</u> 1

(iii) 1.64×10^{-2} (mol) 1
Mark conseq on (ii)

(iv) $5.00 \times 10^{-2} - 1.64 \times 10^{-2} = 3.36 \times 10^{-2}$ (mol) 1
Mark conseq on (i) & (iii)

(v) $3.36 \times 10^{-2} \times ½ = 1.68 \times 10^{-2}$ (mol) *If 2.78×10^{-2}* used 1.39×10^{-2} 1
Mark conseq on (iv)

$1.68 \times 10^{-2} \times 132(.l)$ **or** $1.39 \times 10^{-2} \times 132(.l)$ 1
Mark for M_r

= 2.22 g **or** 1.83 g 1

(b) pV = nRT 1

$n = \frac{0.143}{17} = 8.4(1) \times 10^{-3}$ (mol) 1

$T = \frac{pV}{nR} = \frac{100000 \times 2.86 \times 10^{-4}}{8.31 \times 8.4 \times 10^{-3}}$ (1) 1

= 408.5 – 410.5 (K) 1
Mark conseq on moles

Note *Sig. fig. penalty - apply once if single sf given, unless calc works exactly*

[11]

9. *Ideal gas equation*: pV = nRT **(1)**

Calculation: n = pV/RT = $\frac{103000 \times 127 \times 10^{-6}}{(8.31 \times 415)}$ **(1)**

mark for volume conversion fully correct

= 3.79×10^{-3} (mol) **(1)**

range 3.79×10^{-3} to 3.8×10^{-3}

M_r = m/n = .304/3.79×10^{-3} = 80.1 **(1)** 5

range 80 – 80.3
min 2 s.f. conseq
If 'V' wrong lose M2; 'p' wrong lose M3; 'inverted' lose M3 and M4

[5]

10. (a) M1 % by mass of H = 7.7(0)% **(1)**

M2 mol H = 7.70 / 1 = 7.70
mol C = 92.3 / 12 = 7.69 **(1)**

M3 (ratio 1:1 ∴) CH

Credit variations for M2 78 × $\frac{77}{100}$ **= 6 and** $\frac{78}{12} \times \frac{92.3}{100}$ **= 6**

Correct answer = 3 marks

(b) (CH has empirical mass of 13 and $\frac{78}{13}$ = 6 ∴) C_6H_6

Correct answer 1 mark

4

[4]

11. 23/6.023×10^{23} **(1)**

CE = 0 if inverted or multiplied

tied to M1 3.8(2) × 10^{-23} [2-5 sig figs] **(1)** 2

[2]

12. (a) (simplest) ratio of <u>atoms of each element</u> in compound **(1)**

(b) % oxygen = 39.5% **(1)**

Na 28.4/23	Cr 32.1/52	O 39.5/16 **(1)**
= 1.23	= 0.617	= 2.47

(2:1:4) so empirical formula = Na_2CrO_4 **(1)**4

If % oxygen not calculated, only M2 available; if A_r values wrong, only M1 available

[4]

13. (a) 0·240 **(1)**

Mr ($TiC1_4$) = 190 **(1)**

moles $TiC1_4 = \frac{0 \cdot 24}{4}$ = 0·06 **(1)**

mass = 0·06 × 190 = 11·4 **(1)** 4

(b) moles NaOH = moles HCl = 0.12 **(1)**

vol NaOH $= \frac{\text{moles}}{\text{conc}}$ **(1)**

$= \frac{0 \cdot 12}{1 \cdot 1}$ = 109cm^3 **(1)** 3

(c) moles H_2 $= \frac{\text{moles HC1}}{2}$ = 0·06 **(1)**

(*allow conseq*)

$V = \frac{nRT}{p}$ **(1)** or $PV = nRT$

$= \frac{0 \cdot 06 \times 8 \cdot 31 \times 293}{98\,000}$ **(1)**

= 1·49 × 10^{-3} m^3 **(1)**etc

(if chemical error on moles H_2, max2) **(2)** 4

[11]

14. (a) moles of S $= \frac{10.0}{32.1}$ (= 0.3125) allow $\frac{10}{32}$ **(1)**

mass of sodium sulphide 0.312 × 78.1 i.e. 24.4 g or 24.37 g
(accept 24.3 g or 24.33 g) (no sig.fig. penalty) (ignore units) **(1)** 2

(b) moles of hydrogen sulphide $\frac{5.00}{34.1}$ (i.e. 0.1466 or 0.147 mol) **(1)**

moles of hydrogen gas needed = moles of H_2S **(1)**

volume: 0.1466 × 24500 i.e. 3592 or 3590 cm^3
(3602 or 3600 if 0.147 used) **(1)**

3

answer must be in cm^3 ie × 24500, not × 24.5 / no s.f. penalty / ignore units

allow $PV = nRT$ method with remembered value of R

[5]

15. (a) Ideal gas equation law **(1)** 1

(b) *Moles of **X***: $n = \frac{PV}{RT}$ **(1) =** $\frac{110000 \times 2.34 \times 10^{-4}}{8.31 \times 473}$

$= 6.55 \times 10^{-3}$ **(1)**

6.5 to 6.6 × 10^{-3} , min 2 sig figs

If write $n = \frac{RT}{PV}$ zero here, but can score M_r

*Relative molecular mass of **X***: $M_r = \frac{m}{n}$ **(1)**

= 62 **(1)**

61.5 to 62.5

4

(c) % oxygen = 51.6 **(2)**

C =38.7 / 12 H = 9.68 / 1 O = 57.6**(2)** / 16 **(1)**

= 3.23 = 9.68 = 3.23

1 : 3: 1 ∴ CH_3O **(1)**

If no % O or if wrong A_r used then max 1

Correct empirical formula earns all three marks

3

(d) $(\frac{62}{31} \times CH_3O) = C_2H_6O_2$ **(1)** 1

[9]

16. (a) Moles HCl = $\frac{\text{mass}}{M_r} = \frac{19.6}{36.5}$ **(1)** (= 0.537)

Concentration = $\frac{0.537}{0.25}$ **(1)**

= 2.15 (mol dm^{-3}) **(1)**

Conseq on $\frac{\text{mass}}{M_r}$ correct

min 2 d.p. 2.14 to 2.15

Ignore units

A.E. lose one mark

3

(b) (i) $\frac{21.7}{1000} \times 0.263$ = 5.7**(1)** × 10^{-3} (mol) **(1)**

5.7 to 5.71 × 10^{-3}

(ii) $\frac{5.71 \times 10^{-3}}{2}$ = 2.85 × 10^{-3} (mol) **(1)**

Conseq

(iii) $\frac{0.394}{2.85 \times 10^{-3}}$ = 138 **(1)**

Conseq

(iv) *Relative atomic mass of **M***: 138 - 60 = 78 **(1)**

$\frac{78}{2}$ = 39 **(1)**

*Identify of **M***: Potassium or K or K^+ **(1)**

Conseq

If 78 = M_r then M = selenium

6

[9]

17. (a) L = $\frac{1.0078}{1.6734 \times 10^{-24}}$ **(1)** or $\frac{\text{mass of 1 mol}}{\text{mass of 1 atom}}$

must show working

= 6.0225 × 10^{23} **(1)**

Ignore wrong units

NB answer only scores 1

2

(b) equal **(1)**

Or same or 1:1

1

(c) PV = nRT (or n = $\frac{PV}{RT}$) **(1)**

= $\frac{98000 \times 0.0352}{8.31 \times 298}$ **(1)**

= 1.39 **(1)**

Allow 1.390 to 1.395

ignore units even if incorrect

answer = 1.4 loses last mark

3

(d) $0.732 \times \frac{1000}{250} = 2.93$ **(1)** $mol.dm^{-3}$ **(1)**

OR M, mol/dm^3, $mol.l^{-1}$

allow 2.928 to 2.93

Note unit mark tied to current answer but allow unit mark if answer = 2.9 or 3

2

(e) (i) moles $H_2SO_4 = \frac{25}{1000} \times 1.24 = 0.0310$

If use $m_1v_1 = m_2v_2$ scores 3 if answer is correct otherwise zero

moles NH_3 in 30.8 cm^3 = 0.0310 × 2 = 0.0620 **(1)**

Mark is for ×2

CE if × 2 not used

moles of NH_3 in 1 dm^3 = $0.620 \times \frac{1000}{30.8}$ = 2.01 **(1)** ($mol\ dm^{-3}$)

Allow 2.010 to 2.015

No units OK, wrong units lose last mark

(ii) moles $(NH_4)SO_4$ = moles H_2SO_4 = 0.310 **(1)**

Allow consequential wrong moles in part (i) if clear H_2SO_4=$(NH_4)SO_4$

Wrong formula for $(NH_4)SO_4$ CE=0

M_r $(NH_4)SO_4$ = 132.1 **(1)**

Allow (132)

mass = moles × M_r = 0.0310 × 132.1 = 4.10 **(1)**

if moles of $(NH_4)SO_4$ not clear CE

(g) wrong unit loses mark

Allow 4.09 – 4.1 – 4.11

6

(f) $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$

Formulae (1)

Balanced equation (1)

2

[16]

18. (a) $\dfrac{\underline{\underline{\text{average}}}\ \text{mass of an entity } \mathbf{(1)}}{\text{mass of 1 atom of } ^{12}\text{C}} \times 12$ **(1)** 2

(b) simplest ratio of <u>atoms</u> of each <u>element</u> in a compound 1

(c) (i) %O = 65.7 **(1)**

$C:H:O = \dfrac{32.9}{12} : \dfrac{1.40}{1} : \dfrac{65.7}{16}$ **(1)**

= 1.96: 1 : 2.93

= C_2HO_3 **(1)**

(ii) $C_4H_2O_6$ **(1)** 4

(d) (i) $\dfrac{\text{mass}}{M_r} = \dfrac{1000}{16} = 62.5$ **(1)**

(1)

0.0625 scores one

(ii) pV= nRT **(1)**

(1)

$V = \dfrac{nRT}{P} = \dfrac{2 \times 62.5 \times 8.31 \times 298}{100000}$ **(1)**

= 3.10 m^3 **(1)**

(allow consequential marking but if factor of 2 in missing max = 2) 6

[13]

19. Avogadro's number of molecules **(1)**

allow 6 to 6.1 × 10^{23} molecules OR No. of atoms in 12g of ^{12}C 1

[1]

20. (a) Avogadro's 1

(b) (i) pV=nRT **(1)**

allow {$V = \dfrac{nRT}{P}$ etc., $pV = \dfrac{m}{Mr}$ RT

(ii) $V = \dfrac{nRT}{P}$

$= \dfrac{1 \times 8 \cdot 31 \times 298}{100\,000}$ **(1)**

= 0.0248 m^3 **(1)**

(allow 0.0247 to 0.025)

allow use of 100 for P if ans given as 24.8 $\underline{dm^3}$

(iii) $n = \frac{pV}{RT} = \frac{500000 \times 0.005}{8.31 \times 273}$ **(1)**

(treat 500 as AE–1 other values l^S 2mar

0.005/1000 loses 1st two marks

= 1.10mol **(1)**
(allow 1.1 to 1.11)

Mr (CO2) = 44 **(1)**
treat wrong Mr as AE–1

mass = 44×1.10 = 48.5 (g) **(1)**

(allow 48–49)

(note can use calculation involving $\frac{P_1V_1}{T}$ and 22.4 dm^3 instead of 1st mark - requires same accuracy for full marks)

7

(c) moles HC1 = $\frac{100}{1000} \times 5.0$ = 0.5(0)(mol) **(1)**

moles H2 = $\frac{\text{moles HC1}}{2}$ **(1)** = 0.25 (mol)
(if no factor of 2 CE = O from here)

mass H_2 = 0.25×2 = 0.5(0) (g) **(1)** 3

(d) (i) %O = 44.4 **(1)**
(if incorrect %O, AE–1)

(if %O omitted can score max 1 for FeC_2)

ratio Fe:C:O = $\frac{38.9}{55.8}$ **: (or 50)** $\frac{16.7}{12.0} : \frac{44.4}{16.0}$ **(if use At, CE)**

= 1 : 2 : 4

Fe C_2 O_4 **(1)**

(ii) CO **(1)**
(mark independent of d (ii))

4

[15]

21. (a) moles of NH_3 = $\frac{20.0}{17.0}$ **(1)**

moles of HNO_3 = moles of NH_3 = 1.18

volume = $\frac{1.18}{2}$ **(1)**

= 0.588 **(1)** dm^3 **(1)** 4

(b) (i) PV = nRT **(1)**

$n = \frac{PV}{RT} = \frac{95000 \times 0.0500}{8.31 \times 298}$ **(1)**

= 1.92 mol **(1)**

(ii) *Moles of ammonium nitrate* $\frac{1.92}{1.5}$ **(1)** 1.28 mol

Mass of ammonium nitrate mass = 1.28 × 80 **(1)** = 102 g **(1)** 6

[10]

22. $\frac{12}{1.99 \times 10^{-23}}$[[1] = 6.03×1023 **(1)** 2

[2]

23. (a) mass ratio of O_2:$KClO_3$ = 96 / 245.2 (= 0.392)
or moles of O_2 = 3/2 × 1.20 × 10^{-2} or equivalent **(1)**

mass of O_2 **=** 0.392 × 1.47 = 0.576g **(1)** 2

(b) moles O_2 **=** 1.00/24.00 (= 0.0417 mol) **(1)**

moles $KClO_3$ = 2/3 moles O_2 = 0.0417 × 2/3 = (0.0278 mol) **(1)**

mass $KClO_3$ = 0.0278 × 122.6 = 3.4lg **(1)** 3

give one mark for $pV = nRT$ to get n for O_2,
then second and third mark as above

or 2/3 mole of $KClO_3 \rightarrow$ 1 Mole of O_2 **(1)**
81.7g $\rightarrow$ 24 dm^3 O_2 **(1)**
$\frac{81.7}{24}$ g = 3.4lg $\rightarrow$ 1 dm^3 O_2 **(1)**

penalise other than 2 – 5 sig. figs. once in (d)(i) and (ii)

penalise missing or wrong units once in (d)(i) and (ii)

[5]

24. (a) Mass of each element in the compound **(1)** 1

(b) Number of atoms of each element in a molecule **(1)** 1

(c) (i) Mr $Ba(NO_3)_2$ = 261 **(1)**

moles $Ba(NO_3)_2$ = $\frac{5}{261}$ **(1)** = 0.0192

moles gas = $2\frac{1}{2}$ × 0.0192 **(1)** = 0.0479

$V = \frac{nRT}{p}$ **(1)** $= \frac{0.0479 \times 8.31 \times 298}{100000}$

= 1.19 ×10^{-3} m^3 **(1)**

(ii) moles HCl = 2 × 0.0192 **(1)** = 0.0384

vol HCl = $\frac{0.0384}{1.2}$ = 0.032 dm^3 **(1)** (or 32 cm^3) 7

[9]

25.

percentage by mass of oxygen = 38.0% **(1)**
ratio of elements = 42.9/12 : 2.4/1 : 16.7/14 : 38.0/16 **(1)**
= 3.6 : 2.4 : 1.2 : 2.4
empirical formula is $C_3H_2NO_2$ **(1)**
molecular formula is $C_6H_4N_2O_4$ **(1)** 4

[4]

26.

(a) %H = 18.8 **(1)**

B : H = $\frac{81.2}{10.8} : \frac{18.8}{1}$ **(1)**

= 2 : 5 : B_2H_5 **(1)**

(b) B_4H_{10} **(1)** 4

[4]

27. (a) $\frac{\textit{mean} \text{ mass of an entity (or molecule)}}{\text{mass of 1 atom of } ^{12}\text{C}}$ **(1)** × 12 **(1)** 2

(b) $\frac{12}{1.993 \times 10^{-23}} = 6.02 \times 10^{23}$ **(1)**

(allow 6.020 to 6.023) 1

[3]

28.

(b) (i) %F = 42·8 **(1)**

I:F = $\frac{57 \cdot 2}{127} = \frac{42 \cdot 8}{19}$ **(1)**

= IF_5 **(1)**

(ii) $I_2 + 5F_2 \rightarrow 2IF_5$ **(1)** (or × ½) 4

[4]

29. C 22.24/12 = 1.85 H 3.71/1 = 3.71 Br 74.05/79.9 = 0.927 **(1)**
ratio C:H:Br = 2:4:1 ∴ C_2H_4Br **(1)**
empirical mass = 107.9 ∴ mol formula = 215.8/107.9 × C_2H_4Br = $C_4H_8Br_2$ **(1)**

must use % to justify answer

or
C (22.24/100) × 215.8 = 47.99 i.e. 48/12 = 4 carbon atoms **(1)**
H (3.71/100) × 215.8 = 8.01 i.e. 8/1 = 8 hydrogen atoms **(1)**
Br (74.05/100) × 215.8 = 159.8 i.e. 159.8/79.9 = 2 bromine atoms **(1)**

or
C (48/215.8) × 100 = 22.24% **(1)**
H (8/215.8) × 100 = 3.71 % **(1)**
Br (159.8/215.8) × 100 = 74.05% **(1)** 3

[3]