

Name of the Student: _____

Max. Marks : 18 Marks

Time : 18 Minutes

Mark Schemes

Q1.

- (a) The enthalpy change /
- ΔH
- when one mole of a (solid) ionic compound

Ignore standard states / conditions**Allow** heat change at constant pressure when...**Ignore** heat change (alone) / energy change

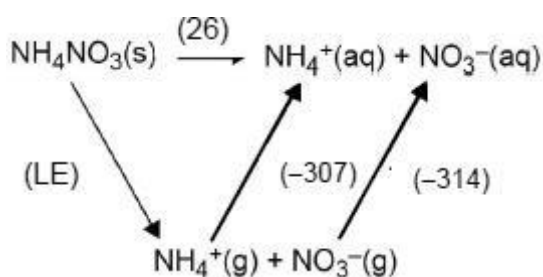
1

dissociates (fully) into gaseous ions

M2 Allow suitable equation with state symbols for ions**Not** one mole of gaseous ions

1

- (b)

**Allow** + water or +aq**M1** = cycle (3 'corners' with formulae and state symbols and suitable arrows)**Allow** equivalent Born-Haber style energy cycle**Not** ecf to M2 and M3 from incorrect cycle

1

$$LE = 26 + 307 + 314$$

$$M2 = \text{working e.g. } 26 = LE - 307 - 314$$

$$= (+)647$$

1

M3 = answer (+)647 gets 3/3 if M1 given or 2/3 if not

-647 = 2/3 if M1 given or 1/3 if not

+595 / -595 = 2/3 if M1 given or 1/3 if not

-621/+621 = 1/3 if M1 given

Not ecf for M3 from incorrect expression in M2

1

- (c) ($q = mc\Delta T$) $25.0 \times 4.18 \times (20.2 - 12.2)$ **OR** $25.0 \times 4.18 \times 8$
 (= 836 (J) or 0.836 (kJ))

Not if $m = 29$

Ignore sign of q

1

$$4.00 \text{ g NH}_4\text{NO}_3 = 4.00/80 \text{ OR } 0.0500 \text{ mol}$$

1

$$\Delta H^{\text{&ohbar}}_{\text{soln}} = 836/0.05 = 16720 = (+)16.7(2) \text{ kJ mol}^{-1}$$

Allow ecf from M1 and/or from M2

$$-16.7(2) = 2/3$$

$$+19.4 = 2/3 \text{ (using } m = 29 \text{ in M1)}$$

$$-19.4 = 1/3$$

$$+2.68 = 2/3$$

$$-2.68 = 1/3$$

$$+587 \text{ or } +588 = 2/3$$

$$-587 \text{ or } -588 = 1/3$$

Allow 2 sig figs or more

1

(d) $(2 \times 0.1/8) \times 100 = 2.5\%$

Allow ecf from ΔT in (c)

1

(e) use a larger mass/amount of NH_4NO_3 / solid

Marking points are independent

Allow smaller volume of water / less water

Allow use more NH_4NO_3

Not larger volume of water

Ignore higher concentration (of NH_4NO_3)

Ignore any references to changing apparatus e.g. insulation

1

so temperature change/decrease is greater

OR final temperature is lower

Allow temperature increase is greater

Not final temperature is higherr

1

(f) heat gain (from the surroundings) / incomplete dissolvingg

Allow incomplete reaction

Allow thermal energy gain

Not heat loss

Ignore energy gain

Ignore references to mistakes in method

1

(g) $\Delta S = (113 + 146) - 151 = +108 \text{ (J K}^{-1} \text{ mol}^{-1}\text{)}$

1

$$\Delta G = \Delta H - T\Delta S \text{ OR } 26 - (298 \times 108 \times 10^{-3})$$

Allow ecf $26 - (298 \times M1 \times 10^{-3})$

Allow ecf $26 - (298 \times M1)$

Allow M2 for $26000 - (298 \times 108)$

Allow M2 for $26 - (298 \times 108)$

1

$$\Delta G = -6.184 / -6.18 / -6.2$$

$$-32158 = \mathbf{M1} \text{ and } \mathbf{M2}$$

$$-32.2 = \mathbf{M1} \text{ and } \mathbf{M2}$$

$$-6184 = \mathbf{M1} \text{ and } \mathbf{M2}$$

$$(+58.2 = \mathbf{M2} \text{ and } \mathbf{M3} \text{ (ecf if } -108 \text{ for M1)})$$

1

negative value for ΔG indicates reaction is feasible/spontaneous

Allow positive value for ΔG indicates reaction is NOT feasible/spontaneous

Allow < 0 or > 0 as appropriate

M4 is standalone

1

(h) Converting ΔH into J **OR** ΔS into kJ

1

$$(T = \Delta H / \Delta S = 123 / 144 \times 10^{-3} \text{ OR } 123000 / 144) = 854(.1666666) \text{ (K)}$$

$$0.854 \text{ (K)} = 1/2$$

$$0.00117 \text{ (K)} = 1/2 \text{ (calculation upside down)}$$

2SF minimum

1

[18]