2014 CHEMISTRY ASOE ANSWERS

Question	Answer	Question	Answer	Question	Answer
1	E	6	B	11	D
2	D	7	A	12	D
3	A	8	B	13	B
4	B	9	E	14	A
5	E	10	D	15	C

Question 16

(a)

$UO_3 + 2H^+ \rightarrow UO_2^{2+} + H_2O$

(b)

$UO_2 + 2Fe^{3+} \rightarrow UO_2^{2+} + 2Fe^{2+}$

(c)

2 × a): $2\ UO_3 + 4\ H^+ \rightarrow 2\ UO_2^{2+} + 2\ H_2O$

1 × b): $UO_2 + 2\ Fe^{3+} \rightarrow UO_2^{2+} + 2\ Fe^{2+}$

Sum: $U_3O_8 + 4\ H^+ + 2\ Fe^{3+} \rightarrow 3\ UO_2^{2+} + 2\ H_2O + 2\ Fe^{2+}$

(d)

$H_2O_2 + 2\ H^+ + 2\ e^- \rightarrow 2\ H_2O$

(e)

Molar mass = 238.0 + 2 × 16.00 + 2 × (14.01 + 3 × 16) + 6 × (2 × 1.008 + 16.00) = 502.116 g mol^{-1}

(f)

$n(UO_2(NO_3)_2 \cdot 6H_2O) = \frac{0.500\ g}{502.116\ g\ mol^{-1}} = 9.958 \times 10^{-4}$ mol

$[UO_2(NO_3)_2 \cdot 6H_2O] = \frac{9.958 \times 10^{-4}\ mol}{0.5\ L} = 1.992 \times 10^{-3}$ mol L^{-1} (1.992 mM)

(g)

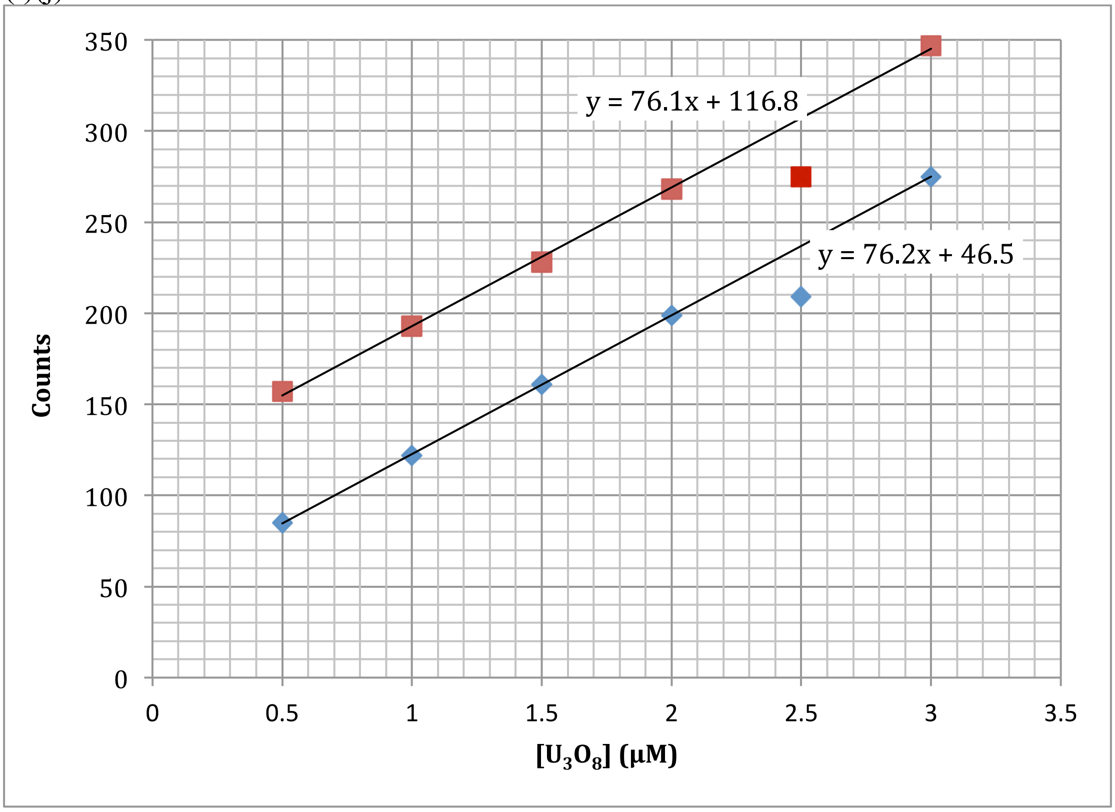
From (c), $U_3O_8 \rightarrow 3UO_2^{2+}$ so $[U_3O_8] = \frac{1.992 \times 10^{-3}\ mol\ L^{-1}}{3} = 6.639 \times 10^{-4}$ mol L^{-1} (0.6639 mM)

(h)

$n(U_3O_8) = 0.5000 \times 10^{-3}$ L × 6.639×10^{-4} mol L^{-1} = 3.319×10^{-7} mol

$[U_3O_8] = \frac{3.319 \times 10^{-3}\ mol}{0.1000\ L} = 3.319 \times 10^{-6}$ mol L^{-1}

(i)(j)



(k)

Increase in fluorescence intensity = 70 counts

So increase in $[U_3O_8]$ in the spiked sample solutions from the ore = 0.92 μM

So $[U_3O_8]$ in 1.00 mL original ore sample = $\frac{101.0}{1.00}$ × 0.92 μM = 92 μM

(l)

$[U] = \frac{20080\ counts}{31.81\ counts\ (mg\ kg^{-1})^{-1}} = 631.2$ mg kg^{-1}

(m)

Th counts = 5.824 coubts (mg kg^{-1}) × 631.2 mg kg^{-1} = 3676 counts

(n)

1 mg Th kg^{-1} gives 2.413 counts in the U-ROI (i.e. due to U).

So 1 mg Th kg^{-1} contains $\frac{2.413\ counts}{31.81\ counts\ (mg\ kg^{-1})^{-1}} = 7.586 \times 10^{-2}$ mg U kg^{-1}

So ratio of [Th] / [U] = $\frac{1\ mg\ kg^{-1}}{7.586 \times 10^{-2}\ mg\ kg^{-1}} = 13.18$

(o)

For the standard Th samples:

Th counts from Th and U = 10.48 counts $(mg\ kg^{-1})^{-1}$

From part n), Th counts from U = $\frac{5.824\ counts\ (mg\ kg^{-1})^{-1}}{13.18} = 0.4417$ counts $(mg\ kg^{-1})^{-1}$

$\therefore$ Th counts from Th = 10.48 – 0.4417 = 10.04 counts $(mg\ kg^{-1})^{-1}$

For the ore sample:

Th counts from Th = (Th counts from Th and U) – (Th counts from U)

From part m), Th counts from U = 3676 counts.

$\therefore$ Th counts from Th = 4200 – 3676 = 524 counts

[Th] = $\frac{524\ counts}{10.04\ counts\ (mg\ kg^{-1})^{-1}} = 52.2$ mg kg^{-1}

Question 17

(a) **B** - Ionisation Energy

(b) $(13.6 \times 1.602 \times 10^{-19}) \times 6.022 \times 10^{23} \times 1 \div 22.71 =$ **57.8 kJ**

(c) $m(\text{sun}) = 2 \times 10^{33}$ g
$m(H)$ approx $= 1.008 \div (6.022 \times 10^{23}) = 1.674 \times 10^{-24}$ g atom^{-1}
$n(H) = 2 \times 10^{33} \div (1.674 \times 10^{-24}) =$ **1.195×10^{57} atoms**
$V(H) = 1.195 \times 10^{57} \div (1000 \text{ atoms mL}^{-1}) = 1.195 \times 10^{54}$ mL
$= 1.195 \times 10^{48}$ m^3
$= (4/3)\pi r^3$
So $r = 6.583 \times 10^{15}$ m
And **$d = 1.317 \times 10^{16}$ m**

(d) **0.7 Å**, minimum of the potential energy curve

(e) **+ 4.8 V**

(f) (i) **Electrons attrac**t positively charged nuclei
Nuclear repulsion is shielded by electrons. Or equivalently, electron-proton attractions overcome nuclear-nuclear repulsions
(ii) **Reduced electron density** between nuclei
Nuclear repulsion stronger due to decreased shielding

(g) He^{2+}: **2**
H_2^+: **2**
TTF^{2+}: Approx **102**

(h) **H_3^+ and C^{4+}**

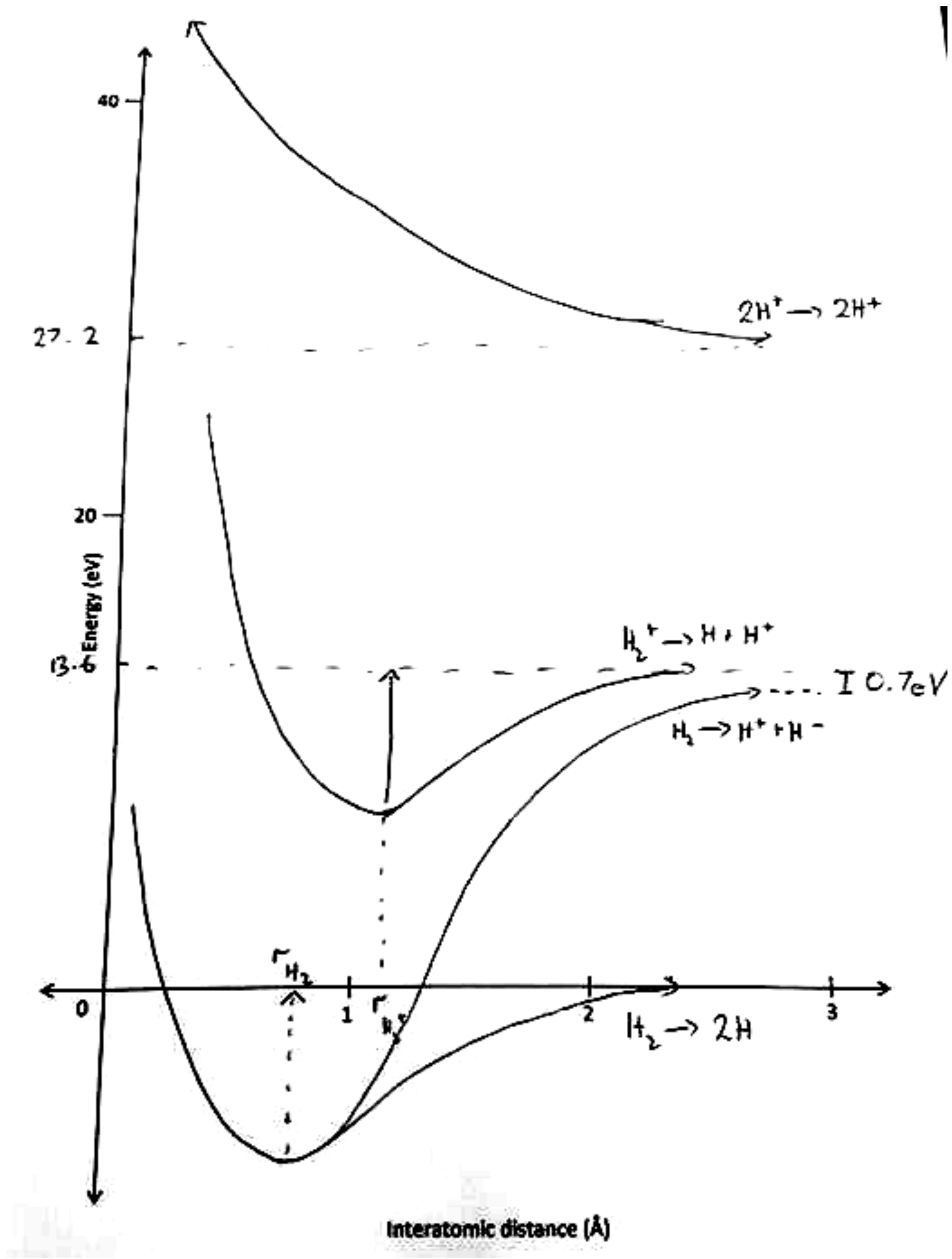
(i) **$H_2^+ + H_2 \rightarrow H_3^+ + H$**

(j) Triangular and linear arrangement of 3 hydrogen atoms
A general comment on "electron deficiency"

(k) Photodissociation: $H_2^+ + h\nu \rightarrow H^+ + H$
Dissociative Recombination: $H_2^+ + e^- \rightarrow 2H$

(l) 13.6 eV

(m) Longer bond length
Decreased electron density decreases shielding and increases nuclear repulsion



(n) Redrawing H_2 curve

H_2^+ Curve: Greater equilibrium bond length than H_2

Curve is higher than H_2 curve

Curve goes to 13.6 eV at infinite distance

Same shape as H_2 curve

$2H^+$ Curve: Correct shape

Goes to 27.2 eV at infinite distance

(o) Correct shape extending from original H_2 curve

Goes to 13.6 - 0.7 = 12.9 eV at infinite distance

Question 18
(a)
eight

(b)
Yes. (Higher temperature will result in a shorter retention time)

(c)
20.30 min

(d)
2, 3, 1

(e)
D. Hexane is a non-polar solvent. The most polar compound would adhere strongly to the polar stationary phase and thus travel the least distance.

(f)
A, C, D, B

(g)
0.35

(h)
Rf values would be higher. Acetone is a more polar solvent, but still less polar than the stationary phase. The reduced difference in polarity between the two phases allows for more travelling by all compounds.

(i)
False. Same Rf value so very similar polarity. Not necessarily same compound.

(j)
When the mobile phase reaches the top edge of the plate, it continues to flow upwards due to evaporation and as a result, mixture components keep moving although the solvent front has stopped. This counteracts the earlier separation.

(k)
Larger molecules would elute first as they are heavier and therefore travels through the medium the fastest. They also have a shorter path to travel as they don't get caught in the pores.

(l)
Glutamic acid would elute last as the negatively charged carboxylates would interact favourably with the positive ions in the column.

(m)
The p*H* should be decreased as the amino acid would become protonated in the acidic p*H* and therefore detach from the positively charged column.

(n)

The chloride ions would attach to the positive column and replace the negative amino acid, hence pushing it off the column.