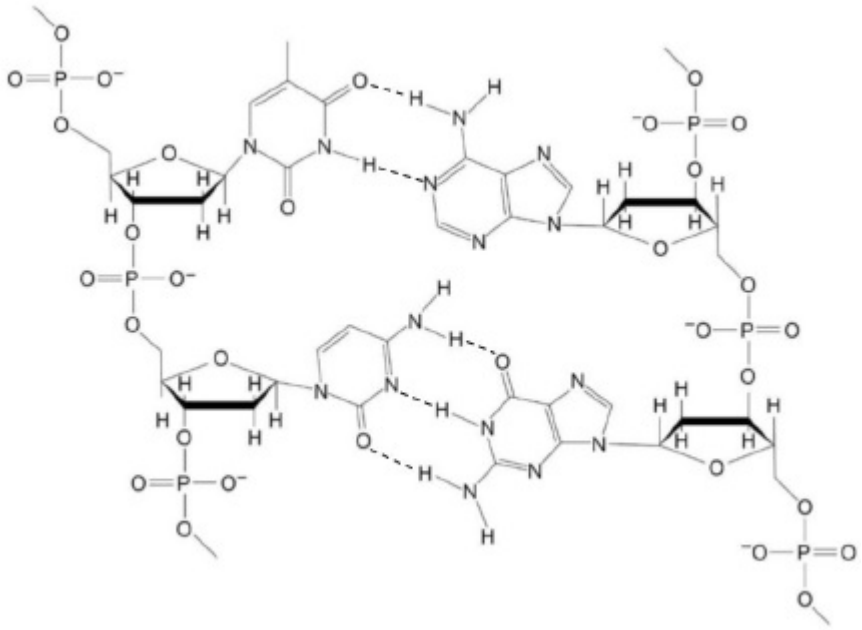
A-Level Chemistry

DNA

Mark Scheme

Time available: 60 minutes
Marks available: 51 marks

1. (a)



M1 *scored for the 2 H 'bonds' between A and T*

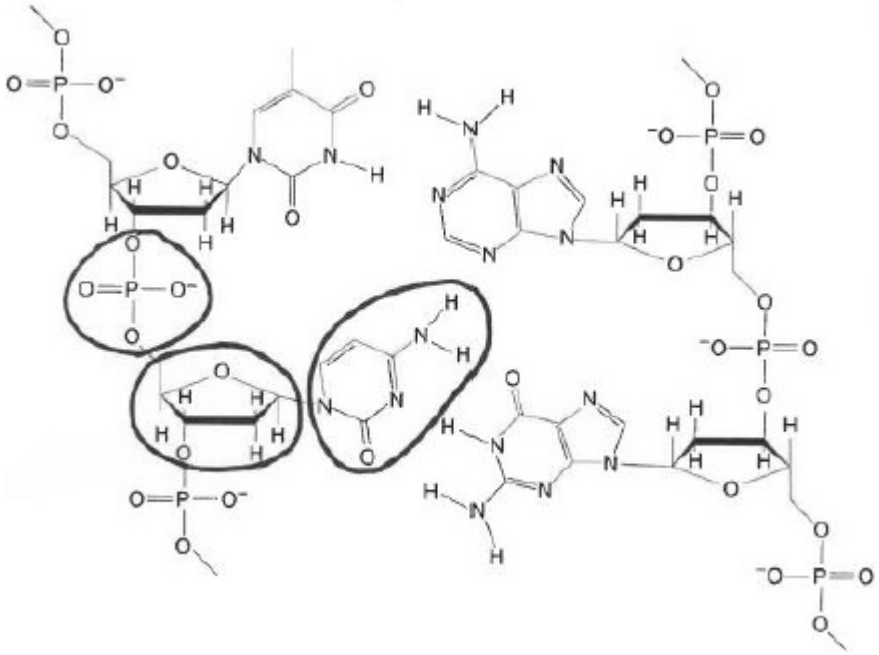
1

M2 *scores for the 3 H 'bonds' between C and G*

1

Lose 1 for each extra 'bond'
H bonds must be linear
Penalise the use of full bonds instead of dashed lines once only
Ignore lone pairs and partial charges even if wrong

(b)



M1 *scored for correct selection of cytosine and associated sugar*

1

M2 *scored for selection of <u>correct</u> (upper) phosphate*

1

M1 *&* ***M2*** *can be scored with one 'ring'*

Allow ring either side of the top O of either phosphate

If wrong base circled, can score ***M2*** *for correct phosphate conseq to their base, i.e. top left, Thymine it's the upper phosphate top right, Adenine it's the lower phosphate bottom right, Guanine it's the lower phosphate*

(c) (Complementary means the two strands must have base sequences) that match (all) <u>A to T and C to G</u>

Ignore reference to (hydrogen) bonding

1

[5]

2. (a) 1 2 3 4 5

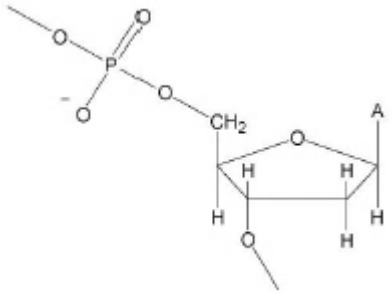
T G C A G

1

(b) 13

1

(c)



1 for completed 2-deoxyribose plus A

Allow either OH or trailing bonds

Don't penalise 'sticks' in 2-deoxyribose.

1

1 for correct phosphate joined to CH_2

If two phosphates shown CE=0

If CH_2 missing award 1 if no further errors

If phosphate attached to oxygen on C3 award 1 if no further errors

1

[4]

3. (a) X – base

1

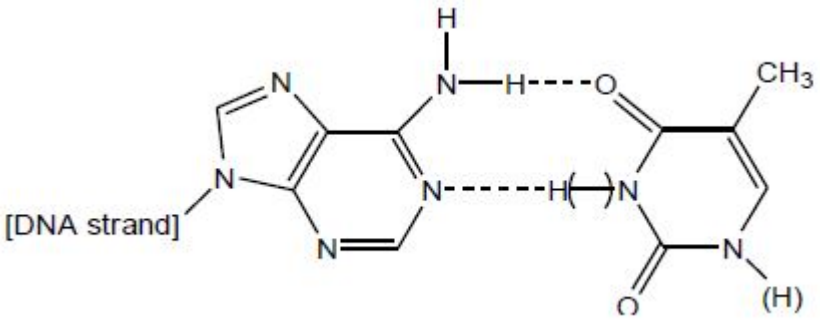
Y – phosphate (group)

1

Ignore organic

Any mention of sugar in either loses that mark

(b) If not Thymine CE=0



Correct structure scores 2, penalise by 1 each error in

- structure of thymine
- orientation of thymine
- hydrogen bonding

Ignore lp on N and O

Don't penalise non-linear H bonds

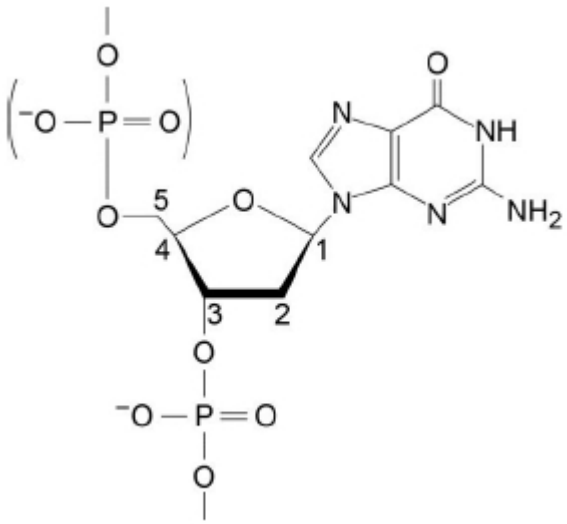
on RHS of thymine – allow with or without H or – [DNA strand]

2

[4]

4.

(a)



*CE=0 if **nucleotide** does not contain one base, one sugar and one phosphate.*

Max 2 for any slips in structures.

Correct phosphate-sugar link on C3.

Allow phosphate attached to C5.

1

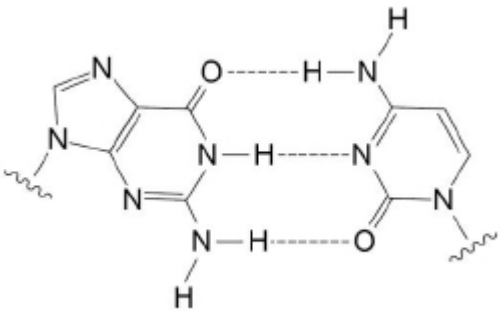
Correct sugar-guanine link on C1.

1

Remainder of molecule correct.

1

(b)



Correct diagram of cytosine (base pair with guanine).

CE=0 if wrong base shown.

1

Three hydrogen bonds drawn.

Allow M2 if slip in M1.

1

(c) There are only two H-bonds in the adenine-thymine base pair.

Allow there is one fewer H-bond in the AT base pair.

1

(d) The amino/-NH_2 groups in urea

1

are able to substitute for the H–bonds in the double helix.

Allow H bonds will form between the urea and the DNA strands.

1

[8]

5. (a) <u>DNA</u> Replication

NOT mitosis

NOT DNA synthesis

Ignore terms relating to cell division processes

Ignore 'damages DNA'

Ignore DNA transcription

Ignore 'cell replication'

1

(b) $[Pt(NH_3)_2Cl_2] + H_2O \rightarrow [Pt(NH_3)_2Cl(H_2O)]^+ + Cl^-$

***M1** Correct formula **and** charge of B*

1

***M2** Correct balancing **and** charges in equation*

1

*Allow **M2** if the **only** error in complex B is the charge*

*(**M1** not awarded) with Cl^- **only***

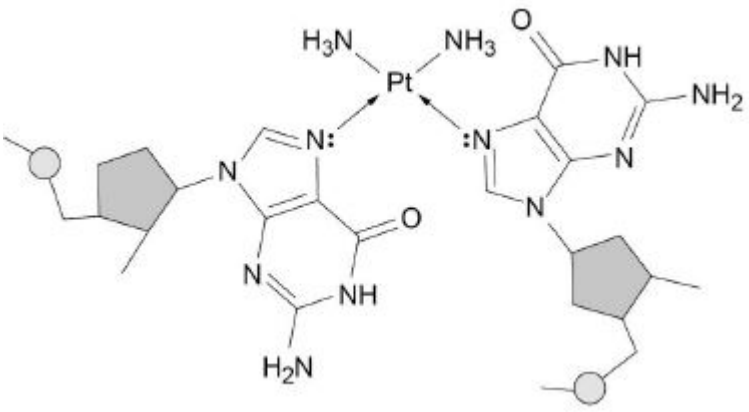
ALLOW complexes without [ ] and/or ( ) around H_2O

IGNORE ( ) around Cl

*NOT any additional different species (loses **M2**)*

(allow uncancelled water on both sides)

(c)



M1 *Pt in a cis-diammine complex bonded to the correct nitrogen atoms*

Pt must have the two ammonia ligands shown

NOT if drawn as trans

IGNORE any charge on Pt

Ignore any wedges and dashes (3D representations)

1

M2 *both lone pairs shown* ***OR*** *two arrows indicating co-ordinate bonds*

Allow ***M2*** *if bonds to platinum are from the incorrect nitrogen atoms*

1

(d) **M1** plot concentration (y-axis) against time (x-axis) **and** take tangents / (calculate the) gradients (to calculate rates)

Allow concentration-time graph

NOT time-concentration graph (unless clarified in words or sketch) but mark on

1

M2 Plot rate/gradients against conc

1

M3 straight line through origin / directly proportional confirms first order

allow first order if rate halves/doubles when conc halves/doubles

1

Alternatives to ***M2*** *and* ***M3****:*

M2 *Plot a graph of log rate vs log conc*
M3 *(Straight) line of gradient = 1*

M2 *measure (at least) two half-lives (in this case, tangents not required for M1)*
M3 *constant half-life means first order*

M2 *compare rates/gradients at different concentrations*
M3 *first order if rate halves when conc halves*

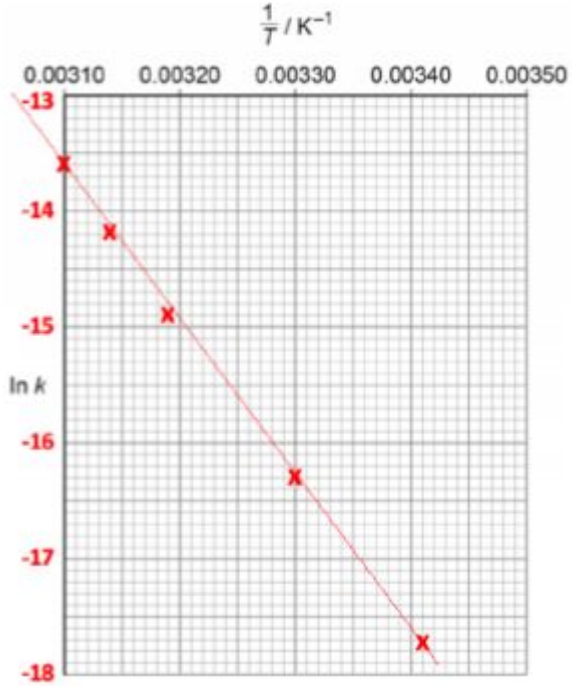
(e)

temperature, T / K	$\frac{1}{T}$ / K^{-1}	rate constant, k / s^{-1}	ln k
318	0.00314	6.63 x 10^{-7}	−14.2

Allow 3.14 x 10^{-3}

2

(f)



Gradient = −13 125

$\left(-13125 = \frac{-E_a}{R}\right)$

E_a = 13 125 x 8.31 = 109 069

= 109 (kJ mol^{-1})

Vertical axis with sensible scales (plotted points must take up more than half the grid) NOT M1 if y-axis in wrong direction

1

all points plotted correctly (within ±0.5 small square)

1

Best fit straight line based on the student's data (ignoring anomalous point if relevant)

1

Gradient calculated within range: 12876 - 13598

1

*Mark is for their (gradient x 8.31) **and** conversion into kJmol^{-1}*

E_a in the range: 107 – 114 kJ mol^{-1}

NOT a negative activation energy

1

[15]

6. (a) 2-deoxyribose

1

(b) Base A

If Base B stated, allow 1 mark only for response including hydrogen bonding

1

Top N–H forms hydrogen bonds to lone pair on O of guanine

1

The lone pair of electrons on N bonds to H–N of guanine

1

A lone pair of electrons on O bonds to lower H–N of guanine

Allow all 4 marks for a correct diagram showing the hydrogen bonding

Students could also answer this question using labels on the diagram

1

(c) Allow either of the nitrogen atoms with a lone pair NOT involved in bonding to cytosine

1

(d) Use in very small amounts / target the application to the tumour

1

[7]

7. (a) $Pt(NH_3)_2Cl_2 + H_2O \rightarrow [Pt(NH_3)_2Cl(H_2O)]^+ + Cl^-$

Correct product

1

Balanced equation

1

(b) (i) Hydrogen bond

1

Oxygen (or nitrogen)

Only score this mark if type of bond is correct

1

(ii) Co-ordinate

1

Nitrogen (or oxygen)

Bond type must be correct to score this mark but allow M2 if bond is covalent

1

(c) Killing them or causing damage (medical side effects)

Allow any correct side effect (e.g. hair loss)
Allow kills healthy (or normal) cells

1

May attach to DNA in normal cells

1

[8]