NSAA Section 2 2019 - Question P1

Question P1

a) Four sheets of transparent material are placed on top of each other. A ray of light propagates through medium 1 and is incident at the boundary between medium 1 and medium 2 at an angle θ_1 to the normal. The refractive index of medium 1 is $n_1 = 1.50$.

(i) Given that $n_1 > n_2 > n_3 > n_4$ and n_4 is such that the ray of light **does not** enter medium 4, complete the diagram to show the path of a ray of light through the different mediums. Label the angles to the normal at the boundaries between medium 1 and 2, medium 2 and 3, and medium 3 and 4.

[2 marks]

(ii) If the angle at which the light meets the normal to the boundary between medium 3 and medium 4 is the critical angle, find an expression for θ_1 in terms of n_1 and n_4.

[3 marks]

(iii) If the refractive index of each medium is given by $n_m = 1.50 \times (0.99)^{m\ 1}$, where m has values 1, 2, 3, and 4, find the minimum value of θ_1 for total internal reflection to occur at the boundary between medium 3 and medium 4.

[2 marks]

NSAA 2019 Section 2 - Question P1 (a) - Worked Solution

(ai)
Diagram should show refraction from 1 into 2 and 2 into 3, then TIR at the boundary between 3 and 4, then refraction from 3 into 2. Theta 1 < theta 2 < theta 3 (angle at ¾ boundary is also theta 3)

(aii)
Using Snell's Law: n1sintheta1 = n2sintheta2
n2sintheta2 = n3sintheta3
n3sintheta3 = n4sin90
sintheta1 = n4/n1
theta1 = arcsin(n4/n1)

(aiii)
n4 = 1.5x(0.99)^3 which is approx. 1.46
theta1 = arcsin(0.99^3) = 76 degrees

b) A meerkat is in a desert on a hot day with a clear blue sky above the sand. A thin layer of air, of thickness t, above the sand is so hot that it has a lower refractive index, n, than the cold air directly above it. The cold air has a refractive index, $n_c = 1.004$. The meerkat has height h where $h \gg t$. The meerkat believes that he is standing on an "island" of sand of radius r, with what appears to be water all around him. He thinks that there is water because at distances greater than r away from him he sees a reflection of the blue sky when he is looking below the horizon towards the ground.

(i) On the diagram, draw rays to show how light reaches the meerkat's eyes from the sky, by reflection, and from the sand, by refraction.

[2 marks]

(ii) Add to the diagram a critical ray showing the path of the light reaching the meerkat's eye from the edge of the "island".

Find an expression for the angle this ray makes with the normal in terms of n_c and n.

[3 marks]

(iii) A giraffe stands at the same position as the meerkat. The giraffe has height H, where $H \gg h \gg t$. The giraffe thinks the edge of the "island" is at a distance R.

Find an expression for $\frac{R}{r}$ in terms of H and h.

[1 mark]

(iv) Using your result from **(ii)**, show that the radius of the meerkat's "island" is given by $r = \frac{anh}{\sqrt{bn_c^2 + kn^2}}$ and find the integer values of a, b and k.

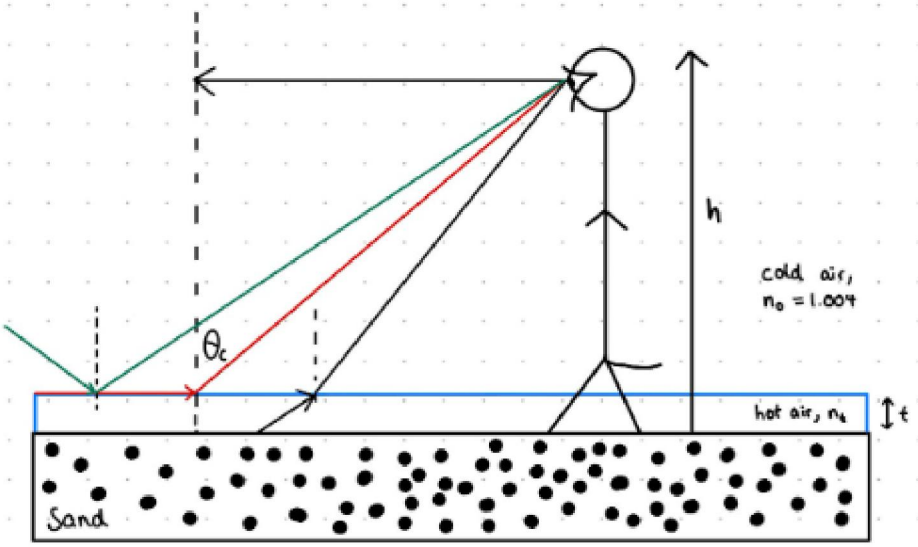
[3 marks]

(v) As the day progresses the hot air warms up and its refractive index n reduces, but the cold air remains at the same temperature and with the same refractive index, n_c. By considering the expression for r from **(iv)**, explain what happens to r as the hot air warms up. Does the meerkat think that the water is **getting closer, staying the same, or getting further away**?

[2 marks]

NSAA 2019 Section 2 - Question P1 (b) - Worked Solution

(bi)



Green Ray [1]

Black Ray [1]

(bii)

Orange Ray [1]

$n_1 \sin 90 = n_0 \sin\theta_c$ [1]

$\sin\theta_c = n_1/n_0$ [1]

(biii)

$\frac{r}{\sqrt{(r^2+h^2)}} = \frac{R}{\sqrt{(R^2+H^2)}}$ (from Snell's Law and sine of angle)

Equally $\tan\theta$ has to be the same for both animals therefore

$\frac{R}{r} = \frac{H}{h}$ [1] **NOTE:** ½ mark for $\frac{R}{r} = \frac{H-t}{h-t}$ as $t \ll h \ll H$ has not been considered

(biv)

$n = n_c \sin\theta_c$ [1]

$n = \frac{n_c r}{\sqrt{h^2 + r^2}}$ [1] this mark is for correctly expressing $\sin\theta_c$ in terms of r and h

$r^2(n_c^2 - n^2) = h^2 n^2$

$r = \frac{hn}{\sqrt{n_c^2 - n^2}}$ therefore a=1, b=1, k=-1 [1] mark in total for the 3 coefficients, any coefficient wrong=[0] marks

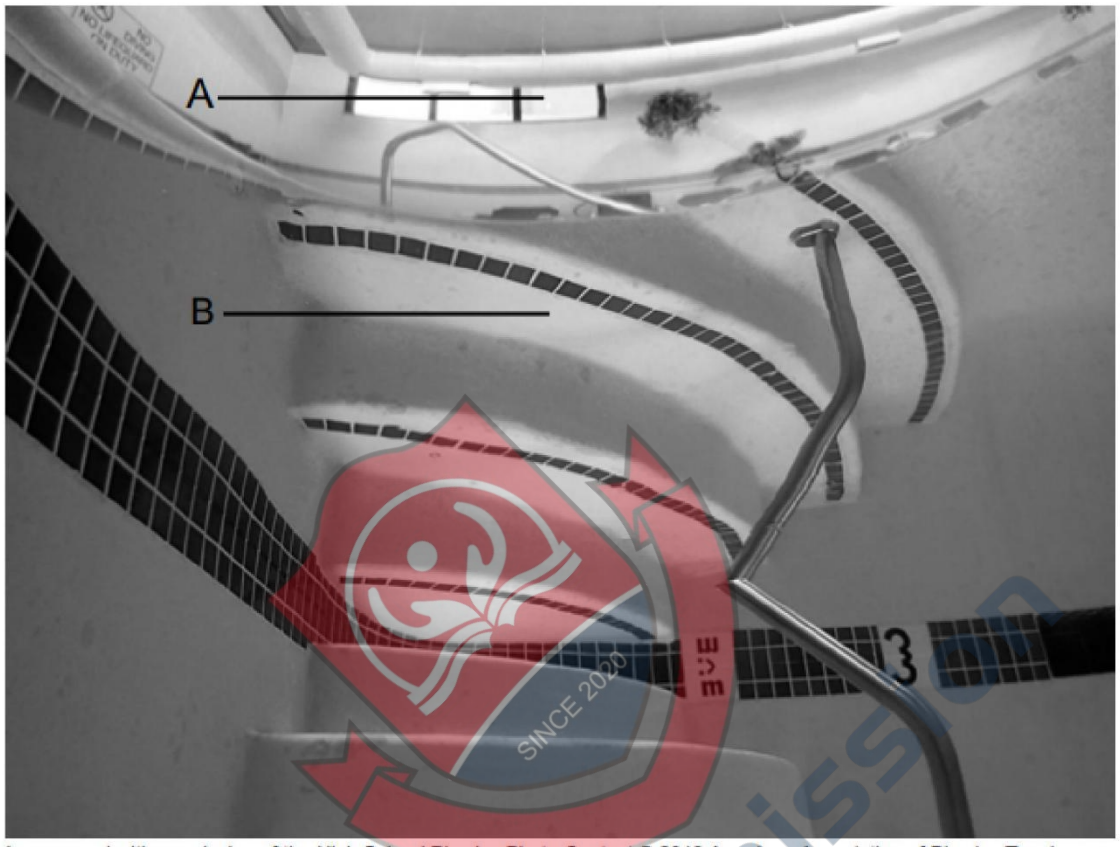
(bv)

As the hot air gets hotter *n* decreases therefore the denominator gets bigger and the numerator gets smaller so r must get smaller (*h* and *n* are constant). Need numerator and denominator **[1 mark]** *r* gets smaller **[1 mark]**

c) The camera that took this photograph was placed at the bottom of a swimming pool. The area labelled A is a window above the pool. The area labelled B is the top surface of a step.

Describe the path that the light has taken to reach the camera from A and from B.

[2 marks]



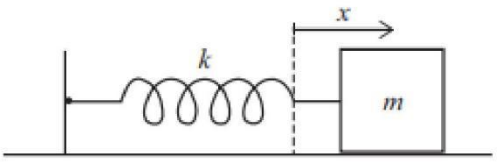
NSAA 2019 Section 2 - Question P1 (c) - Worked Solution

A = refraction **[1 mark]**
B = total internal reflection **[1 mark]**

NSAA Section 2 2019 - Question P2

Question P2

A mass m is placed on a frictionless horizontal surface and attached to the end of a light spring of spring constant k, and the spring is attached to a wall as shown in the diagram.



When displaced from equilibrium the mass oscillates with a frequency f. At time t the mass is at a displacement, x, from equilibrium and is moving with velocity, v.

a) Write down an expression for the elastic potential energy, E_p, stored in the spring at time t.

[1 mark]

NSAA 2019 Section 2 - Question P2 (a) - Worked Solution

Elastic potential energy = 1/2 kx^2

b) Write down an expression for the kinetic energy, E_k, of the mass-spring system.

[1 mark]

NSAA 2019 Section 2 - Question P2 (b) - Worked Solution

Kinetic energy = 1/2mv^2

c) The rate of change of displacement, $\frac{dx}{dt} = v$ and the rate of change of velocity, $\frac{dv}{dt} = a$.

Using the formula $\frac{dE_p}{dt} = \frac{dE_p}{dx} \times \frac{dx}{dt}$ show that $\frac{dE_p}{dt} = kxv$.

Using a similar method, find an expression for $\frac{dE_k}{dt}$ in terms of m, v and a.

Show all of your working.

[3 marks]

NSAA 2019 Section 2 - Question P2 (c) - Worked Solution

dEp/dt = kxv
dEk/dt = dEk/dv dv/dt
dEk/dt = mva

d) Give the physical reason in words why $\frac{d(E_k + E_p)}{dt} = 0$

[1 mark]

NSAA 2019 Section 2 - Question P2 (d) - Worked Solution

Because the total about of energy within a closed system must remain constant the rate of change of the total energy must = 0

e) A formula for the acceleration of the mass is $a = -(2\pi f)^2 x$. Using your answers from part **c)**, the expression given in part **d)** and this formula, find an expression for the frequency of the oscillation, f, in terms of m and k.

Show all of your working.

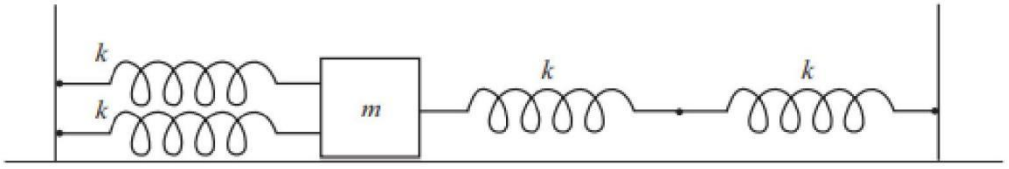
[3 marks]

NSAA 2019 Section 2 - Question P2 (e) - Worked Solution

dET/ dt = kxv +mva = 0
kx = -ma
a = -k/m x x

therefore f = 1/2π √k/m

The mass is now placed on a frictionless surface between two walls. It is attached to the left wall by **two** identical, light springs in **parallel**, each of spring constant k and to the right wall by **two** identical springs in **series**, each of spring constant k.



f) What is the new oscillation frequency, f_{new}, of this new system?

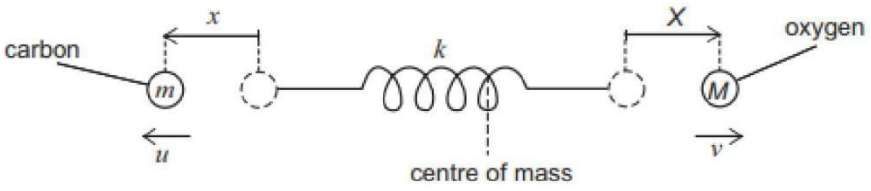
[2 marks]

NSAA 2019 Section 2 - Question P2 (f) - Worked Solution

keff = 2k +k/2
= 5k/2
fnew = 1/2π √5k/2m

A carbon monoxide molecule can be modelled as two different masses, m and M, each on one end of a light spring of spring constant, k.

When the molecule vibrates it does so such that the centre of mass of the molecule does not move. At time t the spring is extended and the masses are displaced from their equilibrium positions as shown in the diagram. The carbon atom, mass m, has moved a distance x to the left and is moving with a speed u to the left. The oxygen atom, mass M, has moved a distance X to the right and is moving with a speed v to the right.



g) What is the total elastic potential energy stored in the spring in terms of k, x and X?

[1 mark]

NSAA 2019 Section 2 - Question P2 (g) - Worked Solution

Ep = 1/2k(x +X)^2

h) What is the total kinetic energy of the whole system in terms of m, u, M and v?

[1 mark]

NSAA 2019 Section 2 - Question P2 (h) - Worked Solution

$$E_k = \frac{1}{2}\left(mu^2 + Mv^2\right)$$

i) Explain in words why $MX = mx$. Hence deduce an expression for the acceleration, a_M, of mass M, in terms of the acceleration, a_m, of mass m.

[2 marks]

NSAA 2019 Section 2 - Question P2 (i) - Worked Solution

Ideal answer is to state that the momenta of each particle must be equal and opposite for the centre of mass to remain stationary, therefore $ma = MA$. [1]

$a_M = \frac{ma_m}{M}$ [1]; can be positive or negative

j) Given that the total energy of the carbon monoxide molecule is constant, find an expression for the acceleration, a_m, of mass m, in terms of k, m, M and x.

Hence deduce the frequency of the oscillation, f.

[3 marks]

NSAA 2019 Section 2 - Question P2 (j) - Worked Solution

ET = 1/2 kx^2 (1+ m/M)^2 + 1/2 (mu^2 +Mm^2/ M^2 u^2)

dET/dt = kxu (1 + m/M)^2 + mua m +m^2/M uam = 0
kxu (1 + m/M)^2 +muam (1+m/M) = 0
k/m x (1+m/M) +am = 0
am = -k (1/m + 1/M) x

therefore
f= 1/2π √k (1/m +1/M)
or
1/2π √k (M+m/mM)

k) Calculate the frequency f of the vibration of the carbon monoxide molecule if the mass of the carbon atom is $12\,m_u$, the mass of the oxygen atom is $16\,m_u$ and $k = 2.0 \times 10^3\,\text{N m}^{-1}$.

If this vibration was caused by an electromagnetic wave incident on the molecule, which part of the electromagnetic spectrum would this wave correspond to?

($m_u = 1.66 \times 10^{-27}$ kg. The wavelength of visible light ranges from 400 nm to 700 nm.)

[2 marks]

NSAA 2019 Section 2 - Question P2 (k) - Worked Solution

f = 6.65 x 10^13 Hz
wavelength = 3 x 10^8 / 6.65 x 10^13
= 4.51 microm
= 45100 nm

therefore intra-red

NSAA Section 2 2019 - Question C1

Question C1

Data: Assume that the molar gas volume = $24.0\,dm^3\,mol^{-1}$ at room temperature and pressure (rtp).

This question concerns the chemistry of tellurium, an element in Group 16 of the Periodic Table.

a) What do you expect will be the maximum and minimum oxidation states of tellurium? Briefly explain your answer.

[3 marks]

NSAA 2019 Section 2 - Question C1 (a) - Worked Solution

Minimum oxidation state = -2
Maximum oxidation state = +6

Te has 6 electrons in it's valence shell, so the minimum ox. state is when it gains 2 e- to attain a noble gas configuration (leading to an ox. state of -2). The maximum ox. state is +6, when it loses all it's valence electrons.

b) How do the electronegativities of the elements vary on descending Group 16?

[1 mark]

NSAA 2019 Section 2 - Question C1 (b) - Worked Solution

Down the group, the electronegativity decreases.

c) Which hydride, H_2O or H_2Te, has the higher boiling point? Briefly explain your answer.

[2 marks]

NSAA 2019 Section 2 - Question C1 (c) - Worked Solution

H2O would have a higher boiling point (1) due to the hydrogen bonding (2).

(Normally, the boiling point would have increased since H2Te would have stronger van der Waals' forces than H2O. However, H2O has hydrogen bonding, making it's boiling point higher.)

Tellurium reacts directly with fluorine gas to form a dense gas, **A**, in which each molecule contains a single tellurium atom bonded to several fluorine atoms. In an experiment, 50 cm^3 of gas **A** is formed from 150 cm^3 of fluorine and a certain mass of tellurium, with all measurements made at room temperature and pressure.

d) Calculate the formula of the gas **A**.

[2 marks]

NSAA 2019 Section 2 - Question C1 (d) - Worked Solution

Ratio of F2 used : A produced = 150cm3 : 50 cm3 = 3:1
So the ratio of moles used = 3: 1

So A has 3 x 2 = 6 atoms of fluorine

(A is therefore TeF6)

e) Predict the value(s) of the F–Te–F bond angles in **A**.

[1 mark]

NSAA 2019 Section 2 - Question C1 (e) - Worked Solution

TeF6 will would have an octahedral structure, so the bond angle must be 90°

f) Calculate the minimum mass of tellurium needed to produce 50 cm^3 of **A**.

[2 marks]

NSAA 2019 Section 2 - Question C1 (f) - Worked Solution

Reaction: Te + 3 F2 ==> TeF6

Moles of F2 used = 150 / 24000 = 0.00625 moles

So 1 mole of Te would be 1/3rd the moles of F2 = 0.00625 / 3 =
So mass of Te used = (0.000625 / 3) x 127.6
= 0.266g

g) Calculate the density of gas **A** in g cm^{-3} at room temperature and pressure.

[2 marks]

NSAA 2019 Section 2 - Question C1 (g) - Worked Solution

Molar mass of TeF6 = 241.6
Moles ofA produced = 50 cm3 / 24000
So mass of TeF6 produced = 241.6g x 50 / 24000

So density of TeF6 = Mass / Volume
= (241.6g x 50 / 24000) / 50cm3
= 0.1007 g/cm3

h) Calculate how many times denser gas **A** is than oxygen gas at room temperature and pressure.

[1 mark]

NSAA 2019 Section 2 - Question C1 (h) - Worked Solution

Since a gas under the same temperature/pressure takes up the same volume per mole, the density is proportional to the molar mass.

Molar mass of oxygen: 16 x 2 = 32 Molar mass ofA: 127.6 + 19 x 6 = 241.6
241.6/32 = 7.55

In another experiment, 5.0 g of tellurium is oxidised and dissolved in water to form 9.0 g of an acid with general formula H_mTeO_n. On neutralisation with aqueous KOH, 18 g of a salt is formed with general formula K_mTeO_n.

i) Give an expression, in terms of m and n, for the oxidation state of the tellurium in the acid H_mTeO_n.

[1 mark]

NSAA 2019 Section 2 - Question C1 (i) - Worked Solution

The oxidation number of H is always +1 and oxidation number of O is - 2.

Let x be the oxidation number of Te. Then +m + x - 2n = 0

x = 2n - m

j) Calculate the relative molecular mass of the acid H_mTeO_n.

[1 mark]

NSAA 2019 Section 2 - Question C1 (j) - Worked Solution

The number of moles of Tellurium: 5/127.6 = 0.0391 mol

0.0391 mol of the acid is 9.0g. The molar mass must be 9.0 / 0.0391 = 229.68g

k) Calculate the values of m and n, and hence the formulae of the acid H_mTeO_n and the salt formed on neutralisation.

[2 marks]

NSAA 2019 Section 2 - Question C1 (k) - Worked Solution

The molar mass of the acid can be written as m + 127.6 + 16n = 229.68, using the results from the previous question.

m + 16n = 102.08. We must now find either m or n.

There are 0.0391 moles of the salt and the acid. Therefore the number of moles of the H and the K are 0.0391m moles.

This difference gives rise to 18 - 9 = 9g difference. In terms of moles, this is 9 / (RAM of K - RAM of H) = 0.236 mol

Therefore, 0.0391m = 0.236. Solving this gives that m = 6.

Using m + 16n = 102.08, we find that n = 6.

The formula of the salt must be K6TeO6

l) Calculate the volume of a 2.0 mol dm^{-3} aqueous solution of KOH that would be needed to neutralise the 9.0 g of acid formed from 5.0 g of tellurium.

[2 marks]

NSAA 2019 Section 2 - Question C1 (l) - Worked Solution

Notice that in the product salt, there is 6 x 0.0391 = 0.235 mol of K.

Therefore the volume needed is 0.235/ 2 = 0.117dm3

NSAA Section 2 2019 - Question C2

Question C2

Trifluoroethanoic acid, TFEA, is a carboxylic acid often used in organic chemistry and has the formula CF_3COOH. The density of TFEA is $1.489\,g\,cm^{-3}$.

a) Draw the structure for trifluoroethanoic acid (TFEA). Indicate on your structure the approximate bond angles around each carbon.

[2 marks]

NSAA 2019 Section 2 - Question C2 (a) - Worked Solution

Angles round CF3 C approx 109.5
Angles round carbonyl carbon approx 120

An aqueous solution of TFEA is made up by mixing 0.0700 mol of the pure acid with water and making the solution up to 100.0 cm^3.

b) Calculate the volume of pure TFEA needed to make the solution.

[3 marks]

NSAA 2019 Section 2 - Question C2 (b) - Worked Solution

Relative molecular mass of TFEA = 144
Mass needed = 0.07 x 114 = 7.98g
1.489g has a volume of 1cm^3
7.98/1.489 = 5.35 cm^3

c) Give an equation for the ionisation of TFEA in water.

[1 mark]

NSAA 2019 Section 2 - Question C2 (c) - Worked Solution

CF3COOH(aq) --> CF3COO^–(aq) + H+ (aq)
(reversible reaction)

d) Give an expression for the equilibrium constant for the ionisation of TFEA in water.

[2 marks]

NSAA 2019 Section 2 - Question C2 (d) - Worked Solution

Keq = [CF3COO^-] [H+] / [CF3COOH]

e) Given that the measured concentration of H^+ ions is $0.4119\,mol\,dm^{-3}$, calculate the value of the equilibrium constant. You may ignore the self-dissociation of water.

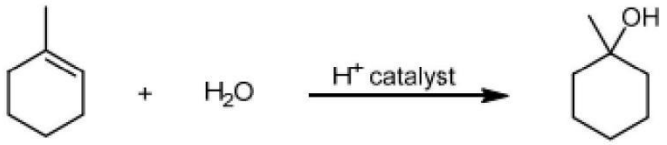
[3 marks]

NSAA 2019 Section 2 - Question C2 (e) - Worked Solution

[CF3COO^-] = [H+] = 0.4119 mol/dm^3
[CF3COOH] = 0.7 - 0.4119
= 0.2881 mol/dm^3
Keq= 0.4119^2/0.2881 = 0.589

A mixture of TFEA and trifluoroethanoic anhydride, $CF_3COOCOCF_3$, was used as the solvent system in a series of experiments to determine the standard enthalpy changes of hydration of various alkenes.

1-methylcyclohexene, **A**, may be hydrated in an acid-catalysed reaction as shown below:



A **B**

f) How may this reaction be classified? Choose from: *addition*, *elimination*, *substitution*, *oxidation*, *addition polymerisation*.

[1 mark]

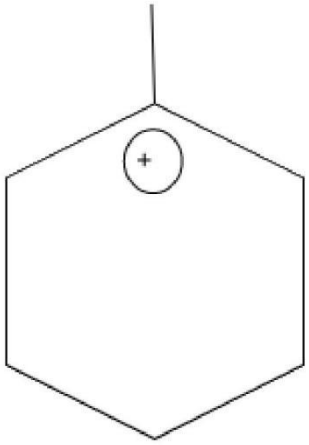
NSAA 2019 Section 2 - Question C2 (f) - Worked Solution

Addition reaction- which is a reaction in which one molecule ocmbines with another to form a larger molecule with no other products

g) Draw the structure of the intermediate initially formed when the H^+ catalyst reacts with alkene **A**.

[1 mark]

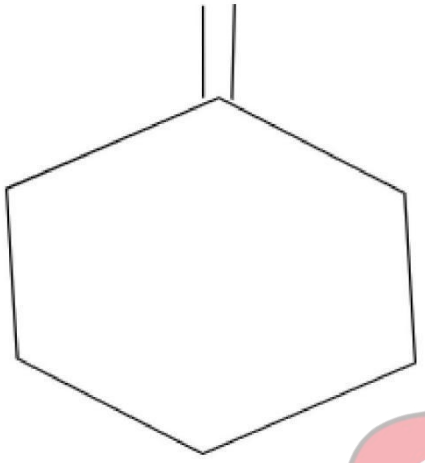
NSAA 2019 Section 2 - Question C2 (g) - Worked Solution



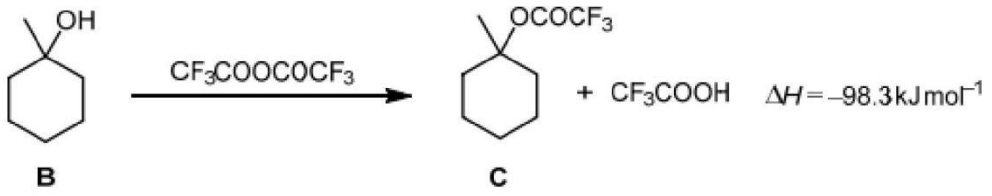
h) The same product **B** is formed when an alkene isomer of **A** is treated under identical conditions. Suggest a structure for this isomer.

[1 mark]

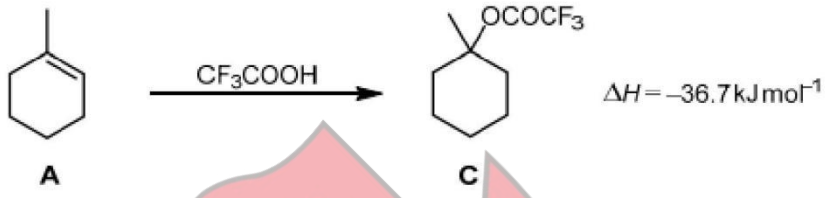
NSAA 2019 Section 2 - Question C2 (h) - Worked Solution



In a mixture of TFEA and trifluoroethanoic anhydride, **B** reacts with the trifluoroethanoic anhydride to form **C** and TFEA as shown below. The standard enthalpy change for this reaction is $-98.3\,kJ\,mol^{-1}$.



Compound **C** may also be formed in the same mixture of TFEA and trifluoroethanoic anhydride from the reaction between 1-methylcyclohexene and TFEA. The standard enthalpy change for this reaction is $-36.7\,kJ\,mol^{-1}$.

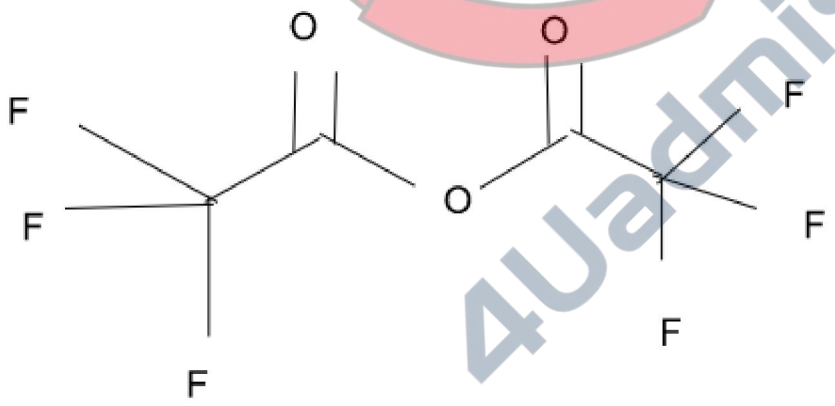


The standard enthalpy change for the reaction between one mole of water and one mole of trifluoroethanoic anhydride is $-75.6\,kJ\,mol^{-1}$.

i) Draw the structure of trifluoroethanoic anhydride.

[1 mark]

NSAA 2019 Section 2 - Question C2 (i) - Worked Solution



j) Give the equation for the reaction between one mole of water and one mole of trifluoroethanoic anhydride.

[1 mark]

NSAA 2019 Section 2 - Question C2 (j) - Worked Solution

$CF_3COOCOCF_3 + H_2O \rightarrow 2CF_3COOH$

k) By constructing an appropriate energy cycle, calculate the standard enthalpy change for the hydration of alkene **A**.

[4 marks]

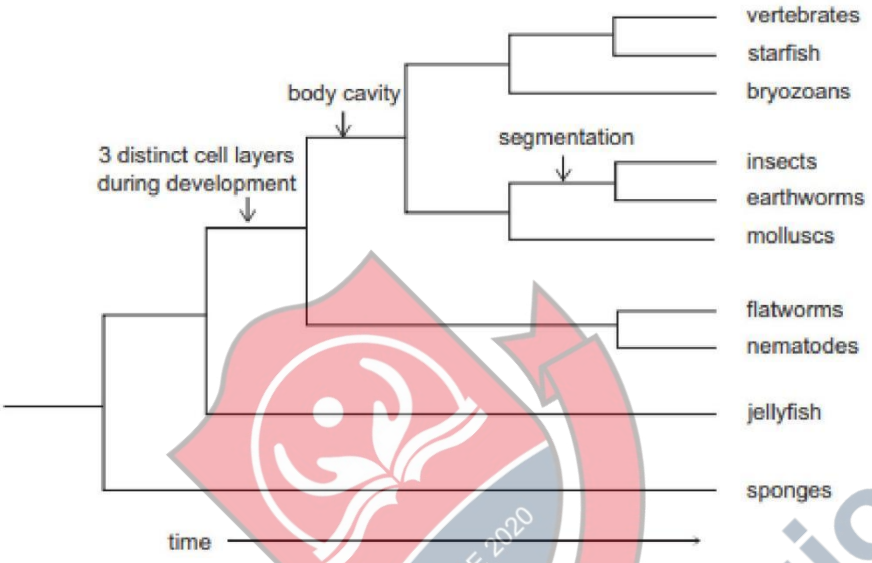
NSAA 2019 Section 2 - Question C2 (k) - Worked Solution

-36.7 -75.6 +98.3 = -14 kJ/mol

NSAA Section 2 2019 - Question B1

Question B1

The diagram shows an evolutionary tree for a kingdom of organisms. This tree was constructed over 20 years ago using shared observable features to group these organisms into smaller groups. The time at which three of these shared features first appeared is shown on the evolutionary tree. Each branching point in the tree indicates the time at which groups of organisms diverged from a common ancestor.



a) Identify the kingdom represented in this evolutionary tree.

[1 mark]

NSAA 2019 Section 2 - Question B1 (a) - Worked Solution

The kingdom is the second highest taxinomic rank, below domain. This kingdom is animalia

b) Recently, molecular evidence has changed our understanding of these relationships. Based upon each of the three findings below, what conclusions about evolution can you draw?

(i) Insects and earthworms are not closely related to each other.

[1 mark]

(ii) Nematodes and insects, both of which undergo moulting, are very closely related.

[2 marks]

(iii) Flatworms, which all lack a true body cavity, are not actually a single group. Some diverged at the base of the tree, some are related to the molluscs, and some are related to starfish and vertebrates.

[2 marks]

NSAA 2019 Section 2 - Question B1 (b) - Worked Solution

i) Segmentation, as shown in the evolutionary tree, is not a good indicator of relatedness. This must have evolved independently or ancestrally.
ii) Moulting arose in a common ancestor of nematodes and insects, and indicates that they are related. It highlights that the evolutionally tree is incorrect.
iii) Abscence of a body cavity is not a good indicator of relatedness. The loss of a body cavity must have happened independently in flatworms, or the body cavity arose on many seperate occasions

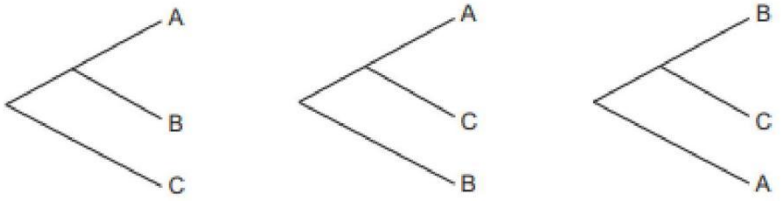
c) Briefly describe two benefits of using molecular evidence, rather than visible characteristics, to construct trees.

[2 marks]

NSAA 2019 Section 2 - Question B1 (c) - Worked Solution

The same morphological traits can arise from multiple evolutionary lineages, genetics provides much more information with less convergence

d) The following three tree diagrams show **all** of the possible relationships between 3 different organisms.

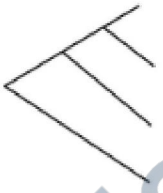


How many possible tree diagrams are there with 4 organisms?

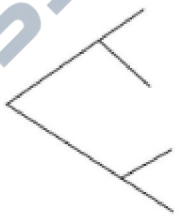
[2 marks]

NSAA 2019 Section 2 - Question B1 (d) - Worked Solution

There are 15 trees, 12 with branching patterns of:



There are a further 3 with a different branching pattern:



e) Using examples, discuss the different ways by which we can measure biodiversity.

[10 marks]

NSAA 2019 Section 2 - Question B1 (e) - Worked Solution

Biodiversity describes the variety and complexity of living organisms. This can be measured at a genetic, population or habitat level.

Genetic biodiversity: total variation in the genetics of a species.
Genetic variation arises from mutations and genetic recombination (when genetic material is rearranged as a cell prepares to divide).
These genetic variations can alter gene activity or protein function, that can lead to altered traits in an organism, if these are beneficial they aid survival and reproduction leading to natural selection.
Measuring genetic diversity: genotype or genome based measures, using differences in the base sequence of DNA or in the amino acid sequence of proteins

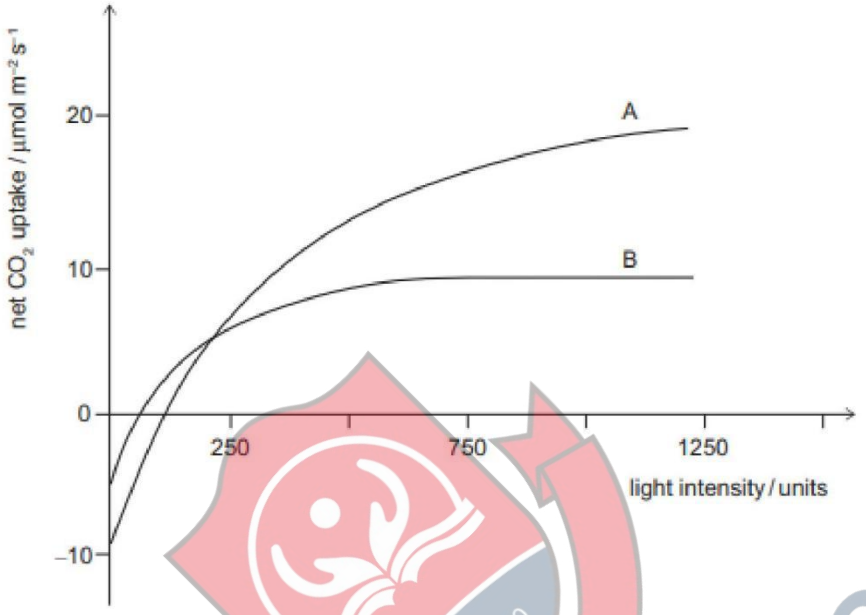
Species biodiversity: the variation in the number and type of different species.
A species is a group of organisms that can reproduce naturally with one another to produce fertile offspring.
Species richness is the total number of distinct species within a community.
Measuring species biodiversity: Quadrats can be used to sample species diversity in order to estimate total diversity within a habitat.
A belt transect can be used to investigate changes in species diversity across a habitat. This method uses quadrat sampling along a line extending from one side of the habitat to another.

Habitat diversity: measure of the different types of ecosystems

NSAA Section 2 2019 - Question B2

Question B2

The graph shows net CO_2 uptake of two different plants, A and B, when exposed to increasing light levels.



a) Name two physiological processes that affect the net CO_2 uptake in plants.

[1 mark]

NSAA 2019 Section 2 - Question B2 (a) - Worked Solution

Photosynthesis and respiration

b) State what can be concluded when the net CO_2 uptake in each plant is zero.

[1 mark]

NSAA 2019 Section 2 - Question B2 (b) - Worked Solution

The rate of photosynthesis equals the rate of respiration

c) For plant B, estimate the value at which increasing light intensity no longer affects CO_2 uptake.

[1 mark]

NSAA 2019 Section 2 - Question B2 (c) - Worked Solution

Estimate where line B becomes horizontal: 650-700

d) Estimate the number of micromoles of CO_2 that would be taken up by a 50 cm^2 leaf of plant B in one minute at light intensity of 750 units.

[2 marks]

NSAA 2019 Section 2 - Question B2 (d) - Worked Solution

50cm^ = 0.005m^2
9 µmol m^-2 s^-2 x 0.005m^2 x 60 s =2.7µmol

e) Propose two explanations for the existence of a plateau in the curve for plant B.

[2 marks]

NSAA 2019 Section 2 - Question B2 (e) - Worked Solution

Increasing light intensity increases the rate of photosynthesis until another factor becomes limiting, these factors may be temperature, CO_2 levels, or enzymatic activity

f) Describe the differences in the curves for plants A and B and suggest why these differences might occur.

[3 marks]

NSAA 2019 Section 2 - Question B2 (f) - Worked Solution

Plant B has a higher CO_2 uptake at lower light intensities, and reaches a lower plateau than plant A. This suggests that plant B is adapted to living in low light conditions

g) Discuss how temperature might affect net CO_2 uptake in plants, with reference to the effects of temperature on enzymatic activity. Use graphs to illustrate your answer.

[10 marks]

NSAA 2019 Section 2 - Question B2 (g) - Worked Solution

CO2 uptake depends on the relative rates of photosynthesis and respiration
Temperature affects the rate of any reaction, at lower temperatures there are slower molecular collisions between the enzyme and substrate while at higher temperatures enzymes may become denatured. High temperatures disrupt the shape of the active site which can reduce activity or prevent it from working
The effect of temperature on these reactions also depends on other limiting factos, for example if CO2 is limiting the rate of photosynthesis, increasing the temperature will not increase the rate of reaction.