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Support Pack | Grade 12

CAPS

Physical Sciences

Matter and materials

This support pack for the **Matter and materials** module in the **Physical Sciences Grade 12 CAPS curriculum** provides valuable practice exercises. All questions have the answers provided. Learners can work through these individually at home or these could form the basis of a catch-up class or online lesson. You have permission to print or photocopy this document or distribute it electronically via email or WhatsApp.

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Revision exercises for Matter and materials

Take the speed of light in air to be 3×10^8 m·s^{-1}.

Question 1

Define the following terms, using the formula for ethane as an example:

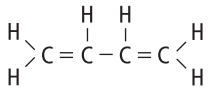
a) molecular formula
b) general formula
c) structural formula.

Question 2

The distinctive group of atoms attached to a carbon chain, which all the members of the homologous series have in common, is called the _____.

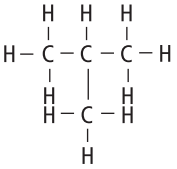
Question 3

Give the IUPAC name for the following compound:



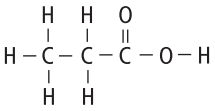
Question 4

Give the IUPAC name for the following compound:



Question 5

Give the IUPAC name for the following compound:



Question 6

Give the structural formula for the compound 2,3-dimethylpentane.

Question 7

Consider the following table of boiling points of alkanes:

Alkane	Boiling point (°C)
Propane	–42
Methylpropane	–12
Butane	0

a) Explain the difference between the boiling points of propane and butane.
b) Explain the difference between the boiling points of methylpropane and butane.

Question 8

When hydrogen gas and unsaturated vegetable oil are passed over a finely divided Pt catalyst, a reaction takes place.

a) What is this reaction called?
b) How is this reaction used in industry?

Question 9

Answer the following questions on alcohols.

a) Give the name of the functional group of alcohols.
b) Give the general formula of alcohols that contain one functional group.
c) Give the name of the alcohol that contains six carbon atoms.
d) Ethanol can be obtained from plant material.
   i) What is this process called?
   ii) Name the inorganic product formed during this process.
e) The boiling points of ethane and ethanol are –89 °C and 78 °C, respectively. Explain the difference in boiling points.

Question 10

Answer the following questions on organic acids.

a) Which acid is responsible for the sour taste of vinegar?
b) Butanoic acid can be found in rancid butter. Give the structural formula of butanoic acid.
c) Butanoic acid can react with methanol in the presence of concentrated sulfuric acid.
   i) Give the IUPAC name of the organic product of this reaction.
   ii) Name the inorganic product of the reaction.

Question 11

Halogenation is used to distinguish between an alkene and an alkane. Describe the method that you would use to carry out this test.

Question 12

When a 1,2-dichloropropane/ethanol mixture is reacted with KOH, a substitution reaction takes place. Write a balanced equation for this reaction by using structural formulae and give the IUPAC names of the organic compounds.

Question 13

a) Draw the structural formulae for 1,5-pentandiol and 1,3-propandioic acid.
b) A polyester molecule can be made from these two monomers.
   i) Draw the repeat unit of this polyester molecule.
   ii) Is this an addition or condensation polymerisation?

Question 14

Explain what is meant by the following terms:

a) photoelectric effect
b) cut-off frequency
c) line emission spectrum.

Question 15

Yellow light with a wavelength of 580 nm strikes the surface of a metal with a work function of $3{,}3 \times 10^{-19}$ J.

a) How much energy is in one photon of this light?
b) Consider an electron released from the surface of the metal.
   i) What is the maximum kinetic energy of this electron?
   ii) Will this kinetic energy increase or decrease if red light is used instead? Explain.

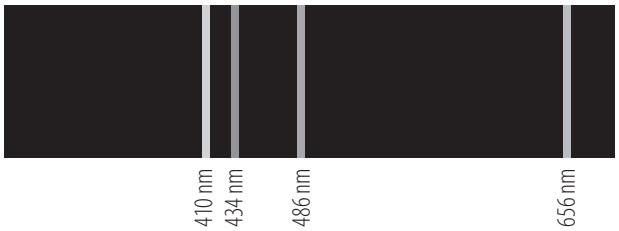
Question 16

When light with a frequency of $8{,}9 \times 10^{14}$ Hz strikes the surface of a metal, electrons are ejected with a maximum speed of $5{,}6 \times 10^{5}$ m·s^{-1}.

a) Taking the mass of an electron to be $9{,}1 \times 10^{-31}$ kg, determine the maximum kinetic energy of an ejected electron.
b) Determine the work function of the metal.
c) Calculate the cut-off wavelength for the metal.

Question 17

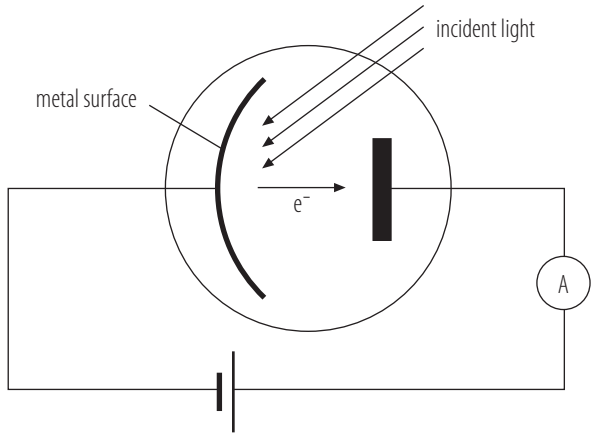
The following diagram is the visible part of the spectrum of hydrogen when its atom makes transitions from the third, fourth, fifth and sixth energy levels to the second energy level. (See the full hydrogen spectrum in colour on the inside front cover.)



a) Is this an emission or absorption spectrum?
b) Which wavelength corresponds to an atomic transition from the sixth energy level to the second energy level?
c) Calculate the energy difference between the second energy level and the third level.

Question 18

The diagram below shows light being radiated on the cathode of a photoelectric cell.



The frequency of the light incident on the cell is $4{,}2 \times 10^{15}$ Hz and the minimum energy required to remove electrons from the surface of the cathode of the cell is $7{,}1 \times 10^{-19}$ J.

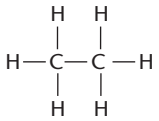
a) What is the work function of the metal making up the cathode of the cell?
b) Calculate the maximum kinetic energy of the electrons ejected from the cathode.
c) Will the reading on the ammeter increase, decrease or remain the same if:
   i) the brightness of the radiated light were increased?
   ii) the radiated light were replaced by light of a higher frequency?
   iii) the polarity of the battery were reversed?

Memorandum for revision exercises

1 a) A molecular formula shows the number of atoms of each element present in the molecule, e.g. the molecular formula of ethane is C_2H_6.

b) A general formula is used to represent a homologous series, which is a family of organic molecules all having the same functional group, e.g. ethane belongs to the family having the general formula C_nH_{2n+2}.

c) A structural formula shows all the atoms and bonds in the molecule, e.g. the structural formula of ethane is:



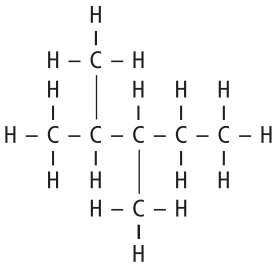
2 functional group

3 but-1,3-diene

4 2-methylpropane

5 propanoic acid

6



7 a) Butane has a larger molecular mass than propane, since it has more carbon and hydrogen atoms. Hence the intermolecular forces are stronger in butane than in propane, leading to a higher boiling point.

b) Although butane and methylpropane have the same molecular mass, butane is a straight-chain molecule, while methylpropane is a branched-chain molecule. The intermolecular forces are stronger in a straight-chain molecule compared to a branched-chain molecule, leading to a higher boiling point.

8 a) hydrogenation

b) It is used in the manufacture of margarine.

9 a) hydroxyl group

b) R–O–H ($C_nH_{2n+1}OH$)

c) hexanol

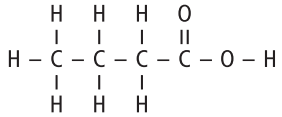
d) i) fermentation

ii) carbon dioxide

e) The forces that hold ethane molecules together are weak van der Waals forces, while strong hydrogen bonding occurs between the molecules of ethanol. Since the intermolecular forces are stronger in ethanol than in ethane, ethanol has a higher boiling point.

10 a) ethanoic acid

b)

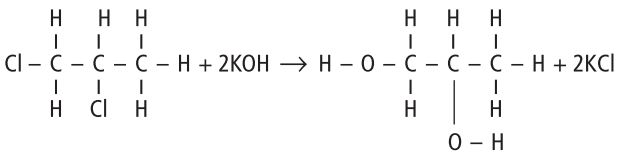


c) i) methyl butanoate

ii) water

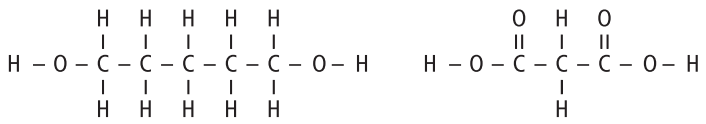
11 A halogen, such as bromine solution, is added to two test tubes: one containing a solution of an alkene and another containing a solution of an alkane. The test tube containing the solution of the alkene will rapidly decolourise, while there will be no reaction in the other test tube.

12



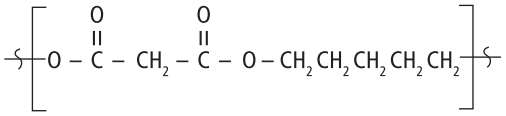
propan-1,2-diol

13 a)



1,5-pentandiol 1,3-propandioic acid

b i)



ii) condensation

14 a) The photoelectric effect is the emission of electrons from the surface of a material when light of a certain frequency strikes the surface.

b) The cut-off frequency of a metal is the minimum frequency of light that is required to remove an electron from the surface of that metal.

c) A line emission spectrum is the spectrum given out by a low pressure gas when it is heated.

15 a) $3{,}43 \times 10^{-19}$ J

b) i) $1{,}3 \times 10^{-20}$ J

ii) Decrease, since red light has a lower frequency than yellow light and hence its photons will carry less energy.

16 a) $1{,}43 \times 10^{-19}$ J

b) $4{,}47 \times 10^{-19}$ J

c) $4{,}45 \times 10^{-7}$ m

17 a) emission

b) 410 nm

c) $3{,}03 \times 10^{-19}$ J

18 a) $7{,}1 \times 10^{-19}$ J

b) $2{,}071 \times 10^{-18}$ J

c) i) Increase, because brighter light will have more photons and hence eject more photoelectrons.

ii) Remain the same, because increasing the frequency only increases the kinetic energy of the photoelectrons, but not the number of photoelectrons.

iii) Decrease, because the ejected electrons from the surface of the metal will be repelled by the negative electrode.