



ALEXANDER ROAD HIGH SCHOOL

JUNE 2015

2,5 HOURS

PHYSICAL SCIENCE

MH, CO, KB

TOTAL = 150

GRADE 11

Instructions

- The question paper consists of 12 questions.
 - Answer all the questions.
 - Answer section A on the answer sheet provided.
 - Answer section B on the folio sheets provided.
 - A non-programmable calculator may be used.
 - Number the answers correctly according to the numbering system used on this question paper.
 - A list of formulas and relevant constants can be found on the last page of this question paper.
 - A periodic table can be found on the back of the answer sheet.
 - Round off to two (2) decimal places unless otherwise stated.
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SECTION A

- Answer on the answer sheet -

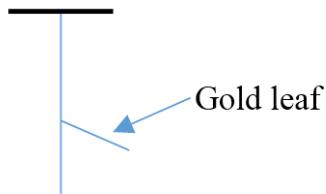
QUESTION 1 Multiple choice:

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (1.1 – 1.10) on the attached ANSWER SHEET.

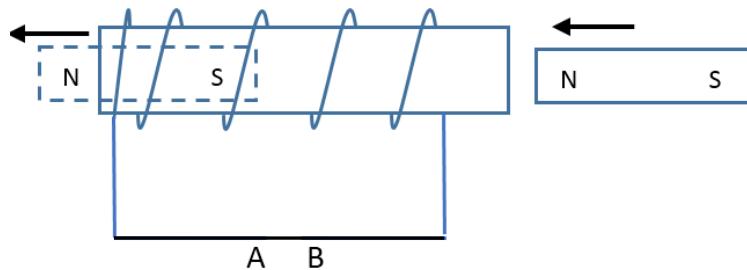
1.1 *The pressure on an enclosed gas is directly proportional to the temperature if the volume remains constant.* This is the law of:

- A Gay-Lussac
- B Boyle
- C Charles
- D Pascal

- 1.2 A positively charged electroscope with gold leaf repelled is approached with a negatively charged ruler. What will happen to the gold leaf?



- A remain as it is
 - B repelled further upwards
 - C lower a little bit
 - D drop to the rest position
- 1.3 The following sketch shows a coil and a magnet that is pushed into the coil and coming out the other side.



What would be the current direction(s) in the circuit (not around the coil) while the magnet moves through the coil?

- A A to B
- B B to A
- C A to B for 1st half of magnet's movement and then B to A for the latter part
- D B to A for 1st half of magnet's movement and then A to B for the latter part

- 1.4 Two forces, \vec{X} and \vec{Y} , act at a point O. The angle between them is α . For which value of α will their resultant be the greatest?
- A 0°
 - B 45°
 - C 90°
 - D 180°
- 1.5 The mass and radius of the moon are less than the mass and radius of the earth. If an object is taken from the earth to the moon, the acceleration due to gravity it experiences on the surface of the moon is less than that which it experiences on the surface of the earth. Which one of the following statements explains this phenomenon?
- A The object is far from the earth.
 - B There is no atmosphere on the moon.
 - C The radius of the moon is less than that of the earth.
 - D The mass of the moon is less than that of the earth.
- 1.6 Which of the following represents 1 mole? The number of
- A molecules in 22.4 dm^3 of water at STP
 - B atoms in $6.02 \times 10^{23} \text{ g}$ of sodium
 - C protons in 1g hydrogen gas
 - D molecules in 34g of ammonia gas
- 1.7 A mole of oxide ions (O^{2-}) has a mass (in grams) of:
- A 32
 - B 16
 - C 8
 - D 4

- 1.8 Determine the refractive index of quartz if the speed of light in quartz is $2.05 \times 10^8 \text{ m.s}^{-1}$
- A 1,50
 - B 1,54
 - C 1,48
 - D 1,46
- 1.9 Which one of the following has the highest bond energy?
- A F_2
 - B Cl_2
 - C Br_2
 - D I_2
- 1.10 Arrange the following in order of increasing boiling points.
- A $\text{HBr}, \text{H}_2\text{O}, \text{BF}_3$
 - B $\text{HBr}, \text{BF}_3, \text{H}_2\text{O}$
 - C $\text{H}_2\text{O}, \text{HBr}, \text{BF}_3$
 - D $\text{BF}_3, \text{HBr}, \text{H}_2\text{O}$

[2 X 10 = 20]

SECTION B

- Answer all questions on the folio pages provided -

QUESTION 2

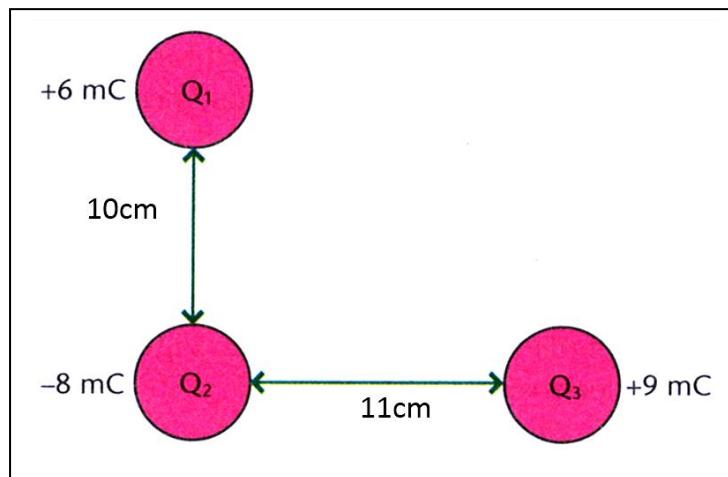
- 2.1 Define electric field strength. (2)
- 2.2.1 Two charges, Q_1 of $-2,1 \text{ mC}$ and Q_2 of $+6,3 \text{ mC}$, are separated by a distance of 80 mm. What is the electric field strength at point X, which is 20 mm from Q_1 and 60mm from Q_2 ?



(5)

- 2.2.2 Draw a sketch to show the Electric field pattern between the charges. (3)

- 2.3 Consider the following charges situated close to each other, perpendicularly to each other, orientated as shown below.



- 2.3.1 Draw a labelled free body diagram of the forces acting on Q_2 as a result of the other 2 charges. (2)
- 2.3.2 Hence, if the force between Q_1 and Q_2 is given as $4,32 \times 10^7$ N, calculate the **magnitude** of the resultant force on Q_2 as a result of both charges Q_1 and Q_3 which are 10 cm and 11 cm from Q_2 respectively. (5)
- 2.3.3 Draw a labelled free body diagram to show the forces acting on Q_1 as a result of the other 2 charges. (2)

[19]

QUESTION 3

- 3.1 State Faraday's law. (2)
- 3.2 A circular coil with radius 5cm, containing 100 windings, is placed inside a constant magnetic field of 0,2 T. The coil gets rotated in this magnetic field, with the plane of the coil initially perpendicular to the field, and then turned 90° clockwise. Calculate the initial flux through the coil. (3)
- 3.2.1 **Name and state** the law that can be used to determine the induced current direction in the coil. (2)
- 3.2.2 Now calculate the magnitude of the induced emf in the coil in 0,2 seconds. (3)

[10]

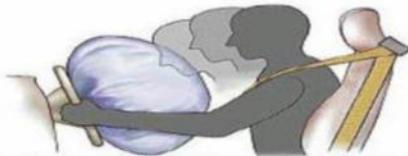
QUESTION 4:

- 4.1 Name any two differences between real and ideal gases (2)
- 4.2.1 The pressure on a gas can be changed by changing two other quantities. Name these quantities. (2)
- 4.2.2 Explain in terms of the kinetic model of gases why the pressure on the gas changes because of one of your answers in 4.2.1. (3)
- 4.3 If the pressure on a gas is 3 kPa, and the volume of the gas is doubled, the temperature on the gas is dropped to a third of the original temperature, calculate the new pressure of the gas. (3)
- 4.4 What volume of gas is occupied at $1,5 \times 10^2$ kPa and 47°C by 5,2g of C₂H₂ gas? (5)

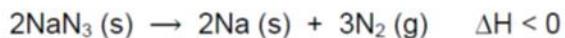
[15]

QUESTION 5

Since the introduction of airbags in the 1980s, many lives have been saved in motor vehicle accidents. Most modern cars are equipped with airbags for the driver and the front passenger. It takes about 30–40 milliseconds for an air bag to deploy (that is faster than you can blink!), while a typical car collision lasts for about 0,125 s.



During a collision, an electrical signal is sent to a sodium azide capsule (found inside the air bag) which decomposes rapidly to generate a large amount of nitrogen gas according to the following reaction:

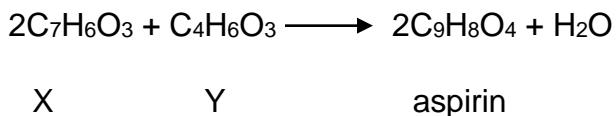


- 5.1 The volume of the airbag is 4 500 cm³. At STP, what mass of sodium azide needs to be packed into the airbag to fully inflate the airbag? The percentage yield of the reaction is 85%. (10)
- 5.2 Do you have any environmental concerns with the reaction? Motivate your answer. (2)

[12]

QUESTION 6

The chemical reaction for the production of the drug, aspirin, from two compounds, X, and Y, is represented by the balanced equation below:



A chemist reacts 14g of compound X with 10g of compound Y.

- 6.1 Define the term *limiting reactant* in a chemical reaction. (2)
- 6.2 Determine which one of compound X or compound Y is in excess. Calculate to 3 decimals. (5)
- 6.3 Calculate the mass of the compound that is in excess after the reaction has taken place. Assume a 100% yield. (3)

[10]

QUESTION 7

Nicotine is the substance found in cigarettes that makes smoking so addictive. The percentage composition of nicotine is 74,07% carbon, 8,65% hydrogen and 17,28% nitrogen.

- 7.1 Determine the empirical formula for nicotine. (5)
- 7.2 The molecular mass of nicotine is 162.2 g.mol^{-1} . Determine the molecular formula. (2)

[7]

QUESTION 8

- 8.1 State Newton's Law of Universal Gravitation. (3)
- 8.2 Use Newton's Law of Universal Gravitation to determine the magnitude of the acceleration due to gravity on the moon.

Mass of the moon: $7,40 \times 10^{22} \text{ kg}$

Radius of the moon: $1,74 \times 10^6 \text{ m}$ (5)

[8]

QUESTION 9

Draw diagrams to represent each of the following vector equations in order to show their meaning clearly:

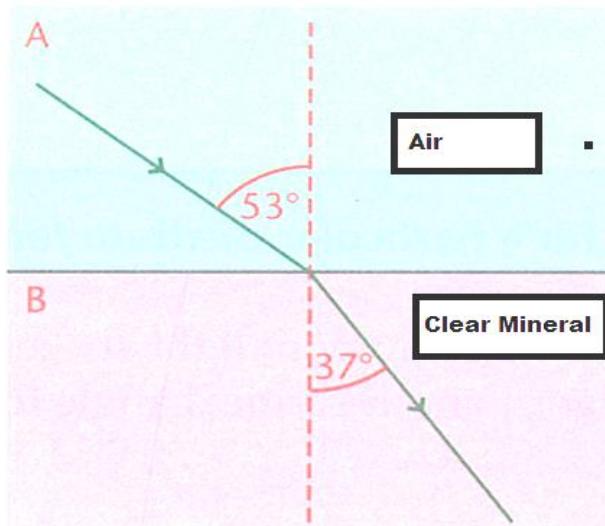
9.1 $\vec{a} + \vec{b} = \vec{c}$ (2)

9.2 $\vec{a} + \vec{b} + \vec{c} = 0$ (3)

[5]

QUESTION 10

- 10.1 A ray of light travels from air ($n = 1$) into an unknown clear mineral. The light ray in air strikes the unknown clear mineral at an angle of incidence of 53° . If the angle of refraction is 37° , calculate:



- 10.1.1 The refractive index of the unknown clear mineral. (4)

- 10.1.2 The speed of light in the unknown clear mineral. (3)

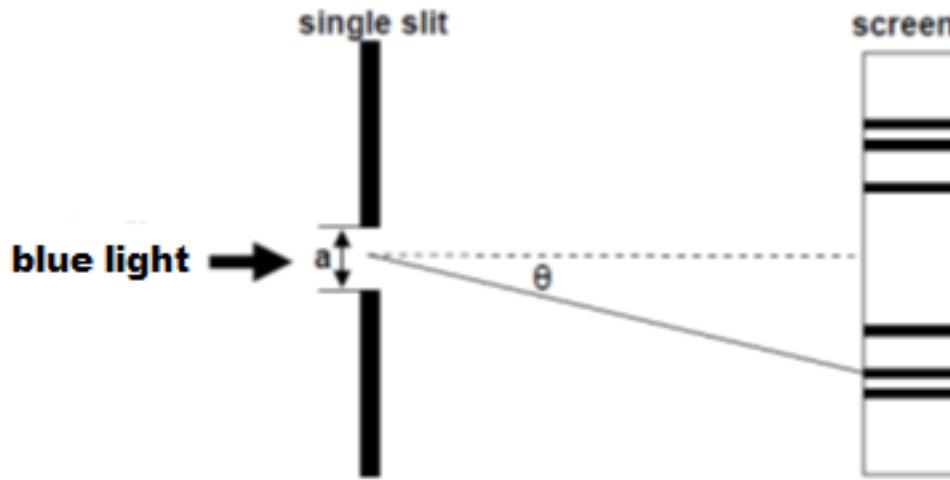
- 10.2 Give two conditions necessary for total internal reflection to occur. (2)

- 10.3 Light travelling from glass ($n = 1.52$) to air, strikes the boundary with an angle of incidence of 52° .

- 10.3.1 Calculate the critical angle for glass. (4)

- 10.3.2 Will the light ray be totally internally reflected? Explain your answer. (2)

- 10.4 A learner investigates the change in broadness of the central bright band in a diffraction pattern when light passes through a single slit of different widths. She uses blue light of wavelength $5 \times 10^{-7}\text{m}$. The apparatus is set up as shown in the diagram below.



10.4.1 Name TWO variables that are kept constant during this investigation. (2)

10.4.2 What is the relationship between the amount of diffraction and the width of the aperture? (2)

10.4.3 The learner now uses a narrower slit.

How will the broadness of the central band change? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give an explanation. (2)

10.4.4 How would the diffraction pattern change if the learner replaces the single slit with a double slit. (2)

[23]

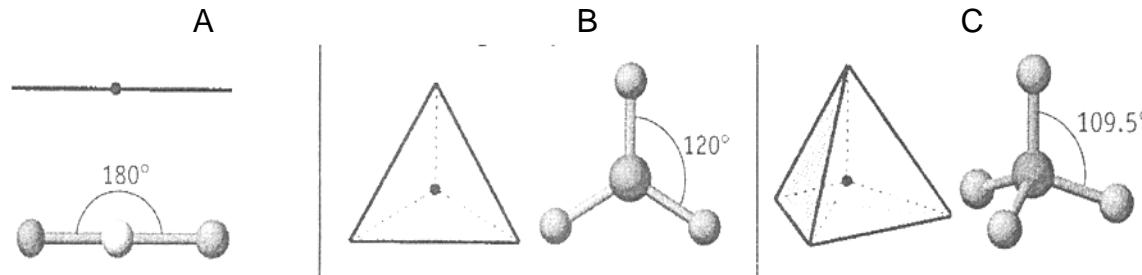
QUESTION 11

11.1 Draw the Lewis structure of BF_3 . (2)

11.2 Using a sketch, indicate whether the BF_3 molecule is polar or non-polar? (2)

11.3 Explain why the NH_3 molecule has a different shape to the BF_3 molecule. (2)

11.4 Give the names of the molecule shapes labelled A, B and C. (3)



[9]

QUESTION 12

12.1 From the list below, state which intermolecular forces exist in each of the following substances .

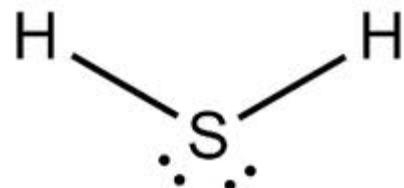
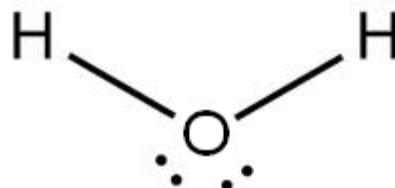
Dipole-dipole, ion-dipole, London forces, hydrogen bond

- a) Ne
- b) HBr
- c) HF

(3)

12.2 A learner has two bottles of clear solutions, but has lost the labels for the bottles. He knows one is NH_3 and the other is BF_3 . Using iodine crystals he was able to determine which bottle was which. Using your knowledge of intermolecular forces, explain how he was able to tell the difference between the two solutions. (5)

12.3 Consider the following two molecules. H_2O and H_2S have the **same shape** and they are **both polar** molecules, however, H_2O has a boiling point of almost 100°C and H_2S has a boiling point of -60°C . Using intermolecular forces, explain why this is the case.



(4)
[12]

TOTAL: 150 MARKS