ALEXANDER ROAD HIGH SCHOOL

JUNE 2017 3 HOUR

PHYSICAL SCIENCES MID-YEAR EXAMINATION

CO, KB, MH TOTAL = 150

GRADE 11

Instructions

- The question paper consists of 12 questions.
- Answer all the questions.
- Answer section A on the answer sheet provided AND section B on folio sheets.
- Rule off after each question in Section B.
- A non-programmable calculator may be used.
- Number the answers correctly according to the numbering system.
- Round off to two (2) decimal places where necessary.
- Formulas have been included at the end of the question paper, and a periodic table on the back of the answer sheet.

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 1 correct answer. Choose the correct answer and write the letter (A – D) next to the relevant question number (1.1 – 1.6) on the answer sheet.

1.1 1. A difference/similarity between acid-base reactions and redox reactions is that …

A electrons are transferred in both, but protons also move from the acid to base

B electrons move in redox, but protons move in acid-base

C both involve ion-electron method and proton transfer

D electrons are transferred in acid-base, and protons are transferred in redox

1.2 The forces that two charges, Q and 3Q, exert on each other, have the following relationship between them:

A $F_{Q\ on\ 3Q} = \frac{1}{3} \times F_{3Q\ on\ Q}$

B $F_{Q\ on\ 3Q} = 3 \times F_{3Q\ on\ Q}$

C $3 \times F_{Q\ on\ 3Q} = F_{3Q\ on\ Q}$

D $F_{Q\ on\ 3Q} = F_{3Q\ on\ Q}$

1.3 Which law/rule applies when the current direction around a solenoid must be determined?

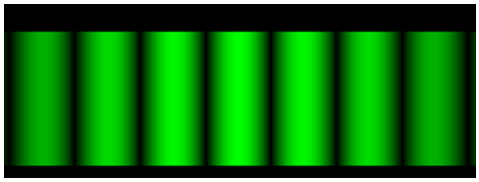
A Conventional current law

B Right hand rule

C Right hand solenoid rule

D Lenz's law

1.4 The following pattern is an example of which characteristic of light?



A Single slit refraction of light

B Double slit refraction of light

C Single slit diffraction of light

D Double slit diffraction of light

1.5 Boyle and Gay-Lussac investigated the following relationships:

	Boyle	**Gay-Lussac**
A	$p \alpha V$	$T \alpha P$
B	$T \alpha {}^{1}/_{P}$	$p \alpha V$
C	$T \alpha P$	$p \alpha {}^{1}/_{V}$
D	$p \alpha {}^{1}/_{V}$	$T \alpha P$

1.6 Which ONE of the following species contains a dative covalent bond?

A ammonia

B nitrogen molecule

C ammonium

D methane

1.7 According to the VSEPR theory, the shape of a BCl3 molecule is …

A trigonal bipyramidal

B octahedral

C trigonal pyramidal

D trigonal planer

1.8 A person is standing in a lift on the 40th floor drinking coffee. The cable holding the lift snaps and the lift free-falls to the ground. The moment the cable snaps, the person lets go of the cup of coffee. Which ONE of the following is true?

A The person falls faster than the coffee.

B The coffee falls faster than the person.

C They fall at the same rate.

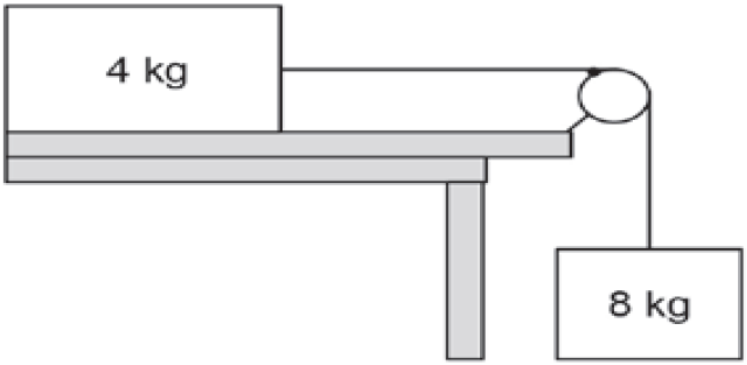
D Not enough information is given to decide which one falls faster.

[2 x 8 = 16]

SECTION B: PHYSICS

QUESTION 2

A 4 kg block on a horizontal, rough surface is connected to an 8 kg block by a light, inelastic string that passes over a frictionless pulley as show below. The system is in equilibrium.



2.1 What is meant by the term *equilibrium*? (1)

2.2 Draw a free-body diagram showing the forces acting on the 4 kg block. (4)

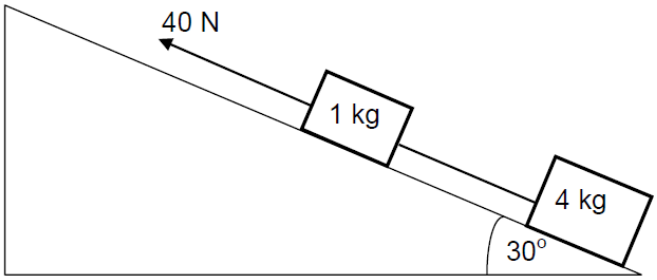
2.3 What is the maximum static friction experience by the 4 kg block? (5)

[10]

QUESTION 3

A block of mass 1 kg is connected to another block of mass 4 kg by a light inextensible string. The system is pulled up a rough plane, inclined at 30° to the horizontal, by means of a constant 40 N force parallel to the plane as shown in the diagram below.

The magnitude of the kinetic frictional force between the surface and the 4 kg block is 10 N and between the surface and the 1 kg block it is 2,5 N.



3.1 State Newton's second law in words. (2)

3.2 Draw a labelled free-body diagram showing ALL the forces acting on the 1 kg block. (5)

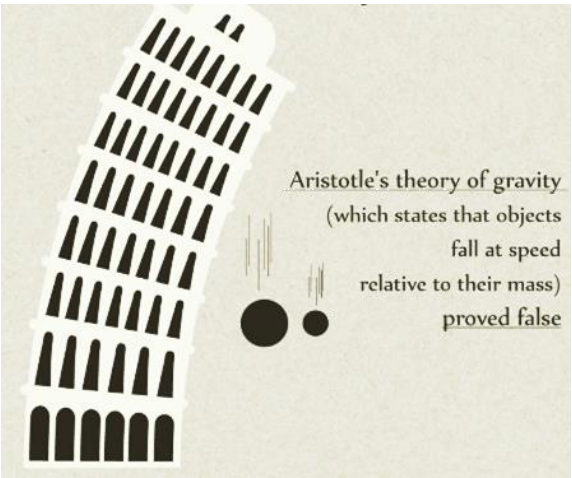
3.3 Calculate the magnitude of the tension in the string connecting the two blocks. (5)

[12]

QUESTION 4

4.1 State Newton's law of gravitation. (3)

4.2 If the force between two masses is 5N, and the masses are moved 2,25 times further apart, and the one mass is halved, what is the new force between the masses? (4)

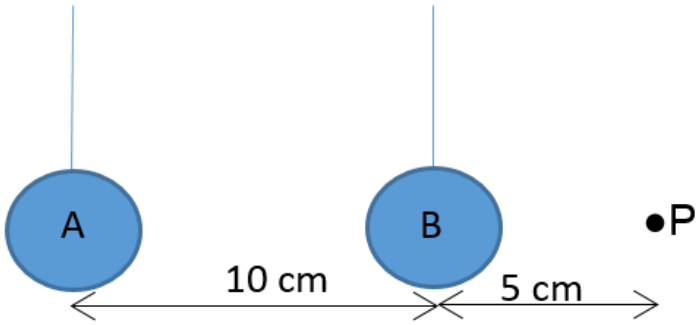


4.3 Explain, by using formulas and mathematical reasoning, why two round metal balls with different masses, will hit the ground simultaneously when released at the same time, as proved by Galileo Galilei (1562–1642), i.e. they will have the same acceleration, irrespective of their masses. Ignore air resistance. (3)

[10]

QUESTION 5

5.1.1 Two charged balloons, A and B, with opposite charges, touch each other and then they are separated to a distance of 10 cm between their centres.



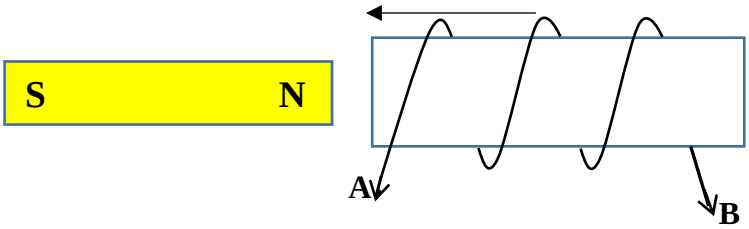
The charge on both balloons after they are separated is 5 μC, and 5×10^{13} electrons moved over from balloon B to A when they touched. Calculate the charge that balloon A had BEFORE they touched. (3)

5.1.2 Draw the field pattern that exists between the two charged balloons AFTER they were separated. (3)

5.1.3 Calculate the net electric field strength at a point, P, that is 5 cm to the right, from the centre of balloon B (after they were separated). (5)

5.2.1 State Faraday's law. (2)

5.2.2 A circular coil (radius 0,1m) with 3 windings is moved over the north pole of a 2 Tesla magnet. What is the direction of the induced conventional current? Only write down the letter (A or B) of the correct current direction. (1)



5.2.3 Calculate the induced emf in the coil, if the field changes from 0 T to 2 T. (3)

[17]

QUESTION 6

A ray of light travels from air (n =1) into a block of Tanzanite. The light ray in air strikes a block of Tanzanite at an angle of incidence of 25°. If the angle of refraction is $14{,}3^{\circ}$, calculate:

6.1 The refractive index of the block of Tanzanite. (4)

6.2 The speed of light in Tanzanite. (3)

6.3 Sketch the path of the light ray as it passes from air into Tanzanite. (make sure to indicate the angle of incidence and refraction as well as refractive index) (4)

The light ray now travels out of the block (from Tanzanite to Air).

6.4 Calculate the critical angle for Tanzanite, if the light ray is travelling from Tanzanite to air. (4)

Light travelling from Tanzanite to air, strikes the boundary with an angle of incidence of 40°.

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

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

[19]

QUESTION 7

7.1 Consider the following equation: $\text{diffraction} \propto \frac{\lambda}{w}$

Using the equation, explain the relationship between:

7.1.1 Diffraction and width of the aperture (2)

7.1.2 Diffraction and wavelength (2)

7.2 Green light is shone through a single slit and creates a diffraction pattern on a white screen directly behind it.

How would the diffraction pattern be affected if:

7.2.1 The width of the aperture is decreased? Explain. (3)

7.2.2 Orange light is used instead of green light? Explain. (3)

7.3 What causes the bright and dark bands observed in the diffraction pattern when light is shone through a narrow single slit? (2)

[12]

SECTION C: CHEMISTRY

8.1 Define an acid according to Arrhenius. (2)

8.2 In the following reactions, use the Lowry-Bronsted theory to identify ONE conjugate acid-base pair, not involving H_2O:

8.2.1 $NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$ (1)

8.2.2 $H_2PO_4^- + H_3O^+ \longrightarrow H_2O + H_3PO_4$ (1)

8.3.1 Which one of the substances in 8.2.2 above, can act as an ampholyte (not H_2O)? (1)

8.3.2 What is an ampholyte? (1)

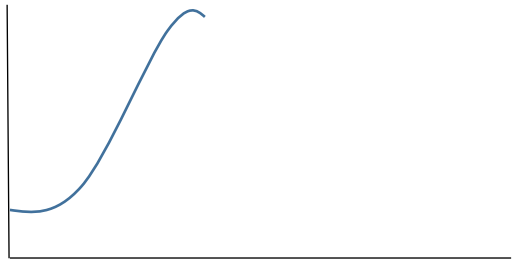
8.3.3 NAME the substance that is diprotic. (1)

8.4. Balance the following reaction by using the ion-electron method:

$$SO_2 + MnO_4^- + H_2O \longrightarrow SO_4^{2-} + Mn^{2+} + H^+$$ (5)

8.4.2 Given the NAMES or FORMULAS of the reducing agent AND the oxidising agent. (2)

8.5.1 Redraw the following energy change graph, and complete it for an exothermic reaction.



(2)

8.5.2 In another experiment, the energy detail was given as follows:

Energy of the reactants = 25 $kJ.mol^{-1}$
Energy needed to reach the activated complex = 20 $kJ.mol^{-1}$
Energy given off when the products formed 10 $kJ.mol^{-1}$

Now calculate ΔH. (3)

8.5.3 What could be done to decrease the activation energy of a chemical reaction? (1)

[20]

QUESTION 9

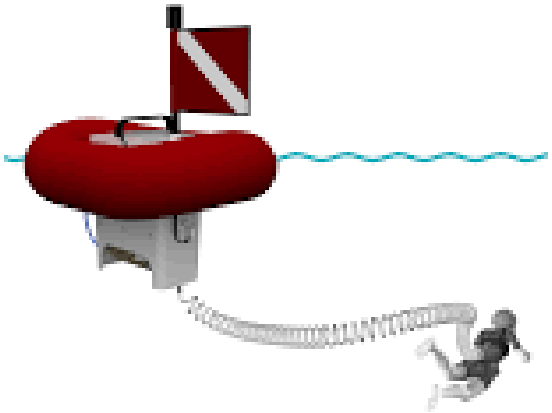
9.1 100g of a certain gas has a volume of $8dm^3$ at 47°C and $1,66 \times 10^3$ kPa.

9.1.1 Calculate the number of moles of this gas. (4)

9.1.2 Calculate the molar mass of this gas. (2)

9.1.3 Name this gas. (1)

9.2 A scuba diver is swimming under the surface of the water and realises that he is running out of air. Below the surface he is breathing in air pressurised at 300kPa and the volume of his lungs is $10dm^3$.



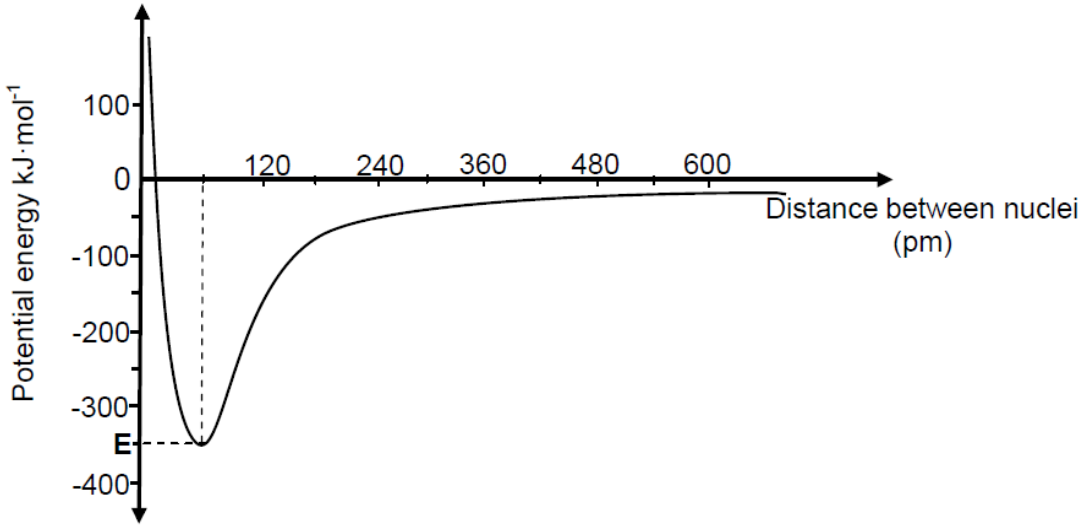
9.2.1 Calculate the volume of the scuba divers lungs at the surface if the pressure at the surface is 100kPa. (4)

9.2.2 Why would this be potentially fatal? (2)

[13]

QUESTION 10

The graph below shows the change in energy that takes place when a hydrogen (H) atom approaches a bromine (Br) atom.



10.1 From the graph, write down the bond length of HBr, in pm. (1)

10.2 How would the bond length of HF compare to that of HBr? Write down LONGER THAN, SHORTER THAN or EQUAL TO. (1)

10.3 Give a reason for your answer in 10.2. (1)

10.4 Based on your answer in 10.3, how would the bond energy of HF compare to that of HBr. Only write HIGHER THAN, LOWER THAN or EQUAL TO. (1)

10.5 Define BOND ENERGY. (2)

[6]

QUESTION 11

Consider the two compounds CO_2 and SO_2.

11.1 Draw the Lewis diagrams for:

11.1.1 CO_2 (2)

11.1.2 SO_2 (2)

11.2 Compare the polarity of the CO_2 and SO_2 molecules by referring to the **polarity of the bonds** and the **effect of the shape** of each molecule on its polarity. (4)

[8]

QUESTION 12

The flow diagram below illustrates the first step in the recovery of gold.

$$\boxed{\text{Gold}} \longrightarrow \boxed{NaAu(CN)_2}$$

The reaction taking place during this process is:

$$4Au\ (s) + 8NaCN\ (aq) + O_2\ (g) + 2H_2O\ (\ell) \rightarrow 4NaAu(CN)_2\ (aq) + 4NaOH\ (aq)$$

12.1 Name this process. (1)

12.2 Will the solution formed during this process be ACIDIC, NEUTRAL or ALKALINE?

Give a reason for your answer. (2)

12.3 Give one reason why this process can be considered harmful to the environment. (1)

The second chemical process in the recovery of gold is illustrated below.

$$\boxed{NaAu(CN)_2} \longrightarrow \boxed{\text{Gold}}$$

12.4 Name the physical process that precedes this process. (1)

12.5 Name the metal used in this process. (1)

12.6 Is the metal, named in 12.5, more or less reactive than gold? (1)

[7]

TOTAL 150 MARKS