**ALEXANDER ROAD HIGH SCHOOL**

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|---|---|---|
| JUNE 2021 | **PHYSICAL SCIENCES JUNE ASSESSMENT** | 180 MINUTES |
| JA | **GRADE 11** | TOTAL = 150 |

Instructions:

- The question paper consists of 13 questions.
- Answer all the questions.
- Answer sections A and C on the answer sheet provided.
- Answer sections B and D on folio sheets.
- 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.
- A formula sheet has been provided at the end of the question paper.
- A periodic table has been provided on the back of the answer sheet.

# PHYSICS

## SECTION A

*(answer on the answer sheet)*

**QUESTION 1:**

Four possible options are provided as answers to the following questions. Each question has only one correct answer. Choose the correct answer and write the letter (A – D) next to the relevant question number (1.1 – 1.5) on the answer sheet.

1.1 Which ONE of the following pairs of quantities are BOTH vectors?

A. Weight and mass

B. Gravitational acceleration and distance

C. Friction and speed

D. Resultant force and acceleration

1.2 A 5 N force and a 12 N force act on the same point. What is the maximum magnitude of their resultant force?

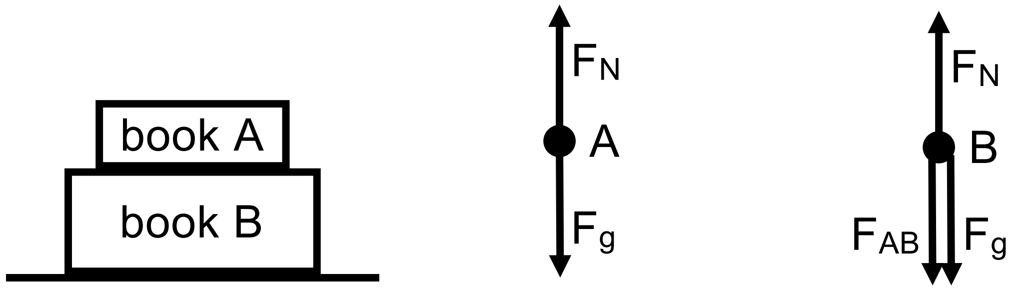
A. 7 N

B. 13 N

C. 17 N

D. 169 N

1.3 Book **A** rests on top of book **B** which rests on the ground as shown in the diagram below. The free-body diagrams for both books are also drawn.




Which ONE of the following combinations represents an action-reaction force pair?

| | **Force on Book A** | **Force on Book B** |
|---|---|---|
| A. | $F_N$ | $F_g$ |
| B. | $F_N$ | $F_{AB}$ |
| C. | $F_N$ | $F_N$ |
| D. | $F_g$ | $F_N$ |

1.4 As part of an investigation of Newton's Universal Law of Gravitation, scientists plot a F vs. $m_1m_2$ graph. Which ONE of the following combinations is correct?

| | **Type of Graph** | **Gradient of Graph** |
|---|---|---|
| A. | Straight-line through origin | $\frac{G}{r^2}$ |
| B. | Straight-line through origin | $G$ |
| C. | Straight-line with non-zero $y$-intercept | $G$ |
| D. | Hyperbola | $\frac{1}{r^2}$ |

1.5 The gravitational force between two objects is **F**. What will the new force be if one object's mass is halved, the other object's mass is tripled and the distance between the centres of the objects is doubled?

A. 0,375**F**

B. 0,75**F**

C. 3**F**

D. 6**F**

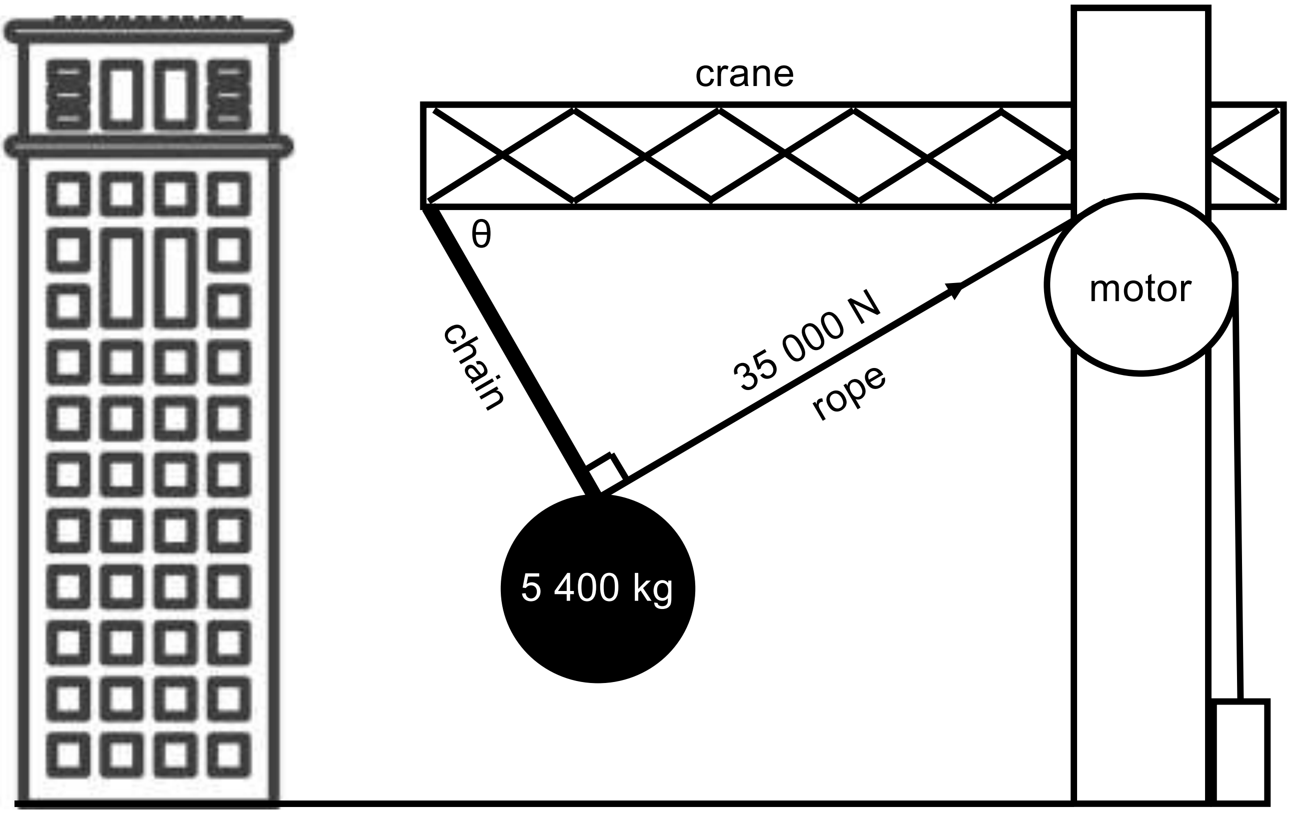
**TOTAL SECTION A = [10]**

## SECTION B

*(answer on folio paper)*

## QUESTION 2:

A motor on a crane pulls a 5 400 kg wrecking ball to the right with a constant force of 35 000 N as shown in the diagram below. When the angle between the chain and the rope is 90°, the system is in equilibrium.




2.1 Explain what is meant by the phrase: *the system is in equilibrium*. (1)

2.2 Define the term *resultant vector*. (2)

2.3 Draw a VECTOR diagram showing all the forces acting on the wrecking ball when the system is in equilibrium. Indicate at least ONE angle in the diagram. (4)

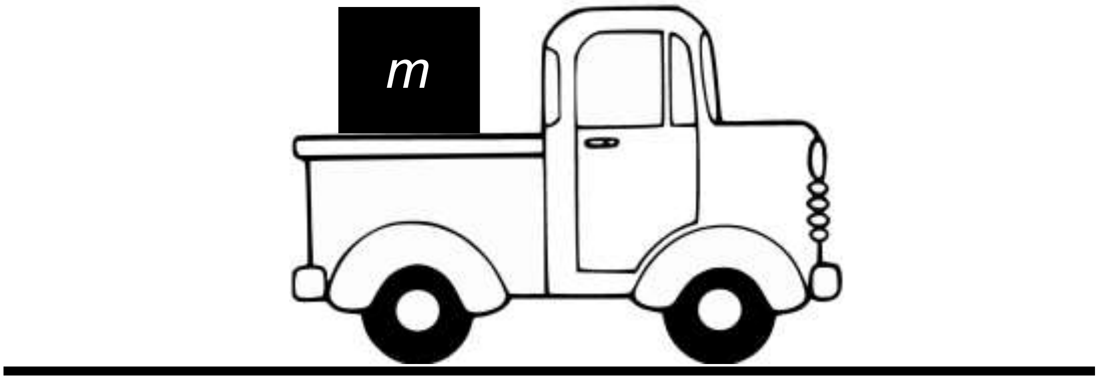
2.4 Calculate the magnitude of the tension in the chain. (3)

2.5 Calculate θ if θ is the angle between the chain and the crane when the system is in equilibrium. (2)

**[12]**

**QUESTION 3:**

A box of unknown mass ***m*** rests on the back of a stationary 1 200 kg bakkie as shown in the diagram below.




3.1 State *Newton's First Law of Motion* in words. (2)

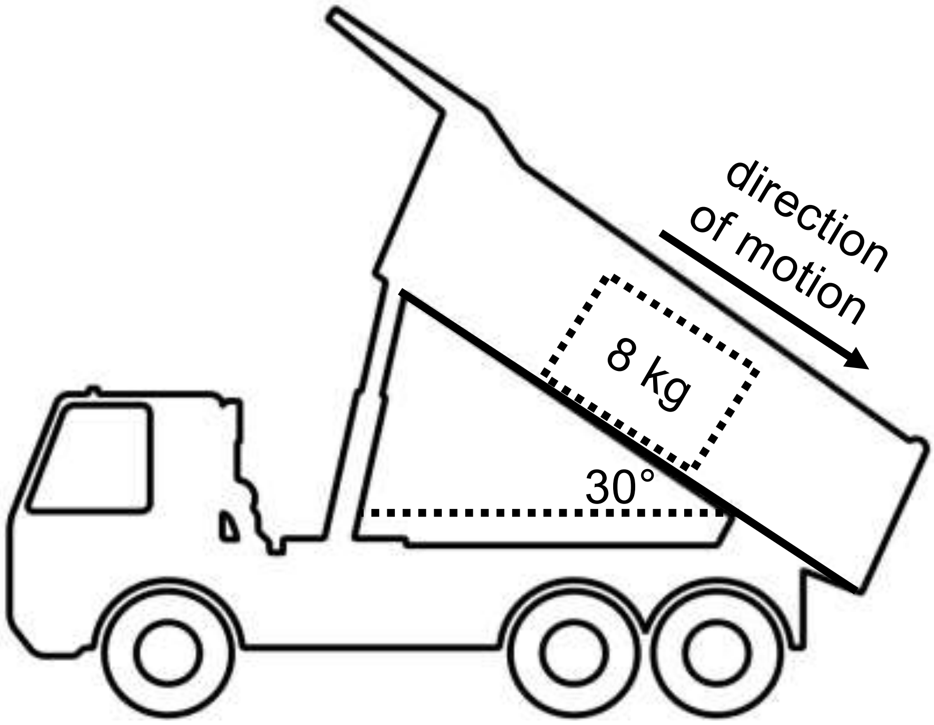
3.2 If the normal force acting on the bakkie is 13 230 N, calculate ***m***. (4)

3.3 The bakkie suddenly accelerates to the right. Relative to the bakkie, how will the box move? Write only TO THE RIGHT, TO THE LEFT or REMAINS STATIONARY. **Give a reason for your answer**. (2)

**[8]**

**QUESTION 4:**

A delivery truck raises its back until it is inclined at 30° to the horizontal causing an 8 kg crate to accelerate down the incline as shown in the diagram below.




A constant kinetic frictional force of 4,4 N acts on the crate as it slides down the incline.

4.1 Draw a free-body diagram showing all forces acting on the 8 kg crate. (3)

4.2 Calculate the acceleration of the 8 kg crate as it slides down the incline. (5)

4.3 A group of scientists conduct an experiment in which they measure the acceleration of several different crates, each having a different mass, as they slide down the incline. The angle of the incline is adjusted to ensure the resultant force acting on each crate is constant throughout the experiment.

4.3.1 Write an investigative question for this experiment. (2)

4.3.2 Besides the resultant force, name ONE other control variable. (1)

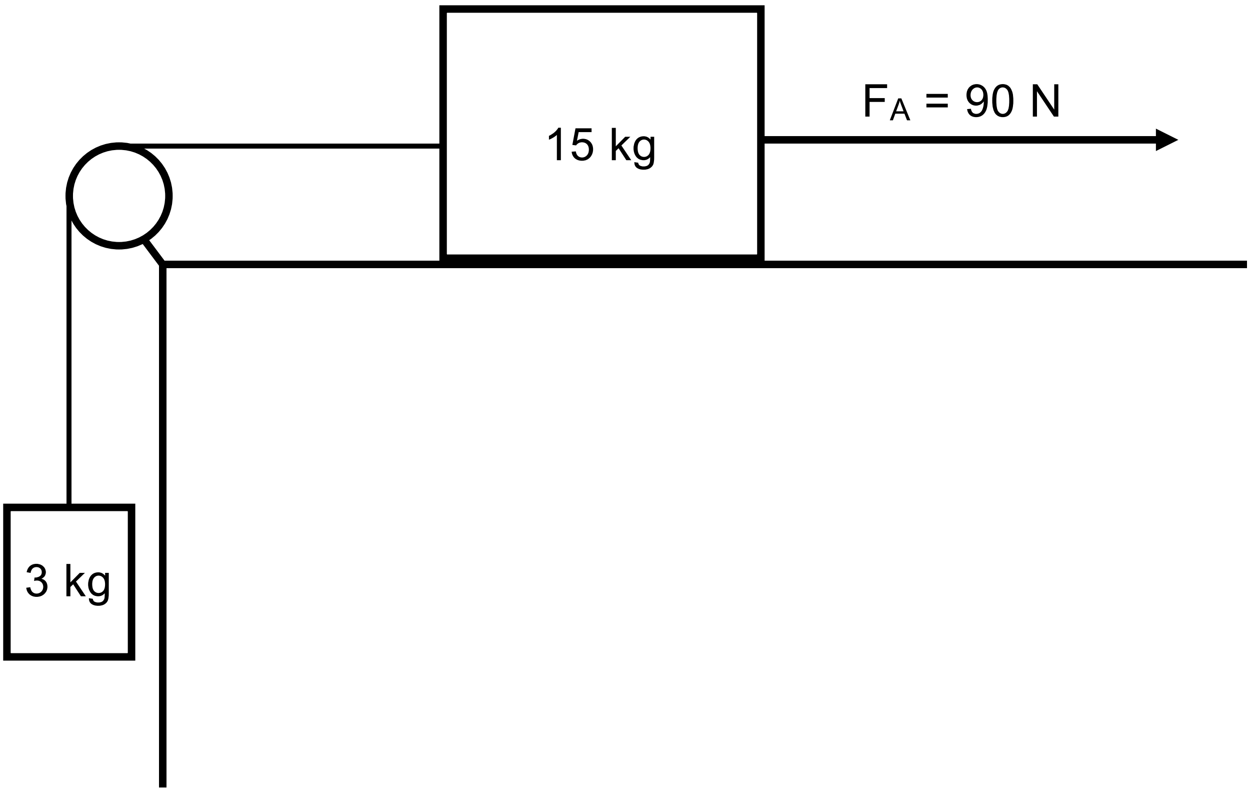
4.3.3 Draw a sketch of the graph of acceleration vs. mass for the experiment. (2)

4.3.4 State *Newton's Second Law of Motion* in words. (2)

**[15]**

**QUESTION 5:**

A 15 kg block is pulled across a horizontal surface by a 90 N force acting parallel to the horizontal as shown in the diagram below. The 15 kg block is connected to a 3 kg block by means of a light, inextensible rope running over a frictionless pulley.




The coefficient of kinetic friction between the 15 kg block and the horizontal surface is 0,35.

5.1 Draw a free-body diagram showing all forces acting on the 15 kg block. (5)

5.2 Calculate the magnitude of:

5.2.1 The kinetic frictional force acting on the 15 kg block. (4)

5.2.2 The acceleration of the system. (6)

5.2.3 The tension in the rope. (2)

5.3 How would the acceleration of the system change if the horizontal surface was frictionless? Write only INCREASES, DECREASES or REMAINS THE SAME. **Give a reason for your answer**. (2)

**[19]**

**QUESTION 6:**

6.1 State *Newton's Universal Law of Gravitation* in words. (2)

6.2 The mass of Mars is **$^1/_{10}$** × the mass of Earth and the average distance between their centres is 3,58 × $10^9$ km. Calculate the magnitude of the gravitational force of Mars on the Earth. (4)

6.3 What is the magnitude of the gravitational force of the Earth on Mars? (1)

6.4 Which of Newton's Laws justifies the answer in question 6.3?
**Fully state the law in words**. (2)

6.5 Elon Musk is determined to colonise Mars. Consider a SpaceX astronaut on Earth with a weight **W**. If the radius of Mars is **½** the radius of Earth, determine the weight of the astronaut on Mars in terms of **W**. (2)

**[11]**

**TOTAL SECTION B = [65]**

# CHEMISTRY

## SECTION C

*(answer on the answer sheet)*

**QUESTION 7:**

Four possible options are provided as answers to the following questions. Each question has only one correct answer. Choose the correct answer and write the letter (A – D) next to the relevant question number (1.1 – 1.5) on the answer sheet.

7.1 Bond energy of a compound is defined as…

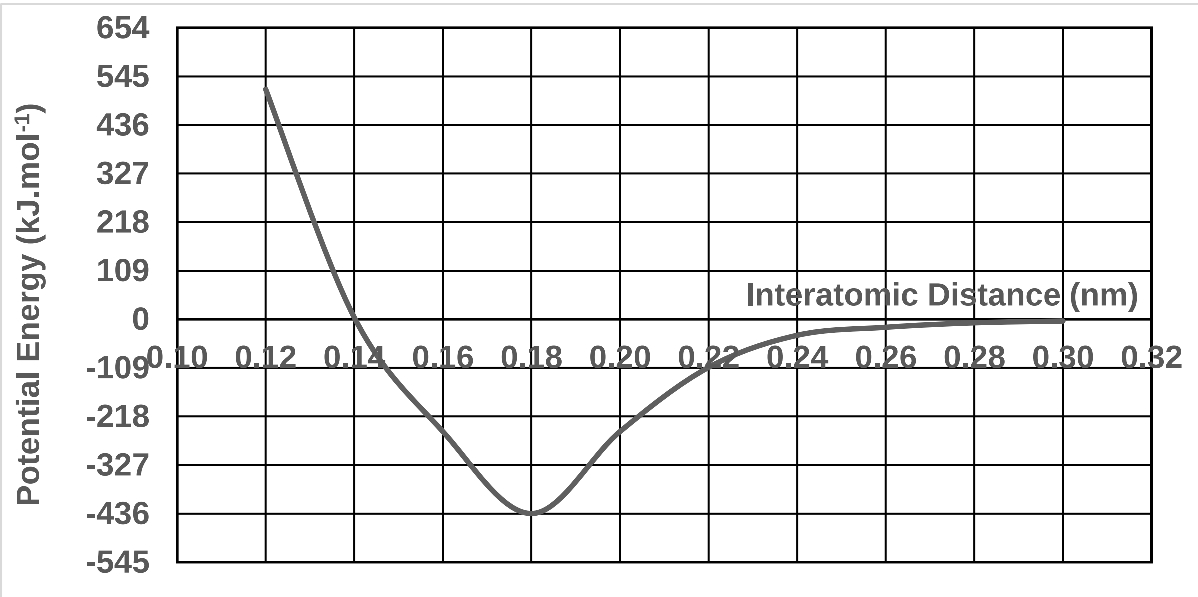
A. the average distance between the nuclei of two bonded atoms.

B. the energy needed to break one mole of its molecules into separate atoms.

C. the energy released when one mole of its molecules are broken apart.

D. the minimum energy needed for a reaction to take place with that compound.

7.2 Consider the following Potential Energy vs. Interatomic Distance graph for $H_2$:




The bond length of $H_2$ is…

A. 0,18 nm

B. $1,8 \times 10^{-9}$ m

C. 0,14 nm

D. 436 $kJ.mol^{-1}$

7.3 Which ONE of the following substances is involved in ION-DIPOLE forces?

A. $H_2O_{(\ell)}$

B. $NH_{3(aq)}$

C. $KBr_{(s)}$

D. $KBr_{(aq)}$

7.4 One mole of $HCN$ and one mole of $HNO_3$ will have the same…

A. mass.

B. molar mass.

C. number of atoms.

D. number of molecules.

7.5 75 $cm^3$ of water is added to a 25 $cm^3$ $Ca(OH)_{2(aq)}$ solution of concentration 2 $mol.dm^{-3}$.

The concentration of the solution **after** the addition of water is…

A. 0,03 $mol.dm^{-3}$

B. 0,5 $mol.dm^{-3}$

C. 0,67 $mol.dm^{-3}$

D. 6 $mol.dm^{-3}$

**TOTAL SECTION C = [10]**

## SECTION D

*(answer on folio paper)*

## QUESTION 8:

Consider the following covalently-bonded compounds:

$N_2$ $HC\ell$ $PH_3$ $H_2S$ $CO_2$ $BF_3$

8.1 Define the term *chemical bonding*. (2)

8.2 Draw the Lewis diagram of:

8.2.1 $H_2S$ (2)

8.2.2 $CO_2$ (2)

8.3 Give the Couper notation of $N_2$. (1)

8.4 From the above list of compounds, write down the formula(e) of the molecule(s) which…

8.4.1 …have polar bonds. (3)

8.4.2 …are polar. (3)

8.5 $H^+$ ions can bond with a lone pair of electrons on the oxygen atom in water to form hydronium ions ($H_3O^+$).

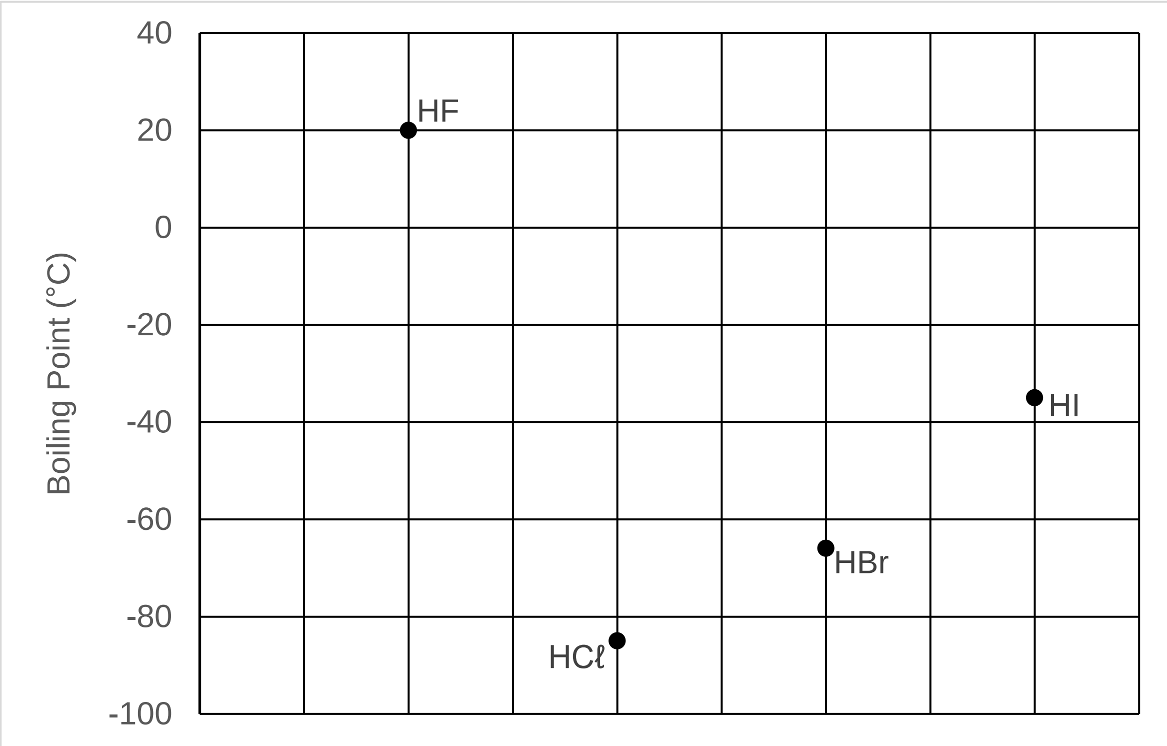
8.5.1 Represent this reaction using Lewis diagrams. (3)

8.5.2 Name the specific bond that forms between the $H^+$ ion and the water. (1)

**[17]**

**QUESTION 9:**

A graph of the boiling points of the hydrogen halides is given below.




9.1 Define the term *boiling point*. (2)

9.2 Fully explain why the boiling point of $HF$ is significantly higher than the boiling point of $HC\ell$. (4)

9.3 All the hydrogen halides are soluble in water. However, none of the halogens in molecular form (i.e. $F_2$, $Cl_2$, $Br_2$ and $I_2$) dissolve in water. **Explain.** (3)

9.4 Two beakers are left on a desk in a lab overnight. Beaker **A** contains $HF$ dissolved in water and the beaker **B** contains an equal amount of $HC\ell$ dissolved in water. The next morning the volume inside both beakers has decreased due to evaporation.

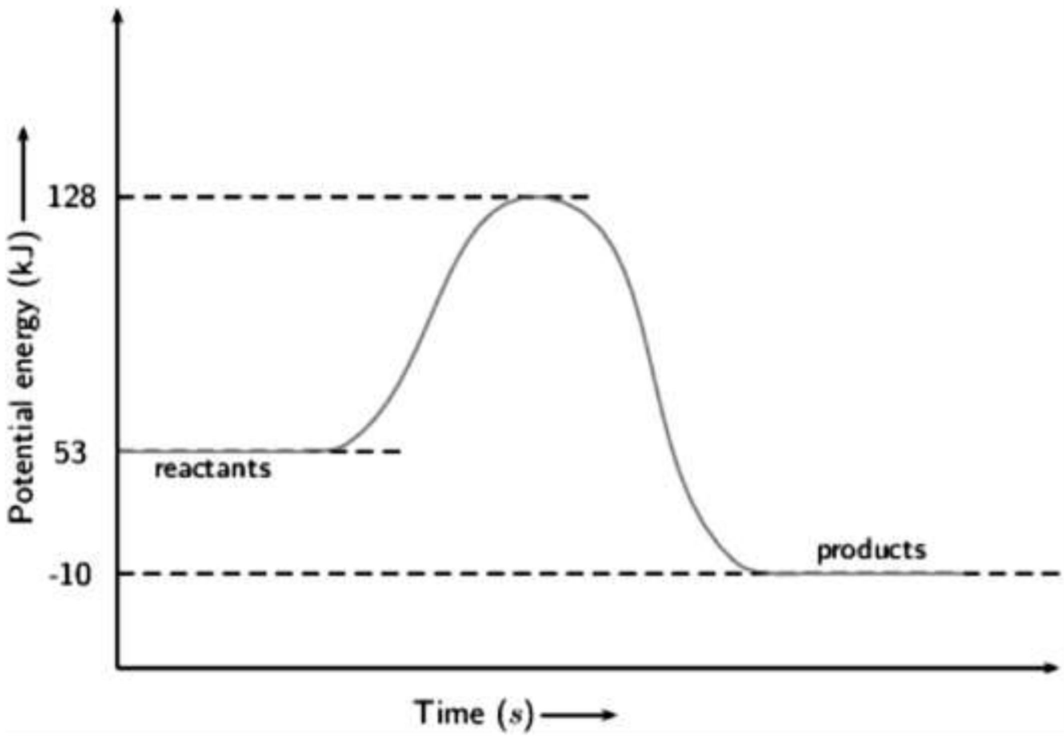
9.4.1 Which beaker would have a larger decrease in volume? Write only **A** or **B.** (1)

9.4.2 Give a reason for your answer by referring to the graph above. (2)

**[12]**

**QUESTION 10:**

Consider the following potential energy graph representing a particular reaction.




10.1 Define the term *heat of reaction*. (2)

10.2 Is the reaction EXOTHERMIC or ENDOTHERMIC?
**Give a reason for your answer** by referring to the graph. (2)

10.3 Use the graph to determine the:

10.3.1 Heat of Reaction (ΔH) (2)

10.3.2 Activation Energy ($E_A$) (2)

10.4 Redraw the potential energy graph and clearly indicate the effect a catalyst would have on the reaction **using a dotted line**. (1)

**[9]**

## QUESTION 11:

| Bond | Bond Energy (kJ.mol$^{-1}$) |
|---|---|
| $N-N$ | 160 |
| $N=N$ | 418 |
| $N\equiv N$ | 946 |
| $H-H$ | 436 |
| $N-H$ | 390 |

11.1 Use the table of bond energies given above to determine the heat of reaction for the following reaction:

$$N_2 + 3\,H_2 \rightarrow 2\,NH_3$$ (5)

11.2 Based on the answer to question 11.1, is the reaction EXOTHERMIC or ENDOTHERMIC? (1)

**[6]**

**QUESTION 12:**

12.1 500 cm$^3$ $AgNO_{3(aq)}$ solution with a concentration of 0,02 mol.dm$^{-3}$ is poured into an excess amount of $KC\ell_{(aq)}$ solution causing the following reaction:

$$AgNO_{3(aq)} + KC\ell_{(aq)} \rightarrow AgC\ell_{(s)} + KNO_{3(aq)}$$

12.1.1 Calculate the mass of $AgC\ell_{(s)}$ formed. (5)

12.1.2 How many $AgC\ell$ particles formed? (3)

12.2 Define the term *limiting reactant*. (2)

12.3 Consider the Haber-Bosch process which is used to produce ammonia ($NH_3$):

$$N_{2(g)} + 3\,H_{2(g)} \rightarrow 2\,NH_{3(g)}$$

If 0,14 mol of $N_2$ reacts with 0,40 mol of $H_2$, calculate the volume of $NH_3$ produced at STP. (5)

**[15]**

**QUESTION 13:**

A chemist working at Tesla needs to design the airbag for their latest car. The airbag contains solid sodium azide ($NaN_3$) which rapidly decomposes during a collision according to the following balanced chemical equation:

$$2\,NaN_{3(s)} \underset{\Delta}{\rightarrow} 2\,Na_{(s)} + 3\,N_{2(g)}$$

The nitrogen gas inflates the airbag in a matter of seconds. After doing some research the engineer determines that 16 dm$^3$ of nitrogen gas is needed to sufficiently inflate the bag. The molar volume of a gas at room temperature is 24 dm$^3$. After some experimentation, the chemist discovers that the average percentage yield of the reaction is 80%. Calculate the mass of sodium azide the chemist should place inside the airbag.

**[6]**

**TOTAL SECTION D = [65]**


WELL DONE!

# Formula Sheet

## PHYSICS

Physical Constants:

| Name | Symbol | Value |
|---|---|---|
| Acceleration due to gravity | g | 9,8 $m.s^{-2}$ |
| Universal gravitational constant | G | 6,67 × $10^{-11}$ $N.m^2.kg^{-2}$ |
| Speed of light in a vacuum | c | 3,0 × $10^{8}$ $m.s^{-1}$ |
| Planck's constant | h | 6,63 × $10^{-34}$ J.s |
| Coulomb's constant | k | 9,0 × $10^{9}$ $N.m^2.C^{-2}$ |
| Charge on electron | e | -1,6 × $10^{-19}$ C |
| Electron mass | $m_e$ | 9,11 × $10^{-31}$ kg |
| Mass of earth | $M_E$ | 5,98 × $10^{24}$ kg |
| Radius of earth | $R_E$ | 6,38 × $10^{6}$ m |

Formulae:

**MOTION**

| | |
|---|---|
| $v_f = v_i + a\Delta t$ | $\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ |
| $v_f^2 = v_i^2 + 2a\Delta x$ or $v_f^2 = v_i^2 + 2a\Delta y$ | $\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ |

**FORCE**

| | |
|---|---|
| $F_{net} = ma$ | $W = mg$ |
| $\mu_s = \frac{f_s^{max}}{N}$ | $\mu_k = \frac{f_k}{N}$ |
| $F = G\frac{m_1 m_2}{r^2}$ | $g = G\frac{M}{r^2}$ |

# CHEMISTRY

Physical Constants:

| Name | Symbol | Value |
|---|---|---|
| Standard pressure | $p^\theta$ | $1{,}013 \times 10^5$ Pa |
| Standard temperature | $T^\theta$ | 273 K |
| Molar gas volume at STP | $V_m$ | $22{,}4\ dm^3.mol^{-1}$ |
| Avogadro's constant | $N_A$ | $6{,}02 \times 10^{23}\ mol^{-1}$ |

Formulae:

| | |
|---|---|
| $n = \frac{m}{M}$ | $n = \frac{N}{N_A}$ |
| $n = \frac{V}{V_m}$ | $c = \frac{n}{V}$ or $c = \frac{m}{MV}$ |