FET PHYSICAL SCIENCES

TERM 1 & 2 2019

TRAINING HANDOUT

What is the NECT?
In 2012 our government launched the National Development Plan (NDP) as a way to eliminate poverty and reduce inequality by the year 2030. Improving education is an important goal in the NDP which states that 90% of learners will pass Maths, Science and languages with at least 50% by 2030. This is a very ambitious goal for the DBE to achieve on its own, so the NECT was established in 2015 to assist in improving education.
The NECT has successfully brought together groups of people interested in education so that we can work collaboratively to improve education. These groups include the teacher unions, businesses, religious groups, trusts, foundations, and NGOs.

How is the NECT performing thus far…?

Please complete the table below:

Positive Experiences:
Negative Experiences:
Practical ways to address negatives (**solutions**):
What must the NECT **START** doing?
What must the NECT **STOP** doing?
What must the NECT **CONTINUE** doing?

What are my expectations for this training?

What commitments am I willing to make for this training?

MOMENTUM AND IMPULSE Grade 12 Term 1 Topic 2

1. Two boys, each of mass *m*, are standing at the back of a flatbed trolley of mass 4 *m*. The trolley is at rest on a frictionless horizontal surface. The boys jump off simultaneously at one end of the trolley with a horizontal velocity of 2 m.s⁻¹ east. The trolley moves in the opposite direction.

1.1 Write down the principle of conservation of linear momentum in words. (2)
1.2 Calculate the final velocity of the trolley. (5)

1.3 The two boys jump off the trolley one at a time. How will the velocity of the trolley compare to that calculated in QUESTION 1.2? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

2. A man of mass 80 kg wearing a seatbelt, is driving a car at 20 m.s⁻¹ which collides with the back of a stationary truck causing the car to bounce backwards at 2 m.s⁻¹ after the collision. The collision lasts for 0,2 s. Calculate the average force of the seatbelt on the man during the collision. (5)

3. The average mass of a minibus taxi on South African roads is 1 500 kg. The law states that the combined mass of all the passengers in a minibus taxi and the taxi itself should not exceed 3 500 kg.

A minibus taxi with an unknown number of passenger's travels at 25 m.s⁻¹ when it collides with a car with a mass of 1 200 kg (passengers included), travelling at 15 m.s⁻¹ in the opposite direction, as shown. During the collision the vehicles stick together and travel at 14 m.s⁻¹ immediately after the collision in the direction of the original motion of the taxi.

3.1 Ignore friction. Use momentum principles to determine whether the minibus taxi was overloaded, that is, above the legal combined mass of 3 500 kg. (7)
3.2 Is the collision between the vehicles elastic or inelastic? Support your answer with an appropriate calculation. (6)

4. Suppose you are traveling in a bus when an insect suddenly splatters onto the front window.
4.1 How does the force that the insect exerts on the bus compare to the force exerted by the bus on the insect? (2)

4.2 How does the change in momentum of the bus compare to the change in momentum of the insect? Explain your answer. (3)

4.3 Which experiences the greater acceleration? Explain your answer. (3)

5 A learner of mass 68 kg on a skateboard, moving horizontally at constant speed in a straight line, sees his 20 kg school bag standing directly in his path. He grabs the school bag and continues to move in a straight line at 3 m.s⁻¹.

5.1 Calculate the learner's speed immediately before he grabs the school bag. Ignore the effects of friction. (4)

5.2 Calculate the impulse provided to the school bag. (4)

5.3 The learner experienced an average force of 100 N during the collision with the bag. Determine how long the collision lasted. (4)

5.4 Without any further calculations, compare the acceleration of the learner and the school bag during the collision. (3)

5.5 Is the collision elastic? Use a calculation to support your answer. (6)

5.6 After grabbing the bag, he continues at a velocity of 3 m.s⁻¹ until he enters a horizontal gravel path. He continues 2 m along the gravel path before coming to rest. Calculate the frictional force acting on the skate board. (5)

6.1
An object of mass m moving at velocity v collides head-on with an object of mass $2m$ moving in the opposite direction at velocity v. Immediately after the collision the smaller mass moves at velocity v in the opposite direction and the larger mass is brought to rest. Refer to the diagram below.
Ignore the effects of friction. Which ONE of the following is CORRECT?

	Momentum	**Mechanical energy**
A	Conserved	Conserved
B	Not conserved	Conserved
C	Conserve	Not conserved
D	Not conserved	Not conserved

(2)

6.2 If the momentum of an object is doubled, then its kinetic energy is ...

| A	halved
B	doubled
C	three times greater
D	four times greater

(2)

6.3 Two trolleys, P and Q, of mass m and $2m$ respectively are at rest on a frictionless horizontal surface. The trolleys have a compressed spring between them.
The spring is released, and the trolleys move apart. Which ONE of the following statements is TRUE?

A	P and Q have equal kinetic energies.
B	The speed of P is less than the speed of Q.
C	The sum of the final kinetic energies of P and Q is zero.
D	The sum of the final momentum of P and Q is zero.

(2)

6.4 Two trolleys, X and Y, are placed head to head with a compressed spring between them. Trolley X has mass m, while trolley Y has mass $2m$. The compressed spring is released and the trolleys are shot apart.
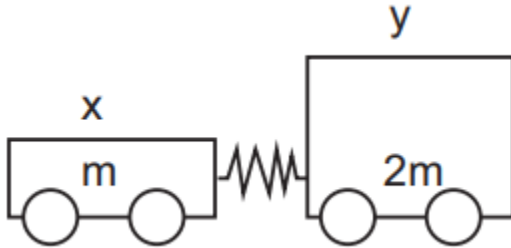
Immediately after the trolleys have been shot apart, trolley X moves with a speed v. What will be the speed of trolley Y immediately after the trolleys are shot apart?

A	½v
B	v
C	2 v
D	4 v

(2)

6.5 Two friends, Peter and Lana, both on ice skates, are standing on the ice. Peter has twice the mass of Lana. They press their hands together and push away from each other.
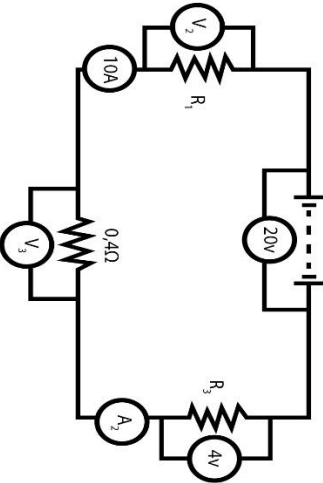Which ONE of the following is CORRECT regarding the magnitude of the force exerted by Peter on Lana?

A $F_{Peter\ on\ Lana} = 3F_{Lana\ on\ Peter}$

B $F_{Peter\ on\ Lana} = 2F_{Lana\ on\ Peter}$

C $F_{Peter\ on\ Lana} = F_{Lana\ on\ Peter}$
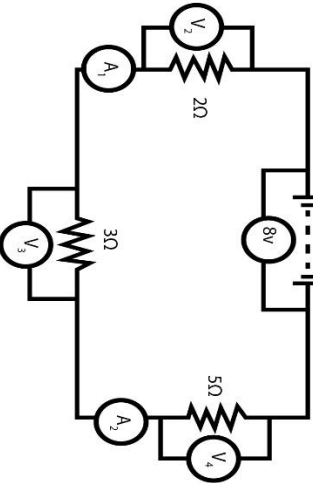
D $F_{Peter\ on\ Lana} = \frac{1}{2}F_{Lana\ on\ Peter}$
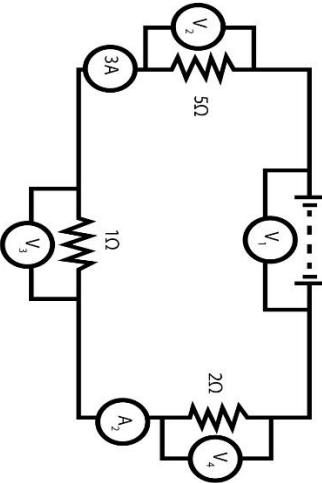
(2)

ELECTRIC CIRCUITS Grade 10 Term 2 Topic 16

7.

V_2 A_1 1Ω

0,4A A_2 2A V_3 R_4 2Ω   1Ω   12,2v

2Ω A_5 V_4

6.

V_2 A_1 2,4Ω

A_3 A_2 V_3 1Ω   4Ω   10V

0,8Ω A_4 V_4

9.

20V A_1 R_1

A_4 A_3 2A V_3 0,5Ω   0,4Ω   2Ω V_1

1,8Ω A_5 V_4

8.

10V A_1 2Ω

A_4 1A A_2 V_3 R_4 R_3 2,5Ω   30V

3Ω A_5 V_4
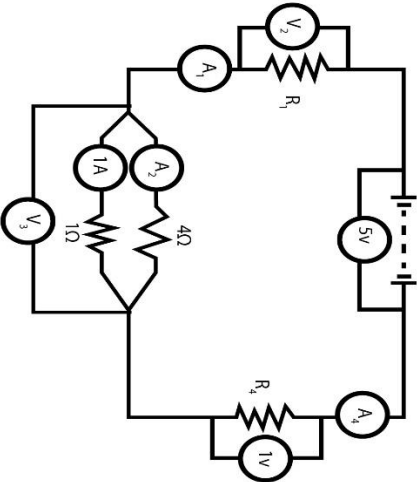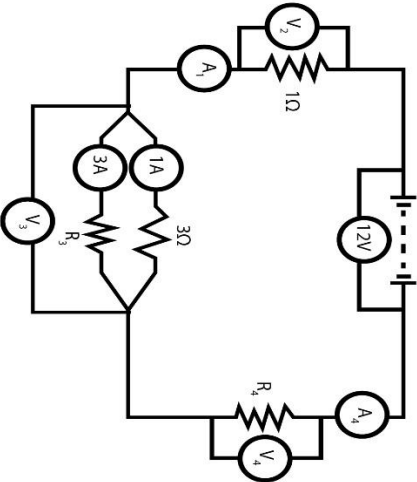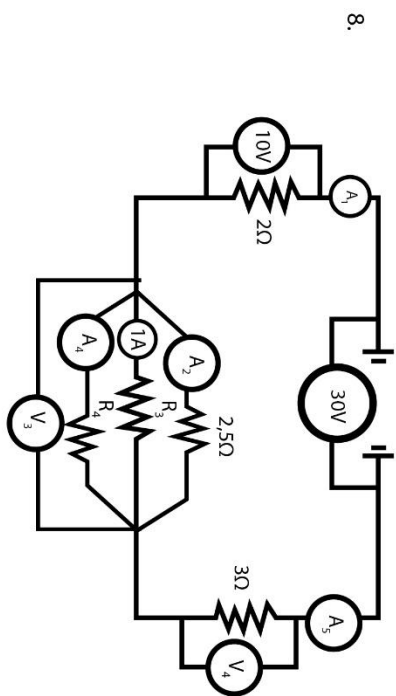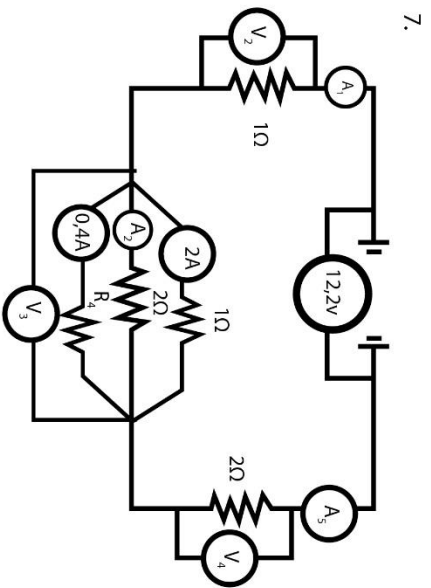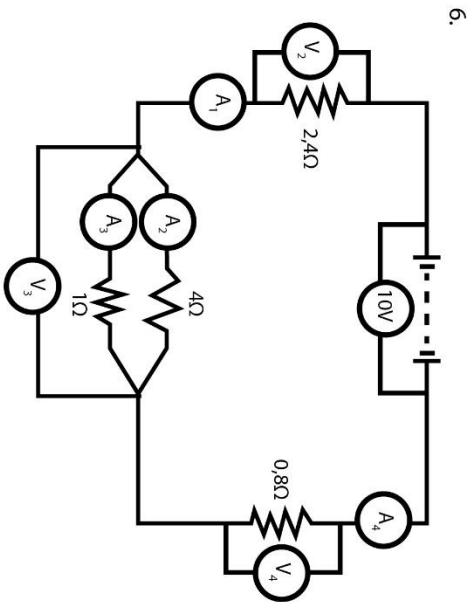
ATOMIC COMBINATIONS AND MOLECULAR STRUCTURE Grade 11 Term 1

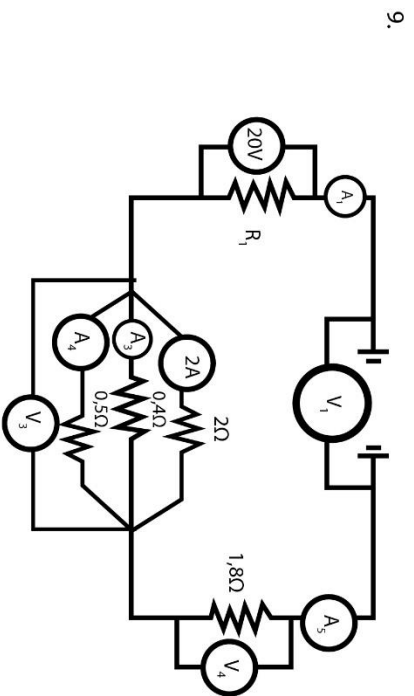| Name	Formula	Lewis Diagram	Couper Diagram	Shape	Intermolecular Force
Fluorine					
Oxygen					
Nitrogen					
Hydrogen chloride					
Water					
Ammonia					
Carbon Dioxide					
Methane					

ORGANIC CHEMISTRY Grade 12 Term 1 Topic 4

FORMAL EXPERIMENT: The Preparation of Esters

GRADE 12 TERM 1

This section provides guidance and assessment of the learner's knowledge and understanding when carrying out a virtual experiment using the NECT video of the same name.

If your class is carrying out the experiment using laboratory apparatus and taking down their own results, you must set up your classroom appropriately and give the learners the relevant instructions.

If the learners are proceeding with the virtual experiment, then continue with the NECT programme by using the information, handouts and marking guide contained in the following section of this Resource Book.
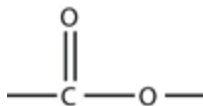
GRADE 12 TERM 1 FORMAL EXPERIMENT

Aim: To prepare esters from alcohols and carboxylic acids.   **30 marks**

Theory:

An ester has the functional group:

This functional group is also called "an ester link".

In this experiment esters are prepared from an alcohol and a carboxylic acid in the presence of concentrated sulfuric acid (which acts a catalyst). The reaction between an alcohol and a carboxylic acid to form an ester is known as esterification. It is an example of a condensation reaction because the two molecules of alcohol and carboxylic acid link up by eliminating a small molecule (a water molecule).

The reaction takes place very slowly at room temperature so, we heat up the reactants to about 60 °C. Because two alcohols (ethanol and methanol) which we will use in this experiment are inflammable, we cannot heat the reaction test tube directly in case the contents catch fire. Therefore, we use a water bath to heat the reactants. We also use concentrated sulfuric acid as a catalyst to increase the rate of production of the esters.

The alcohols and the carboxylic acids generally have their own distinct odours, and the esters that are produced smell completely different from their reactants. The products of the reaction are poured into a solution of sodium carbonate which dissolves the alcohol and reacts with any remnants of carboxylic acid as well as with the sulfuric acid, leaving the oily ester floating on the surface of the solution. This helps us to distinguish the fragrance of the ester more easily.

Be aware of the safety precautions that should be adhered to during this experiment.

Apparatus:

      2 × test tubes
      2 × 100 ml beakers
      1 × 250 ml beaker ("empty" beaker)
      Hot plate (or Bunsen burner, tripod and gauze mat)
      Tongs or a test tube holder
      4 × droppers (propettes)
      Spatula
      1 × 3 ml test tube ("small" test tube)
      Electronic balance (or triple beam balance)
      Methanol
      Ethanol
      Ethanoic acid
      Salicylic acid
      Concentrated sulfuric acid

Safety measures and precautions:

- Do not sniff any of these chemicals directly. They can all cause respiratory problems, as well as irritate the mucous linings of the nostrils and throat.
- In particular sniffing either methanol or ethanol can cause temporary loss of vision. Sniffing methanol can cause permanent blindness.
- Concentrated sulfuric acid is corrosive, an oxidant, and a dehydrating agent. It must be handled with extreme care. Wear gloves to protect your hands.
- Wear goggles to protect your eyes from the fumes of these substances.
- Work carefully and respect each other's safety.

Variables

Independent variable: Type of alcohol and carboxylic acid

Dependent variable: Smell of the ester (name of the ester)

Controlled variable: Amount of alcohol and carboxylic acid

Method

Preparing an ester from two liquid substances: ethanol and ethanoic acid

1. Add about 20 drops (20 ml) of ethanoic acid to a clean, dry test tube.
2. Add about 20 drops (20 ml) of ethanol to the ethanoic acid in the test tube.
3. Swirl the contents of the test tube a few times to mix the substances.
4. Add two or three drops of concentrated sulfuric acid to the test tube, by letting the sulfuric acid run slowly down the side of the test tube. Do this slowly so that the contents of the test tube do not become too hot, and the acid does not splatter out of the test tube.
4. Put 20 ml of water in a 100 ml beaker.
5. Carefully lower the tube test into the beaker so that it is supported and stands up.
6. Place the beaker of water with its test tube on a tripod and gauze mat,and light the burner. Heat until the water starts to boil, and then stop heating.
7. Allow the test tube to stand for 1 minute in the hot water. If the mixture in the tube boils, use tongs to lift test tube out of the water until boiling stops, then return it to the hot water.
8. After 1 minute, using tongs, carefully remove the test tube and allow it to cool in an empty beaker or in a test tube stand.
9. When the test tube is cool, pour the mixture into a beaker half-full of dilute sodium carbonate solution. There will be some effervescence.
10. Use a stirring rod to mix the contents of the beaker well. A layer of ester will separate and float on top of the aqueous layer.
11. Smell the product by gently wafting the odour towards your nose with your hand – do not put your nose near the top of the tube!

Preparing an ester from a solid acid: salicylic acid and methanol.

1.   Weigh out 0,5 g of salicylic acid (2-hydroxybenzoic acid) in a small (3 ml) test tube.
2.   Add the acid to a clean dry test tube. Then add 3 ml of methanol to the small test tube to wash the remainder of the salicylic acid crystals into the reaction test tube.

Proceed as above from step 3 to 11.

Observations and results: [2]

Watch the video and record the odours of the esters as described by the presenters.

Carboxylic acid	Alcohol	Odour of ester
ethanol	ethanoic acid	(1)
methanol	salicylic acid	(1)

Analysis and interpretation:

1.   Name the two homologous series of organic compounds that are used in the preparation of esters.   (2)

2.   Write down the structural formula of the functional group of the following compounds:

2.1   An alcohol   (1)

2.2   A carboxylic acid   (1)

3.   This question concerns the reaction between **ethanol** and **ethanoic acid**. Concentrated sulfuric acid acts as a catalyst in this reaction.

3.1   Use full structural formulae to write the balanced equation for this reaction.   (4)

3.3   Name the ester formed during this reaction.   (2)

3.4   Name an everyday substance which smells like ethanoic acid.   (1)

3.5   Would this reaction take place if the catalyst was not added to the reaction mixture? Explain briefly.   (3)

3.3   Briefly explain how the presence of a catalyst speeds up the rate of a reaction.   (3)

3.3   At the end of the reaction the presenters said that they could not detect the smell of ethanoic acid in the test tube. What does this tell us about the contents of the test tube?

(1)

3.6   Why does dilute sodium carbonate solution fizz (effervesce) when the contents of the test tube are added to it at the end of the reaction?   (3)

[21]

4.   This question concerns the reaction between salicylic acid and methanol. Concentrated sulfuric acid acts as a catalyst in this reaction.

4.1   Write down the full structural formula for methanol.   (1)

4.2   Which of these two alcohols has the higher boiling point? Ethanol or methanol? Explain briefly with reference to the forces between the molecules.   (3)

4.3   Name the ester formed by this reaction.   (2)

4.4   Give ONE use of this ester (in everyday life).   (1)

[7]

MY COMMITMENT

The most important thing that I learnt in this training is:

_____

_____

_____

_____

_____

As an FET Physical Sciences educator, one thing that I will commit to doing consistently and thoroughly is:

_____

_____

_____

_____

_____

In addition, I will also try my best to:

_____

_____

_____

_____

_____

Signature:

Date:

'Commitment is what turns promise into reality.'

Abraham Lincoln

DECIDE. COMMIT. SUCCEED.

MOMENTUM AND IMPULSE Grade 12 Term 1 Topic 2

1.1 The total linear momentum of an isolated system✓ remains constant (is conserved)✓.

(2)

1.2   Choose east as positive:

$p_{before} = p_{after}$

$m_T v_{Ti} = m_b v_{bf} + m_b v_{bf} + m_t v_{tf}$

$(6m).(0) ✓ = (m).(+2) + (m).(+2) ✓ + (4m)v_f ✓$

$0 = 4m + 4mv_f$

$-4 = 4v_f$

$v_f = -1 = 1 \, m.s^{-1} ✓west ✓$ (5)

(5)

1.3 Equal to✓
The total change in momentum of the trolley is equal to the sum of the changes in momentum of the boys.   (1)

2. Choose forward as positive:

$F_{net} = \frac{\Delta p}{\Delta t}$

$F_{net} = \frac{mv_f - mv_i}{\Delta t}$

$F_{net} = \frac{(80).(-2) ✓ - (80).(+20) ✓}{0,2 ✓}$

$F_{net} = \frac{-160 - 1600}{0,2}$

$F_{net} = -8800 = 8800 \, N ✓backwards ✓$ (5)

3.1   Choose the original direction of the taxi as positive:

$p_{before} = p_{after}$

$m_T v_{Ti} + m_C v_{Ci} = m_{Total} v_f$

$(m_T).(+25) ✓ + (1200).(-15) ✓ = (m_T + 1200 ✓).(+14) ✓$

$25m_T - 18000 = 14m_T + 16800$

$11m_T = 34800$ ✓

$m_T = 3163,64 \ kg$ ✓

Not overloaded✓ (7)

3.2 $E_{k \ before} = \frac{1}{2}(3163,64).(25)^2$ ✓ $+ \frac{1}{2}(1200).(15)^2$ ✓ $= 5139309 \ J$ ✓

$E_{k \ after} = \frac{1}{2}(4363,64).(14)^2$ ✓ $= 427636 \ J$ ✓

Inelastic collision✓ (6)

4.1 The force of the insect on the bus is equal in magnitude✓ but opposite in direction✓ to the force of the bus on the insect (Newton's third law). (2)

4.2 The change in momentum of the insect is equal in magnitude✓ but opposite in direction✓ to the change in momentum of the bus.

This is because both objects experience equal and opposite impulses✓. (3)

4.3 The net force on each object is the same but the masses are different.✓

According to Newton's second law, the acceleration is inversely proportional✓ to the mass of an object.

$a = \frac{F_{net}}{m}$

The insect has the smaller mass and therefore experiences the greater✓ acceleration. (3)

5.1 Choose forward a positive:

$p_{before} = p_{after}$

$m_L v_{Li} + m_B v_{Bi} = m_{total} v_f$

$(68).v_{Li}$ ✓ $+ (20).(0)$ ✓ $= (88).(+3)$ ✓

$68v_{Li} + 0 = 264$

$v_{Li} = 3,88 \ m.s^{-1}$ ✓ (4)

5.2 $F_{net}.\Delta t = \Delta p$

$F_{net}.\Delta t = mv_f - mv_i$

$F_{net}.\Delta t = (20)(+3)$ ✓ $- (20).(0)$ ✓

$F_{net}.\Delta t = 60 \ N.s$ ✓ $forward$ ✓ (4)

5.3 $F_{net}.\Delta t = \Delta p$

$F_{net}.\Delta t = mv_f - mv_i$

$(-100 ✓). \Delta t = (68)(+3) ✓ - (68).(+3,88) ✓$

$-100\Delta t = 204 - 263,84$

$-100\Delta t = -59,84$

$\Delta t = 0,60 \ s ✓$ (4)

5.4 Both the learner and the bag experience the same net force in opposite directions✓.

The acceleration is inversely proportional to the mass of the object.

The school bag has the smaller mass and therefore experiences the greater acceleration✓. (3)

5.5 $E_{k \ before} = \frac{1}{2}m_L v_L^2 + \frac{1}{2}m_B v_B^2$

$E_{k \ before} = \frac{1}{2}(68).(3,88)^2 ✓ + 0 ✓ = 511,85 \ J ✓$

$E_{k \ after} = \frac{1}{2}m_T v_T^2$

$E_{k \ after} = \frac{1}{2}(88).(3)^2 ✓ = 396 \ J ✓$

Inelastic collision✓ (6)

5.6 $v_f^2 = v_i^2 + 2a\Delta x$

$0 = (3 ✓)^2 + 2a(2 ✓)$

$a = \frac{-9}{4} = -2,25 \ m.s^{-2} ✓$

$f = F_{net} = m.a = (88).(-2,25) = -198 = 198 \ N ✓ \ backwards ✓$ (5)

6

6.1

C✓ ✓ $p_{before} = mv + (2m).(-v) = -mv$

$p_{after} = m(-v) + 0 = -mv$

$E_{k\,before} = \frac{1}{2}mv^2 + \frac{1}{2}(2m)v^2 = \frac{3}{2}mv^2$

$E_{k\,after} = \frac{1}{2}mv^2 + 0 = \frac{1}{2}mv^2$ [CL 3]   (2)

6.2

D✓ ✓ $p = mv$

$v = \frac{p}{m}$

$E_k = \frac{1}{2}mv^2 = \frac{1}{2}m(\frac{p}{m})^2 = \frac{p^2}{2m}$

$E_{k\,new} = \frac{(2p)^2}{2m} = 4(\frac{p^2}{2m}) = 4E_k$ [CL 4]   (2)

6.3

D✓ ✓ Total linear momentum before the explosion is zero.

Total linear momentum after the collision must also be zero.   [CL 3]   (2)

6.4

A✓ ✓ $p_{before} = p_{after}$

$0 = m(-v) + 2mv_Y$

$v = 2v_Y$

$v_Y = \frac{1}{2}v$ [CL 3]   (2)

6.5

C✓ ✓ Newton's third law   [CL 2]   (2)

ELECTRIC CIRCUITS Grade 10 Term 2 Topic 16

1. A_2 = 10A

   R_3 = 0,4Ω

   V_3 = 4V

   V_2 = 12 V

   R_1 = 1,2Ω

2. R_{Total} = 10Ω

   V_{Total} = 8V

   I = V/R = 8/10 = 0,8A

   A_1 = A_2 = 0,8A

   V_2 = 1,6V

   V_3 = 2,4V

   V_4 = 4V

3. A_2 = 3A

   V_4 = 6V

   V_2 = 15V

   V_3 = 3V

   V_1 = 24V

4. V_3 = 1V
   A_2 = 1/4 = 0,25A
   A_1 = 1,25A
   A_4 = 1,25A
   R_4 = 1/1,25 = 0,8Ω
   V_2 = 3V
   R_1 = 3/1,25 = 2,4Ω

5. V_3 = 3V V_2 = 4V
   R_3 = 3/3 = 1Ω V_4 = 5V
   A_1 = 4A R_4 = 1,25Ω
   A_4 = 4A

6. R_p = 4/5 = 0,8Ω

   R_{Total} = 2,4+0,8+0,8 = 4Ω

   I=V/R = 10/4 = 2,5A

   V_2 = 6V   (2,4)(2,5)

   V_4 = 2V   (0,8) (2,5)

   A_3 = 2A

   A_2 = 0,5A

   A_1 = A_4 = 2,5A

7. V_3 = 2V

   A_2 = 1A

   A_1 = A_5 = 3,4A

   V_4 = 6,8V

   V_2 = 3,4V

8. A_1 = 5A = A_5

   V_4 = 15V

   V_3 = 5V

   A_2 = 2A

   A_4 = 2A

   R_4 = 1,5Ω

9. V_3 = 4V

   A_3 = 10A

   A_4 = 8A

   A_1 = A_5 = 20A

   R_1 = 1Ω

   V_4 = 36V

   V_1 = 60V

Grade 12: Chemistry: Preparation of esters - Memorandum   **30 marks**

Aim: To prepare esters from alcohols and carboxylic acids.

Observations and results: [2]

Carboxylic acid	Alcohol	Odour of ester
ethanol	ethanoic acid	Paint thinners (paint or enamel paint)✓ (1)
methanol	salicylic acid	Wintergreen (or "Deep heat" or equivalent muscle rub) ✓ (1)

Analysis and interpretation:

1.   Name the two homologous series of organic compounds that are used in the preparation of esters   (2)

        Alcohol(s) ✓
        Carboxylic acid(s) ✓

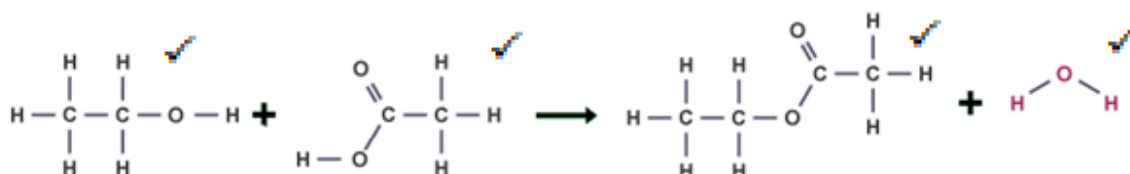2.   Write down the structural formula of the functional group of the following compounds:

2.1   An alcohol   -OH ✓   (1)

2.2   A carboxylic acid $-COOH$✓   or $-\overset{O}{\underset{||}{C}}-OH$ ✓   (1)

3.   This question concerns the reaction between **ethanol** and **ethanoic acid**. Concentrated sulfuric acid acts as a catalyst in this reaction.

3.1   Use full structural formulae to write the balanced equation for this reaction.   (4)

3.3   Name the ester formed during this reaction.   (2)

ethyl ✓ ethanoate ✓

3.4   Name an everyday substance which smells like ethanoic acid.   (1)

vinegar ✓

3.5   Would this reaction take place if the catalyst was not added to the reaction mixture?
       Explain briefly.   (3)

*Yes. ✓ The catalyst speeds up the reaction without changing its own chemical
composition ✓ so the reactants will react **very slowly**. ✓*

3.3   Briefly explain how the presence of a catalyst speeds up the rate of a reaction.   (3)

*The catalyst lowers the activation energy of the reaction ✓ by providing an alternative
way for the reactants to interact with each other. ✓ If the activation energy is lower there
will be more molecules of the reactants with sufficient kinetic energy. This results in
more effective collisions, ✓ and hence the reaction rate is increased.*

3.3   At the end of the reaction the presenters said that they could not detect the smell of
       ethanoic acid in the test tube. What does this tell us about the contents of the test tube?
                                                                                                         (1)

*All (or most of) the ethanoic acid has reacted. ✓ (or There is no ethanoic acid left over
from the reaction) or equivalent response.*

3.6   Why does dilute sodium carbonate solution fizz (effervesce) when the contents of the
       test tube are added to it at the end of the reaction?   (3)

Sodium carbonate reacts ✓with the sulfuric acid ✓ giving off carbon dioxide (gas). ✓

                                                                                                     [21]

4.   This question concerns the reaction between salicylic acid and methanol.
       Concentrated sulfuric acid acts as a catalyst in this reaction.

4.1   Write down the full structural formula for methanol.   (1)
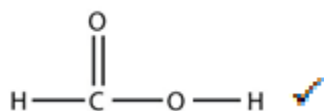
4.2   Which of ethanol or methanol has the higher boiling point? Explain briefly with reference
       to the forces between the molecules.   (3)

*Ethanol. ✓ Ethanol has larger molecules than methanol and therefore the London forces
✓between its molecules are stronger than those between methanol molecules. More
energy is needed to overcome the intermolecular forces in ethanol. ✓*

4.3 Name the ester formed by this reaction. (2)

methyl ✓ salicylate ✓

4.4 Give ONE use of this ester (in everyday life). (1)

To treat sore muscles (sprained ankles) ✓ (or equivalent answer).

[7]