DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	6,38 x 10^6 m
Mass of the Earth *Massa van die Aarde*	M_E	5,98 x 10^{24} kg
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} $J \cdot s$
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

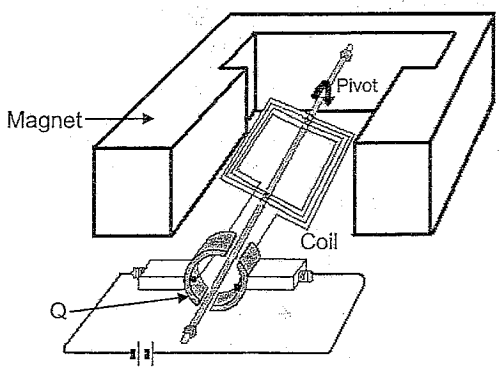
$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s}f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b}f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$	

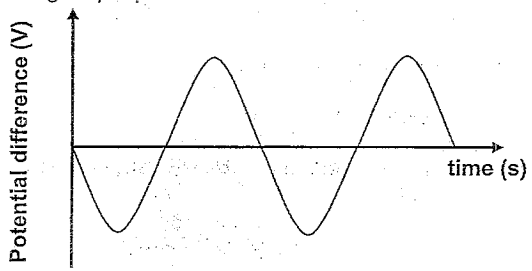
QUESTION 10

Study the sketch given below:



10.1 Write down the function of the component labelled Q in the above sketch. (1)

Two changes are made to the structure of the device shown in the above sketch to obtain the following output potential difference.



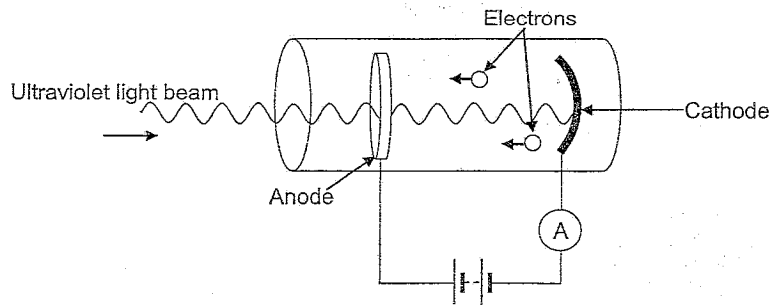
10.2 Write down the two changes that were made. (2)

When a 60 W light bulb is connected to the new device, a peak current of 0,54 A flows through the light bulb..

10.3 Calculate the potential difference of a DC supply that will produce the same brightness of the light bulb. (5)
[8]

QUESTION 11

The photo-electric effect has many practical applications. A photocell, such as the one below used in burglar alarm systems, is one such application.



The largest wavelength of monochromatic light that will cause the ejection of photoelectrons in the above photocell, is 229 nm. When a person interrupts the beam, the sudden drop in current activates a switch, which sets off the alarm.

11.1 Calculate the frequency of the monochromatic light of wavelength 229 nm. (3)

11.2 Give the scientific term for the frequency that you calculated in question 11.1 above. (1)

11.3 Define, in words, work function. (2)

11.4 Calculate the frequency of the monochromatic light that must be used to emit photoelectrons with a velocity of $1,57 \times 10^6$ m.s^{-1} from the cathode of the above photocell. (5)

11.5 How will the answer in QUESTION 11.4 change if the largest wavelength of monochromatic light needed to eject photoelectron is reduced to 189 nm? Write down INCREASE, DECREASE or REMAINS THE SAME. Give a reason for your answer. (3)

[14]

TOTAL SECTION B: [130]

TOTAL MARKS: [150]

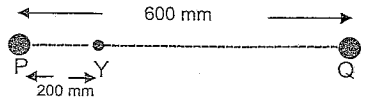
QUESTION 7

Below is an isolated point charge, P, of magnitude + 200 pC.

P ●

7.1 Draw a diagram to show the electric field pattern around the point charge P. (2)

7.2 A second point charge, Q, also carrying a charge of +200 pC, is placed 600 mm away from the point charge P as shown in the diagram below:



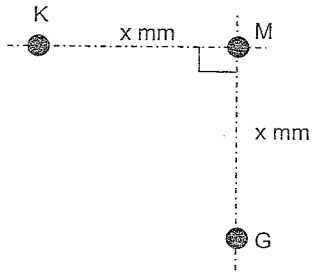
Y is a point 200 mm to the right of point charge P.

7.2.1 Define the term *electric field at a point.* (2)

7.2.2 Calculate the net electric field at point Y due to the charges P and Q. (6)
[10]

QUESTION 8

Three small, identical metal spheres, K, M and G are placed in a vacuum. Each sphere carries a charge of 6 nC. The spheres are arranged such that K and G are each x mm from M as shown in the diagram below:



8.1 State Coulomb's Law in words. (2)

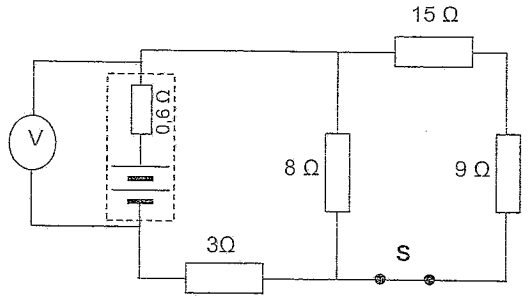
The magnitude of the **net force** exerted on M by K and G is $2,864 \times 10^{-6}$ N.

8.2 Calculate the magnitude of the electrostatic force exerted on G by M. (4)

8.3 Calculate the distance, x, between G and M. (4)
[10]

QUESTION 9

9.1 The battery used in the circuit below has an internal resistance of 0,6 Ω. It is observed that 12 J of energy is given to each coulomb of charge that passes through the battery per second.



The resistance of the connecting wires can be ignored.

9.1.1 Write down the term that is used to describe the underlined words. (1)

9.1.2 Calculate the current that flows through the 3 Ω resistor. (6)

9.1.3 Determine the reading on the voltmeter. (3)

The switch, S, is now opened.

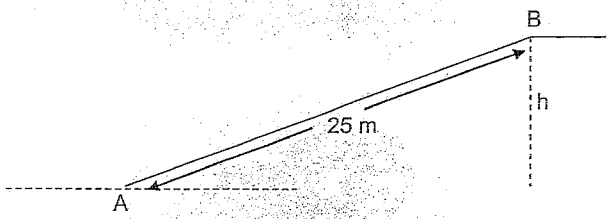
9.1.4 Will the reading on the voltmeter, V, INCREASE, DECREASE or REMAIN THE SAME. (1)

9.1.5 Briefly explain your answer to question 9.1.4 above. (3)

9.2 A learner uses an electrical heater of resistance 48 Ω that operates at a potential difference of 240 V to heat her room for half an hour. Calculate the cost of operating the heater if the cost of electricity is R1,47 per unit. (1 unit = 1 k.W.h) (4)
[18]

QUESTION 5

The diagram below shows a truck of mass, 12 000 kg free-wheeling, (engine of the truck does no work on the truck) up a straight inclined road of length 25 m. The truck experiences a constant frictional force of magnitude 3 400N as it moves up the incline. The truck enters the bottom of the incline, point A, with a speed of 25 $m.s^{-1}$ and reaches the top of the incline, point B, with a speed of 20 $m.s^{-1}$.



5.1 State the work-energy theorem in words. (2)

5.2 Draw a labelled force diagram showing all the forces acting on the truck as it moves up the incline. (3)

5.3 Calculate the net work done on the truck on moving from the bottom of the incline to the top of the incline. (4)

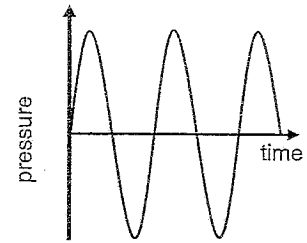
5.4 What is meant by a non-conservative force? (1)

5.5 Show that the work done by the non-conservative force is – 85 000 J. (3)

5.6 Hence calculate the height, h, reached by the truck at the top of the incline. (5)
[18]

QUESTION 6

The following is a pressure versus time graph (not drawn to scale) for the sound waves emitted from the siren of a stationary ambulance as detected at a given point.



The ambulance now moves towards the detector at a speed of 31,50 $m \cdot s^{-1}$. The detector records a reading of 445 Hz.

6.1 Copy the above graph in your answer book and label it P. On the same system of axes draw the graph that best represents the sound wave, that was emitted by the siren of the ambulance as it moved towards the detector. (2)

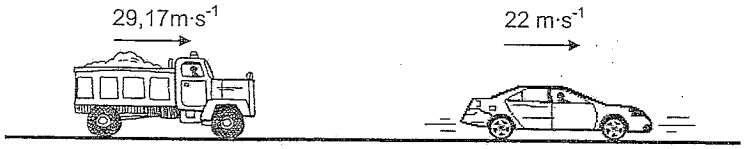
6.2 Describe the phenomenon observed in QUESTION 6.1. (2)

6.3 Calculate the frequency of the sound waves emitted by the siren of the ambulance. The speed of sound in air is 340 $m \cdot s^{-1}$. (6)

6.4 Describe ONE positive impact of the above phenomenon in medicine. (3)
[13]

QUESTION 3

A truck of mass 3 000 kg is travelling at 29,17 $m \cdot s^{-1}$ to the right. At the same time a car of mass 1 000 kg is travelling at 22 $m \cdot s^{-1}$ in the same direction ahead of the truck.



Ignore the effects of friction.

The truck collides with the car and they stick together after the collision.

3.1 State the *principle of conservation of linear momentum* in words. (2)

3.2 Calculate the velocity of the truck-car system immediately after the collision. (5)

3.3 Is the collision between the truck and the car elastic or inelastic? (1)

3.4 On impact the truck exerts a force of magnitude F on the car and the car experiences an acceleration of magnitude *a*.

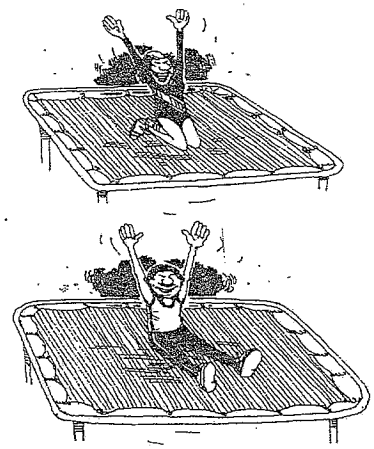
3.4.1 Will the magnitude of the force that the car exerts on the truck, on impact, be GREATER THAN, LESS THAN or EQUAL TO, F. (1)

3.4.2 Name and state the Law of motion that explains the answer to question 3.4.1. (3)

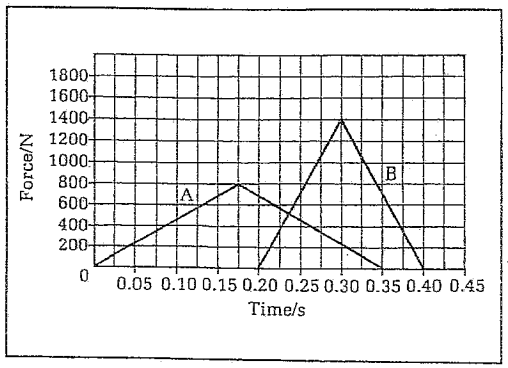
[12]

QUESTION 4

The pictures below show a girl of mass 45 kg and boy of mass 65 kg, bouncing off separate, identical trampolines at a fun fair.



The graphs below show how the forces exerted by the trampolines on the children vary with time during one bounce. Graph A represents the force exerted on the girl by the trampoline and Graph B represents the force exerted on the boy by the trampoline.



4.1 Define IMPULSE. (2)

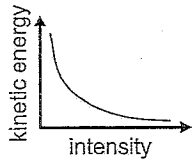
4.2 Show with the aid of relevant calculations that the impulse of the boy is equal in magnitude to the impulse of the girl. (5)

4.3 If the boy and girl jumped onto their trampolines from the same height, Which ONE of the two will rebound with a greater speed? (1)

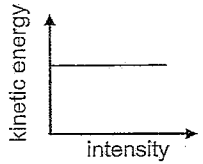
[8]

1.10 Which ONE of the following graphs best represents the relationship between the maximum kinetic energy of the emitted photoelectrons and the intensity of the incident radiation?

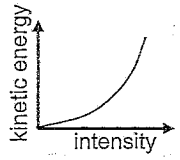
A



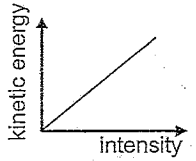
B



C



D

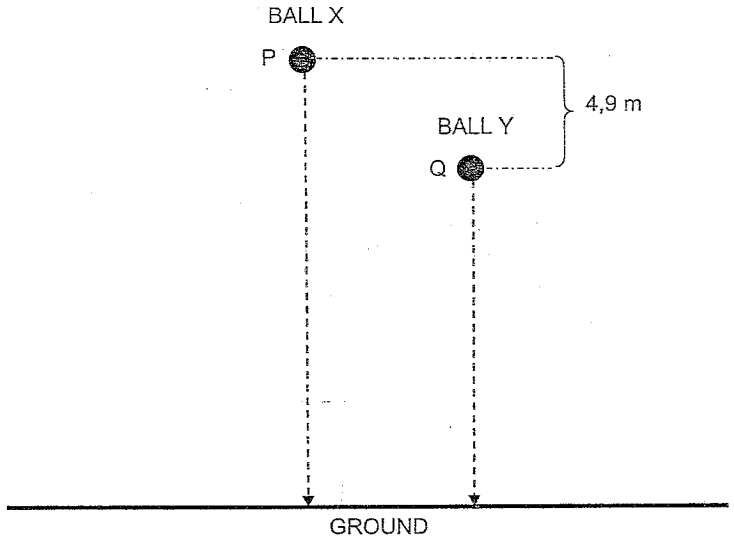


(2)

TOTAL FOR SECTION A: [20]

QUESTION 2

A ball, X, is thrown vertically downwards, with an initial speed of 2,5 $m.s^{-1}$, from a point P located above the ground. At the same instant a second identical ball, Y, is dropped from a point Q which is located 4,9 m below point P.



Both balls hit the ground at the same time.

In answering the following questions ignore the effects of air friction.
Take downward motion as positive.

2.1 Once in motion both balls are said to be in free fall.
Give a reason to support this statement. (1)

2.2 Calculate the time taken by ball Y to hit the ground. (5)

2.3 Calculate the velocity with which ball, X, strikes the ground. (4)

2.4 Use the answer obtained in question 2.3 to calculate the height of point Q above the ground. (4)

2.5 Will ball Y strike the ground with a velocity GREATER THAN, LESS THAN or EQUAL TO, the velocity with which ball X strikes the ground? (1)

2.6 On the same system of axes, sketch the relevant velocity-time graph for the entire motion of both balls X and Y. Indicate on your graph the corresponding velocity and time values. Label your graphs. (4)
[19]

1.4 The engine of a car does work, *W*, to increase its velocity from 0 to *v*. The work done by the engine to increase the velocity from ***v* to 2*v***, is:

A W
B 2 W
C 3 W
D 4 W

(2)

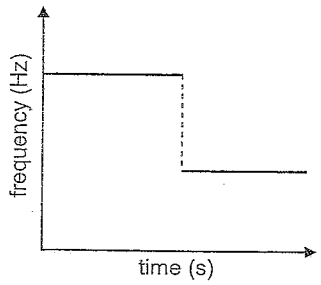
1.5 The red shift can be used to estimate the speed of a galaxy relative to Earth. Which ONE of the following statements is CORRECT? Distant galaxies are moving . . .

A faster than nearer galaxies and the universe is expanding.
B faster than nearer galaxies and the universe is contracting.
C slower than nearer galaxies and the universe is contracting.
D moving at the same speed as nearer galaxies and the universe remains unchanged.

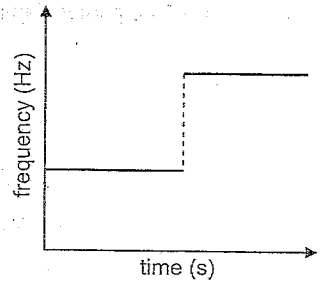
(2)

1.6 A source of sound approaches a stationary listener in a straight line at constant velocity. It passes the listener and moves away from him in the same straight line at the same constant velocity.
Which ONE of the following graphs best represents the change in observed frequency against time?

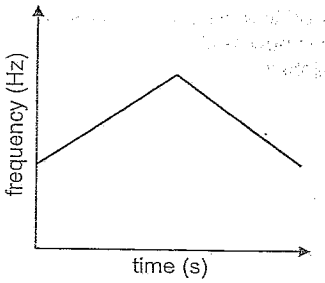
A



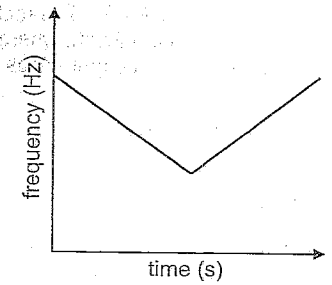
B



C



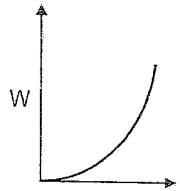
D



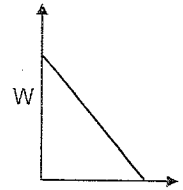
(2)

1.7 Which ONE of the following graphs best represent the relationship between the electrical power and the current in a given ohmic conductor?

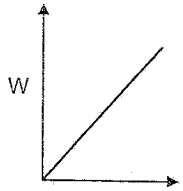
A



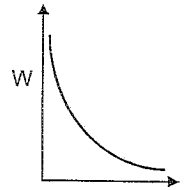
B



C

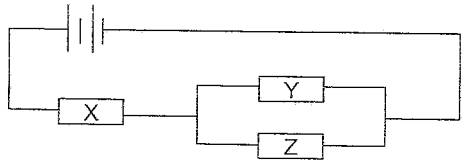


D



(2)

1.8 Three identical resistors X, Y and Z are connected as shown in the circuit below.



If the power in X is P, then the power in Y is ...

A P
B ½ P
C ¼P
D 2P

(2)

1.9 Which ONE of the following statements is true?

A An atomic absorption spectrum is formed when certain frequencies of electromagnetic radiation that passes through a medium such as a cold gas is absorbed.
B An atomic absorption spectrum is formed when certain frequencies of electromagnetic radiation that passes through a medium such as a cold gas is emitted.
C An atomic emission spectrum is formed when certain frequencies of electromagnetic radiation are absorbed due to an atom's electrons making a transition from a high-energy state to a lower energy state.
D An atomic emission spectrum is formed when certain frequencies of electromagnetic radiation are emitted due to an atom's electrons making a transition from a low-energy state to a higher energy state.

(2)

ELECTROSTATICS/*ELEKTROSTATIKA*

$F=\frac{kQ_1Q_2}{r^2}$	$E=\frac{kQ}{r^2}$
$E=\frac{F}{q}$	$V=\frac{W}{q}$
$n=\frac{Q}{e}$ or/*of* $n=\frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R=\frac{V}{I}$	emf $(\varepsilon) = I(R + r)$ emk $(\varepsilon) = I(R + r)$
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p}=\frac{1}{R_1}+\frac{1}{R_2}+\ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\,\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P=\frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P=\frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms}=\frac{I_{max}}{\sqrt{2}}$ / $I_{wgk}=\frac{I_{maks}}{\sqrt{2}}$	$P_{average}=V_{rms}I_{rms}$ / $P_{gemiddeld}=V_{wgk}I_{wgk}$
$V_{rms}=\frac{V_{max}}{\sqrt{2}}$ / $V_{wgk}=\frac{V_{maks}}{\sqrt{2}}$	$P_{average}=I_{rms}^2R$ / $P_{gemiddeld}=I_{wgk}^2R$
	$P_{average}=\frac{V_{rms}^2}{R}$ / $P_{gemiddeld}=\frac{V_{wgk}^2}{R}$

SECTION A

QUESTION 1: MULTIPLE- CHOICE QUESTIONS

Four options are provided as possible answers to each of the following questions. Each question has only ONE correct answer. Write only the letter (A - D), of your choice next to the question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 A student throws a tennis ball vertically upwards into the air. She catches the ball 10 s later at the same height from which she threw it. Which ONE of the following statements is INCORRECT with regards to the above situation?

A The velocity of the ball decreases as it moves upwards.
B The velocity of the ball is zero when it reaches its maximum height.
C The ball returns to the student's hands with the same speed with which she threw the ball upwards.
D The acceleration of the ball as it goes upwards is equal to the acceleration of the ball as it falls downwards but in the opposite direction. (2)

1.2 A spacecraft of mass M is moving in free space with a velocity v when it explodes and breaks into two parts. After the explosion, a portion of the spacecraft with mass m is left stationary. Which ONE of the expressions below gives the velocity of the portion that is motion?

A $\frac{Mv}{(M+m)}$
B $\frac{Mv}{(M-m)}$
C $\frac{(M+m)v}{M}$
D $\frac{Mv}{m}$ (2)

1.3 A rocket of mass M, experiences a gravitational force F on the surface of the Earth, which has a radius R. The rocket blasts off to a distance R, vertically above the surface of the Earth, where its mass is now ¾ M.
The gravitational force it experiences at this height is . . .

A F
B 3 F
C ¾ F
D 3/16 F (2)

QUESTION 10

10.1 ensure continuous rotation of the coil✓ (1)

10.2 remove the source of potential difference✓
replace the split ring commutator with 2 slip rings✓ (2)

10.3 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{rms} = \frac{0,54}{\sqrt{2}}$ ✓

$= 0,38$ A

$P_{ave} = V_{rms} I_{rms}$ ✓

$60 = V_{rms} \times 0,38$✓

$V_{rms} = 157,89$ V✓ (5)
[8]

QUESTION 11

11.1 $c = f \times \lambda$✓

$3 \times 10^8 = f \times 229 \times 10^{-9}$✓

$f = 1,31 \times 10^{15}$ Hz✓ (3)

11.2 threshold frequency✓ (1)

11.3 the minimum amount of energy required to emit electrons from the surface of a metal. ✓✓ (2)

11.4 $hf = W_o + \frac{1}{2} mv^2$ ✓

$6,63 \times 10^{-34} \times f$✓ $= (6,63 \times 10^{-34} \times 1,31 \times 10^{15})$ ✓ $+ \frac{1}{2} (9,11 \times 10^{-31}) (1,57 \times 10^6)^2$ ✓

$f = 3 \times 10^{15}$ Hz ✓ (5)

11.5 INCREASES✓
A decrease in wavelength results in an increase in the frequency. ✓
Work function increases. ✓ (3)
[14]

TOTAL MARKS: [150]

QUESTION 1

1.1 D✓✓ (2)
1.2 B✓✓ (2)
1.3 D✓✓ (2)
1.4 C✓✓ (2)
1.5 A✓✓ (2)
1.6 A✓✓ (2)
1.7 A✓✓ (2)
1.8 C✓✓ (2)
1.9 A✓✓ (2)
1.10 B✓✓ (2)

QUESTION 2

2.1 Only the force of gravity acts on the balls. ✓ (1)

2.2 X: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$✓

$= (2,5)\ \Delta t$ ✓ $+ \frac{1}{2}(9,8)\ \Delta t^2$✓

Y: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$

$= 0 + \frac{1}{2}(9,8)\ \Delta t^2$✓

Y must be increased by 4,9 m to equal X

$(2,5)\ \Delta t + \frac{1}{2}(9,8)\ \Delta t^2 = 4,9 + \frac{1}{2}(9,8)\ \Delta t^2$

$\Delta t = 1,96$ s✓ (5)

2.3 $v_f = v_i + a\Delta t$✓

$= 2,5$ ✓ $+ (9,8)(1,96)$ ✓

$= 21,71$

$v_f = 21,71$ m.s^{-1}downwards ✓ (4)

2.4 X: $v_f^2 = v_i^2 + 2a\Delta y$✓

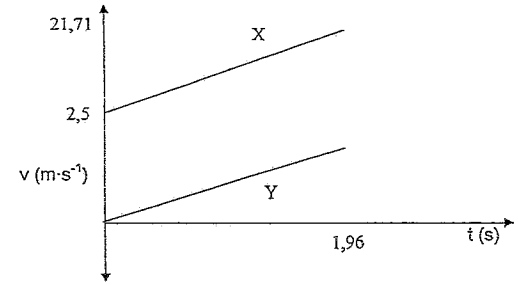
$21,71^2 = 2,5^2$ ✓$+ 2(9,8)(\Delta y)$ ✓

$\Delta y = 23,73$ m

Height Q = 23,73 - 4,9 = 18,83 m ✓ (4)

2.5 less than✓ (1)

2.6



Label both axes✓
Both parallel lines✓
Y starts on (0,0) ✓
X (0, 2,5) and (1,96, 21,71) ✓ (4)

If candidates choose downward motion as negative (Maximum 18/19)

2.2 X: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓
$= (-2,5)\,\Delta t$ ✓ + $\frac{1}{2}(-9,8)\,\Delta t^2$ x

Y: $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= 0 + \frac{1}{2}(-9,8)\,\Delta t^2$✓

Y must be increased by 4,9 m to equal X

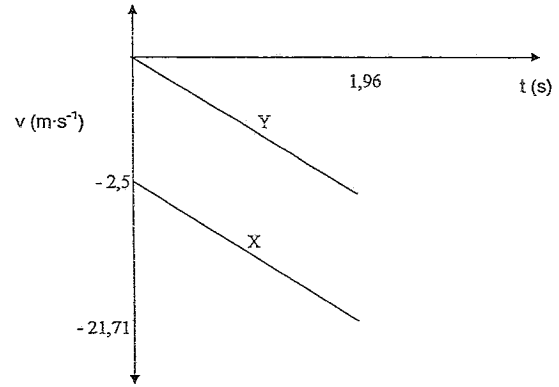
$(-2,5)\,\Delta t + \frac{1}{2}(-9,8)\,\Delta t^2 = -4,9 + \frac{1}{2}(-9,8)\,\Delta t^2$
$\Delta t = 1,96$ s✓ maximum 4/5 (4)

2.3 $v_f = v_i + a\Delta t$✓
$= -2,5$ ✓ + $(-9,8)(1,96)$ ✓
$= -21,71$
$v_f = 21,71$ m.s^{-1}downwards ✓ (4)

2.4 X: $v_f^2 = v_i^2 + 2a\Delta y$✓
$-21,71^2 = -2,5^2$ ✓+ $2(-9,8)(\Delta y)$ ✓
$\Delta y = -23,73$ m
Height Q = -23,73 + 4,9 = 18,83 m ✓ (4)

2.5 less than✓ (1)

2.6



Label both axes✓
Both parallel lines✓
Y starts on (0,0) ✓
X (0, -2,5) and (1,96, -21,71) ✓ (4)
[18/19]

QUESTION 3

3.1 Total linear momentum of an isolated system remains constant in magnitude an direction✓✓ (2)

3.2 Total p before = Total p after
$mv_i + mv_i = mv_f + mv_f$✓
(3 000 x 29,17) ✓ + (1 000 x 22) ✓ = (4 000) v_f✓
$v_f = 27,38$ m.s^{-1} in the original direction✓ (5)

3.3 inelastic✓ (1)

3.4.1 equal to F✓ (1)

3.4.2 Newton's third Law of motion. ✓
If body A exerts a force on body B, body B exerts an equal force on body A but in opposite direction. (3)

(12)

QUESTION 4

4.1 Product of net force and the time for which the force acts. ✓✓ / OR impulse is the change in momentum. (2)

4.2 Change in momentum of the girl = Δp = impulse
= area under graph A ✓
= ½ x b x h
= ½ x 0,35 x 800 ✓
= 140 kg·m·s^{-1} (or N·s) ; (up) ✓
Change in momentum of the boy = Δp = impulse
= area under graph B
= ½ x b x h
= ½ x (0,4 – 0,2) x 1 400 ✓
= 140 kg·m·s^{-1} (or N·s) ; (up) ✓ (5)

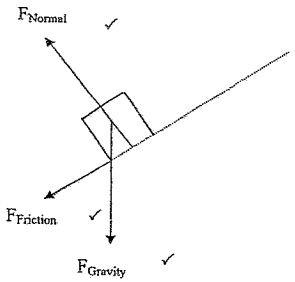
4.3 girl ✓ (1)

[8]

QUESTION 5

5.1 Net work done on an object is equal to the change in the kinetic energy of the object. ✓✓ (2)

5.2



(3)

5.3 $W_{net} = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$= ½ mv_f^2 - ½ mv_i^2$ ✓
$= ½(12\,000)(20)^2$ ✓ - $½(12\,000)(25)^2$ ✓
$= -1350\,000$ J ✓ (4)

5.4 The work done by this force is not dependant on the path taken. ✓ (1)

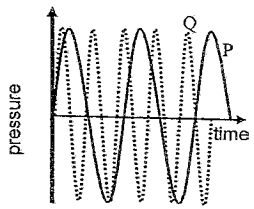
5.5 $W_{Ff} = F_f \Delta x \cos\theta$ ✓
$= (3\,400)(25)$ ✓ $(\cos 180)$ ✓
$F_f = -85\,000$ J (3)

5.6 $W_{nc} = \Delta U + \Delta K$ ✓
$-85\,000$ ✓ $= mgh_f - mgh_i + ½ mvf^2 - ½ mvi^2$
$= (12\,000 \times 9,8 \times h - 0)$ ✓ $+ (-1350\,000)$ ✓
$h = 10,76$ m ✓ (5)

[18]

QUESTION 6

6.1



smaller wavelength ✓ but same amplitude ✓ (2)

6.2 The apparent change in the frequency of the sound wave heard by a listener when there is relative motion between the listener and the source producing the sound waves. ✓✓ (2)

6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

445 ✓ $= \frac{340 \text{ ✓} + 0}{340 - 31,5 \text{ ✓}} \times f_s$ ✓
$f_s = 403,77$ Hz ✓ (6)

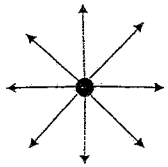
6.4 The Doppler effect is used in the Doppler flow meter to determine the speed of blood in the vessels. ✓
This indicates whether the vessels are narrowing or not which influences a change in lifestyle ✓
Hence prevents/reduces the chances of a stroke or heart attack. ✓ (3)

[13]

QUESTION 7

7.1 The force per unit charge at that point. ✓✓ (2)

7.2.1



✓✓

(2)

7.2.2 $E_P = \frac{kQ_1}{r^2}$ ✓

$= \frac{9 \times 10^9 \times 200 \times 10^{-12}}{(0,2)^2}$ ✓✓

$= 45\ N.C^{-1}$ to the right

$E_Q = \frac{kQ_1}{r^2}$

$= \frac{9 \times 10^9 \times 200 \times 10^{-12}}{(0,4)^2}$ ✓✓

$= 11,25\ N.C^{-1}$ to the left

$E_{net} = 45 + (-11,25) = 33,75\ N.C^{-1}$ to the right✓ (6)

[10]

QUESTION 8

8.1 The force of attraction or repulsion between two charges at rest is directly proportional to the product of the charges and inversely proportional to the square of the distance between their centres. ✓✓ (2)

8.2 Since $F_{K\ on\ M} = F_{G\ on\ M}$✓

$(F_{net})^2 = (F_{K\ on\ M})^2 + (F_{G\ on\ M})^2$✓

$(2,864 \times 10^{-6})^2$✓ $= F^2 + F^2$

$F = 2,025 \times 10^{-6}$ N✓ (4)

8.3 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$2,025 \times 10^{-6}$✓ $= \frac{9 \times 10^9 \times 6 \times 10^{-9} \times 6 \times 10^{-9}}{(x)^2}$ ✓

$x = 0,4$ m✓ (4)

[10]

QUESTION 9

9.1.1 emf ✓✓ (1)

9.1.2 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_p} = \frac{1}{8} + \frac{1}{9+15}$ ✓✓

$Rp = 6\ \Omega$

$Rext = 6 + 3 = 9\ \Omega$

$emf = I(R + r)$ ✓

$12 = I(9 + 0,6)$ ✓

$I = 1,25$ A✓ (6)

9.1.3 $V = IR$✓

$= (1,25)(9)$ ✓

$= 11,25$ V✓ (3)

9.1.4 increase✓ (1)

9.1.5 total resistance increases✓
total current decreases✓
lost volts decreases✓ (3)

9.2 $W = \frac{V^2 \Delta t}{R}$ ✓

$= \frac{240^2 \times (30 \times 60)}{48}$ ✓

$= 2160\ 000$ J

Cost $= \frac{2160\ 000}{(3600 \times 1000)} \times 1,47$✓

$= R\ 0,882$✓ (4)

[18]

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name in the appropriate spaces on the ANSWER BOOK.
2. Answer ALL the questions in the ANSWER BOOK
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Data sheet and periodic table are attached for your use.
7. Give brief motivations, discussions, et cetera where required.

QUESTION 1: MULTIPLE – CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 An organic compound that is always found in alcoholic drinks:

A CH_3OH
B C_6H_{10}
C C_2H_5OH
D $C_6H_5(CH_3)$ (2)

1.2 In which one of the following alternatives are the three compounds listed in order of their increasing boiling point?

A pentanoic acid, pentane, pentan-1-ol
B pentan-1-ol, pentane, pentanoic acid
C pentane, pentan-1-ol, pentanoic acid
D pentane, pentanoic acid, pentan-1-ol (2)

1.3 Which one of the following correctly shows the two homologous series which react together to produce esters?

A	Carboxylic acid	Haloalkane
B	Alcohol	Alkene
C	Haloalkane	Ketone
D	Carboxylic acid	alcohol

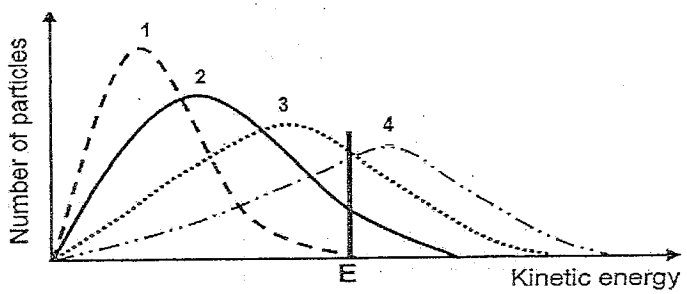
(2)

1.4 Magnesium reacts with sulphuric acid to liberate hydrogen gas. Which one of the set of conditions for the sulphuric acid will ensure the highest rate of hydrogen gas released?

	Temperature (°C)	Volume (cm^3)	Concentration ($mol.dm^{-3}$)
A	20	50	1
B	20	100	2
C	40	100	1
D	40	50	2

(2)

1.5 The following is the Maxwell-Boltzmann energy distribution curve for a reaction at four different temperatures. E represents the activation energy for the reaction.



Which one of these curves represent the reaction with the highest rate?

A 1
B 2
C 3
D 4 (2)

1.6 The air pollutant sulphur dioxide (SO_2) can be removed from a gas mixture by passing the mixture over calcium oxide according to the reaction:

$$CaO(s) + SO_2(g) \rightleftharpoons CaSO_3(s)$$

If the equilibrium concentration of $SO_2(g)$ at 25°C is equal to 0,01 mol.dm^{-3}, the value of the equilibrium constant at this temperature will be:

A 200
B 150
C 100
D 50 (2)

1.7 Consider the following reaction equation:

$$NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

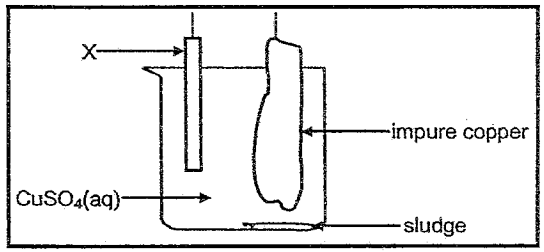
The two Bronsted-Lowry bases in the reaction equation are:

A NH_3 and H_2O
B NH_4^+ and OH^-
C H_2O and NH_4^+
D NH_3 and OH^- (2)

1.8 The cell notation for a standard Zn – Cu electrochemical cell is:

A $Cu^{2+}(aq) / Cu(s) \;//\; Zn(s) / Zn^{2+}(aq)$
B $Zn(s) / Zn^{2+}(aq) \;//\; Cu^{2+}(aq) / Cu(s)$
C $Cu(s) / Zn^{2+}(aq) \;//\; Cu^{2+}(aq) / Zn(s)$
D $Zn(s) / Zn^{2+}(aq) \;//\; Cu(s) / Cu^{2+}(aq)$ (2)

1.9 The diagram below represents a part of an electrochemical cell used for refining copper. The impure copper contains silver metal and zinc metal.



Which ONE of the following half-reactions will take place at electrode X?

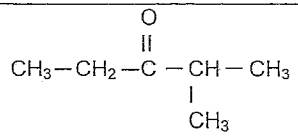
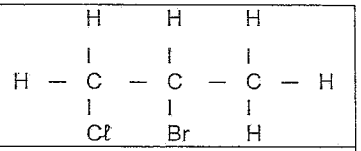
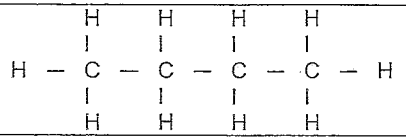
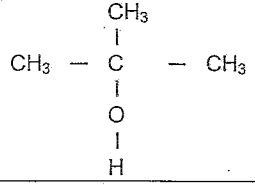
A $Ag^+ + e^- \rightarrow Ag$
B $Cu \rightarrow Cu^{2+} + 2e^-$
C $Cu^{2+} + 2e^- \rightarrow Cu$
D $Zn^{2+} + 2e^- \rightarrow Zn$ (2)

1.10 What is name of the process used for the industrial preparation of sulphuric acid?

A Haber process
B Ostwald process
C Contact process
D Fractional distillation (2)
[20]

QUESTION 2

Consider the following representation of organic molecules **A** to **F** listed in the table below:

A		**B**	
C		**D**	Methanal
E	2-methylhex-3-yne	**F**	

2.1 Write down the letter that represents a compound that:

2.1.1 Is an aldehyde (1)

2.1.2 Is a saturated hydrocarbon (1)

2.1.3 Has a general formula C_nH_{2n-2} (1)

2.2 Write down the homologous series to which each of the following compounds belongs:

2.2.1 **A** (1)

2.2.2 **B** (1)

2.2.3 **F** (1)

2.3 Write down the:

2.3.1 Molecular formula of the next compound in the same homologous series as compound **C**. (1)

2.3.2 Structural formula of compound E (2)

2.3.3 IUPAC name of compound **B** (2)

2.3.4 Functional group of compound **D** (1)

[12]

QUESTION 3

Two compounds **A** and **B**, have the molecular formula $C_2H_4O_2$.

3.1 What is meant by the term **structural isomers**? (2)

3.2 Compound A has a lower vapour pressure than compound B.

3.2.1 How will the boiling point of compound A compare to that of compound B. Only write HIGHER THAN, LOWER THAN, or EQUAL TO. (1)

3.2.2 Write down the name of compound A. (1)

3.2.3 To which class of organic compound does compound B belong? (1)

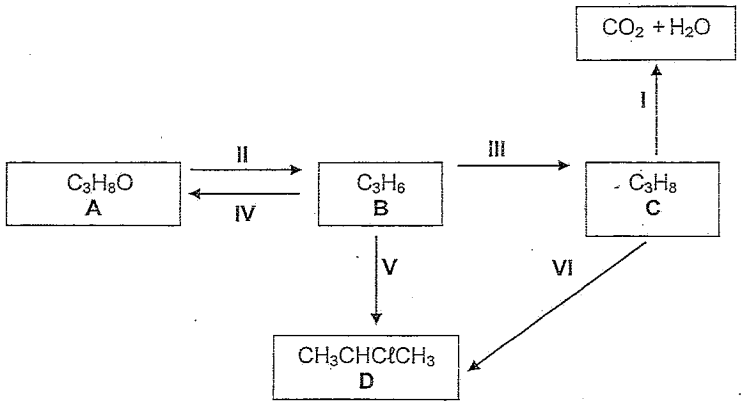
3.2.4 Write down the structural formula for compound B and give its IUPAC name. (3)

3.2.5 Explain in terms of intermolecular forces and energy why compound A has a lower vapour pressure than compound B. (3)

[11]

QUESTION 4

Consider the following sequence of organic reactions and then answer the questions that follow. Reactions are labeled from **I** to **VI** while organic compounds are labeled from **A** to **D.**



4.1 Give the reagent needed for each of the following reactions:

4.1.1 Reaction **III** (1)

4.1.2 Reaction **V** (1)

4.2 Compound **A** is a major product of reaction **IV**.

4.2.1 Name the type of reaction that takes place. (1)

4.2.2 Write down the structural formula of compound **A**. (2)

4.3 Reaction **II** converts compound **A** to compound **B** in the presence of concentrated sulphuric acid.

4.3.1 Is compound **A** a PRIMARY, SECONDARY or TERTIARY alcohol? (1)

4.3.2 Name the type of reaction that takes place. (1)

4.4 Reaction **I** is a combustion reaction.

4.4.1 Write down the balanced chemical equation for this reaction. (2)

4.4.2 Eleven grams (11g) of C_3H_8 undergoes complete combustion. Determine the mass of CO_2 gas produced at STP. (4)

[13]

QUESTION 5

A manufacturer makes a polymer, polyethene from the monomer, ethene by means of addition polymerisation. The polymer produced has an average relative molecular mass of $1,0 \times 10^4$.

5.1 What is meant by the following terms?

5.1.1 monomer (2)

5.1.2 polymerisation (2)

5.2 Write down an equation for the polymerisation of ethene to produce polyethene. (3)

5.3 How many monomer units are joined together to give polyethene with a relative molecular mass of 1.0×10^4? (2)

5.4 Most plastic bags are made from polyethene. Give one negative impact of the use of plastics on the environment. (1)

[10]

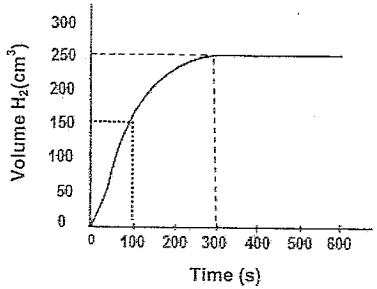
QUESTION 6 (Start on a new page.)

A group of learners conduct an experiment to investigate the rate of a reaction. The learners use a small amount of granulated zinc which is added to excess hydrochloric acid.

The balanced equation for the reaction is as follows:

$$Zn\,(s) + 2HC\ell\,(aq) \rightarrow ZnC\ell_2\,(aq) + H_2\,(g)$$

The hydrogen gas produced is collected at 290K. By measuring the volume of gas produced as a function of time, the graph below was obtained.



6.1 What information does the gradient of this graph give? (2)

6.2 Describe how the gradient of this graph changes between t=100s and t=200s? Give a reason for your answer. (2)

6.3 Give a reason why the graph becomes flat after 300 seconds? (2)

6.4 Calculate the average rate of reaction in $cm^3 \cdot s^{-1}$ for the first 100s. (3)

6.5 Use the collision theory to explain how the rate of the above reaction will change when the temperature is increased from 290K to 313K. (3)

6.6 The gas liberated in this experiment was collected at STP. Calculate the mass of zinc that was used. (5)

[17]

QUESTION 7

The Haber process is represented by the equation below:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

7.1 The percentage yield of ammonia increases with an increase in pressure at a a given temperature. Give a reason for this.

A mixture of nitrogen with an initial concentration 0,50 $mol.dm^{-3}$ and hydrogen with an initial concentration 1,50 $mol.dm^{-3}$ are placed in a closed 1 dm^{-3} container. When the equilibrium is attained at a certain temperature, 25,0% of the original nitrogen is consumed (used up).

7.2 Calculate the value of the equilibrium constant (Kc) under these conditions. (8)

7.3 How will the value of Kc change when:

7.3.1 Some NH_3 is pumped into the container? (1)

7.3.2 The temperature has been increased? (1)
(Write only INCREASES; DECREASES or STAYS THE SAME)

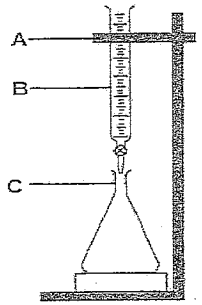
[12]

QUESTION 8

Commercial vinegar contains a small percentage of ethanoic acid. A laboratory technician wishes to determine the concentration of ethanoic acid in vinegar. He titrates a solution of ethanoic acid against a standard solution of sodium hydroxide of concentration 0,009 mol.dm^{-3}. The equation for the reaction is:

$$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(aq)$$

The apparatus shown below was used during the titration.



25,00 cm^3 of vinegar was diluted with distilled water and made up to a volume of 250,00 cm^3. Some of the diluted solution was added to apparatus B. 25,00 cm^3 of sodium hydroxide solution was added to apparatus C and few drops of an indicator added.

8.1 What is the name of apparatus B? (1)

8.2 Ethanoic is considered a weak acid. What is meant by term 'weak acid'? (2)

A titration was carried out and the results tabulated as shown below:

Experiment	Volume of CH_3COOH (cm^3)
1	21,1
2	21,1
3	20,9

8.3 What observation is made to identify the end point for the acid-base titration? (1)

8.4 Which one of the indicators listed in the table below is suitable to be used for the above titration? Give a reason for the answer. (3)

Indicator	pH range
Methyl orange	2,9 – 4,0
Bromothymol blue	6,0 – 7,6
Phenolphthalein	8,3 – 10,0

8.5 Calculate the concentration of dilute ethanoic acid. (5)

8.6 Calculate the concentration of ethanoic acid in vinegar. (4)
[16]

QUESTION 9

A grade 12 learner finds a 250cm^3 sulphuric acid (H_2SO_4) solution bottle with the following information and hazard symbol:

pH = 2,2

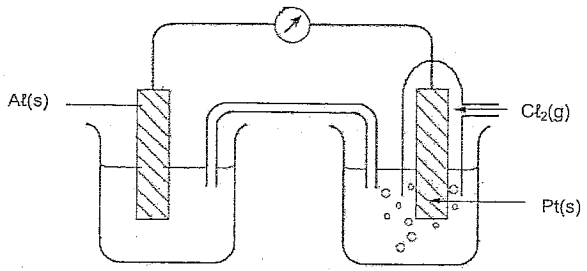
9.1 Suggest ONE safety precaution that should be taken when using the sulphuric acid in the experiment. (2)

9.2 Calculate the concentration of the sulphuric acid solution in the bottle. (6)

[8]

QUESTION 10

A galvanic cell is set up with $A\ell / A\ell^{3+}$ (aq) and $Pt / C\ell_2 / C\ell^-$(aq) half cells under standard conditions as shown below.



10.1 State the standard conditions that apply to this cell. (3)

10.2 Is Aℓ the anode or cathode? Give a reason for the answer. (2)

10.3 How will the mass of aluminium electrode change while the cell is in operation? (Write only INCREASES, DECREASES or STAYS THE SAME). (1)

10.4 Write a half reaction to support the answer in 10.3 above. (2)

10.5 Write down the:

10.5.1 Formula of the oxidizing agent in this cell. (1)

10.5.2 Reduction half reaction (2)

10.5.3 Overall net cell reaction (3)

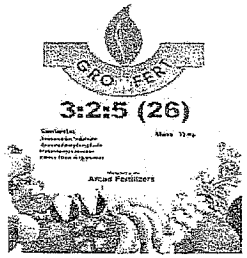
10.6 Calculate the initial emf of the cell. (4)

[18]

QUESTION 11

A 50 kg bag of fertilizer contains some information as shown below:

N - P - K



11.1 What information is represented by the numbers 3:2:5 (26) printed on the bag. (3)

11.2 Calculate the percentage of nitrogen in this bag. (2)

11.3 Is this fertiliser suitable for growing tomatoes? Give a reason for your answer. (2)

11.4 A member of a community came across a dam near the farm and saw the dam with a thick green covering on it. According to the community member the area was filled with a stench that was unbearable. The community member also noticed rotten fish floating on the surface.

11.4.1 NAME the phenomenon taking place in the dam. (2)

11.4.2 State a possible cause of the phenomenon in 11.4.1 (2)

11.4.3 Suggest TWO possible ways to prevent the phenomenon named in 11.4.1 from occurring. (2)

[13]

TOTAL MARKS: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2,0 5 B 11	2,5 6 C 12	3,0 7 N 14	3,5 8 O 16	4,0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1,5 13 Al 27	1,8 14 Si 28	2,1 15 P 31	2,5 16 S 32	3,0 17 Cl 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1,6 23 V 51	1,6 24 Cr 52	1,5 25 Mn 55	1,8 26 Fe 56	1,8 27 Co 59	1,8 28 Ni 59	1,9 29 Cu 63,5	1,6 30 Zn 65	1,6 31 Ga 70	1,8 32 Ge 73	2,0 33 As 75	2,4 34 Se 79	2,8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1,4 40 Zr 91	1,6 41 Nb 92	1,8 42 Mo 96	1,9 43 Tc	2,2 44 Ru 101	2,2 45 Rh 103	2,2 46 Pd 106	1,9 47 Ag 108	1,7 48 Cd 112	1,7 49 In 115	1,8 50 Sn 119	1,9 51 Sb 122	2,1 52 Te 128	2,5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 81 Tl 204	1,8 82 Pb 207	1,9 83 Bi 209	2,0 84 Po	2,5 85 At	86 Rn
0,7 87 Fr	0,9 88 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/*SLEUTEL*

Atomic number / *Atoomgetal*

Electronegativity / *Elektronegatiwiteit* → 1,9 Cu 63,5 ← Symbol / *Simbool*

Approximate relative atomic mass / *Benaderde relatiewe atoommassa*

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD- REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*			$E^{\ominus}$(V)
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$Cℓ_2(g) + 2e^-$	⇌	$2Cℓ^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$Br_2(ℓ) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(ℓ)$	+ 0,85
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	⇌	$H_2(g)$	0,00
$Fe^{3+} + 3e^-$	⇌	Fe	− 0,06
$Pb^{2+} + 2e^-$	⇌	Pb	− 0,13
$Sn^{2+} + 2e^-$	⇌	Sn	− 0,14
$Ni^{2+} + 2e^-$	⇌	Ni	− 0,27
$Co^{2+} + 2e^-$	⇌	Co	− 0,28
$Cd^{2+} + 2e^-$	⇌	Cd	− 0,40
$Cr^{3+} + e^-$	⇌	Cr^{2+}	− 0,41
$Fe^{2+} + 2e^-$	⇌	Fe	− 0,44
$Cr^{3+} + 3e^-$	⇌	Cr	− 0,74
$Zn^{2+} + 2e^-$	⇌	Zn	− 0,76
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	− 0,83
$Cr^{2+} + 2e^-$	⇌	Cr	− 0,91
$Mn^{2+} + 2e^-$	⇌	Mn	− 1,18
$Aℓ^{3+} + 3e^-$	⇌	Aℓ	− 1,66
$Mg^{2+} + 2e^-$	⇌	Mg	− 2,36
$Na^+ + e^-$	⇌	Na	− 2,71
$Ca^{2+} + 2e^-$	⇌	Ca	− 2,87
$Sr^{2+} + 2e^-$	⇌	Sr	− 2,89
$Ba^{2+} + 2e^-$	⇌	Ba	− 2,90
$Cs^+ + e^-$	⇌	Cs	− 2,92
$K^+ + e^-$	⇌	K	− 2,93
$Li^+ + e^-$	⇌	Li	− 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD- REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*			$E^{\ominus}$(V)
$Li^+ + e^-$	⇌	Li	− 3,05
$K^+ + e^-$	⇌	K	− 2,93
$Cs^+ + e^-$	⇌	Cs	− 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	− 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	− 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	− 2,87
$Na^+ + e^-$	⇌	Na	− 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	− 2,36
$Aℓ^{3+} + 3e^-$	⇌	Aℓ	− 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	− 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	− 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	− 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	− 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	− 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	− 0,40
$Co^{2+} + 2e^-$	⇌	Co	− 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	− 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	− 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	− 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	− 0,06
$2H^+ + 2e^-$	⇌	$H_2(g)$	0,00
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(ℓ)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(ℓ) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$Cℓ_2(g) + 2e^-$	⇌	$2Cℓ^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

Basic Education

KwaZulu-Natal Department of Basic Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES: CHEMISTRY (P2)

PREPARATORY EXAMINATION

MEMORANDUM

SEPTEMBER 2014

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS : 150

TIME : 3 Hours

This memorandum consists of 10 pages.

SECTION A

QUESTION 1

1.1 C✓✓ (2)
1.2 C✓✓ (2)
1.3 D✓✓ (2)
1.4 D✓✓ (2)
1.5 D✓✓ (2)
1.6 C✓✓ (2)
1.7 D✓✓ (2)
1.8 B✓✓ (2)
1.9 C✓✓ (2)
1.10 C✓✓ (2)

Total Section A: **[20]**

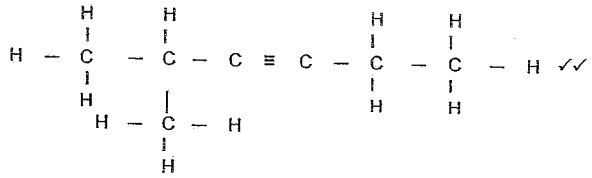
QUESTION 2

2.1.1 D ✓ (1)
2.1.2 C ✓ (1)
2.1.3 E ✓ (1)

2.2.1 Ketone ✓ (1)
2.2.2 Alkyl halide (haloalkane) ✓ (1)
2.2.3 Alcohol ✓ (1)

2.3.1 C_5H_{12} ✓ (1)

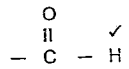
2.3.2



(2)

2.3.3 2-bromo✓-1-chloropropane ✓ (2)

2.3.4 (1)



[12]

QUESTION 3

3.1 Structural isomers are organic molecules with the same molecular formula, but different structural formulae. ✓✓ (2)

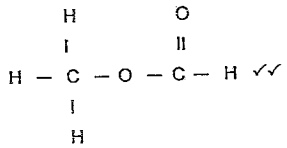
3.2

3.2.1 Greater (1)

3.2.2 Ethanoic acid (1)

3.2.3 Ester (1)

3.2.4



Methyl methanoate ✓ (3)

3.2.5 Compound A has strong hydrogen bond ✓ and compound B has weak Van der Waals forces. ✓ More energy is needed to overcome the intermolecular forces in compound A than in compound B. ✓ (3)

[11]

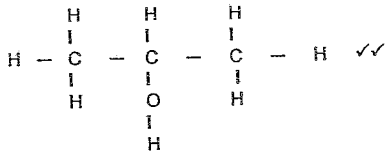
QUESTION 4

4.1.1 H_2 ✓ (1)

4.1.2 HCℓ ✓ (1)

4.2.1 Hydration (Addition) ✓ (1)

4.2.2 (2)



4.3.1 Secondary alcohol ✓ (1)

4.3.2 Dehydration ✓ (Elimination) (1)

4.4.1 $C_3H_8 + 5O_2$✓ $\rightarrow 3CO_2 + 4H_2O$ (Bal) ✓ (2)

4.4.2 $n = \frac{m}{M}$

$= \frac{11}{44}$ ✓

$= 0.25$ mol

Ratio of $C_3H_8 : CO_2$

1 : 3

0,75 mol of CO_2 produced✓

$n = \frac{m}{M}$

$0,75 = \frac{m}{44}$ ✓

$m = 33g$✓ (4)

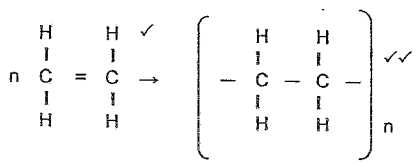
[13]

QUESTION 5

5.1.1 Small organic molecules that can be covalently bonded to each other in a repeating pattern. ✓✓ (2)

5.1.2 A chemical reaction in which monomer molecules join to form a polymer. ✓✓ (2)

5.2 (3)



5.3 number of units = $\frac{1 \times 10^4}{28}$ ✓

357.14 units ✓ (2)

5.4 Plastics causes pollution, it makes our country dirty and uncared for. ✓ (1)

[10]

QUESTION 6

6.1 reaction rate ✓ (2)

6.2 Between t=100s and t=200s the gradient is decreasing because the reaction rate decreases ✓as zinc is gradually being used up. ✓ (2)

6.3 After t=300s the reaction has stopped ✓because the zinc has been completely used up. ✓ (2)

6.4

rate of reaction = $\frac{\Delta \text{volume } (H_2)}{\Delta \text{time}}$

$= \frac{150 - 0}{100 - 0}$ ✓ ✓

$= 1.5 cm^3 s^{-1}$ ✓ (3)

6.5 High temperature means that reactant particles have more kinetic energy ✓ (E_K) therefore there will be more effective collisions per unit time, ✓ thus reaction rate increases. ✓ (3)

6.6 1 mol of H_2 ⟶ 22,4 dm^3 ✓
x mol of H_2 ⟶ 0,25 dm^3 ✓
$\therefore x$ = 0,011mol

From the equation 1mol of Zn produce 1mol of H_2. ✓(ratio)

Mass Zn = nM

m = nM

= (0,011)(65,4) ✓

= 0,73 g✓ (5)

[17]

QUESTION 7

7.1 An increase in pressure will favour the forward reaction because the equilibrium position will shift in the direction of smaller number of moles and there will be an increase in the yield of ammonia (2)

7.2 According to the equation, 1 mole of $N_2(g)$ reacts with 3 moles of $H_2(g)$ to give 2 moles of $NH_3(g)$.
As 25,0% of $N_2(g)$ are consumed, therefore the concentration of $N_2(g)$ decreases by (0.500 x 0.250). ✓✓
The concentration of $H_2(g)$ decreases by (3 x 0.500 x 0.250) } ✓
and the concentration of $NH_3(g)$ increases by (2 x 0.500 x 0.250) }
Equilibrium concentration of $N_2(g)$ = (0.500 – 0.500 x 0.250) = 0.375
Equilibrium concentration of $H_2(g)$ = (1.50 – 3 x 0.500 x 0.250) = 1.125 ✓
Equilibrium concentration of NH3(g) = (2 x 0.500 x 0.250) = 0.25✓
(8)

$$Kc = \frac{[NH_3]^2}{[N_2].[H_2]^3} \checkmark$$

$$Kc = \frac{(0.25)^2}{(0.375)(1.125)^3} \checkmark$$

Kc = 0.117 ✓

OR

	$N_2(g$	$3H_2(g$	$2NH_3(g)$
Initial concentration	0,50	1,50	0
Change in concentration	(0,125✓✓	0,375)	0,25 ✓
Equilibrium concentration	(0,375	1,125)✓	0,25✓

$$Kc = \frac{[NH_3]^2}{[N_2].[H_2]^3} \checkmark$$

$$Kc = \frac{(0.25)^2}{(0.375)(1.125)^3} \checkmark$$

Kc = 0.117 ✓

7.3.1 Stays the same ✓ (1)
7.3.2 decrease ✓ (1)
[12]

QUESTION 8

8.1 Burette ✓ (1)
8.2 weak acid ionizes (incompletely) in water to form a low concentration of H_3O✓✓ (2)
8.3 colour change of indicator✓ (1)
8.4 Phenolphthalein ✓ because the equivalent point will be at pH > 7 since CH_3COOH is weak acid and KOH a strong base. ✓✓ (3)

8.5 average volume = $\frac{21,1 + 21,1 + 20,9}{3}$

= 21,0 ✓

$\frac{Ca\ Va}{Cb\ Vb} = \frac{na}{nb}$ ✓

$\frac{Ca \times 21,0✓}{0,009 \times 25} = \frac{1}{1}$✓

Ca = 0,01 mol.dm^{-3} ✓ (5)

8.6 no of moles of CH_3COOH before dilution = no of moles of CH_3COOH after dilution.
n(CH_3COOH before dilution = n(CH_3COOH) after dilution ✓

$C_1V_1 = C_2V_2$

$C_1 \times 25✓ = 0,01 \times 250✓$

$C_1 = 2,5$ mol.dm^{-3} ✓ (4)
[16]

QUESTION 9

9.1 corrosive ✓
avoid spillage of acid ✓ (2)

9.2 $H_2SO_4 \rightarrow 2H_3O^+ + SO_4^{2-}$ ✓
$pH = -\log [H_3O^+]$ ✓
$2,2 = -\log [H_3O^+]$ ✓
$[H_3O^+] = 0,00631$ ✓
But H_2SO_4 is diprotic $\therefore [H_3O^+] = \frac{0,006}{2}$ ✓
$\therefore [H_2SO_4] = 0,003$ mol.dm^{-3} ✓ (6)
[8]

QUESTION 10

10.1 Temperature = 25^{0}C (298K) ✓
Concentration = 1mol.dm^{-3}✓
Pressure = 1,013 x 10^{5}Pa✓ (3)
10.2 Anode. Aℓ is a strong reducing agent OR Aℓ is oxidized to $Aℓ^{3+}$✓✓ (2)
10.3 Decreases ✓ (1)
10.4 $Aℓ \rightarrow Aℓ^{3+} + 3e^-$ ✓✓ (2)

10.5.1 $Cℓ_2$✓ (1)

10.5.2 $Cℓ_2 + 2e^- \rightarrow 2Cℓ^-$ ✓✓ (2)

10.5.3 $2Aℓ + 3Cℓ_2$ ✓ $\rightarrow 2Aℓ^{3+} + 6Cℓ^-$ ✓ balance ✓ (3)

10.6 $E^o_{cell} = E^o_{cathode} - E^o_{anode}$ ✓
$E^o_{cell} = 1,36$✓ – (- 1,66) ✓
$E^o_{cell} = 3,02$V✓ (4)
[18]

QUESTION 11

11.1 The ratio of nitrogen✓, phosphorus✓ and potassium✓ (3 parts nitrogen , 2 parts phosphorous , 5 parts potassium) (3)

11.2 %N = (3 / 10) x 26✓
= 7,8 ✓ (2)

11.3 Yes✓ because it has a high percentage of potassium that promotes flower and fruit development ✓ (2)

11.4.1 Eutrophication✓✓ (2)

11.4.2 Sudden growth of algae through excess fertilizes washed into the dam✓✓ (2)

11.4.3
- Responsible use of fertilizer ✓
- Use fertilisers sparingly. OR Do not over-fertilise. ✓
- Prevent run-offs through contour ploughing (2)

[13]
TOTAL MARKS: [150]