basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

TECHNICAL SCIENCES

PRACTICAL ASSESSMENT TASKS

GRADE 12

2018

MARKING GUIDELINES

These marking guidelines consist of 19 pages.

GRADE 12 FORMAL EXPERIMENTS

EXPERIMENT 1: DETERMINE THE RELATIONSHIP BETWEEN ACCELERATION AND FORCE FOR A CONSTANT MASS.

WORKSHEET FOR NEWTON'S SECOND LAW: OPTION 1

35

PRACTICAL SKILLS

1. Following instructions and manipulation.

CRITERIA		MARKS
Accurately following a sequence of written/verbal instructions	Following a sequence of instructions including branched instructions	1
Manipulative skills include correct and safe handling of apparatus and materials	Able to use all apparatus and material correctly and safely	1

2.1 Dependent variable: Acceleration✓ (1)

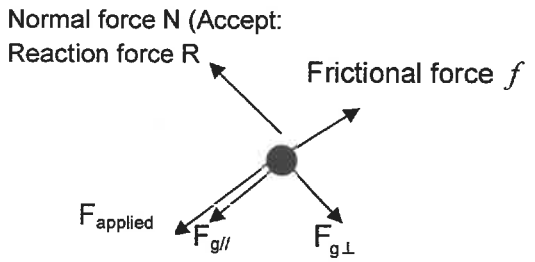
2.2 Independent variable: Net force✓ (1)

2.3 Controlled variable: Mass of the system (mass of the trolley and mass pieces)✓
Accept: Angle of inclination of the surface. **OR** surface **OR** length of the runway. (1)

3. **NOTE:** Credit 4 marks for free body diagram ONLY.
The reason for raising the runway MUST be credited on subquestion 4.

This question should have read as follows:
In point 1 of the METHOD of the experiment, you were asked to raise the runway. Draw a fully labelled free body diagram showing ALL forces acting on the trolley placed on the raised runway.

OPTION 1:



Credit: Weight/Gravitational for F_g

Marking Criteria:

Normal force✓

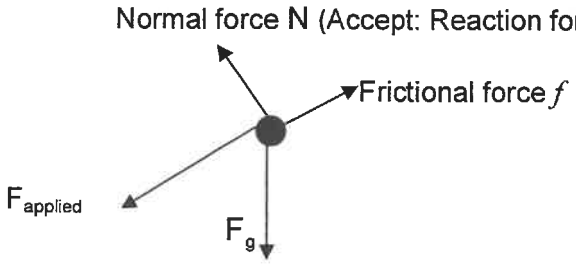
Frictional force✓

Weight (2 components)✓

$F_{applied}$ (tension on the string)✓

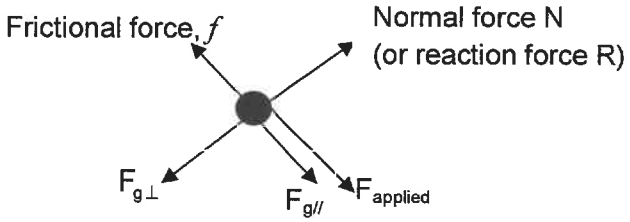
NOTE: If only ONE of the components is incorrect: No mark. (4)

OPTION 2:



Credit: Weight/gravitational for F_g

NOTE: For both OPTION 1 & 2 credit if the frictional, normal and applied forces are facing the other way indicated in the diagram below:



4. To overcome (the effects of) friction.✓ (1)

NOTE: Allocate ONE mark, not two marks as indicated in the questions.

5. To keep the mass of the system (mass of the trolley and mass pieces) constant✓ (1)

NOTE: Allocate ONE mark, not two marks as indicated in the questions.

6. **Data representation and interpretation of results**

TABLE 1:

1 mass piece (10 g) hanging (18)

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,798	4,45	0,146 - 0 = 0,146	$\frac{0,146}{4,45}$ =0,033	0,0263
2	0,65	0,798	4,50 ✓	0,144 – 0✓ = 0,144	$\frac{0,144}{4,50}$ =0,032✓	0,0255 ✓
3	0,65	0,798	4,49	0,145 – 0 = 0,145	$\frac{0,146}{4,45}$ =0,033	0,0263
Average	0,65	0,798	4,48	0,145	0,033	0,0260

2 mass pieces (2 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,788	2,48	0,262 - 0 = 0,262	$\frac{0,262}{2,48}$ =0,106	0,0835
2	0,65	0,788	2,45 ✓	0,265 – 0 = 0,265✓	$\frac{0,265}{2,45}$ =0,108✓	0,0851 ✓
3	0,65	0,788	2,54	0,256 – 0 = 0,256	$\frac{0,256}{2,54}$ =0,101	0,0796
Average	0,65	0,788	2,49	0,261	0,105	0,0827

3 mass pieces (3 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,778	1,70	0,382 - 0 = 0,38	$\frac{0,382}{1,70}$ =0,225	0,175
2	0,65	0,778	1,78 ✓	0,365 – 0 = 0,365✓	$\frac{0,365}{1,78}$ =0,205✓	0,159 ✓
3	0,65	0,778	1,78	0,365 – 0 = 0,365	$\frac{0,365}{1,78}$ =0,205	0,159
Average	0,65	0,778	1,75	0,371	0,211	0,164

4 mass pieces (4 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,768	1,51	0,430 - 0 = 0,430	$\frac{0,433}{1,51}$ =0,287	0,220
2	0,65	0,768	1,51 ✓	0,430 - 0✓ = 0,430	$\frac{0,433}{1,51}$ =0,287✓	0,220 ✓
3	0,65	0,768	1,51	0,430 - 0 = 0,430	$\frac{0,433}{1,51}$ =0,287	0,220
Average	0,65	0,768	1,51	0,430	0,287	0,220

NOTE: Mass indicated in all 4 tables✓
Δx indicated in all 4 tables ✓

2 mass pieces (2 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,788	2,48	0,262- 0 = 0,262	$\frac{0,262}{2,48}$ =0,106	0,0835
2	0,65	0,788	2,45 ✓	0,265– 0 = 0,265✓	$\frac{0,265}{2,45}$ =0,108✓	0,0851 ✓
3	0,65	0,788	2,54	0,256 – 0 = 0,256	$\frac{0,256}{2,54}$ =0,101	0,0796
Average	0,65	0,788	2,49	0,261	0,105	0,0827

3 mass pieces (3 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,778	1,70	0,382- 0 = 0,38	$\frac{0,382}{1,70}$ =0,225	0,175
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3	0,65	0,778	1,78	0,365 – 0 = 0,365	$\frac{0,365}{1,78}$ =0,205	0,159
Average	0,65	0,778	1,75	0,371	0,211	0,164

4 mass pieces (4 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,768	1,51	0,430- 0 = 0,430	$\frac{0,433}{1,51}$ =0,287	0,220
2	0,65	0,768	1,51 ✓	0,430- 0✓ = 0,430	$\frac{0,433}{1,51}$ =0,287✓	0,220 ✓
3	0,65	0,768	1,51	0,430- 0 = 0,430	$\frac{0,433}{1,51}$ =0,287	0,220
Average	0,65	0,768	1,51	0,430	0,287	0,220

NOTE: Mass indicated in all 4 tables✓
Δx indicated in all 4 tables ✓

2 mass pieces (2 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,788	2,48	0,262- 0 = 0,262	$\frac{0,262}{2,48}$ =0,106	0,0835
2	0,65	0,788	2,45 ✓	0,265– 0 = 0,265✓	$\frac{0,265}{2,45}$ =0,108✓	0,0851 ✓
3	0,65	0,788	2,54	0,256 – 0 = 0,256	$\frac{0,256}{2,54}$ =0,101	0,0796
Average	0,65	0,788	2,49	0,261	0,105	0,0827

3 mass pieces (3 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,778	1,70	0,382- 0 = 0,38	$\frac{0,382}{1,70}$ =0,225	0,175
2	0,65	0,778	1,78 ✓	0,365– 0 = 0,365✓	$\frac{0,365}{1,78}$ =0,205✓	0,159 ✓
3	0,65	0,778	1,78	0,365 – 0 = 0,365	$\frac{0,365}{1,78}$ =0,205	0,159
Average	0,65	0,778	1,75	0,371	0,211	0,164

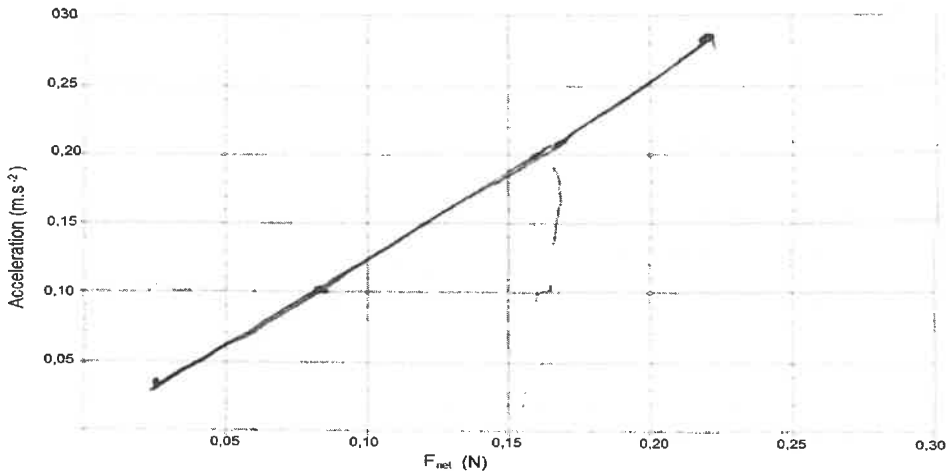
4 mass pieces (4 x 10 g) hanging

Interval	Δx	Mass (kg)	Time (s)	$\Delta v = v_f - v_i$	$a = \frac{v_f - v_i}{\Delta t}$	$F_{net}=ma$
1	0,65	0,768	1,51	0,430- 0 = 0,430	$\frac{0,433}{1,51}$ =0,287	0,220
2	0,65	0,768	1,51 ✓	0,430- 0✓ = 0,430	$\frac{0,433}{1,51}$ =0,287✓	0,220 ✓
3	0,65	0,768	1,51	0,430- 0 = 0, 30	$\frac{0,433}{1,51}$ =0,287	0,220
Average	0,65	0,768	1,51	0,430	0,287	0,220

NOTE: Mass indicated in all 4 tables✓
Δx indicated in all 4 tables ✓

7. Data analysis

A graph of F_{net} vs acceleration.



MARKING CRITERIA	
Heading indicated	✓
Axis labelled with correct units	✓
4 points plotted	✓
A straight-line graph drawn	✓
Total	4 marks

(4)

8. Conclusion

Acceleration is directly proportional to the net force✓ provided the mass remains constant✓

(2)

TOTAL: 35

THE RELATIONSHIP BETWEEN RESULTANT FORCE AND ACCELERATION (NEWTON'S SECOND LAW)

WORKSHEET FOR NEWTON'S SECOND LAW: OPTION 2

35

PRACTICAL SKILLS

1. Following instructions and manipulation.

CRITERIA		MARKS
Accurately following a sequence of written/verbal instructions	Following a sequence of instructions including branched instructions	1
Manipulative skills include correct and safe handling of apparatus and materials	Able to use all apparatus and material correctly and safely	1

2.1 Dependent variable: Acceleration✓ (1)

2.2 Independent variable: Net force✓ (1)

2.3 Controlled variable: Mass of the system (trolley and mass pieces)✓
Accept: Angle of inclination of the surface. **OR** surface **OR** length of the runway. (1)

3. $T = \frac{1}{f}$

$T = \frac{1}{50}$ ✓

$T = 0,02$ s✓ (2)

4. $t = n \times T$
$t = 10 \times 0,02$✓
$t = 0,2$ s✓ (2)

5.
- Using an extensible string ✓
- Not compensating for friction
- Failure to ensure that there is no friction or little friction between pulleys and the thread.
- Failure to switch off the fan so that the wind does not affect the results.

Any one (1)

6. Any one
   - Make sure that the runway is firmly secured.✓
   - Handle elastic/rubber bands with care to avoid hitting other learners.
   - Do not use/touch bare electrical conductors when they are being used.
   - Avoid loose cables on floor so that learners do not trip over them (use tape to fix them to the floor).

(1)

7. **TABLE 1:**

Using 1 rubber band

Trial number	Resultant force, F (number of elastic bands)	PQ (m)	v_x ($m \cdot s^{-1}$)	QR (m)	v_y ($m \cdot s^{-1}$)	a ($m \cdot s^{-2}$)	$\frac{F_{net}}{a}$ (kg)	F_{net} (N)
1	1	0,019	0,095	0,042	0,21	0,575	0,758	0,436
2	1	0,018	0,090	0,044	0,22	0,650	0,758	0,493
3	1	0,020	0,100	0,038	0,19	0,450✓	0,758	0,341✓
Average	1	0,019✓	0,095✓	0,041✓	0,21✓	0,558	0,758	0,423

NOTE: $\frac{F_{net}}{a}$ =m =0,758 kg (mass of a trolley) but F_{net} = m a

Using 2 rubber bands

Trial number	Resultant force, F (number of elastic bands)	PQ (m)	v_x ($m \cdot s^{-1}$)	QR (m)	v_y ($m \cdot s^{-1}$)	a ($m \cdot s^{-2}$)	$\frac{F_{net}}{a}$ (kg)	F_{net} (N)
1	2	0,037	0,185	0,069	0,345✓	0,800	0,758	0,606
2	2	0,039	0,195	0,071	0,355	0,800✓	0,758	0,606
3	2	0,038	0,190	0,073	0,365	0,875	0,758	0,663
Average	2	0,038✓	0,190✓	0,062✓	0,355	0,825	0,758	0,625✓

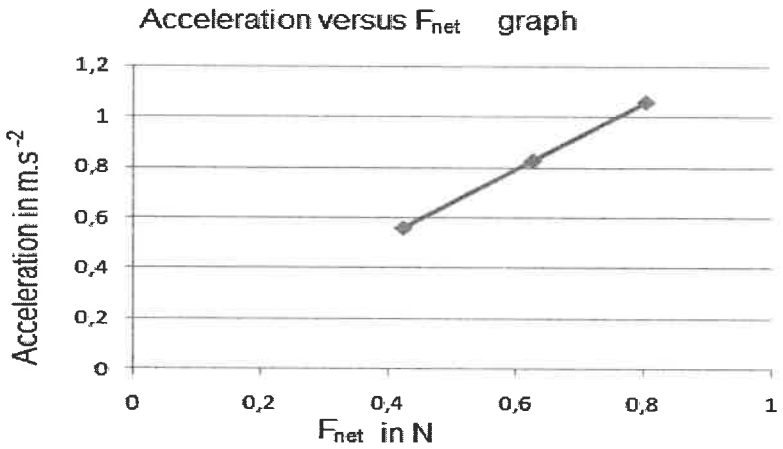
Using 3 rubber bands

Trial number	Resultant force, F (number of elastic bands)	PQ (m)	v_x ($m \cdot s^{-1}$)	QR (m)	v_y ($m \cdot s^{-1}$)	a ($m \cdot s^{-2}$)	$\frac{F_{net}}{a}$ (kg)	F_{net} (N)
1	3	0,055	0,275	0,096	0,480✓	1,025	0,758	0,777
2	3	0,049	0,245	0,093	0,465	1,10	0,758	0,834
3	3	0,053	0,265	0,095	0,475	1,050	0,758	0,796
Average	3	0,052✓	0,262✓	0,095✓	0,473	1,058✓	0,758	0,802✓

(18)

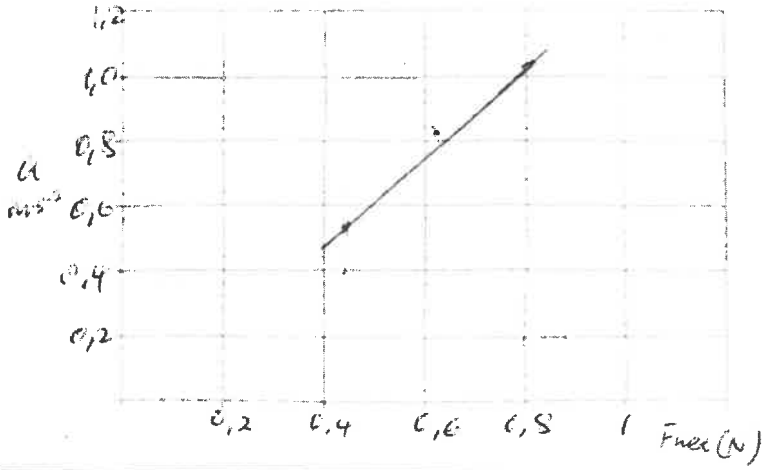
8. Data analysis

Draw a graph of F_{net} vs acceleration. (4)



OR

a graph of acceleration versus F_{net}.



MARKING CRITERIA	
Heading indicated	✓
Axis labelled with correct units	✓
4 points plotted	✓
A straight-line graph drawn	✓
Total	4 marks

9. Conclusion

Acceleration is directly proportional to the net force✓ provided the mass remains constant✓ (2)

TOTAL: 35

THE RELATIONSHIP BETWEEN RESULTANT FORCE AND ACCELERATION (NEWTON'S SECOND LAW)

WORKSHEET FOR NEWTON'S SECOND LAW: OPTION 3

35

PRACTICAL SKILLS

1. Following instructions and manipulation.

CRITERIA		MARKS
Accurately following a sequence of written/verbal instructions.	Following a sequence of instructions including branched instructions	(1)
Manipulative skills include correct and safe handling of apparatus and materials	Able to use all apparatus and material correctly and safely.	(1)

2.1 Dependent variable: Acceleration✓ (1)

2.2 Independent variable: Net force✓ (1)

2.3 Controlled variable: Mass of the system (Mass of the trolley and mass pieces)✓
Accept: Angle of inclination of the surface.
OR surface **OR** length of the runway. (1)

3. $T = \frac{1}{f}$ ✓
$T = \frac{1}{50}$ ✓
$T = 0,02$ s
(2)

4. $t = n \times T$
$t = 10 \times 0,02$✓
$t = 0,2$ s✓
(2)

5. Any one
- Using an extensible string.✓
- Not compensating for friction
- Failure to ensure that there is no friction or little friction between pulleys and the thread.
- Failure to switch of the fan so that the wind does not affect the results.

(1)

6.
- Switch off all electrical appliances when not in use.✓
- Make sure that the runway is firmly secured.
- Do not use/touch bare electrical conductors when they are being used by anyone.
- Avoid loose cables on floor so that learners do not trip over them (use tape to fix them to the floor).

Any one (1)

7. **TABLE 1:**

20 g mass piece (2 x 10 g) hanging and 40 g stacked on top of the trolley

Trial Number	Resultant force: ($F_R = Fg = mg$)	Distance PQ (m)	v_x (ms^{-1})	Distance QR (m)	v_x (ms^{-1})	a (ms^{-2})
1	0,196	0,038	0,190	0,084	0,420	1,150
2	0,196✓	0,039✓	0,195✓	0,088✓	0,440✓	1,225✓
3	0,196	0,037	0,185	0,084	0,420	1,175
Average	0,196	0,038	0,190	0,085	0,427	1,183

NOTE: 20 g = 0,02 kg and Period (T) of the time is 0,02 s but in each interval PQ and QR t = 0,2 s.

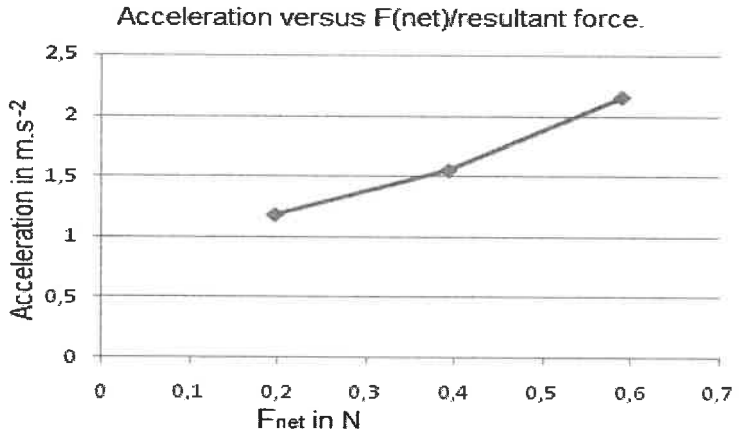
40 g mass piece (4 x 10 g) hanging and 20 g stacked on top of the trolley

Trial Number	Resultant force: ($F_R = Fg = mg$)	Distance PQ (m)	v_x (ms^{-1})	Distance QR (m)	v_x (ms^{-1})	a (ms^{-2})
1	0,392	0,074	0,370	0,138	0,690	1,600
2	0,392✓	0,073✓	0,365✓	0,136✓	0,680✓	1,575✓
3	0,392	0,077	0,385	0,136	0,680	1,475
Average	0,392	0,075	0,375	0,137	0,683	1,550

60 g mass piece (6 x 10 g) hanging and no mass stacked on top of the trolley

Trial Number	Resultant force: ($F_R = Fg = mg$)	Distance PQ (m)	v_x (ms^{-1})	Distance QR (m)	v_x (ms^{-1})	a (ms^{-2})
1	0,588	0,110	0,550	0,192	0,960	2,050
2	0,588✓	0,107✓	0,535✓	0,196✓	0,980✓	2,225✓
3	0,588	0,107	0,535	0,194	0,970	2,175
Average	0,588	0,108	0,540	0,194	0,970	2,150

8. **Data analysis**



MARKING CRITERIA	
Heading indicated	✓
Axis labelled with correct units	✓
4 points plotted	✓
A straight-line graph drawn	✓
Total	4 marks

(4)

9. **Conclusion**

Acceleration is directly proportional to the net force✓ provided the mass remains constant✓

(2)

TOTAL: 35

EXPERIMENT 2: DETERMINE THE PATH OF A RAY OF LIGHT THROUGH A GLASS SLAB FOR DIFFERENT ANGLES OFINCIDENCE.

WORKSHEET FOR EXPERIMENT 2

35

PRACTICAL SKILLS

1. Following instruction and manipulation.

CRITERIA		MARKS
Accurately following a sequence of written/verbal instructions.	Following a sequence of instructions including branched instructions	1
Manipulative skills include correct and safe handling of apparatus and materials	Able to use all apparatus and material correctly and safely.	1

2.1 Dependent variable: Angle of refraction✓ (1)

2.2 Independent variable: Angle of incidence ✓ (1)

2.3 Controlled variable: Frequency/wavelength of light (1)

OR

Rectangular glass block✓

3. Incorrect measurement of the angle of incidence and the angle of refraction.✓ (1)

4. Do not point a laser beam/light ray at another learner's eyes.✓ (1)

OR

Switch off all electrical appliances when they are not being used.

OR

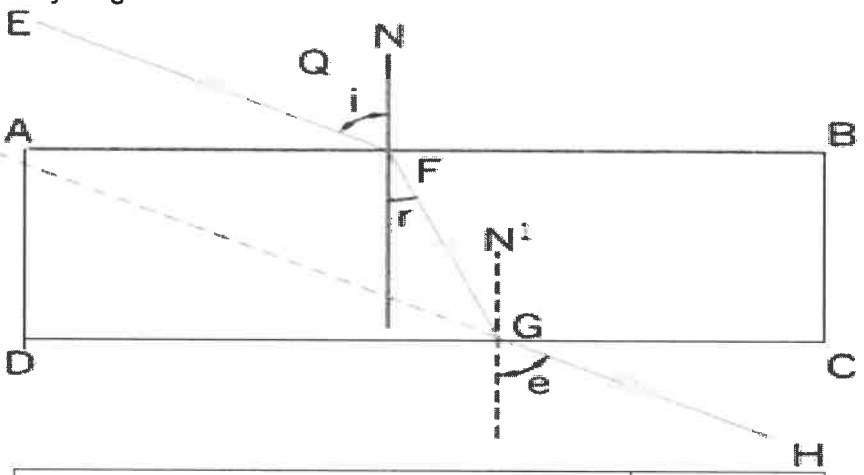
Do not use/touch bare electrical conductors when they are being used.

5. **TABLE 1:**

Experiment	Angle of incidence (degrees)	Angle of refraction (degrees)	Angle of emergence (degrees)	
1	70✓	38,8✓	70✓	
2	60✓	35,3✓	60✓	
3	50✓	30,7✓	50✓	**Any four sets**
4	40✓	25,4✓	40✓	
5	30	19,5	30	
6	20	13,2	20	

(12)

6.1 A labelled ray diagram.



CRITERIA	MARK
Measuring the incident angle correctly	1
Measuring the angle of refraction correctly	1
Drawing the line GF	1
Drawing the line GH	1
Measuring the emergent angle correctly	1
TOTAL	**5**

(5)

6.2 The angle of incidence is greater than the angle of refraction.✓✓ (2)

6.3 The angle of incidence is smaller than the angle of refraction✓✓ (because light is moving from a medium of higher optical density, glass, to a medium of lower density, air).

(2)

6.4 Air has a refractive index of 1,00✓which is a lower than refractive index glass, which is 1,5.✓

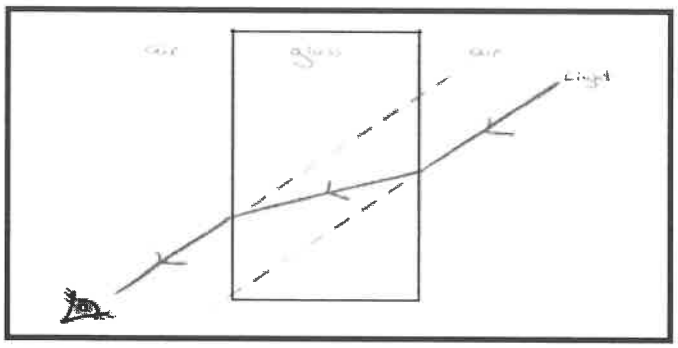
OR

Glass has higher optical density than air. (2)

6.5 When the light ray moves from the air to the glass, the light ray bends towards the normal. ✓ When the light ray moves from the glass block back into the air, it bends away from the normal ✓ (and the angle of emergence is larger the incident angle between glass and air).

(2)

6.6 The direction of the light ray through different media.



✓

NOTE: This subquestion MUST be disregarded and this experiment must be marked out of 34 instead of 35 marks.

7. Conclusion

If light enters any substance with a *higher* refractive index (such as from air into glass) it slows down.✓ The light bends *towards* the normal line.✓

OR

If light enters a substance with a *lower* refractive index (such as from water into air) it speeds up. The light bends *away* from the normal line.

OR

A higher refractive index shows that light will slow down and change direction more as it enters the substance. (2)

TOTAL: 34

EXPERIMENT 3: TO DETERMINE THE ELECTRODE POTENTIAL OF A Cu-Zn ELECTROCHEMICAL CELL.

WORKSHEET FOR EXPERIMENT 3

35

PRACTICAL SKILLS

1. Following instruction and manipulation.

CRITERIA		MARKS
Accurately following a sequence of written/verbal instructions.	Following a sequence of instructions including branched instructions	1
Manipulative skills include correct and safe handling of apparatus and materials	Able to use all apparatus and material correctly and safely.	1

(1)

2.1 Dependent variable: Emf✓ (voltmeter reading)

2.2 Independent variable: Type of electrolyte and electrodes used✓ (1)

2.3 Controlled variable.
- Type of voltmeter✓
- Length of the connecting wires with crocodile clippers
- Temperature (of the electrolyte solution) salt bridge solution

Any one (1)

3.
- Temperature and concentration not under standard conditions✓
- Voltmeter readings errors
- Salt bridge solution leaking or unsuitable electrolyte used

Any one (1)

4.
- Switch off all electrical appliances when not in use.✓
- Do not use/touch bare electrical conductors when they are being used.
- Avoid skin/eye contact with the electrolytes.

Any one (1)

5. TABLE 1:

Mass of Electrodes			
Plate/Electrode	Initial Mass		Final Mass
Copper	4,32 g		6,89 g
Zinc	5,02 g✓		4,25 g✓
Voltmeter readings			
Before placing the U-tube filled with a salt solution/paste in the beakers	0 V✓	After placing the U-tube filled with a salt solution/ paste in the beakers	1,1 V✓
Colours of the electrodes			
	At the beginning of the experiment	Between10 to 20 minutes during the reaction	
Copper electrode	Brown copper colour✓	Brown copper colour✓	
Zinc Electrode	Shiny metallic colour✓	Dull metallic colour✓	
Colours of the solutions in the beakers			
	At the beginning of the reaction	A few hours after the reaction occurred	
$CuSO_4$	Blue solution✓	Colourless/Light blue solution✓	
$ZnSO_4$	Colourless solution✓	Colourless solution✓	

(12)

6.1 To keep the solution of KNO_3 (potassium nitrate) inside the salt bridge✓ but allow the ions in the salt bridge to move across the cotton wool membrane. ✓ (2)

6.2 As the reaction proceeds, the zinc electrode oxidizes and decreases in mass because zinc atoms in the zinc electrode form zinc(II) ions.✓ Simultaneously, the copper electrode gains mass, because the copper(II) ions gain electrons to form copper metal which is deposited on the copper electrode, thus increasing its mass.✓ (2)

6.3 The original colour of the zinc sulphate is colourless. The Zn^{2+} ions react with the NO_3^- ions, from the salt bridge, as the reaction proceeds and the colour of the electrolyte remains colourless.✓
The blue copper sulphate electrolyte solution changes to colourless or light blue, because the copper(II) ions form Cu atoms which are deposited on the copper electrode. ✓ (2)

6.4 Zinc electrode is the anode.✓
Copper electrode is the cathode✓ (2)

6.5 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$✓✓ (2)

6.6 $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$✓✓ (2)

6.7 **NOTE:** This subquestion MUST be disregarded and this experiment must be marked out of 33 instead of 35 marks.

For the responses below the question should have read as follows:
What is the importance of the U-tube filled with a salt solution that was placed between the $CuSO_4$ and $ZnSO_4$ electrolytes?

- It completes the cell.✓
- Maintain electrical neutrality (by allowing the ions to move between the two half cells)✓ (2)

7. **Conclusion**

The electrode potential of the zinc-copper cell is 1,10 V✓✓ (2)

TOTAL: 33

NOTE: The total marks for this PAT are 103 NOT 105 as indicated in the instruction booklet.