



Province of the
EASTERN CAPE
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

IBANGA 12

SEPTEMBER 2021

IINZULULWAZI P1

AMANQAKU: 150

IXESHA: 3 iiyure

Eli phepha lemibuzo linamaphepha ali 19 kunye nee datha shithi ezi 3.

IMIQATHANGO/IMYALELO NOLWAZI

1. Bhala IGAMA neFANI kwizithuba ezifanelekileyo kwi NCWADI YEEMPENDULO.
2. Eli phepha liqulethe imibuzo ELISHUMI. Phendula YONKE imibuzo kweli phepha.
3. Qala umbuzo ngamnye KWIPHEPHA ELITSHA KWINCWADI YAKHO YEEMPENDULO.
4. Nambarisha iimpendulo zakho NGOKUTHE NGQO ngendlela imibuzo enamabarishwe ngayo.
5. Shiya umgca phakathi kwemibuzwana umzekelo: UMBUZWANA 2.1 no MBUZWANA 2.2.
6. Uvumelekile ukusebenzisa ikhalthyuleytha engafakwanga lwazi.
7. Ungazisebenzisa izixhobo zeMathematika ezifanelekileyo.
8. Bonakalisa ZONKE iifomyula nee sabstityushini kwizibalo zakho ZONKE.
9. Shiya impendulo yakho YOKUGQIBELA yamanani yezibalo kubuncinane bee desimali pleyisi EZIMBINI.
10. Xhasa okanye unike iingxoxwana apho zifuneka khona.
11. Uyacetyiswa ukuba uyisebenzise IIDATHA SHITHI ezikweli phepha.
12. Bhala ngokucocekileyo nangokucacileyo.

UMBUZO 1: UXUBO-KHETHO MIBUZO

Unikwe iimpendulo ezahlukeneyo kule mibuzo ilandelayo. Khetha impendulo echanekileyo uze ubhale kuphela unobumba (A–D) ecaleni kwenombolo yombuzo (1.1–1.10) KWINCWADI YAKHO YEMPENDULO, umzekelo: 1.11 E.

1.1 I imphalsi eyenziwe yinethi fosi esebenza kwi objekhthi ilingana ne/no ...

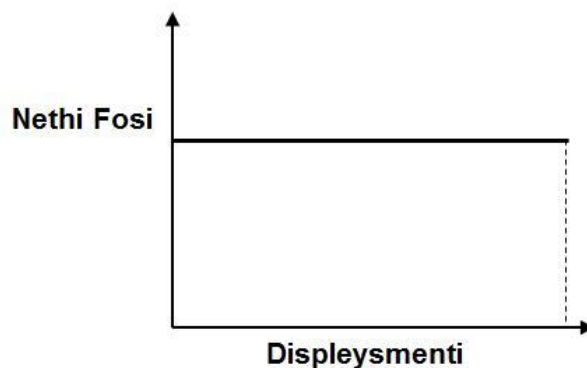
A momentam yokuqala ye objekhthi.

B momentam yokugqibela ye objekhthi.

C kutshintsha momentam ye objekhthi.

D reyithi yokutshintsha kwemomentam ye objekhthi (2)

1.2 Igrafu engezantsi ibonisa unxulumano phakathi kwenethi fosi esetyenziswe kwi objekhthi kunye ne displaysimenti eyihambileyo. Inethi fosi ne displaysimenti ziya cala nye.



SESIPHI isiqwengana kwezi zilandela esiboniswa yigrafu?

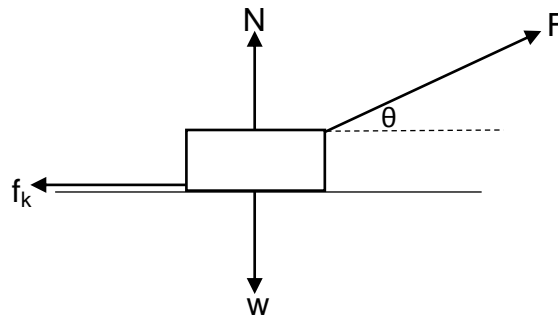
A I eriya phakathi kwigrafu nedispleysimenti eksisi imele inethi work done eyenziwe yifosi.

B I eriya phakathi kwigrafu nedispleysimenti eksisi imele ipower ekhutshwe yifosi.

C Igradiyenti yigrafu imele utshintsho kwi kinetic eneji ye objekhthi.

D Igradiyenti yigrafu imele work done ye objekhthi. (2)

- 1.3 Umzobo ongezantsi ubonisa zonke iifosi ezisebenza kwiobjekhthi etsalelwa ngasekunene yifosi u F esebenza kwi engile u θ ngakuhorizontali.



Yeyiphi indlela yokubeka kwezi zilandelayo engasetyenziswa ukufumana ubungakanani be khayinethikh frikhshinal fosi (f_k) esebenza kwi obhjekhthi?

A $\mu(w + F\sin\theta)$

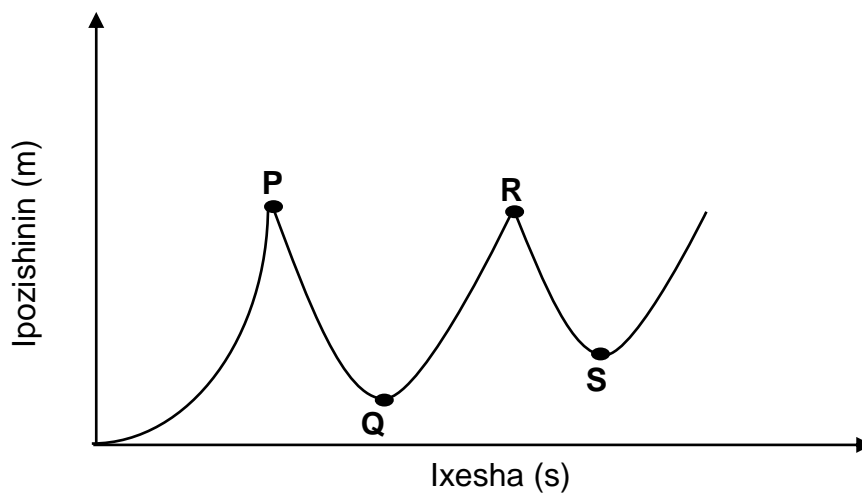
B $\mu(w - F\sin\theta)$

C $\mu(N - w)$

D μw

(2)

- 1.4 Igrafu ye posishin thayim engezantsi imele ukuhamba kwebhola ukusuka ekukhululweni ngexesha imile kumphakamo othile ngasentla komgangatho yabetha yabuya ukusuka kumgangatho amatyeli ngamatyeli. Ungayinanzi iresistensi yomoya.



Yeyiphi ipoyinti (**P**, **Q**, **R** okanye **S**) kwi grafu emele iikho-odineyith zepozishini thayim zowona mphakamo mkhulu kunayo yonke ofikelelwe yibhola emva kwebhawunsi yesibini?

A **P**

B **Q**

C **R**

D **S**

(2)

1.5 Ikhayinethikhi eneji yemoto ehamba ngevelosithi u v ngu K . Ivelosithi yemoto itshintshela ku $2v$. Ithini ikhayinethikhi eneji entsha yemoto?

A $\frac{1}{4}K$

B $\frac{1}{2}K$

C $2K$

D $4K$

(2)

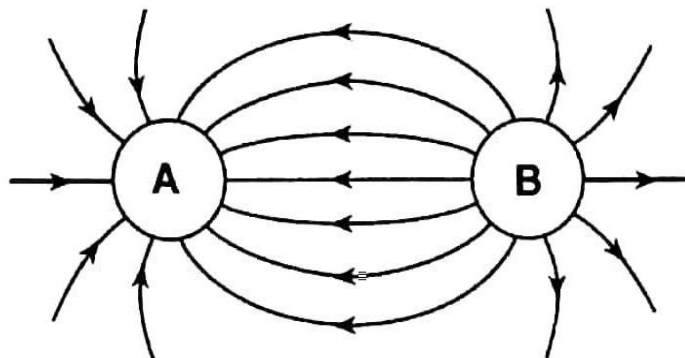
1.6 Umthombo wesandi uya ngakwi obhzeva emileyo nge velosithi engaguqukayo.

Yeyiphi kwezi zilandelayo ecacisa nzulu ukohluka kwe frikhwensi neweyivulenti eviweyo/boniweyo kuleyo yomthombo wesandi?

	Iweyivulenti eviweyo/boniweyo	ifrikhwensi eviweyo/boniweyo
A	Inkulu kuno/kune	Inkulu kuno/kune
B	Incinane kuno/kune	Incinane kuno/kune
C	Incinane kuno/kune	Inkulu kuno/kune
D	Inkulu kuno/kune	Incinane kuno/kune

(2)

1.7 Iphatheni yefildi yombane phakathi kwezifiye ezitshajweyo ezibini u **A** no **B**, ubonisiwe ngezantsi.



Sesiphi esi NYE kwezi ziqwengana zilandelayo, ngokubhekiselele kwitshaji kwizifiye u **A** no **B**, ESICHANEKILEYO?

A Isifiye u **A** sitshajwe sanegethivu, sona isifiye u **B** sitshajwe saphozithivu.

B Isifiye u **A** sitshajwe saphozithivu, sona isifiye u **B** sitshajwe sanegethivu.

C Zozibini izifiye u **A** no **B** zitshajwe zaphozithivu.

D Zozibini izifiye u **A** no **B** zitshajwe zanegethivu.

(2)

1.8 I SI yunithi yokumesharisha/yomlinganiselo weREYITHI YOKUQUKUQELA KWETSHAJI kwiconductor yi ...

A watt.

B volt.

C ampere.

D coulomb.

(2)

1.9 Yeyiphi kwezi zilandelayo iinguqu kumyilo wejenereyitha i AC enokunyusa eyona miphumela ephezulu ye emf?

A Tshintsha pholarithi yoozibuthe (iimagnethi).

B sebenzisa iisliph ringi ezinkudlwana kunezo zisetyenzisiweyo.

C sebenzisa iibhrashi ezinkudlwana kunezo zisetyenzisiweyo.

D Nyusa inani lemijikelezo kwikhoyili.

(2)

1.10 Ilayini emishin spekhthram yenzeka xa ...

A ii elekhtroni ezikwi grawundi steyithi zisiya kwi eneji steyithi ephezulu

B ii elekhtroni ezikwi eneji steyithi ephezulu zisiya kwi eneji steyothi engezantsi

C ilitha elimhlophe lidlula kwigesu ebandayo.

D ilitha elimhlophe lidlula kwiprizim engunxantathu.

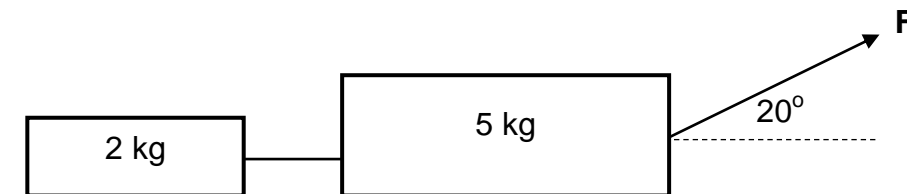
(2)

[20]

UMBUZO 2

- 2.1 Iibhlokhi ezimbini ezinobunzima u 2 kg no 5 kg zidityaniswe ngomsonto ongandisekiyo. Iibhlokhi zitsalwe kumphezulu orhabaxa othe tye (horizontal) yifosi u **F**. Le fosi yenza i engile engu 20° ukusuka kuhorizontali. Bhekisela kumfanekiso ongezantsi.

Iibhlokhi u 2 kg no 5 kg beva ikhayinethikhi frikshinal fosi engu 10 N no 15 N ngokulandelelana kwazo.



- 2.1.1 Chaza Umthetho Wesibini kaNewton ngamagama. (2)
- 2.1.2 Zoba ifri bhodi dayagram eleyibhelishiweyo yebhlokhi u 5 kg. (5)
- 2.1.3 Bala ubungakanani befosi u **F** emayisetyenziswe kwi engile engu 20° ukusuka kuhorizontali ukwenza iibhlokhi zombini zi akhselereyithe ngo 2 m.s^{-2} ukuya ngasekunene. (5)
- 2.2 Umhlaba usebenzisa ifosi engu 1 842,50 N ukugcina isathelayithi enemesi engu 200 kg ikwi obhithi ukujikeleza umhlaba njengoko kubonisiwe kumfanekiso ongezantsi.



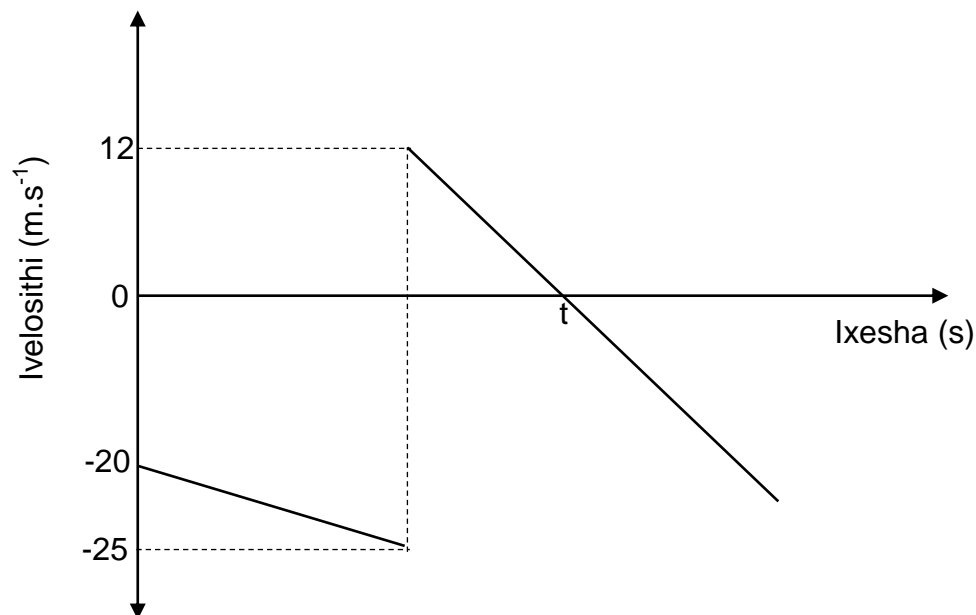
Bala umgama, ngentla ko MHLABA, apho isathelayithi ijikeleza umhlaba.

(5)
[17]

UMBUZO 3

Igrafu yevelosithi vesazi thayim engezantsi ibonisa ukuhamba kwebhola ephoswe **ezantsi ngokuthe ngqo** isuka enkcocheyini yesakhiwo ibhawunsa ukusuka kumgangatho xa ibetha phantsi.

Ungayinanzi ifrikhshini yomoya. THATHA UKUYA PHEZULU NJENGO PHOZITHIVU.



3.1 Usebenzisa ii IKHWEYISHINI ZEMOWUSHINI KUPHELA, bala:

3.1.1 Umphakamo ukusuka apho ibhola ibiphosiwe (3)

3.1.2 Ixesha t elikwigrafu (5)

3.1.3 Ubungakanani bedispleysmenti yebhola ukusuka ekuphosweni kwayo ukuya kwixesha u t (4)

3.2 Zoba igrafu yepozishini vesaz thayim yokuhamba kwebhola ukusuka ekuphosweni kwayo de ifike enkcocheyini emva kwebhawunsi. SEBENZISA IGRAWUNDI/PHANTSI NJENGEPOZISHINI ENGU ZIRO.

Bonisa oku kulandelayo kwi grafu yakho:

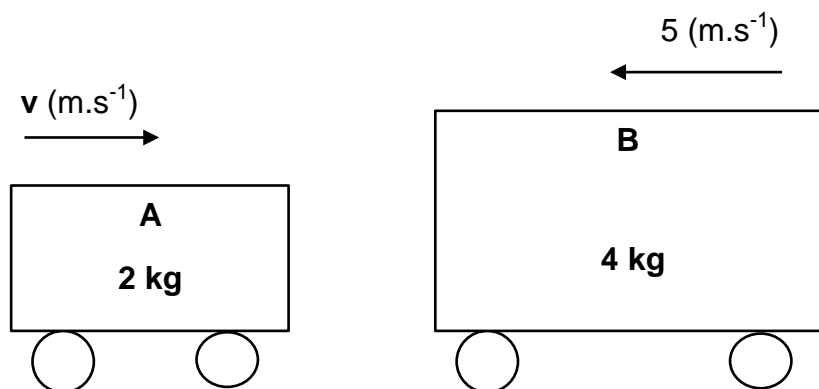
- Umphakamo ukusuka apho ibhola ibiphoswe
- Ixesha u t

(3)
[15]

UMBUZO 4

Umzobo ongezantsi ubonisa itroli u **A** enobunzima engu 2 kg ihamba ngevelosithi u $v \text{ m}\cdot\text{s}^{-1}$ ukuya ngase mpuma kumphezulu othe ngqo othe tye (horizontal) ingqubana ngeentloko netroli u **B** enobunzima u 4 kg ehamba ngevelosithi engaguqukiyo engu $5 \text{ m}\cdot\text{s}^{-1}$ ukuya ngasentshona.

Emva kongqubano, iitroli zombini ziyancamathelana zihambe ngevelosithi engu $1,67 \text{ m}\cdot\text{s}^{-1}$ ukuya ngasentshona. Ungqubano luthathe u 0,01 s. Ungayinanzi impembelelo yefrikhshini.



4.1 Chaza iprinsipli yekhonzeveyshini yemomentam eliniya ngamagama. (2)

4.2 Bala:

4.2.1 Ubukhulu bevelosithi v yetroli u **A** ngaphambi kokungqubana netroli u **B** (4)

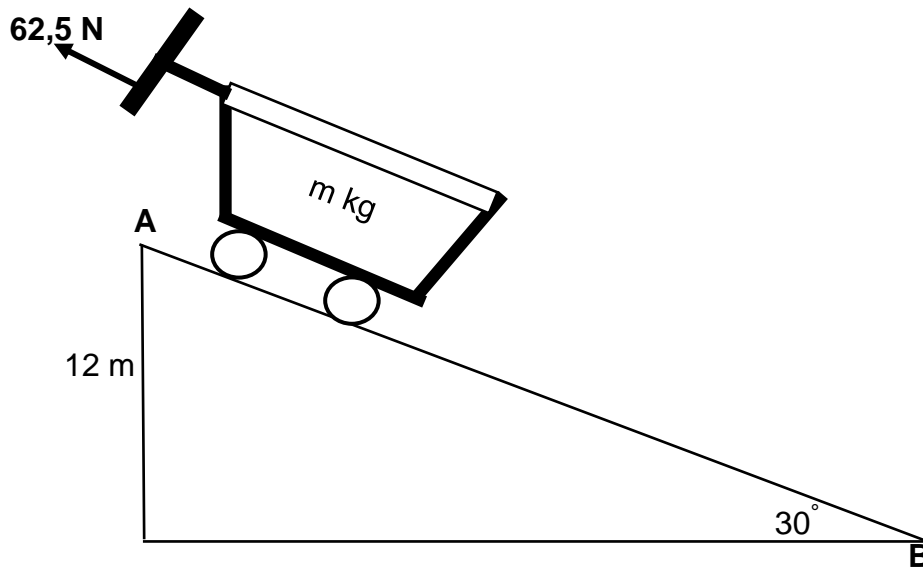
4.2.2 Ifosi esetyenziswe ngu **B** kwitroli u **A** (4)

[10]

UMBUZO 5

Ifosi engu 62,5 N isetyenziswe kwitroli enobunzima obungu m kg ipharaleli kumphezulu othambekileyo njengoko kubonisiwe ukuyigcina isiya ezantsi kumphandle othambekileyo NGEVELOCITY ENGAGUQUKIYO. Umphakamo obheke phezulu (ivethikhali hayithi) womphezulu othambekileyo ngu 12 m. Bhakisela kumfanekiso ongezantsi.

Ikhayinethikhi frikshinali fosi engu 35,5 N isebenza kwitroli ngexesha isehla kumphezulu wethambeka.



- 5.1 Bhala igama lekhon'zeveythivu fosi esebenza kwi troli. (1)
- 5.2 Bala iwekhi dani eyenziwe yifrikshinal fosi kwi troli. (4)
- 5.3 Bhala phantsi itsheyinji kwikhayinethikhi enoji xa itroli ifika kumzantsi wethambeka. (1)
- 5.4 Sebenzisa iwork-eneji theorem ukubala ubunzima u m , betroli. (5)

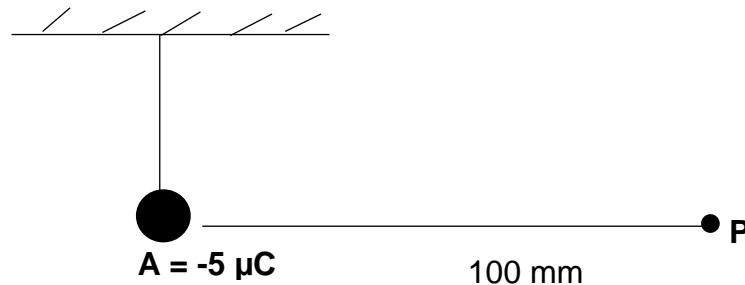
[11]

UMBUZO 6

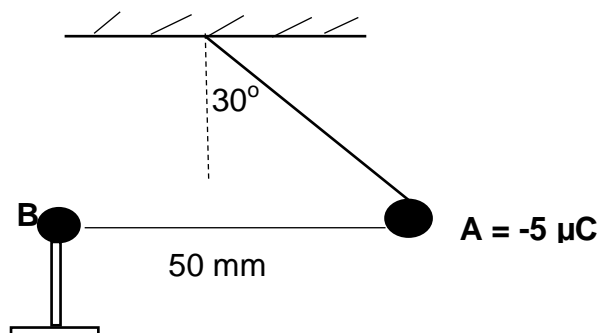
- 6.1 Umtshini wokukhangela isandi (sound detector) omileyo ubekwe endaweni ethile ushicilela izandi zamaza ezingama 520 ngomzuzu ezisuka kumthombo (isosi) wesandi ohambayo okhupha izandi zamaza ezinefrikhwensi engu 480 Hz.
- 6.1.1 Bhala phantsi ifrikhwensi yamaza esandi ashicilelwe ngumtshini wokushicilela isandi ibekwii Hz. (1)
- 6.1.2 Chaza igama lefenomenon ecacisa ngokubanzi ukutshintsha kwefrikhwensi eboniweyo/eviweyo. (2)
- 6.1.3 Ingaba umthombo wesandi uya NGAKU mphulaphuli/mbukeli okanye UYASUKA kumphulaphuli/kumbukeli? Nika isizathu sempendulo yakho. (2)
- 6.1.4 Bala ivelosithi ohamba ngayo umthombo wesandi. Thatha ivelosithi yesandi njengo $343 \text{ m}\cdot\text{s}^{-1}$. (5)
- 6.1.5 Izawutshintsha njani iweyivulenthini yesandi eyenziwe ngumthombo wesandi xa ifrikhwensi yamaza esandi ibangaphezulu kuka 480 Hz?
- Bhala kuphela IYANDA, IYANCIPHA okanye IHLALA INJALO. Cacisa impendulo usebenzisa i ikhweyshini yamaza. (2)
- 6.2 Imigca yespekthram esuka kwinkwenkwezi ekude ibonakala ikekelela ngakubomvu. Cacisa igama elikrwelelwe umgca ngaphantsi. (2)
- 6.3 Bhala phantsi umsebenzi ubemnye weDopla ifekhthi kwinkalo yamachiza. (1)
- [15]**

UMBUZO 7

- 7.1 Isifiye u **A** esinetshaji engu $-5 \mu\text{C}$ sixhonywe ngokubhekelele nkqo phezulu ngomsonto ongandisekiyo. Ipoyinti u **P** ikumgama oli 100 mm ngasekunene kuka **A** njengoko ibonakalisiwe **kumfanekiso 1** ongezantsi.

UMFANEKISO 1

- 7.1.1 Ingaba isifiye u **A** UMKELWE or UFUMENE iielektroni ukuze abenetshaji engu $-5 \mu\text{C}$? (1)
- 7.1.2 Bala inani lee elektroni ezimkileyo okanye ezifunyenwe sisifiye esitshajiweyo u **A**, ukufumana itshaji engu $-5 \mu\text{C}$. (3)
- 7.1.3 Bala i elektri fildi ku **P**, eyenziwa bubukho besifiye esitshajiweyo u **A**. (5)
- 7.2 Isifiye esifanayo u **B** onetshaji engaziwayo sibekwe kwiqonga elikhuselweyo (elogqunyiweyo) sisondezwe kwisifiye u **A**. Isifiye esitshajiweyo u **A** ujingajingela ngasekunene akugqiba ame ukuze umsonto wenze i engile engu 30° nomnyuko ngqo (vethikhali) kwaye ithenshini kumsonto ingu 25 N. Umgama phakathi kwezizifiye zitshajiweyo ungu 50 mm njengoko kubonisiwe **kumfanekiso 2** ongezantsi.

UMFANEKISO 2

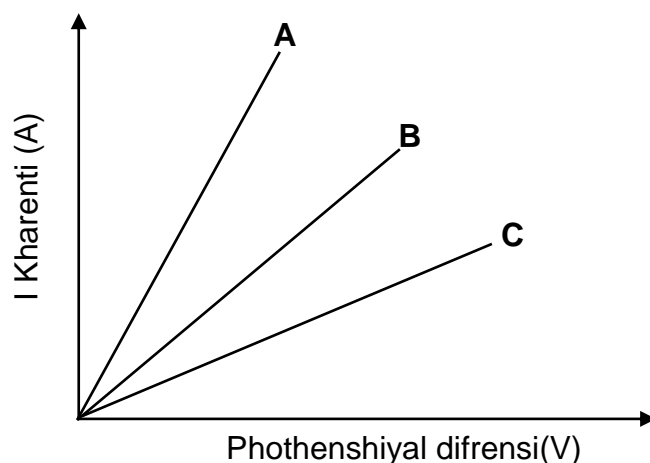
- 7.2.1 Ingaba itshaji kwi sifiye u **B** IPHOZITHIVU okanye NEGETHIVU? Nika isizathu sempendulo. (2)
- 7.2.2 Bala ubungakanani betshaji kwisifiye u **B**. (6)

[17]

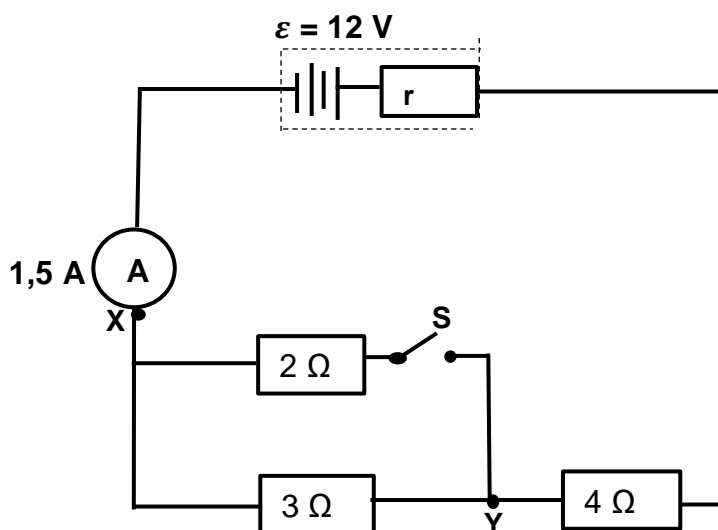
UMBUZO 8

- 8.1 Iqela labafundi beBanga le 12 bafuna ukufumanisa ukuba yeyiphi ikhondakhtha elungele ukusetyenziswa njenge hithingi khoyli yeketile abayenzela iprojekthi yabo ye Eskom Expo.

Bakonekhthe ikhondakhtha nganye kwezintathu (u**A**, **B** no **C**) kwi sekethe baze bamejarisha ikharenti edlula kwi khondakhtha nephothenshiyali difrensi kwii khondakhtha. Iziphumo ziboniswe kwi grafu engezantsi.



- 8.1.1 Nika naziphi iivariyabhuli EZIMBINI ekufuneka zigcinwe zingatshintshi ukuze oluphando lube lolungenamakhwiniba (fair). (2)
- 8.1.2 Bhala ifizikhali khwantithi emelwe yigradiyenti yegrafu nganye. (1)
- 8.1.3 Yeyiphi kwezi khondakhtha eNYES elungele ukusetyenziswa njenge hithingi khoyli yeketile? Xhasa impendulo yakho. (2)
- 8.2 Umfanekiso wesekethe ongezantsi umele indibanisela yeeresista ezikwi sirisi nezikwi pharaleli. Ibhethri ine emf engu 12 V nerezistensi yangaphakathi u r engaziwayo.



Xa iswitshi u **S** IVULIWE, iridingi kwi ametha **A** ingu 1,5 A. Bala i:

8.2.1 Rezistensi epheleleyo yesekethi (3)

8.2.2 Resistensi yangaphakathi yebhethri (4)

8.2.3 Eneji ekhutshwe yiresista u $3\ \Omega$ kwimizuzu emi 3 (3)

8.3 Iswitshi u **S** ngoku IVALIWE.

Ingaba zingachaphazeleka njani nganye kwezi zilandelayo? Bhala kuphela IYANDA, IYANCIPHA okanye IHLALA INJALO.

8.3.1 Irezistensi epheleleyo yesekethi (1)

8.3.2 Iridingi kwi amitha u **A**. (1)

8.4 Ucingo lokudlulisa umbane oluneresistensi engananzwanga ngoku lukonekhthwe phakathi kuka **X** no **Y** ngokomboniso ongasentla. Luzakuba nomphumela onjani olu tshintsho kwithempitsha yebhethri?

Bhala kuphela IYANDA, IYANCIPHA okanye IHLALA INJALO. Cacisa impendulo yakho ngokupheleleyo.

(3)
[20]

UMBUZO 9

Iijenereyitha ze AC kumaziko ombane ophehlwa ngamalahle ziphaka uninzi lwe eneji yombane edingeka elizweni.

- 9.1 Chaza inguqulelo ye eneji eyenzekayo xa le jenereyitha isebenza. (2)
- 9.2 Chaza umohhluko UBEMNYE ngobume phakathi kwe jenereyitha eyi AC nejenereyitha eyi DC. (1)
- 9.3 Zoba igrafu yephothenshiyal deferensi vesaz thayim yale jenereyitha ye AC. Leyibhelisha ngokucacileyo ii ekziz ubonise u V_{\max} kwi eksis ye phothenshiyal diferensi. (2)

Isixhobo sombane silinganiselwe u 2 000 W, 230 V. Esi sixhobo sikonekhthwe kwi phawa sosi eyi olthaneythingi kharenti.

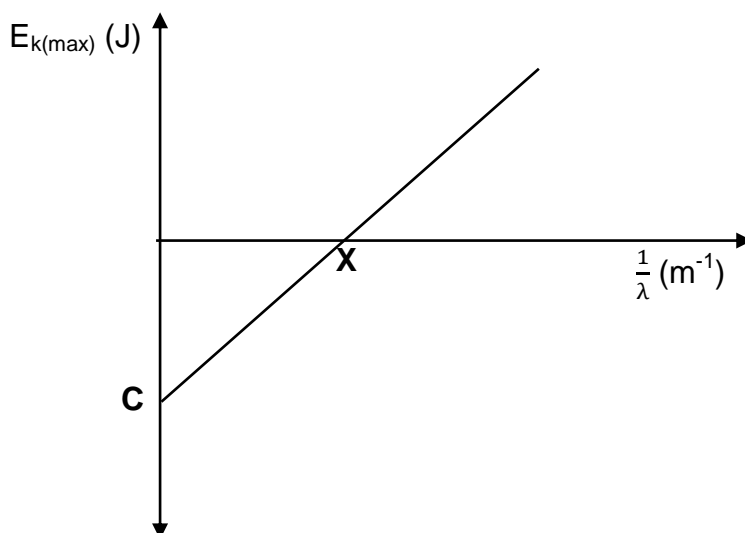
Bala:

- 9.4 Eyona kharenti iphezulu (I_{\max}) eveliswe yijenereyitha (4)
- 9.5 Eyona voltheyiji iphezulu (V_{\max}) ekhutshwe yi jenereyitha (3)

[12]

UMBUZO 10

Iqela labafundi lwenza i ekhsperimenti ukufumanisa unxulumano phakathi kwe inverse ye wayivlenti $\left(\frac{1}{\lambda}\right)$ yee insident foton kwintsimbi kunye neyona khayinethikhi eneji inkulu ($E_{k(max)}$) yee fothoelektroni ezikhutshwe kumphezulu wepleyiti yentsimbi. Babonise iziphumo zabo njengoko kubonisiwe kwigrafu engezantsi



- 10.1 Yeyiphi ifizikhal khwantithi emelwe ngunobumba u **C** (i intasephthi ye eksis eya eme ngqo) kwigrafu? Sebenzisa i ikhweyshini efanelekileyo ukucacisa impendulo (3)
- 10.2 Ifothoni zelitha ezinefrikhwensi engu $6,16 \times 10^{14}$ Hz zi insidentwe kwipleyiti ye methali kwaye iifothoelektroni zikhutshwe ngeyona khayinethikhi eneji iphezulu engu $5,6 \times 10^{-20}$ J.
- Bala ubungakanani befizikhal khwantithi emelwe ngunobumba u **X** kwi grafu. (5)
- 10.3 Iqondo lokukhanya lelitha eliyi insidenti ngoku lonyuselwe. Ingaba olu tshintsho luzoba nomphumela onjani kwezi zinto zilandelayo? (Bhala kuphela IYANDA, IYANCIPHA okanye IHLALA INJALO)
- 10.3.1 Igradiyenti yigrafu. Cacisa impendulo yakho. (2)
- 10.3.2 Eyona khayinethikhi eneji inkulu yee fothoelektroni ezikhutshiweyo. Zoba igrafu yonxulumano phakathi kweqondo lokukhanya kwe litha lee insident foton neyona khayinethikhi eneji inkulu ukucacisa impendulo yakho. (3)

[13]**AMANQAKU EWONKE: 150**

DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 1 (PHYSICS)

IDATA YEENZULULWAZI IBANGA LE 12

IPHEPHA 1 (FIZIKHSI)

TABLE 1: PHYSICAL CONSTANTS/IITHEYIBHILE 1: IIFIZIKHALI KHONSTENTI

NAME/IGAMA	SYMBOL/ ISIMBOLI	VALUE/IVELYU
Acceleration due to gravity / <i>akhselereyshini ye gravithi</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant / <i>khonstenti ye yunivesal gravitheyshini</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Speed of light in a vacuum / <i>santya se litha kwi vakhthyum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant / <i>Ikhonstenti ka Planki</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant / <i>Ikhonstenti ka Khulomb</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron / <i>Itshaji ye elekhtroni</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass / <i>Imesi ye elekhtroni</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$
Mass of earth / <i>Imesi yomhlaba</i>	M	$5,98 \times 10^{24} \text{ kg}$
Radius of earth / <i>Ireyidiyasi yomhlaba</i>	R_E	$6,38 \times 10^3 \text{ km}$

TABLE 2: FORMULAE// THEYIBHULI YESI 2: II FOMYULA**MOTION / IMOWUSHINI**

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ 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 / IFOSI

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1 m_2}{d^2}$	$g = G \frac{M}{d^2}$

WORK, ENERGY AND POWER / IWEKHI, I ENEJI NEPHAWA

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

ELECTROSTATICS / I ELEKHTHROSTATIKI

$F = \frac{kQ_1 Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$V = \frac{W}{q}$	$n = \frac{Q}{q_e}$

ELECTRIC CIRCUITS/ ISEKETHE ZOMBANE

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

ALTERNATING CURRENT/ I OLTHANEYITHINGI KHARENTI

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