KERNKONSEPTE / KEY CONCEPTS/ DIKAKANYOKGOLO

FAKULTEIT / FACULTY/ LEGORO: Natuurwetenskappe / Natural Sciences/ Disaense tsa Tlhago
SKOOL / SCHOOL/ SEKOLO: Fisika / Physics/ Fisika
KONTAKPERSOON / CONTACT PERSON/ IKGOLAGANYE LE: Hesta Vosloo
MODULEKODE EN -NAAM / MODULE CODE AND MODULE NAME/ LEINA LE KHOUTE YA MODULE: FSKN III LAW

Kernbegrip in Afrikaans	**Definisie/verklaring in Afrikaans**	**Key concept in English**	**Definition/explanation in English**	**Kakanyokgolo ka Setswana**	**Tlhaloso/thanolo mo Setswaneng**
1. Kinematika	Die studie van beweging sonder om na die oorsake van die beweging te vra.	**1. Kinematics**	The study of motion without specifying the causes of the motion.	**1. Kinematika**	Thuto ya motsamao ntle le go totobatsa dilo tse di tlholang motsamao.
2. Posisie	Dit vertel ons waar ’n voorwerp is. Om die ligging van 'n voorwerp te bepaal, beteken om sy posisie relatief tot ’n verwysingspunt te vind, soos die oorsprong van ’n grafiek.	**2. Position**	It tells us where the object is. To locate an object means to find its position relative to some reference point, like the origin on graphs.	**2. Kemo**	E re bolelela fa sere se leng teng. Go batla fa sere se leng teng go kaya go batla ntlha ya sona mabapi le kemo ya ntlha nngwe, jaaka tshimologo mo dikerafong.
3. Vektor-grootheid	'n Grootheid wat slegs volledig gespesifiseer is as beide die grootte én rigting daarvan gespesifiseer is.	**3. Vector quantity**	A quantity that is fully specified only when both its magnitude and direction are specified.	**3. Sere sa beketara**	Sere se totabaditswe ka botlalo fa fela bokanakang le ntlha ka bobedi di totobaditswe.
4. Verplasing	Die verandering in die posisie	**4. Displacement**	A change from one position x_1 to	**4. Sekgalantlha**	Phetogo go tswa kemo e nngwe x_1 go ya go kemo e nngwe x_2 ya

	van 'n voorwerp, dit wil sê die afstand gemeet langs 'n reguitlyn *vanaf* die beginposisie x_1 na die eindposisie x_2 van die voorwerp. Verplasing is 'n vektorgrootheid (dit het grootte en rigting). $\Delta x = x_2 - x_1$ Simbool Δ word gebruik om 'n verandering aan te dui, nl. *altyd* 'n eindwaarde minus 'n beginwaarde.		another position x_2 of an object, in other words, the distance from the initial position to the final position of the object, measured along a straight line. Displacement is a vector quantity (it has magnitude and direction). $\Delta x = x_2 - x_1$ Note that when the symbol Δ is used to indicate a change, it *always* refers to a final value minus an initial value.		sere, ka mantswe a mangwe, sekgala go tswa go kemo ya tshimologo go ya go kemo ya bofelo ya sere, e lekanngwa mo moleng o o tlhamaletseng. Sekgalantlha ke sere sa beketara (se na le bokanakang le ntlha). $\rightarrow \Delta x = x_2 - x_1$ Ela tlhoko gore fa letshwao Δ le dirisitswe go bontsha phetogo, *ka nako tsotlhe* le supa boleng jwa bofelo boleng le jwa *tshimologo.*
5. Afstand	Die grootte van verplasing (ignoreer die rigting) is altyd positief (+).	**5. Distance**	The magnitude of displacement (ignore the direction) is always positive (+).	**5. Sekgala**	Bokanakang jwa sekgalantlha (ikgatholose ntlha) ka nako tsotlhe ke (+).
6. Gemiddelde snelheid van 'n voorwerp	Dit dui op die tempo van verandering van verplasing, m.a.w. die totale verplasing wat die voorwerp ondergaan het, gedeel deur die tyd waarin dit plaasgevind het. Eenhede: m/s $\bar{v} = \frac{\text{totale verplasing}}{\text{tyd}}$ $= \frac{\Delta x}{\Delta t}$ $= \frac{x_2 - x_1}{t_2 - t_1}$ $=$ gradient van die $x(t)$ grafiek	**6. Average velocity of an object**	It gives an indication of the rate of change of displacement, i.e. the total displacement of the object divided by the time taken. Units: m/s	**6. Palogare ya belosithi**	E fa sesupo sa kelo ya phetogo ya sekgalantlha, sk. bogotlhe jwa sekgalantlha jwa sere bo arolwa ka nako e e se tsereng. Diyuniti:m/s $\bar{v} = \frac{\text{total displacement}}{\text{time}}$ $= \frac{\Delta x}{\Delta t}$ $= \frac{x_2 - x_1}{t_2 - t_1}$ $=$ gradient of the $x(t)$ graph

	Die gemiddelde snelheid is ’n *vektorgrootheid* en het altyd dieselfde teken as die verplasing ($\overline{v}$ kan dus +, – of nul wees).		$\overline{v} = \frac{\text{total displacement}}{\text{time}}$ $= \frac{\Delta x}{\Delta t}$ $= \frac{x_2 - x_1}{t_2 - t_1}$ $= \text{gradient of the } x(t) \text{graph}$ The average velocity is a *vector quantity* and always has the same sign as the displacement ($\overline{v}$ may be +, – or zero).		Palogare ya belosithi ya *sere sa beketara* mme ka gale e na le letshwao le le tshwanang le la sekgalantlha ($\overline{v}$ e ka nna +, - kgotsa lefela).
7. Gemiddelde spoed van 'n voorwerp	Dit is die totale afstand wat die voorwerp afgelê het, gedeel deur die tyd waarin dit plaasgevind het (skalaar).	**7. Average speed of an object**	This is the total distance covered by the object, divided by the time taken (scalar).	**7. Palogare ya lebelo la sere**	Se ke palogotlhe ya sekgala se se tserweng ke sere, le arolwa ka nako e e tserweng (sekalara).
8. Oombliklike snelheid	Dit is die waarde van die snelheid op 'n bepaalde oomblik en word wiskundig weergegee deur die uitdrukking $v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$ waar Δx die verplasing is wat die voorwerp in 'n tyd Δt ondergaan het.	**8. Instantaneous velocity**	This is the value of the velocity at a specific instant of time and is mathematically expressed by $v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$ where Δx is the displacement that the object undergoes in time interval Δt.	**8. Belosithi-pong**	Se ke bolengpalo ba belosithi ka sebaka se se rileng sa nako gape se tlhagisiwa ka mogopolo wa mmetshe ka: $v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$ Mo Δx e leng sekgalantlha sere seo se se tsayang mo kgaotsong ya nako Δt.

9. Oombliklike spoed	Dit is die waarde van die spoed op 'n bepaalde oomblik. (Die grootte van die snelheid.)	**9. Instantaneous speed**	It is the value of the speed at a specific instant. (The magnitude of the velocity.)	**9. Lebelo-pong**	Ke bolengpalo ba lebelo mo sebakeng se se rileng sa nako. (Bokanakang ba belosithi).
10. Gemiddelde versnelling	Dit is die verandering in die snelheid van 'n voorwerp gedeel deur die tydsinterval waarin die verandering plaasgevind het. $\bar{a} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$	**10. Average acceleration**	It is the change in the velocity of an object divided by the time in which the change took place. $\bar{a} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$	**10. Palogare ya kelolebelo**	Ke phetogo mo belosithing ya sere e arolwa ka nako e e phetogo e diragetseng ka yona. $\bar{a} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$
11. Oombliklike versnelling	Dit is die tempo waarteen die snelheid op die bepaalde oomblik verander. $a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{\Delta v}{dt}$	**11. Instantaneous acceleration**	It is the rate at which the velocity is changing at that instant. $a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$	**11. Kelolebelo-pong**	Ke kelo e belosithi e fetogang mo sebakeng seo $a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$
12. Vryval	'n Voorwerp val vry as dit slegs onder die invloed van sy eie gewig beweeg, m.a.w. 'n voorwerp val vry as sy eie gewig die enigste krag is wat daarop inwerk gedurende die beweging.	**12. Free-fall**	An object falls freely if it moves only because of the influence of its own weight. In other words, an object falls freely if its weight is the only force acting on it during the motion.	**12. Go wa ka kgololosego**	Sere se wa se gololosegile fa se suta fela ka ntlha ya bokete jwa sona. Ka mafoko a mangwe, sere se ikwela ka kgololosego fa bokete ba sona e le thata e e nosi fela e e dirang mo go sona ka nako ya motsamao.
13. Skalaar	Dit is fisiese grootheid wat net grootte besit, bv. temperatuur, tyd en afstand.	**13. Scalar**	A scalar is a physical quantity that has magnitude only, e.g. temperature, time and distance.	**13. Sekalara**	Sekalara ke selo ka namana se se nang le bokanakang fela, (sk. themphereitšha, nako le

					sekgala).
14. Vektor	Dit is 'n fisiese grootheid wat grootte en rigting besit, bv.verplasing, snelheid en versnelling. Vektore word met pyle voorgestel.	**14. Vector**	A vector is a physical quantity that has both a magnitude and a direction, e.g. displacement, velocity and acceleration. It is represented graphically with an arrow.	**14. Beketara**	Beketara ke selo ka namana se se nang bokanakang le ntlha mmogo, sk. sekgalantlha, belosithi le kelolebelo. E emelwa sekerafo ka motsu.
15. Verplasing	Dit is die verandering van ’n voorwerp van een posisie x_1 na ’n ander posisie x_2. ’n Vektor wat ’n verplasing voorstel, heet ’n **verplasingsvektor.**	**15. Displacement**	When an object changes from one position x_1 to another position x_2, it is called displacement. A vector that represents a displacement is called a **displacement vector.**	**15. Sekgalantlha**	Fa sere se fetoga go tswa mo ntlheng nngwe x_1 go ya ntlheng e nngwe x_2 ya sere, e bidiwa sekgalantlha. Beketara e e emelang sekgalantlha e bidiwa **beketara ya sekgalantlha.**
16. Resultante van 'n paar vektore	Die resultante van 'n aantal vektore is daardie enkele vektor wat die ander vektore kan vervang en wat presies dieselfde uitwerking as die ander vektore gesamentlik sal hê.	**16. Resultant of a few vectors**	The resultant of a number of vectors is a single vector that can replace the other vectors and that has exactly the same effect as all those vectors together.	**16. Sephethokopano sa dibeketara tse di mmalwa**	Sephethokopano sa dibeketara tse di mmalwa ke beketara e le nngwe e e ka emelang dibeketara tse dingwe mme e na le bokao jo bo tshwanang thwi le ba dibeketara tsotlhe tseo di le mmogo.
17. Eenheids-vektor	Dit is ’n vektor waarvan die grootte presies een is en wat in ’n spesifieke rigting wys. Die hoofdoel van so ’n eenheidsvektor is om rigting aan te dui.	**17. Unit vector**	A unit vector is a vector that has a magnitude of exactly one and points in a particular direction. Its sole purpose is to indicate direction.	**17. Beketara-bongwe**	Beketara-bongwe ke beketara e e nang le bokanakang jwa nngwe mme bo supa kwa ntlheng e e rileng. Mosola wa yona tota ke go supa ntlha.

18. Vektor · vektor = skalaar	Die skalaarproduk $\underline{a}\cdot\underline{b}$ van twee vektore $\underline{a}$ en $\underline{b}$ word weergegee deur $\underline{a}\cdot\underline{b} = ab\cos\theta$, met θ die hoek tussen $\underline{a}$ en $\underline{b}$; dit is dus die produk van die grootte van een van die vektore (a) en die skalaarkomponent ($b\cos\theta$) van die tweede vektor.	**18. Vector times vector = scalar**	The scalar product $\underline{a}.\underline{b}$ of two vectors $\underline{a}$ and $\underline{b}$ is given by $\underline{a}\bullet\underline{b} = ab\cos\theta$ with θ the angle between $\underline{a}$ and $\underline{b}$, thus the product of the magnitude of one vector (a) and the scalar component $(b\cos\theta)$ of the second vector.	**18. Beketara atisa ka beketara = sekalara**	Seatiso sa sekalara $\underline{a}.\underline{b}$ ya dibeketara tse pedi a le b e neelwa ke $\underline{a}\bullet\underline{b} = ab\cos\theta$ *ka* θ ke sekhutlo magareng ga $\underline{a}$ le $\underline{b}$, ka jalo katiswa ya bokanakang jwa beketara e le nngwe (a) le karolwana ya sekalara $(b\cos\theta)$ ya beketara ya bobedi.
19. Vector **Die vektorproduk**	Die vektorproduk (kruis-produk) $\underline{a}\times\underline{b}$ van twee vektore $\underline{a}$ en $\underline{b}$ is 'n vektor $\underline{c}$ loodreg op die ander twee vektore. Die *grootte* word weergegee deur $c = ab\sin\phi$ met ϕ die kleinste hoek tussen $\underline{a}$ en $\underline{b}$. Die *rigting* van $\underline{c}$ word weergegee deur die regterhandreël: draai met die regterhand se vier vingers vanaf die eerste vektor ($\underline{a}$) deur die *kleinste* hoek na die tweede vektor ($\underline{b}$) - die duim sal in die rigting van $\underline{c}$ wys; $\underline{c}$ is loodreg op die vlak waarin $\underline{a}$ en $\underline{b}$ lê. Die rigting van $\underline{c}$ is ook dieselfde as die rigting waarin 'n regterhandse skroef sal beweeg as dit in dieselfde rigting gedraai word as wanneer $\underline{a}$ deur die *kleinste* hoek gedraai word om met $\underline{b}$ saam te val.	**19. The vector product**	The vector product (cross product) $\underline{a}\times\underline{b}$ of two vectors $\underline{a}$ and $\underline{b}$ is a vector $\underline{c}$ perpendicular on the other two vectors. The *magnitude* is given by $c = ab\sin\phi$ with ϕ the smallest angle between $\underline{a}$ and $\underline{b}$. The *direction* of $\underline{c}$ is given by the right-hand rule: turn with the four fingers of the right hand from the first vector ($\underline{a}$) to the second vector ($\underline{b}$) through the smallest angle – the thumb will show in the direction of $\underline{c}$, which is perpendicular to the plane that contains $\underline{a}$ and $\underline{b}$. The direction of $\underline{c}$ is the same as the direction of motion of a right-hand screw when turned from $\underline{a}$ to $\underline{b}$ through the smallest angle.	**19. Katiso ya dibeketara**	Seatiso sa beketara (katiso kgaogano) $\underline{a}\times\underline{b}$ ya dibeketara tse pedi $\underline{a}$ le $\underline{b}$ ke beketara $\underline{c}$ e e tsepameng mo dibeketareng tse dingwe tse pedi. *Bokanakang* bo neelwa ke $c = ab\sin\phi$ ka ϕ sekhutlo se se nnyennye fa gare ga $\underline{a}$ le $\underline{b}$. Ntlha ya $\underline{c}$ e neelwa ke molawana wa letsogo la moja: retolola ka menwana e mene ya letsogo la moja go tswa mo beketareng ya ntlha ($\underline{a}$) go ya kwa beketareng ya bobedi ($\underline{b}$) go ralala sekhutlo se se nnyennye – monwana wa kgononnope o tla go bontsha go ya ntlheng ya $\underline{c}$, e e tsepameng mo sefatleng se se nang le $\underline{a}$ le $\underline{b}$. Ntlha ya $\underline{c}$ e tshwana le ntlha ya motsamao wa sekurufu sa letsogo la moja fa se retololwa go tswa go $\underline{a}$ go ya $\underline{b}$ go ralala sekhutlo se se nnyennye.

20. Posisievektor	Die posisie van die deeltjie word m.b.v. die ***posisie vektor*** $\underline{r}$ (wat die vektorsom van sy vektorkomponente parallel aan die koördinaat-asse is) aangedui. Ons kan $\underline{r}$in eenheids-vektornotasie uitdruk: $\underline{r} = x\underline{i} + y\underline{j} + z\underline{k}$	**20. Position vector**	The position of a particle is indicated by the ***position vector*** $\underline{r}$, which is the vector sum of its vector components parallel to the co-ordinate axes. We can express $\underline{r}$ in unit-vector notation: $\underline{r} = x\underline{i} + y\underline{j} + z\underline{k}$	**20. Beketara ya kemo**	Kemo ya karolwana e supiwa ka **beketara ya kemo** $\underline{r}$, e e leng palo ya beketara ya dikarolwana tsa yona tse di rapaletseng le dikhodineite tsa melagare. Re ka tlhagisa $\underline{r}$ ka mokgwa wa beketara-bongwe: $\underline{r} = x\underline{i} + y\underline{j} + z\underline{k}$
21. Gemiddelde snelheid	Wanneer 'n deeltjie deur ’n verplasing $\Delta\underline{r}$ in ’n tyd Δt beweeg, word die gemiddelde snelheid weergegee deur $\underline{v}_{gem} = \frac{\Delta\underline{r}}{\Delta t}$ $\underline{v}_{gem} = \frac{\Delta x\underline{i} + \Delta y\underline{j} + \Delta z\underline{k}}{\Delta t}$ $\underline{v}_{gem} = \frac{\Delta x}{\Delta t}\underline{i} + \frac{\Delta y}{\Delta t}\underline{j} + \frac{\Delta z}{\Delta t}\underline{k}$	**21. Average velocity**	When a particle moves through a displacement $\Delta\underline{r}$ in a time Δt , its average velocity is $\underline{v}_{avg} = \frac{\Delta\underline{r}}{\Delta t}$ $\underline{v}_{avg} = \frac{\Delta x\underline{i} + \Delta y\underline{j} + \Delta z\underline{k}}{\Delta t}$ $\underline{v}_{avg} = \frac{\Delta x}{\Delta t}\underline{i} + \frac{\Delta y}{\Delta t}\underline{j} + \frac{\Delta z}{\Delta t}\underline{k}$	**21. Palogare ya belosithi**	Fa karolwana e tsamaya go ralala sekgalantlha sa $\Delta\underline{r}$ mo nakong Δt, palogare ya belosithi ke $\underline{v}_{avg} = \frac{\Delta\underline{r}}{\Delta t}$ $\underline{v}_{avg} = \frac{\Delta x\underline{i} + \Delta y\underline{j} + \Delta z\underline{k}}{\Delta t}$ $\underline{v}_{avg} = \frac{\Delta x}{\Delta t}\underline{i} + \frac{\Delta y}{\Delta t}\underline{j} + \frac{\Delta z}{\Delta t}\underline{k}$
22. Oombliklike snelheid	Die oombliklike snelheid (snelheid op ’n spesifieke oomblik) $\underline{v}$ is die waarde waarna die gemiddelde snelheid in die limiet nader wanneer Δt verminder word na 0:	**22. Instantaneous velocity**	The instantaneous velocity (velocity at a specific moment) $\underline{v}$ is the value that the average velocity approaches in the limit as we shrink Δt to 0:	**22. Belosithipong**	Belosithipong (belosithi ka nakong e e rileng) $\underline{v}$ ke bokanakang jo palogare ya belosithi e tlhagelelang mo limiting fa re ngotlafatsa Δt go 0:

	$\underline{v} = \lim_{\Delta t \to 0} \frac{\Delta \underline{r}}{\Delta t}$ $\underline{v} = \frac{d\underline{r}}{dt}$ = afgeleide van die verplasingsv		$\underline{v} = \lim_{\Delta t \to 0} \frac{\Delta \underline{r}}{\Delta t}$ $\underline{v} = \frac{d\underline{r}}{dt}$ = derivative of position vector		$\underline{v} = \lim_{\Delta t \to 0} \frac{\Delta \underline{r}}{\Delta t}$ $\underline{v} = \frac{d\underline{r}}{dt}$ = derivative of position vector
23. Gemiddelde versnelling	As die snelheid van 'n deeltjie van $\underline{v}_1$ na $\underline{v}_2$ in 'n tydinterval Δt verander, word die gemiddelde versnelling weergegee deur $\underline{a}_{gem} = \frac{\underline{v}_2 - \underline{v}_1}{\Delta t} = \frac{\Delta \underline{v}}{\Delta t}$	**23. Average acceleration**	If the velocity of a particle changes from $\underline{v}_1$ to $\underline{v}_2$ in a time period Δt, its average acceleration is given by $\underline{a}_{avg} = \frac{\underline{v}_2 - \underline{v}_1}{\Delta t} = \frac{\Delta \underline{v}}{\Delta t}$	**23. Palogare ya kelolebelo**	Fa belosithi ya karolwana e fetoga go tswa go $\underline{v}_1$ go ya go $\underline{v}_2$ mo nakong ya paka Δt, palogare ya kelolebelo la yona e neelwa ka $\underline{a}_{avg} = \frac{\underline{v}_2 - \underline{v}_1}{\Delta t} = \frac{\Delta \underline{v}}{\Delta t}$
24. Oombliklike versnelling	Die oombliklike versnelling $\underline{a}$ is die waarde waarheen die gemiddelde versnelling in die limiet nader wanneer Δt verminder word na 0: $\underline{a} = \lim_{\Delta t \to 0} \frac{\Delta \underline{v}}{\Delta t}$ $\underline{a} = \frac{d\underline{v}}{dt}$ = afgeleide van die snelheid	**24. Instantaneous acceleration**	The instantaneous acceleration $\underline{a}$ is the value that the average acceleration approaches in the limit as we shrink Δt to 0: $\underline{a} = \lim_{\Delta t \to 0} \frac{\Delta \underline{v}}{\Delta t}$ $\underline{a} = \frac{d\underline{v}}{dt}$ = derivative of velocity	**24. Kelolebelopong**	Kelolebelopong $\underline{a}$ ke bolengpalo jo palogare ya kelolebelo e tlhagelelang mo limiting fa re ngotlafatsa Δt go 0: $\underline{a} = \lim_{\Delta t \to 0} \frac{\Delta \underline{v}}{\Delta t}$ $\underline{a} = \frac{d\underline{v}}{dt}$ = derivative of velocity
25. Projektiel-beweging	Dit is die beweging van 'n deeltjie wat met 'n snelheid $\underline{v}_0$ begin en slegs aan gravitasieversnelling onderhewig is. ('n Vryval in twee dimensies, dus word lugweerstand buite rekening gelaat.)	**25. Projectile motion**	It is the motion of a particle that is launched with an initial velocity $\underline{v}_0$ and that is subject to gravitational acceleration only. (A free fall in two dimensions, thus air friction are not taken into account).	**25. Motsamao wa sethunngwa**	Ke motsamao wa karolwana e e thunngwang ka belosithi ya tshimologo $\underline{v}_0$ mme e le ntlha ya kgatelelong ya kgogedi fela. (Go wa ka kgololosego mo selekanyo-gabedi, ka jalo kgotlhano ya mowa ga ya tsewa

					tsiya).
26. Uniforme sirkelbeweging	’n Deeltjie is in uniforme sirkelbeweging as dit teen konstante spoed langs ’n sirkel of boogvormige pad beweeg.	**26. Uniform circular motion**	A particle is in uniform circular motion if it travels around a circle or circular path at constant speed.	**26. Motsamao tshekeletsa o o sa fetogeng**	Karolwana e mo motsamaong tshekeletsa o o sa fetogeng fa e tsamaya go dikologa sediko kgotsa tselana e e tshekeletsa ka lebelo le le sa fetogeng
27. Die wet van snelheids-optelling	Die snelheid van voorwerp P soos gemeet deur A is gelyk aan die snelheid van P soos gemeet deur B plus die snelheid van B soos gemeet deur A.	**27. The law of velocity addition**	The velocity of object P as measured by A is equal to the velocity of P as measured by B plus to the velocity of B as measured by A.	**27. Molao wa tlhakanyo ya belosithi**	Belosithi ya sere sa P fa se lekanngwa ke A e lekana le belosithi ya P fa e lekanngwa ke B e tlhakanngwa le belosithi ya B fa e lekanngwa ke A.
28. Newton-meganika	In die meganika word die verband tussen die kragte wat op 'n voorwerp werk en die beweging (versnelling, snelheid, en verplasing) van die voorwerp beskryf.	**28. Newtonian mechanics**	It is the study of the relationship between forces acting on an object and the motion (acceleration, velocity, and displacement) of the object.	**28. Meganika wa Newton**	Ke thuto ya kamano magareng ga dithata tse di dirang mo sereng le mo motsamaong (kelolebelo, belosithi, le sekgalantlha) sa sere.
29. 'n Krag	'n Krag is dit wat 'n voorwerp se snelheid laat verander, dit wil sê 'n krag laat 'n voorwerp versnel.	**29. A force**	It is that which causes a change in an object's velocity, in other words a force causes an object to accelerate.	**29. Thata**	Ke se se tlholang phetogo mo belosithing ya sere, ka mantswe a mangwe thata e tlhola gore sere se nne le kelolebelo.
30. Newton se eerste wet:	As die resulterende krag wat op 'n voorwerp werk nul is, sal (i) die voorwerp, indien dit in rus is, in rus bly, of (ii) die snelheid van die voorwerp, indien dit met 'n	**30. Newton's first law**	If the resultant force on an object is zero, this object will (i) remain at rest (if it is at rest), or (ii) continue to move at constant velocity (if it is moving at	**30. Molao wa ntlha wa Newton**	Fa sephethokopanyo sa thata mo sereng e le lefela, sere se, se tla (i) sala se ntse fela (fa se ne se ntse fela), Kgotsa

	konstante snelheid beweeg, konstant bly.		constant velocity).		(ii) tswelela go tsamaya ka belosithi e e sa fetogeng (fa se ntse se tsamaya ka belosithi e e sa fetogeng).
31. Inersie-sisteem	'n Koördinaatsisteem waarin Newton se eerste wet geld (nl. dat die voorwerp nie sal versnel indien daar nie 'n krag daarop inwerk nie), word 'n **inersiesisteem** genoem.	**31. Inertial frame**	A co-ordinate system in which Newton's first law holds (i.e. that an object will not accelerate if there is no force acting on it), is called an **inertial frame**.	**31. Kgatlha ya go sa fetogeng ga kelolebelo**	Thulaganyo ya kgokagano e molao wa ntlha wa Newton o leng nnete (sk. gore sere se ka se oketse kelolebelo fa go se na thata e e dirang mo go sona), e bidiwa **kgatlha ya go sa fetogeng ga kelolebelo.**
32. Massa	Dit is daardie eienskap van 'n voorwerp wat bepaal hoe groot die voorwerp se versnelling sal wees indien 'n krag daarop uitgeoefen word.	**32. Mass**	It is that property of an object that determines the magnitude of the object's acceleration when a force is exerted on it.	**32. Mmase**	Ke pharologantsho ya sere e e tlhomamisang bokanakang jwa kelolebelo ya sere fa thata se gatelelwa mo go yona.
33. Newton se tweede wet:	As daar 'n resulterende krag op 'n voorwerp inwerk, (i) sal die voorwerp in die rigting van die resulterende krag versnel en (ii) is die grootte van die versnelling direk eweredig aan die grootte van die resulterende krag. Die wiskundige uitdrukking vir hierdie wet: $\sum F = m\underline{a}$ Opmerking: $\sum F$ is **altyd** die resultant (vektorsomtotaal of	**33. Newton's second law**	If a resultant force is acting on an object, (i) the object accelerates in the direction of the resultant force and (ii) the magnitude of the acceleration is directly proportional to the magnitude of the resultant force. The mathematical expression for this law: $\sum \underline{F} = m\underline{a}$ $\sum F$ is **always** the resultant	**33. Molao wa bobedi wa Newton**	Fa sephethokopanyo sa thata se dira mo sereng, (i) sere se nna le kelolebelo go ya kwa ntlheng ya sephethokopanyo sa thata mme (ii) bokanakang jwa kelolebelo bo kgaogantswe ka tlhamalalo mo bokanakang jwa sephethokopanyo sa thata. Tlhagiso ya mokgwa wa semmetshe wa molao o :

	netto krag) van al die kragte wat op **een enkele voorwerp** met massa *m* inwerk.		(vector sum or net force) of all the forces acting on **one single object** of mass *m*.		$\sum \underline{F} = m\underline{a}$ $\sum F$ ka **nako tsotlhe** ke sephethokopanyo (palo ya beketara kgotsa thata ya kopanelo) ya dithata tsotlhe tse di dirang mo **sereng se le sengwe se se sosi** sa mmase *m*.
34. Newton se derde wet	As 'n voorwerp *A* 'n krag op 'n voorwerp *B* uitoefen, sal (i) *B* ook 'n krag op *A* uitoefen; (ii) hierdie twee kragte (a) gelyk aan mekaar wees en (b) ook in teenoorgestelde rigtings werk.	**34. Newton's third law**	When an object *A* exerts a force on an object *B*, then (i) *B* exerts a force on *A;* (ii) these forces (a)are equal in magnitude and (b) act in opposite directions.	**34. Molao wa boraro wa Newton**	Fa sere sa *A* se gatelela thata mo sereng sa *B, ka* jalo (i) *B* e gatelela that mo go *A;* (ii) dithata tse (a) di a lekana ka bokanakang di bo di (b) dira mo dintlheng tse di farologaneng.
35. Statiese wrywingskrag	Dit is die wrywingskrag wat werk wanneer daar nie (gly-) beweging is nie. Die wrywingskrag wat dan die beweging teenstaan, word die kinetiese wrywingskrag $\underline{f}_k$ genoem. Die grootte van $\underline{f}_s$ het 'n maksimum waarde, $\underline{f}_{s,maks,}$ weergegee deur: $f_{s,maks} = \mu_s N$ waar μ_s die ***statiese wrywingskoëffisiënt*** en *N* die	**35. Static frictional force**	It is the frictional force that acts when there is no sliding. The frictional force that opposes the motion then is called the kinetic frictional force $\underline{f}_k$. The magnitude of $\underline{f}_s$ has a maximum value, $\underline{f}_{s,max}$, given by: $\underline{f}_{s,max} = \mu_s N$ where μ_s is the **static frictional coefficient** and *N* the magnitude of the normal force $\underline{N}$. If the	**35. Thata ya kgotlhano ya go sa suteng**	Ke thata ya kgotlhano e e dirang fa go se thelelo epe. Thata ya kgotlhano e e leng kgatlhano le motsamao ka jalo e bidiwa thata ya kgotlhano ya maatlatsamao $\underline{f}_k$. Bokanakang jwa $\underline{f}_s$ bona le paloboleng ya palobotlalo ya, $\underline{f}_{s,max}$, E neelwa ke: $\underline{f}_{s,max} = \mu_s N$ fa μ_s e le **khoefišente ya**

	grootte van die normaalkrag $\underline{N}$ *is*. As die parallelle komponent van $\underline{F}$ die waarde van $f_{s,maks}$ oorskry, begin die voorwerp beweeg.		parallel component of $\underline{F}$ exceeds the value of $f_{s,max}$, the object starts moving.		**kgotlhano ya go sa suteng** mme *N* ke bokanakang jwa thata ya tlwaelo ya $\underline{N}$. Fa karolwana e e bapileng ya $\underline{F}$ e feta bolengpalo jwa , $f_{s,max}$, sere se simolola go suta.
36. Kinetiese wrywingskrag	$f_k \rightarrow$ die wrywingskrag wat beweging teëwerk. Terwyl die voorwerp oor die oppervlak beweeg, neem die grootte van die wrywingskrag af na die konstante waarde f_k, *weer*gegee deur: $f_k = \mu_k N$, waar μ_k die ***kinetiese wrywingskoëffisiënt*** is.	**36. Kinetic frictional force**	$f_k \rightarrow$ the frictional force that acts when there is sliding. As the object moves over the surface, the magnitude of the frictional force decreases to the constant value f_k, *expressed by:* $f_k = \mu_k N$, where μ_k is the **kinetic frictional coefficient.**	**36. Thata ya kgotlhano ya maatlatsamao**	$f_k \rightarrow$ thata ya kgotlhano e e dirang fa go na le thelelo. Jaaka sere se tsamaya mo godimo ga sefatla, bokanakang jwa thata ya kgotlhano bo fokotsegela go bolengpalo bo bo e sa fetogeng f_k, *e tlhagisiwa ke:* $f_k = \mu_k N$, fa μ_k e leng **khoefišente ya kgotlhano ya maatlatsamao.**
37. Die sleurkrag en terminale spoed	Wanneer daar 'n relatiewe snelheid tussen 'n fluïde en 'n liggaam bestaan, sal die liggaam 'n sleurkrag $\underline{D}$**,** wat die beweging teëwerk, ervaar. Wanneer 'n voorwerp, soos 'n bal, 'n ver afstand deur die lug val, en die grootte van $\underline{D}$ gelyk is aan die gewig van die voorwerp, val die voorwerp teen 'n ***konstante terminale spoed***.	**37. The drag force and terminal speed**	When there is a relative velocity between a fluid and a body, the body will experience a drag force $\underline{D}$ that opposes the motion. When an object, like a ball, falls far enough through the air and the magnitude of $\underline{D}$ equals the weight of the object, the object falls at a **constant terminal speed**.	**37. Thata ya kgogô le lebelo la pheletso**	Fa go na le belosithi e e tsamaelanang magareng ga seedi le sere, sere se tla itemogela thata ya kgogô ya $\underline{D}$ e e leng kgatlhanong le motsamao. Fa sere, se se jaaka kgwele, se wela kwa kgakala mo go utlwalang go sutlha mo moweng mme bokanakang ba $\underline{D}$ bo lekana le bokete ba sere, sere se wa ka **lebelo la pheletso le le sa fetogeng.**

38. Arbeid	Arbeid is energie wat na of van 'n voorwerp oorgedra word deur middel van 'n krag wat op die voorwerp inwerk. Energie wat **na** 'n voorwerp oorgedra word, is positiewe arbeid en energie wat **van** 'n voorwerp oorgedra word, is negatiewe arbeid.	**38. Work**	Work is energy transferred to or from an object by means of a force acting on the object. Energy transferred **to** an object is positive work, and energy transferred **from** an object is negative work.	**38. Tiro**	Tiro ke maatla a a fetisediwang kwa kgotsa go tswa mo sereng ka thata e e dirang mo sereng. Maatla a a fetisediwang **go ya kwa** sereng ke tiro ya palokoketso, mme maatla a a fetisetswang **go tswa mo** sereng ke tiro ya palophokotso.
39. Arbeid-energie-stelling	Die arbeid wat deur die *resulterende krag* (dit wil sê die resultant van *al die kragte* wat op die voorwerp inwerk) op 'n voorwerp verrig word, is gelyk aan die verandering in die kinetiese energie van die voorwerp.	**39. Work–energy theorem**	The work done by the *resultant force* (i.e. the resultant of *all the forces* working on the object) on an object equals the change in the kinetic energy of the object.	**39. Tioreme ya maatlatiro**	Tiro e e dirwang ke *sephethokopanyo sa thata* (sk. sephethokopanyo sa *dithata tsotlhe* tse di dirang mo sereng) mo sereng a lekana le phetogo mo maatlatsamaong a sere.
40. Arbeid verrig deur gravitasiekrag	$W_{\mathbf{g}} = mgd\cos\theta$	**40. Work done by gravity**	$W_{\mathbf{g}} = mgd\cos\theta$	**40. Tiro e e dirilweng ke maatlakgogedi**	$W_{\mathbf{g}} = mgd\cos\theta$
41. Arbeid verrig deur 'n veranderende krag	$W = \int_{x_i}^{x_f} F(x)dx.$	**41. Work done by a variable (non-uniform) force**	$W = \int_{x_i}^{x_f} F(x)dx.$	**41. Tiro e e dirilweng ke thata e e fetogang thata (e e sa fetogeng)**	$W = \int_{x_i}^{x_f} F(x)dx.$
42. Arbeid verrig deur 'n veerkrag (die krag wat deur 'n veer uitgeoefen word)	$W = -\frac{1}{2}kx^2$	**42. Work done by a spring force (the force exerted by a spring)**	$W = -\frac{1}{2}kx^2$	**42. Tiro e e dirilweng ke thata ya seporeng (kgatelelo ya thata ka seporeng)**	$W = -\frac{1}{2}kx^2$
43. Potensiële	Potensiële energie *U* is energie	**43. Potential energy**	Potential energy *U* is energy that	**43. Maatlakgonego**	Maatlakgonego a *U* ke maatla a

energie	wat met die konfigurasie van 'n sisteem van voorwerpe wat kragte op mekaar uitoefen, geassosieer kan word. ('n Voorwerp besit energie as 'n krag arbeid daarop verrig.)		can be associated with the configuration of a system of objects that exert forces on one another. (An object possesses energy when a force does work on it.)		a ka golaganngwang le popego ya thulagano ya dire tse di gatelelang dithata mo go tse dingwe. (Sere se na le maatla fa thata e dira tiro mo go sona.)
44. Konserwa-tiewe krag	As die arbeid wat 'n krag op 'n deeltjie verrig het, nie van die pad wat die deeltjie gevolg het, afhanklik is nie, maar slegs van die begin- en eindposisies van die deeltjie, word die krag 'n konserwatiewe krag genoem. Anders gestel: As die netto arbeid wat deur ’n krag verrig is om ’n deeltjie in ’n geslote baan te beweeg, nul is, is die krag ’n konserwatiewe krag.	**44. Conservative force**	A force is a conservative force if the net work it does on a particle moving between two points does not depend on the path taken by the particle. Or to state it differently, if the net work done by a force to move a particle around a closed path is zero, then the force is a conservative force.	**44. Thata e e khonsebetifi**	Thata ke thata e e khonsebetifi fa tiro yotlhe e e e dirang mo karolwaneng e e tsamayang gareng ga dikhutlo tse pedi e sa ikaega mo tselaneng e e tserweng ke karolwana. Kgotsa go e baya ka mokgwa o o farologaneng, fa tiro yotlhe e e dirilweng ke thata go sutisa karolwana go dikologa tselana e e tswalegileng e le lefela, ka jalo thata e nna thata e e khonsebetifi.
45. Arbeid-potensiële energiestelling	Die negatief van die arbeid wat verrig is deur 'n konserwatiewe krag is gelyk aan die verandering in die ooreenstemmende potensiële energie van die liggaam.	**45. Work potential energy theorem**	The negative of the work done by a conservative force equals the change in the corresponding potential energy of the body.	**45. Tioreme ya maatlatiro kgonego**	Palophokotso ya tiro e e dirilweng ke thata e e khonsebetifi e lekana le phetogo mo maatlakgonego a a tsamaelanang a sere.
46. Gravitasie potensiële energie	'n Liggaam het gravitasie potensiële energie as gevolg van sy posisie, dit wil sê omdat dit op 'n afstand van die aarde af is.	**46. Gravitational potential energy**	A body has gravitational potential energy because of its position above the earth.	**46. Maatlakgonego a maatlakgogedi**	Sere se na le maatlakgonego a maatlakgogedi ka ntlha ya kemo ya mo godimo ga lefatshe.

47. Elastiese potensiële energie	'n Veer het elastiese potensiële energie omdat die vorm daarvan verander het, dit wil sê omdat dit gerek of saamgedruk is.	**47. Elastic potential energy**	A spring has elastic potential energy because of its deformation, in other words because it is stretched or compressed.	**47. Maatlakgonego a a nang le bongaologo**	Seporeng se na le maatlakgonego a a ngaologang ka ntlha ya phetolo ya sona, ka mantswe a mangwe ka gonne se ngaologile kgotsa se pinyeletswe.
48. Die meganiese energie E_{mec}	Die meganiese energie E_{mec} van 'n sisteem is die som van die potensiële energie (U) en die kinetiese energie (K) van die voorwerpe binne die sisteem.	**48. The mechanical energy E_{mec}**	The mechanical energy E_{mec} of a system is the sum of its potential energy (U) and the kinetic energy (K) of the objects within it.	**48. Maatla ka motšhini E_{mec}**	Maatla ka motšhini a E_{mec} a thulaganyo ke palo ya maatlakgonego a *(U)* maatlatsamao a (K) a dire tse di mo teng ga ona.
49. Die wet van behoud van meganiese energie	Wanneer 'n voorwerp beweeg a.g.v. die arbeid wat konserwatiewe krag(te) daarop verrig, en slegs die konserwatiewe krag(te) energieveranderinge veroorsaak, bly die totale meganiese energie, dit wil sê $E_{mec} = K + U$, van die voorwerp konstant. ($E_{mec} = K_{liggaam} + U_{gravitasie}$ vir die voorwerp-aarde sisteem en $E_{mec} = K_{blok} + U_{elasties}$ vir die blok-veer sisteem.) Of As slegs konserwatiewe kragte	**49. The principle of conservation of mechanical energy**	When an object moves under the action of a conservative force and only the conservative force causes energy changes, the total mechanical energy, i.e. $E_{mec} = K + U$, of the object remains constant. ($E_{mec} = K_{object} + U_{gravity}$ for the object-earth system and $E_{mec} = K_{block} + U_{elastic}$ for the block-spring system.) Or When a system is isolated and only conservative forces cause energy changes, the sum of its	**49. Theo ya tshomarelo ya maatla ka motšhini**	Fa sere se tsamaya ka ntlha ya tiragatso ya thata ya khonsebetifi mme e le maatla a khonsebetifi fela a a tlholang diphetogo tsa maatla, palogotlhe ya maatla ka motšhini, sk. $E_{mec} = K + U$, a sere a sala a sa fetoga. (E_{mec} = Ksere + Umaatlakgogedi a thulaganyo ya sere-lefatshe le $E_{mec} = K_{block} + U_{elastic}$ mo thulaganyong ya semika-seporeng.) Kgotsa

	energieveranderinge in 'n geïsoleerde sisteem veroorsaak, sal die som van die sisteem se potensiële energie (*U*) en die kinetiese energie (*K)* vir enige toestand van die sisteem = som van die potensiële energie (*U*) en die kinetiese energie *(K)* vir enige ander toestand van die sisteem.		potential energy (*U*) and the kinetic energy (*K*) for any state of the system = the sum of its potential energy (*U*) and the kinetic energy (*K)* for any other state of the system.		Fa thulaganyo e arogantswe mme e le dithata tsa khonsebetifi fela di bakang diphetogo mo maatleng, palo ya maatlakgonego a yona a (*U*) le maatlatsamao a (*K*) a maemo mangwe le mangwe a thulaganyo = palo ya maatlakgonego a yona a (*U*) le maatlatsamao a (*K*) a maemo mangwe le mangwe fela a thulaganyo.
50. Eksterne krag	Dit is 'n krag wat deur iemand of iets buite die sisteem op die sisteem of op dele van die sisteem uitgeoefen word.	**50. External force**	It is a force exerted by someone or something outside the system on the system or on part of the system.	**50. Thatantle**	Ke thata e e ntshitsweng ke mongwe kgotsa sengwe ka kwa ntle ga thulaganyo mo thulaganyong kgotsa mo karolong ya thulaganyo.
51. Arbeid-energie stelling	Die arbeid wat deur die **eksterne nie-konserwatiewe** kragte wat op 'n liggaam inwerk,verrig word, is gelyk aan die verandering in die kinetiese energie plus die verandering in die potensiële energie van die liggaam. (As daar meer as een krag op 'n sisteem inwerk, is die netto arbeid die energie wat oorgedra.is. As daar nie wrywing betrokke is nie, is die arbeid wat op die sisteem verrig is, gelyk aan die verandering in die meganiese energie van die	**51. Work-energy theorem**	The work done by the **external non-conservative forces** acting on a body equals the increase in the kinetic energy plus the increase in the potential energy of the body. *(*When more than one force acts on a system, their net work is the transferred energy. When friction is not involved, the work done on the system and the change in the mechanical energy of the system are equal.)	**51. Tioreme ya Maatlatiro**	Tiro e dirilweng ke **dithata tse e seng tsa khonsebetifi tsa kwa ntle** tse di dirang mo sereng e lekana le koketsego ya maatlatsamao e tlhakanngwa le maatlakgonego a sere. (Fa thata e e fetang bongwe e dira mo thulaganyong, tiro yotlhe ya yona ke maatla a a fetisitsweng. Fa kgotlhano e sa dire fao, tiro e e dirilweng mo thulaganyong le phetogo mo thulaganyong ya maatla ka motšhini e a lekana.)

	sisteem.)				
52. Die wet van behoud van energie	In ’n geïsoleerde sisteem kan energie van een vorm na ’n ander oorgedra word, maar die totale energie van die sisteem bly konstant.	**52. The law of conservation of energy**	In an isolated system, energy can be transferred from one type to another, but the total energy of the system remains constant.	**52. Molao wa tshomarelo ya maatla**	Mo thulaganyo e e tlhaotsweng, maatla a ka fetisiwa go tswa mo mofuteng o mongwe go ya go o mongwe, fela palogotlhe ya maatla mo thulaganyong e sala e sa fetoga.
53. Massa-middelpunt	Die massamiddelpunt van ’n voorwerp of 'n stelsel van voorwerpe is daardie punt wat beweeg asof al die massa daar gekonsentreer is en al die eksterne kragte daar aangewend word.	**53. Centre of mass**	The centre of mass of an object or a system of objects is the point that moves as though all the mass were concentrated and all external forces applied there.	**53. Ntlhagare ya mmase**	Ntlhagare ya mmase wa sere kgotsa thulaganyo ya dire ke ntlha e e tsamayang jaaka e kete mmase otlhe o ne o loile mme dithata tsotlhe tsa kwa ntle di dira moo.
54. Lineêre momentum	Die lineêre momentum $\underline{p}$ van ’n deeltjie met massa m en snelheid $\underline{v}$ is die produk van sy massa en snelheid en word omskryf as $\underline{p} = m\underline{v}$.	**54. Linear momentum**	The linear momentum $\underline{p}$ of a particle of mass m and velocity $\underline{v}$ is the product of its mass and velocity and is defined as $\underline{p} = m\underline{v}$.	**54. Momenthamo wa lethetho**	Momenthamo wa lethetho $\underline{p}$ wa karolwana ya mmase wa m le belosithi ya $\underline{v}$ ke seatiswa sa mmase wa sona le belosithi o ranolwa jaaka $\underline{p} = m\underline{v}$.
55. Newton se tweede wet in terme van momentum	$\sum \underline{F} = m\underline{a} = m\frac{d\underline{v}}{dt} = \frac{d}{dt}(m\underline{v}) = \frac{d\underline{p}}{dt}$ Die tempo van verandering van momentum van ’n deeltjie is eweredig aan die netto krag wat op die deeltjie inwerk en is in die rigting van daardie krag.	**55. Newton's second law in terms of momentum**	$\sum \underline{F} = m\underline{a} = m\frac{d\underline{v}}{dt} = \frac{d}{dt}(m\underline{v}) = \frac{d\underline{p}}{dt}$ The time rate of change of momentum of a particle is equal to the net force acting on the particle and is in the direction of that force.	**55. Molao wa bobedi wa Newton go ya ka momenthamo**	$\sum \underline{F} = m\underline{a} = m\frac{d\underline{v}}{dt} = \frac{d}{dt}(m\underline{v}) = \frac{d\underline{p}}{dt}$ Nako ya kelo ya phetogo ya momenthamo wa karolwana o lekana le tiro gotlhe e e dirang mo karolwaneng mme o mo ntlheng ya thata eo.

56. Die lineêre momentum van 'n stelsel van deeltjies (of star liggaam)	Dit is gelyk aan die produk van die totale massa *M* van die sisteem en die snelheid $\underline{v}_{com}$ van die massamiddelpunt (com = centre of mass).	**56. The linear momentum of a system of particles (or rigid body)**	It is equal to the product of the total mass *M* of the system and the velocity $\underline{v}_{com}$ of the centre of mass.	**56. Momenthamo wa lethetho lwa thulagano ya dikarolwana (kgotsa sere se se komota)**	E lekana le seatiswa sa palogotlhe ya mmase wa *M wa* thulagano le belosithi ya $\underline{v}_{com}$ ya ntlhagare ya mmase.
57. Wet van behoud van lineêre momentum	Indien 'n sisteem van deeltjies geïsoleer word sodat geen eksterne kragte op die sisteem van deeltjies inwerk nie, bly die totale lineêre momentum konstant. Hierdie wet kan ook geskryf word as $\underline{P}_i = \underline{P}_f$ waar $\underline{P}_i$ en $\underline{P}_f$ na die begin- én finale momentum van 'n sisteem van deeltjies verwys.	**57. Law of conservation of linear momentum**	If a system of particles is isolated so that no net external forces act on the system of particles, the total linear momentum of the system remains constant. Alternatively, this law can be written as $\underline{P}_i = \underline{P}_f$ where $\underline{P}_i$ and $\underline{P}_f$ refer to the initial and final momentum of a system of particles.	**57. Molao wa tshomarelo ya momenthamo wa lethetho**	Fa thulaganyo ya dikarolwana e tlhaotswe gore go se nne le dithata tsa kwa ntle tse di dirang mo thulaganyong ya dikarolwana, palogotlhe ya momenthamo wa lethetho la thulagano e sala e sa fetoga. E seng jalo, molao o, o ka kwala jaaka $\underline{P}_i = \underline{P}_f$ mo $\underline{P}_i$ le $\underline{P}_f$ di rayang momenthamo wa tshimologo le wa bofelo wa thulaganyo ya dikarolwana.
58. 'n Botsing	Dit is 'n geïsoleerde gebeurtenis waarin twee of meer liggame relatief sterk kragte vir relatief kort tye op mekaar uitoefen.	**58. A collision**	A collision is an isolated event in which two or more bodies exert relatively strong forces on each other for a relatively short time.	**58. Thulano**	Thulano ke tiragalo e e tlhaolegileng e mo go yona dire tse pedi kgotsa go feta di gatelelana ka dithata tse di tseneletseng mo go tse dingwe mo nakong e khutshwane e le tota.
59. Impuls	(i): As 'n uniforme krag $\underline{F}$ vir 'n kort tyd Δt op 'n voorwerp inwerk, word die impuls van die	**59. Impulse**	(i): If a uniform force $\underline{F}$ acts on an object for a short time Δt, the impulse of the force is given by	**59. Imphalese**	(i): Fa thata e e sa fetogeng ya $\underline{F}$ e dira mo sereng ka nako e khutshwane Δt, imphalese ya

	krag deur die produk van die krag en die tyd $\underline{J} = \underline{F}\Delta t$ weergegee.		the product of the force and the time $\underline{J} = \underline{F}\Delta t$.		thata e neelwa ke katiso ya thata le nako $\underline{J} = \underline{F}\Delta t$.
60. Impuls	(ii): As 'n nie-uniforme krag $\underline{F(t)}$ van tyd t_i tot tyd t_f op 'n voorwerp inwerk, word die impuls van die krag deur $\underline{J} = \int_{t_i}^{t_f} \underline{F}(t)dt$ weergegee.	**60. Impulse**	(ii): If a non-uniform force $\underline{F(t)}$ acts on an object from time t_i to time t_f , the impulse of the force is given by $\underline{J} = \int_{t_i}^{t_f} \underline{F}(t)dt$.	**60. Imphalese**	(ii): Fa thata e e seng e e fetogang ya $\underline{F(t)}$ e dira mo sereng ka nako le nako t_i go ya mo nakong ya t_f , imphalese ya thata e neelwa ka $\underline{J} = \int_{t_i}^{t_f} \underline{F}(t)dt$.
61. Die impuls-lineêre momentum-stelling	$\underline{p}_f - \underline{p}_i = \Delta \underline{p} = \underline{J}$ waar $\underline{p}_i$ die waarde van die momentum by tyd t_i en $\underline{p}_f$ die waarde by t_f *is.* In woorde: → Die impuls wat op 'n voorwerp inwerk, is gelyk aan die verandering in die momentum van die voorwerp.	**61. The impulse-linear momentum theorem**	$\underline{p}_f - \underline{p}_i = \Delta \underline{p} = \underline{J}$ where $\underline{p}_i$ is the value of the momentum at time t_i and $\underline{p}_f$ the value at t_f. In words: → The impulse acting on an object is equal to the change in the momentum of the object.	**61. Tioreme ya imphalese ya momenthamo wa lethetho**	$\underline{p}_f - \underline{p}_i = \Delta \underline{p} = \underline{J}$ mo $\underline{p}_i$ ke bolengpalo jwa momenthamo mo nakong ya t_i mme $\underline{p}_f$ ke boleng ka t_f. Ka mafoko: → Imphalese e e dirang mo sereng e lekana le phetogo mo momenthamong wa sere.
62. Die wet van behoud van momentum gedurende botsings	In alle botsings tussen liggame is die totale momentum van die liggame voor en na die botsing dieselfde (indien daar **geen** eksterne kragte op die liggame inwerk nie).	**62. The law of conservation of momentum during collisions**	In all collision between bodies, the total momentum of the colliding bodies before a collision equals the total momentum of the bodies after the collision (if **no** external forces act on the bodies).	**62. Molao wa tshomarelo ya momenthamo ka nako ya thulano**	Mo dithulanong tsotlhe magareng ga dire, palogotlhe ya momenthamo ya dire tse di thulanang pele ga thulano e lekana le palogotlhe ya momenthamo wa dire morago ga thulano (fa **go se** thata epe ya kwa ntle e e dirang mo direng.)
63. 'n Nie-elastiese	Dit is 'n botsing waarin die totale	**63. An inelastic**	It is a collision in which the total	**63. Thulano e e sa**	Ke thulano e mo go yona

botsing	kinetiese energie van die liggame ná die botsing minder as voor die botsing is. (Momentum bly behoue, maar nie die energie nie.)	**collision**	kinetic energy of the colliding bodies after the collision is less than before the collision. (Momentum is conserved, but energy is not.)	**ngaologeng**	palogotlhe ya maatlatsamao a dire tse di thulanang morago ga gore thulano e fokotsege pele go nna le thulano. (Momenthamo o a somarelwa, fela maatla ona ga a somarelwe.)
64. 'n Elastiese botsing	'n Botsing waarin die totale kinetiese energie van die liggame voor en na die botsing dieselfde is, word 'n **elastiese botsing** genoem. (LW: Die kinetiese energie van elke botsende liggaam kan verander, maar die totale energie van die sisteem bly konstant.)	**64. An elastic collision**	It is a collision in which the total kinetic energy of the colliding bodies before the collision equals the total kinetic energy of the bodies after the collision. (NB: The kinetic energy of each colliding body may change, but the total energy of the system remains constant.)	**64. Thulano e e ngaologang**	Ke thulano e palogotlhe ya maatlatsamao a dire tse di thulanang pele ga thulano e lekanang le palogotlhe ya maatlatsamao morago ga thulano.(ET: Maatlatsamao a sere sengwe le sengwe se se thulanang a ka fetoga, fela palogotlhe ya maatla a thulaganyo a sala a sa fetoga.)
65. Translasie	Dit is beweging langs 'n reguit lyn.	**65. Translation**	It is motion along a straight line.	**65. Go namalala**	Ke motsamao go bapa le mola o o tlhamaletseng.
66. Rotasie	Dit is beweging om 'n vaste as.	**66. Rotation**	It is motion around a fixed axis.	**66. Go dikologa**	Ke motsamao go dikologa ase e e tlhomameng.
67. Die hoekposisie	Hoekposisie, θ word relatief tot die positiewe *x*-as gemeet, en θ word weergegee deur: $\theta = \frac{s}{r}$ *s* = lengte van die boog, *r* = radius van die sirkel, θ =	**67. The angular position**	Angular position θ is measured relative to the positive *x*-axis, and θ is given by: $\theta = \frac{s}{r}$ $\theta = \frac{s}{r}\theta = \frac{s}{r}$ *s* = length of arc, *r* = radius of the circle, θ = angular position	**67. Kemo ya sekhutlo**	Kemo ya sekhutlo ya θ e lekanngwa ka go ya ka fa palokoketso ya ase-*x*, le θ e neelwa ke: $\theta = \frac{s}{r}$ $\theta = \frac{s}{r}$ *s* = boleele ba segopo, *r*

	hoekposisie (dimensieloos; maar word in *radiale* gemeet; die radiaal is die verhouding van twee lengtes).		(has no dimension; but measured in *radians*; the radian is the ratio of two lengths).		=sedikisi sa sediko, θ = kemo ya sekhutlo (ga e na tekani; fela e lekanngwa ka di*radiene*; radiene ke kabo ya boleele jo bobedi.)
68. Wringkrag	Die wringkrag (of draaimoment) van 'n krag $\underline{F}$ rondom 'n punt *O* is die grootte van die krag $\underline{F}$ vermenigvuldig met die loodregte afstand *r* (moment-arm) vanaf die draaipunt na die werklyn van die krag: $\underline{\tau} = \underline{r} \times \underline{F}$.	**68. Torque**	The magnitude of the torque of a force $\underline{F}$ about a point *O* is the magnitude of the force $\underline{F}$ multiplied with the perpendicular distance *r* (moment arm) from the turning point to the line of action of the force: $\underline{\tau} = \underline{r} \times \underline{F}$.	**68. Maatlatikoloso**	Bokanakang jwa maatlatikoloso a thata ya $\underline{F}$ ka ga ntlha ya *O* ke bokanakang jwa thata ya $\underline{F}$ e atisiwa ka sekgala se se tsepameng sa *r* (letsogo la momente) go tswa mo ntlheng ya go dikologa go ya mo moleng wa tiragatso ya thata: $\underline{\tau} = \underline{r} \times \underline{F}$.
69. Rolbeweging	Dit is 'n kombinasie van rotasie- en translasie-beweging.	**69. Rolling**	It is a combination of rotation and translation.	**69. Go Kgokologa**	Ke kopano ya go dikologa le go namalala.
70. Star liggaam	'n Liggaam is 'n star liggaam wanneer dit as 'n geheel kan roteer sonder dat sy vorm enigsins verander.	**70. Rigid body**	A rigid body is a body that can rotate with all its parts locked together and without any change in its shape.	**70. Sere se se komota**	Sere se komota ke sere se se ka dikologang ka dikarolo tsa sona tsotlhe di golagantswe mmogo ntle le phetogo epe mo popegong ya tsona.
71. Statiese ewewig	'n Liggaam is in statiese ewewig indien die snelheid van die massamiddelpunt nul is (liggaam in rus), en die hoeksnelheid van enige punt van die liggaam om	**71. Static equilibrium**	A body is in static equilibrium if the velocity of its centre of mass is zero (body at rest) and if the angular velocity of any point of the body about the centre of	**71. Tekatekano e e sa suteng**	Sere se mo tekatekanong ya go sa suteng fa belosithi ya ntlhagare ya mmase e le lefela (sere se eme fela) le fa belosithi ya sekhutlo sa ntlha nngwe le

	die massamiddelpunt, of enige ander punt, ook nul is.		mass, or any other point, is zero.		nngwe ya sere ka ga ntlhagare ya mmase, kgotsa ntlha nngwe fela, ke lefela.
72. Dinamiese ewewig	'n Liggaam is in dinamiese ewewig indien dit met 'n konstante snelheid beweeg (translasie-ewewig) en met 'n konstante hoeksnelheid om enige as roteer (rotasie-ewewig).	**72. Dynamic equilibrium**	A body is in dynamic equilibrium if it is moving at a constant velocity (translational equilibrium) and rotating about any axis at a constant angular velocity (rotational equilibrium).	**72. Tekatekano ya taenamiki**	Sere se mo tekanong ya taenamiki fa se tsamaya ka belosithi e e sa fetogeng (tekatekano ya namalalo) mme se dikologa mo aseng ya belosithi e e sa fetogeng ya sekhutlo (tekatekano e e dikologang).
73. Die voorwaardes vir ewewig (statiese en dinamiese ewewig)	(i) Die vektorsom van al die eksterne kragte wat op die liggaam inwerk, moet nul wees (dit verseker translasie-ewewig). (ii) Die vektorsom van al die eksterne wrywingskragte wat op die liggaam inwerk, gemeet op enige moontlike punt, moet nul wees (dit verseker rotasie-ewewig).	**73. The requirements (conditions) for equilibrium** **(static and dynamic equilibrium)**	(i) The vector sum of all the external forces that act on the body must be zero (it ensures translation equilibrium). (ii) The vector sum of all the external torques that act on the body, measured about any possible point, must be zero (it ensures rotation equilibrium).	**73. Ditlhokego (mabaka) a tekatekano** **(tekatekano e e sa suteng le ya taenamiki)**	(i) Palo ya beketara ya dithata tsotlhe tsa kwa ntle tse di dirang mo sereng di tshwanelwa ke go nna lefela (e netefatsa tekatekano ya namalalo). (ii) Palo ya beketara ya dithata tsa maatlatikoloso a kwa ntle tse di dirang mo sereng, e lekanngwa mo ntlheng nngwe le nngwe e e kgonegang, e tshwanelwa ke go nna lefela (e netefatsa tekatekano ya go dikologa).
74. Swaartepunt	Die swaartepunt van 'n liggaam is daardie punt waarin die netto aantrekkingskrag wat die aarde op die liggaam uitoefen, (dit is die gewig van die liggaam), aangryp. Neem kennis dat dit in die meeste gevalle dieselfde is as	**74. The centre of gravity**	The gravitational force on a body effectively acts at a single point called the centre of gravity (cog) of the body. Note that, in most cases, it is the same as the centre of mass.	**74. Ntlhagare ya maatlakgogedi**	Thata ya maatlakgogedi mo sereng e dira ka nonofo mo ntlheng e e nosi e e bidiwang ntlhagare ya maatlakgogedi (ke bokete) jwa sere. Ela tlhoko gore, mo mabakeng a le mantsi, e tshwana le ntlhagare ya

	die massamiddelpunt.				mmase.