



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE  
NASIONALE  
SENIOR SERTIFIKAAT**

**GRADE/GRAAD 12**

**TECHNICAL SCIENCES P2/  
TEGNIESE WETENSKAPPE V2**

**NOVEMBER 2019**

**MARKING GUIDELINES/NASIENRIGLYNE**

**MARKS/PUNTE: 150**

**These marking guidelines consist of 16 pages.  
*Hierdie nasienriglyne bestaan uit 16 bladsye.***

### QUESTION/VRAAG 1

- 1.1 B ✓✓ (2)
- 1.2 C ✓✓ (2)
- 1.3 A ✓✓ (2)
- 1.4 B ✓✓ (2)
- 1.5 C ✓✓ (2)
- 1.6 D ✓✓ (2)
- 1.7 B ✓✓ (2)
- 1.8 C ✓✓ (2)
- 1.9 D ✓✓ (2)
- 1.10 B ✓✓ (2)
- [20]**

### QUESTION/VRAAG 2

- 2.1 A series of organic compounds that can be described by the same general formula ✓ and where each member differs from the next by a CH<sub>2</sub> group. ✓
- 'n Reeks organiese verbindings wat deur dieselfde algemene formule beskryf kan word en waar een lid van die volgende met 'n CH<sub>2</sub> groep verskil.* (2)
- 2.2 Alkanes/Alkenes/ Alkynes ✓                      *Alkane/Alkene/Alkyne*  
(Any ONE)    *(Enige EEN)* (1)
- 2.3
- Saturated hydrocarbons have carbon-carbon single (covalent) bonds only. ✓ /Each carbon atom contains a maximum possible number of hydrogen atoms.
  - Unsaturated hydrocarbons have double/triple/multiple (covalent) bonds between carbon-carbon atoms. ✓
  - *Versadigde koolwaterstowwe bestaan slegs uit enkel (kovalente) verbindings tussen die koolstofatome. /Elke koolstofatoom het 'n maksimum moontlike aantal waterstofatome.*
  - *Onversadigde koolwaterstowwe is verbindings waarin dubbel of drievoudige/meervoudige (kovalente) bindings tussen die koolstofatome voorkom.* (2)

2.4 An atom/a group of atoms/bond ✓ that determine(s) the physical and chemical properties of a group of organic compounds. ✓

*'n Atoom/'n groep atome/binding wat die fisiese en chemiese eienskappe van 'n groep organiese verbindings bepaal.*

**OR/OF**

An atom/a group of atoms/bond that determines the chemistry of a molecule.

*'n Atoom/groep atome/binding wat die chemie van 'n molekule bepaal.* (2)

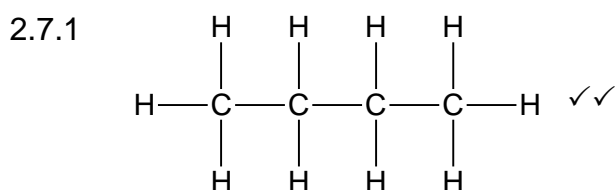
2.5.1 F ✓ (1)

2.5.2 A ✓ (1)

2.5.3 D ✓ (1)

2.5.4 B and/en G ✓  
C and/en H ✓ (2)

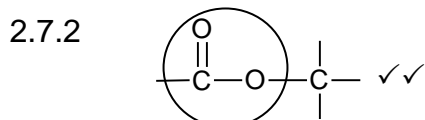
2.6 B and G : positional isomers ✓ *B en G : posisionele isomere*  
C and H : functional isomers ✓ *C en H : funksionele isomere* (2)



**Marking criteria/Nasienriglyne:**

- If a hydrogen atom or a bond is missing, 1/2
- *Indien 'n waterstofatoom of 'n binding uitgelaat is, 1/2*

(2)



**Marking criteria/Nasienriglyne:**

- If the bonds are missing, 0/2
  - If hydrogen atoms are added, 0/2
- NB: Do not penalise if the functional group is encircled.
- *Indien binding uitgelaat is, 0/2*
  - *Indien waterstofatome bygevoeg is, 0/2*
- NB: *Moenie penaliseer indien die funksionele groep omsirkel is nie.*

(2)

2.8.1 2-bromo ✓ butane ✓  
2-bromobutaan

**Marking criteria/Nasienriglyne:**

- If the hyphen is omitted or added incorrectly, 1/2
- If position of Br is omitted, 1/2
- If butane only, ½
- *Indien koppelteken uitgelaat is of in verkeerde posisie, 1/2*
- *Indien posisie van Br uitgelaat is, 1/2*
- *Indien slegs butaan, 1/2*

(2)

2.8.2 Butan ✓ -2-one ✓ /2-butanone

Butan-2-oon /2-butanoon

**Marking criteria/Nasienriglyne:**

- If the hyphen is omitted or added incorrectly, 1/2
- *Indien koppelteken uitgelaat is of in verkeerde posisie, 1/2*

(2)

2.9.1 A large molecule composed of smaller monomer units covalently bonded ✓ to each other in a repeating pattern. ✓

*'n Groot molekuul wat uit kleiner monomeereenhede bestaan wat kovalent aan mekaar gebind is in 'n herhalende patroon.*

(2)

2.9.2 Plastic bottles ✓  
Balloons ✓

*Plastiekbottels*  
*Ballonne*

(2)

**[26]**

### QUESTION/VRAAG 3

- 3.1 London forces/dispersion forces/induced dipole forces (momentarily dipole forces) ✓

*London-kragte/dispersie kragte/geïnduseerde dipoolkragte (momentele dipoolkragte)*

(1)

- 3.2
- **B** has a shorter chain length/is more compact (branched/spherical) /smaller surface area than **A**. ✓
  - The intermolecular forces/London forces/dispersion forces between molecules of **B** are weaker than those of **A**. ✓
  - Less energy is needed to overcome intermolecular forces/London forces/dispersion forces in **B** than in **A**. ✓

**OR**

- **A** has a longer chain length/is less compact /larger surface area/no branch than **B**.
- The intermolecular forces/London forces/dispersion forces between molecules of **A** are stronger than those of **B**.
- More energy is needed to overcome intermolecular forces/London forces/dispersion forces in **A** than in **B**.

- ***B** het 'n korter kettinglengte/is meer kompak (vertakte ketting/ sferies)/ kleiner oppervlakte as **A**.*
- *Die intermolekulêre kragte/London-kragte/dispersie kragte tussen molekules van **B** is swakker as die van **A**.*
- *Minder energie is nodig om intermolekulêre kragte/London kragte/dispersie kragte in **B** te oorkom as in **A**.*

**OF**

- ***A** het 'n langer kettinglengte/is minder kompak/groter oppervlakte/onvertakte ketting as **B**.*
- *Die intermolekulêre kragte/London-kragte/dispersie kragte tussen molekules van **A** is sterker as die van **B**.*
- *Meer energie is nodig om intermolekulêre kragte/London-kragte/dispersie kragte in **A** te oorkom as in **B**.*

(3)

- 3.3 The temperature at which the solid and liquid phases of a substance are at equilibrium. ✓✓

*Die temperatuur waarby die vaste- en vloeistoffases van 'n stof in ewewig is.*

(2)

- 3.4 A ✓  
**Accept:** butane (structural formula of butane/  $-0,5^{\circ}\text{C}$ )  
**Aanvaar:** butaan (struktuurformule van butaan/  $-0,5^{\circ}\text{C}$ ) (1)

3.5 (NEGATIVE MARKING FROM QUESTION 3.4)  
(NEGATIEWE NASIEN VAN VRAAG 3.4)

The higher the boiling point, the higher the melting point. ✓✓  
*Hoe hoër die kookpunt, hoe hoër die smeltpunt.*

**OR/OF**

The lower the boiling point, the lower the melting point.  
*Hoe laer die kookpunt, hoe laer die smeltpunt.*

**OR/OF**

The stronger the intermolecular forces, the higher the melting point.  
*Hoe sterker die intermolekulêre kragte, hoe hoër die smeltpunt.*

**OR/OF**

The weaker the intermolecular forces, the lower the melting point.  
*Hoe swakker die intermolekulêre kragte, hoe laer die smeltpunt.*

**OR/OF**

The longer the chain length, the higher the melting point.  
*Hoe langer die kettinglengte, hoe hoër die smeltpunt.*

**OR/OF**

The shorter the chain length, the lower the melting point  
*Hoe korter die kettinglengte, hoe laer die smeltpunt.*

**OR/OF**

The more the branches, the lower the melting point.  
*Hoe meer vertakkings/sykettings, hoe laer die smeltpunt.*

**OR/OF**

The less the branches, the higher the melting point  
*Hoe minder vertakkings/sykettings, hoe hoër die smeltpunt.* (2)

- 3.6 Lower than ✓  
*Laer as* (1)

**[10]**

#### QUESTION/VRAAG 4

4.1 Combustion/oxidation ✓  
*Verbranding/oksidasie* (1)

4.2.1 Hydrolysis/substitution ✓  
*Hidrolise/substitusie* (1)

4.2.2 Hydrohalogenation/hydrobromination/addition ✓  
*Hidrohalogenering/hidrohalogenasie/hidrobrominering/addisie* (1)

4.3.1 Butane ✓✓  
*Butaan* (2)

4.3.2 Butan-2-ol ✓✓  
(**Accept:** 2-butanol)  
*Butaan-2-ol*  
(**Aanvaar:** 2-butanol) (2)

**Marking criteria/Nasienriglyne:**

- If the hyphen or 2 is omitted or incorrect position of functional group, 1/2
- *Indien koppelteken of 2 uitgelaat is of verkeerde posisie van funksionele groep, 1/2*

4.3.3 2-bromo ✓ butane ✓  
2-bromobutaan (2)

**Marking criteria/Nasienriglyne:**

- If the hyphen is omitted or added incorrectly, 1/2
- If position of Br is omitted, 1/2
- If butane only, 1/2
- *Indien koppelteken uitgelaat is of in verkeerde posisie, 1/2*
- *Indien posisie van Br uitgelaat is, 1/2*
- *Indien slegs butaan, 1/2*

4.4 Mild heat. ✓  
(**Accept:** low temperature)  
(**NOTE:** Penalise if only 'Heat' has been written.)

Matige hitte

(**Aanvaar:** lae temperatuur)

(**LET WEL:** Penaliseer indien slegs 'Hitte' geskryf is.)

**OR/OF**

A dilute (aqueous solution of a) strong base/NaOH/KOH  
'n Verdunde (waterige oplossing van 'n) sterk basis/NaOH/KOH

(1)  
**[10]**

**QUESTION/VRAAG 5**

5.1. Electrolytic (cell) ✓/Elektrolitiese (sel) (1)

5.2. Electrical (energy) to chemical (energy). ✓✓  
 Elektriese (energie) na chemiese (energie). (2)

5.3. A substance that dissolves in water to give a solution that conducts electricity. ✓✓  
 'n Stof wat in water oplos om 'n oplossing te gee wat elektrisiteit gelei.

**OR/OF**

A solution that conducts electricity (through the movement of ions).  
 'n Oplossing wat elektrisiteit gelei (deur die beweging van ione).

**OR/OF**

A substance of which the aqueous solution contains ions.  
 'n Stof waarvan die waterige oplossing ione bevat. (2)

5.4. Cations ✓ /Katione (1)

5.5.1  $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$  ✓✓ (2)

<b>Marking criteria/Nasienriglyne:</b>	
$\text{Cu} \leftarrow \text{Cu}^{2+} (\text{aq}) + 2\text{e}^- \left( \frac{2}{2} \right)$	$\text{Cu}^{2+} (\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu} \left( \frac{1}{2} \right)$
$\text{Cu} \rightleftharpoons \text{Cu}^{2+} (\text{aq}) + 2\text{e}^- \left( \frac{0}{2} \right)$	$\text{Cu}^{2+} (\text{aq}) + 2\text{e}^- \leftarrow \text{Cu} \left( \frac{0}{2} \right)$

5.5.2  $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$  ✓✓ (2)

<b>Marking criteria/Nasienriglyne:</b>	
$\text{Cl}_2 + 2\text{e}^- \leftarrow 2\text{Cl}^- \left( \frac{2}{2} \right)$	$2\text{Cl}^- \rightleftharpoons \text{Cl}_2 + 2\text{e}^- \left( \frac{1}{2} \right)$
$2\text{Cl}^- + 2\text{e}^- \rightleftharpoons \text{Cl}_2 \left( \frac{0}{2} \right)$	$2\text{Cl}^- \leftarrow \text{Cl}_2 + 2\text{e}^- \left( \frac{0}{2} \right)$

5.6. A substance that is reduced/gains electrons. ✓✓  
 'n Stof wat gereduseer word/wins van elektrone.

**OR/OF**

A substance that undergoes reduction./'n Stof wat reduksie ondergaan.

**OR/OF**

A substance that undergoes a decrease in oxidation number.  
 'n Stof wat 'n afname in oksidasiegetal ondergaan. (2)

5.7.  $\text{Cl}^-$  / Chloride ions ✓  $\text{Cl}^-$  / Chloriedione (1)

5.8. Anode to cathode ✓ / Anode na katode (1)

5.9.  $\text{Cu}^{2+} + 2\text{Cl}^- \rightarrow \text{Cu} + \text{Cl}_2$  ✓  
 (bal ✓)

<b>Marking criteria/Nasienriglyne:</b>
<ul style="list-style-type: none"> <li>• Reactants/Reaktanse ✓</li> <li>• Products/Produkte ✓</li> <li>• Balancing/Balansering ✓</li> </ul>

(3)  
**[17]**



### QUESTION/VRAAG 6

6.1 (Electrochemical) cell that converts chemical energy to electrical energy. ✓✓

**Accept:** Spontaneous cell, 1/2

*'n (Elektrochemiese) sel waarin chemiese energie omgeskakel word na elektriese energie.*

**Aanvaar:** Spontane sel, 1/2 (2)

6.2 Mg/Magnesium ✓

**Accept:** negative electrode.

**Aanvaar:** negatiewe elektrode. (1)

6.3 (Ions in) moist soil ✓/(Ione in) nat/klam grond. (1)

6.4 • It maintains electrical neutrality of the electrolyte (cell) through the movement of ions. ✓

• It completes the circuit. ✓

• Handhaaf elektriese neutraliteit van die elektroliet (sel) deur die beweging van ione.

• *Voltooi die stroombaan.* (2)

6.5 Decreases ✓ /Afneem (1)



6.6 **(NEGATIVE MARKING FROM QUESTION 6.5)  
(NEGATIEWE NASIEN VAN VRAAG 6.5)**

Magnesium is oxidised (to magnesium ions). ✓✓

**OR**

Magnesium loses electrons.

*Magnesium word (na magnesium ione) geoksideer.*

**OF**

*Magnesium verloor elektrone.* (2)

6.7  $2\text{Mg} + \text{O}_2 + 4\text{H}^+ \checkmark \rightarrow 2\text{Mg}^{2+} + 2\text{H}_2\text{O} \checkmark$   
(bal ✓)

**Marking criteria/Nasienriglyne:**

- Reactants/Reaktanse ✓
- Products/Produkte ✓
- Balancing/Balansering ✓

OPTION/OPSIE 1	OPTION/OPSIE 2
$E_{\text{cell}}^{\theta} = E_{\text{cathode}}^{\theta} - E_{\text{anode}}^{\theta} \checkmark$ $E_{\text{sel}}^{\theta} = E_{\text{katode}}^{\theta} - E_{\text{anode}}^{\theta}$ $= 1,23 \checkmark - (-2,36) \checkmark$ $= 3,59 \text{ V} \checkmark$	$\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^{-} \quad -(-2,36) \checkmark$ $\text{O}_2 + 4\text{H}^{+} + 4\text{e}^{-} \rightarrow 2\text{H}_2\text{O} \quad 1,23 \checkmark$ <hr/> $2\text{Mg} + \text{O}_2 + 4\text{H}^{+} \rightarrow 2\text{Mg}^{2+} + 2\text{H}_2\text{O} \checkmark \quad 3,59 \text{ V} \checkmark$

(4)

**Accept:** any correct formula from data sheet.

**Aanvaar:** enige korrekte formule in die inligtingbladsy.

**NOTE:**

Penalise once if unconventional abbreviations are used in the formula.

**LET WEL:**

Penaliseer eenmalig indien onkonvensionele afkortings in die formule gebruik is.

- 6.9.1
- Solar (energy)/photovoltaic cells/Radiant (energy) ✓
  - Biodiesel ✓
  - Fuel cells ✓
  - Wind (energy)
  - Nuclear (energy) (Any THREE)

- *Son(energie)/ fotovoltaïese selle/stralings(energie)*
- *Biodiesel*
- *Brandstofselle*
- *Wind (energie)*
- *Kern (energie) (Enige DRIE)*

(3)

- 6.9.2
- It is easy to use. ✓
  - Cost is lower than petroleum diesel. ✓
  - Lower CO<sub>2</sub> emission/less greenhouse gases/environmentally friendly. ✓
  - It is not toxic.
  - Safer to handle and store.
  - Ensure proper recycling of waste products.
  - Uses natural resources/renewable (resources). (Any THREE)

- *Maklik om te gebruik*
- *Koste is minder as petroleumdiesel*
- *Laer CO<sub>2</sub> emissie/minder kweekhuisgasse/omgewings vriendelik.*
- *Nie-toksies.*
- *Veiliger om te hanteer en te stoor.*
- *Verseker behoorlike herwinning van afvalprodukte.*
- *Gebruik natuurlike bronne/herwinbare (bronne). (Enige DRIE)*

(3)

[22]

### QUESTION/VRAAG 7

- 7.1 When light falls upon a plane surface it is so reflected that the angle of reflection is equal to the angle of incidence. ✓  
The incident ray, the normal and reflected ray all lie in the same plane. ✓

*Wanneer lig op 'n platvlak val, weerkaats dit sodat die weerkaatsingshoek gelyk is aan die invalshoek.  
Die invalstraal, weerkaatste straal en normaalstraal lê almal op dieselfde vlak.*

(2)

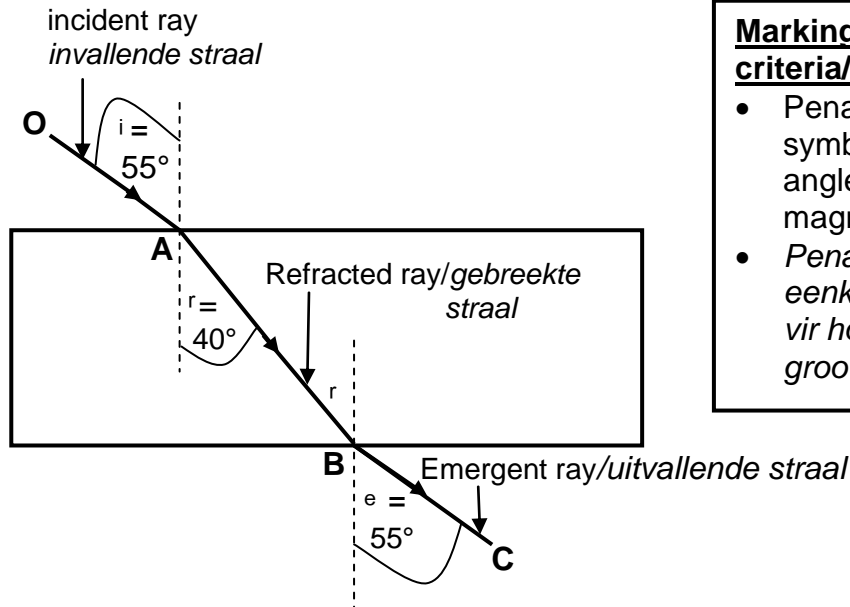
- 7.2 Along the normal to the surface. ✓  
*Al langs die normaal op die oppervlak.*

**OR/OF**

The incident ray should be at  $90^\circ$  (perpendicular) to the surface.  
*Die invalshoek moet 'n hoek van  $90^\circ$  (loodreg) met die oppervlak maak.*

(1)

7.3



**Marking**

**criteria/Nasienriglyne:**

- Penalise once if only symbols are used for angles without magnitude.
- *Penaliseer slegs eenkeer indien simbool vir hoeke sonder groottes gebruik is.*

<b>Marking criteria/Nasienriglyne:</b>	<b>Marks/Punte</b>
Correct label and direction of incident ray. <i>Korrekte byskrif en rigting van die invallende straal.</i>	✓
Correct label and direction of refracted ray. <i>Korrekte byskrif en rigting van die gebreekte straal.</i>	✓
Correct label and direction of emergent ray. <i>Korrekte byskrif en rigting van die uitvallende straal.</i>	✓
Correct position and magnitude of incident angle, $i = 55^\circ$ <i>Korrekte posisie en grootte van die invalshoek, <math>i = 55^\circ</math></i>	✓
Correct position and magnitude of refracted angle, $r = 40^\circ$ <i>Korrekte posisie en grootte van die brekingshoek, <math>r = 40^\circ</math></i>	✓
Correct position and magnitude of emergent angle, $e = 55^\circ$ <i>Korrekte posisie en grootte van die uitvalshoek, <math>e = 55^\circ</math></i>	✓

(6)

7.4.1 The angle of incidence in the optically denser medium/in the medium of higher refractive index, is such that the refracted ray just passes through the surface of separation of the two media. ✓✓

*Die invalshoek in die optiese digter medium/medium met 'n hoër refraksie indeks, is sodanig dat die gebreekte straal al langs die skeidingsoppervlak van die twee media beweeg.*

**OR/OF**

The angle of incidence of which the angle of refraction is  $90^\circ$ .

*Die invalshoek met 'n brekingshoek van  $90^\circ$ .*

(2)

7.4.2 2 ✓

(1)

7.4.3 A ray will be reflected back into the more optical dense medium. ✓  
*'n Straal sal terug weerkaats word in die meer opties digte medium.*

(1)

- 7.4.4 Total internal reflection ✓  
*Totale interne weerkaatsing.* (1)
- 7.4.5 When the angle of incidence (in the optically more dense medium ) is greater than the critical angle, ✓ the ray of light reflects back into the original medium. ✓  
  
*Wanneer die invalshoek (in die opties meer digte medium) groter as die grenshoek is, word die ligstraal terugweerkaats in die oorspronklike medium.* (2)
- 7.5.1 Virtual ✓  
*Skynbeeld* (1)
- 7.5.2 **a:** The image is as far behind the mirror as the object is in front of the mirror./Image is the same distance in the mirror as the object is in front of the mirror. ✓  
*Die beeld is net so ver agter die spieël as die voorwerp voor die spieël is./Die afstand tussen die beeld in die spieël en die voorwerp voor die spieël is ewever.* (1)
- b:** The image is the same size as the object. ✓  
*Die beeld is dieselfde grootte as die voorwerp.* (1)

**[19]**

### QUESTION/VRAAG 8

8.1 Dispersion ✓/Dispersie/verstrooiing. (1)

- 8.2
- It consists of light of different frequencies/wavelengths. ✓
  - Light of different frequencies/wavelengths are refracted differently. ✓
  - *Dit bestaan uit lig van verskillende frekwensies/golflengtes.*
  - *Lig met verskillende frekwensies/golflengtes word verskillend gebreek.* (2)

8.3 (Continuous) spectrum ✓/(Kontinue) spektrum. (1)

8.4 Green (light) ✓/Groen (lig) (1)

8.5  (NEGATIVE MARKING FROM QUESTION 8.4)  
(NEGATIEWE NASIEN VAN VRAAG 8.4)

- Green (light) has a higher frequency (than yellow light). ✓
- The higher the frequency of light the higher the energy of a photon ✓

#### OR

- Green (light) has a shorter wavelength (than yellow light).
- The shorter the wavelength of light the higher the energy of a photon.
- *Groen (lig) het 'n hoër frekwensie (as geel lig).*
- *Hoe hoër die frekwensie van lig, hoe hoër die energie van die foton.*

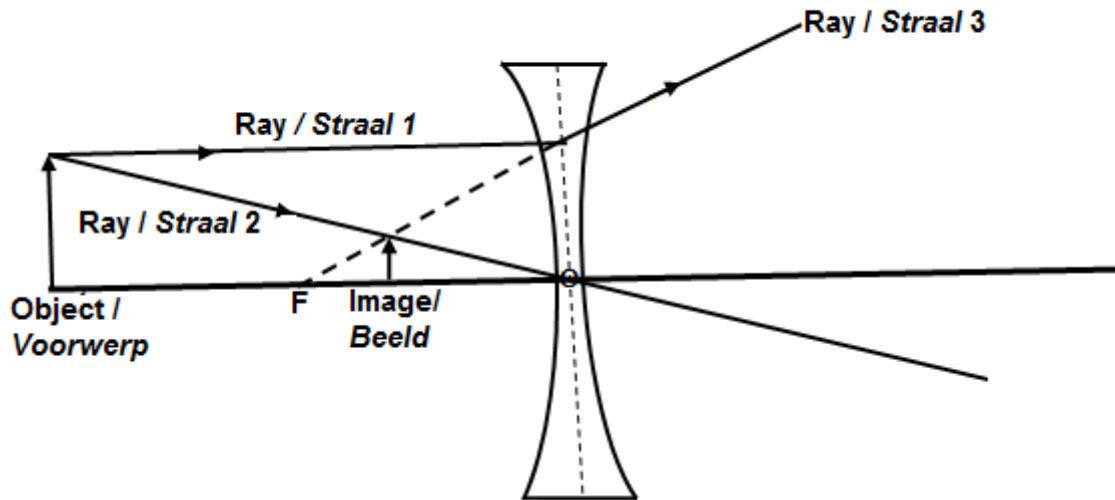
#### OF

- Groen (lig) het 'n korter golflengte (as geel lig).
- Hoe korter die golflengte van lig, hoe hoër die energie van die foton. (2)

8.6 A ray of light passes through the optical centre of the convex lens. ✓  
*Die ligstraal gaan deur die optiese middelpunt van die konvekse lens.* (1)

8.7 Concave (diverging) ✓/Konkawe (divergerende) (1)

8.8



**NOTE:**

Penalise once if rays are not drawn as arrows.

**LET WEL:**

Penaliseer eenmalig indien die strale nie as pyle aangetoon is nie.

<b>Marking criteria/Nasienriglyne:</b>	<b>Marks/Punte</b>
<p><b>Ray 1</b> starts at the top of the object and moves parallel to the principal axis.  <b>Straal 1</b> begin aan bokant van voorwerp en beweeg parallel aan die hoofas.</p>	✓
<p><b>Ray 2</b> starts at the top of the object and passes through the optical centre without changing direction.  <b>Straal 2</b> begin aan bokant van voorwerp en beweeg deur die optiese middelpunt sonder om van rigting te verander.</p>	✓
<p><b>Ray 3</b> diverges from ray 1 on the other side of the lens and is extrapolated backwards to <b>F</b>.  <b>Straal 3</b> buig uitwaarts vanaf straal 1 aan die anderkant van die lens en word terug na <b>F</b> geëkstrapoleer.</p>	✓
<p><b>Image</b> is between <b>F</b> and the optical centre on the same side as the object.  <b>Beeld</b> is tussen <b>F</b> en die optiese middelpunt aan dieselfde kant as die voorwerp.</p>	✓
<p><b>Image</b> diminished and upright.  <b>Beeld</b> is verklein en regop.</p>	✓

**NOTE:**

- If a convex lens is used credit marks to **ray 1** and **ray 2** if drawn correctly, 2/5

**LET WEL:**

- Indien 'n konvekse lens gebruik is, gee krediet punt vir **straal 1** en **straal 2** indien korrek geteken, 2/5

(5)

[14]

**QUESTION/VRAAG 9**

9.1 A quantum/packet of energy ✓✓

*'n Kwantum/pakkie energie*

(2)

9.2 A.→ Infrared ✓/Infrarooi

B.→ X rays ✓/X-strale

C.→ Ultraviolet ✓

D.→ Gamma rays ✓/Gammastrale

**Accept:** infrared/visible/UV

**Aanvaar:** infrarooi/sigbare/UV

E.→ Radio waves ✓/Radiogolwe

**Accept:** microwaves

**Aanvaar:** mikrogolwe

F.→ Microwaves ✓/Mikrogolwe

(6)

9.3

OPTION/OPSIE 1	OPTION/OPSIE 2
$c = f\lambda$ $3,0 \times 10^8 = f(600 \times 10^{-9}) \checkmark$ $f = 5,0 \times 10^{14} \text{ Hz}$  $E = hf \checkmark$ $E = (6,63 \times 10^{-34})(5,0 \times 10^{14}) \checkmark$ $E = 3,32 \times 10^{-19} \text{ J} \checkmark$	$E = h\frac{c}{\lambda} \checkmark$ $E = \frac{(6,63 \times 10^{-34})(3,0 \times 10^8)}{600 \times 10^{-9}} \checkmark$ $E = 3,32 \times 10^{-19} \text{ J} \checkmark$

(4)  
 [12]

**TOTAL/TOTAAL: 150**