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# basic education

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

## NATIONAL SENIOR CERTIFICATE

**GRADE 12**

**TECHNICAL SCIENCES P1**

**NOVEMBER 2023**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 16 pages and 3 data sheets.**



**INSTRUCTIONS AND INFORMATION**

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, etc. where required.
12. Write neatly and legibly.

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

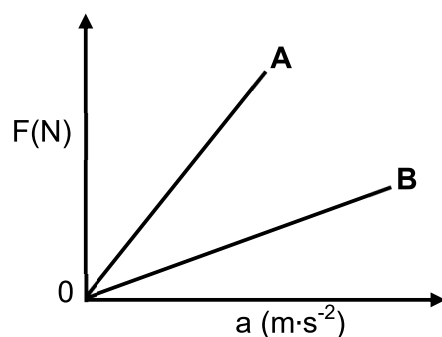
- 1.1 A girl is standing on a floor and pushes against a wall.

Which ONE of the following statements is the CORRECT action-reaction pair of forces?

	<b>ACTION</b>	<b>REACTION</b>
A	The force exerted by the girl on the wall	The force exerted by the floor on the girl
B	The force exerted by the girl on the wall	The force exerted by the wall on the girl
C	The force exerted by the girl on the floor	The force exerted by the wall on the girl
D	The force exerted by the floor on the wall	The force exerted by the wall on the floor

(2)

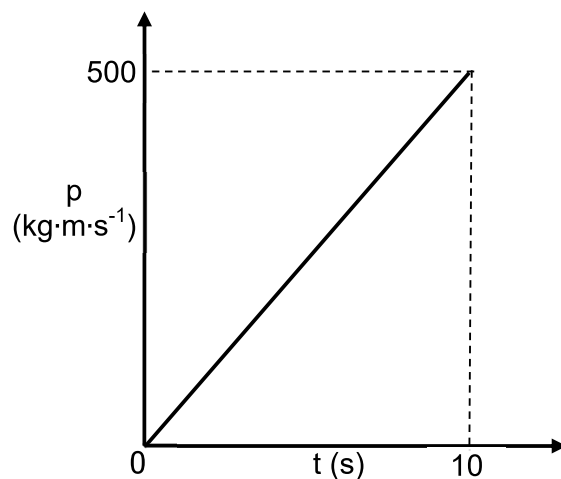
- 1.2 In the verification of Newton's Second Law of Motion, the graphs of force versus acceleration for two objects, **A** and **B**, were obtained, as shown in the diagram below.



Refer to the gradients of the graphs and choose a statement that is TRUE from the following:

- A The mass of object **A** is smaller than that of object **B**.  
 B The mass of object **B** is smaller than that of object **A**.  
 C Both objects **A** and **B** have equal masses.  
 D The gradient of the graph is independent of the mass of an object. (2)

- 1.3 The graph below shows how the momentum of a motorcycle changes with time.



Which ONE of the following represents the magnitude of the resultant force on the motorcycle?

- A 50 N
  - B 500 N
  - C 2 500 N
  - D 5 000 N
- (2)

- 1.4 Choose the CORRECT answer:

Both work and energy have ...

- A magnitude, direction and an SI unit.
  - B magnitude and an SI unit only.
  - C direction and an SI unit only.
  - D magnitude only and no SI unit.
- (2)

- 1.5 The fluid pressure at a given depth depends upon the ...

- A total volume or mass of the liquid.
  - B density and mass of the liquid.
  - C total volume of the liquid and gravitational acceleration.
  - D density of the liquid and gravitational acceleration.
- (2)

- 1.6 Which ONE of the following statements defines strain in a material?

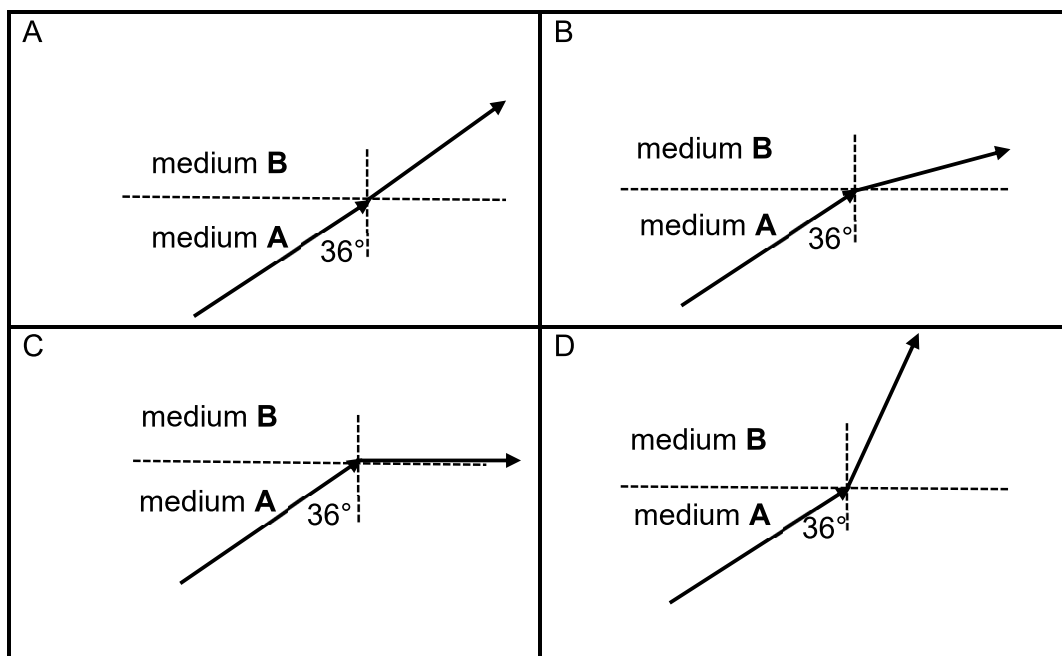
Strain is the ratio of ...

- A total length to the original length.
- B change in stress to the original stress.
- C change in strength to the original strength.
- D change in dimension to the original dimension.

(2)

- 1.7 A light ray travels between two optical media **A** and **B**. The optical density of medium **A** is HIGHER than that of medium **B**. The critical angle for medium **A** is  $36^\circ$ .

Which ONE of the sketches below represents the CORRECT path of the light ray?



(2)

- 1.8 Which ONE of the following statements is CORRECT about the relationship between the wavelength of a light wave and the energy of its photons?

- A As the wavelength increases, the energy of the photons also increases.
- B As the wavelength increases, the energy of the photons decreases.
- C The wavelength has no effect on the energy of the photons.
- D None of the above-mentioned

(2)



1.9 The SI unit for capacitance is ...

A volt.

B watt.

C farad.

D coulomb.

(2)

1.10 A transformer is defined as a device that ...

A converts electrical energy into mechanical energy.

B is used to step up or step down the voltage.

C is used for storing electric charge.

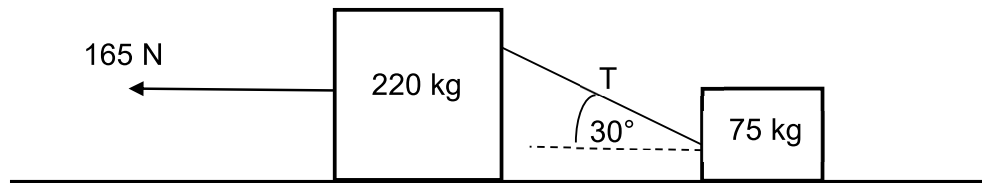
D is used to measure voltage.

(2)

**[20]**

**QUESTION 2 (Start on a new page.)**

Two blocks of masses 220 kg and 75 kg lie stationary on a ROUGH horizontal surface. The blocks are connected by a light inextensible string. The string makes an angle of  $30^\circ$  with the horizontal, as shown in the diagram below.



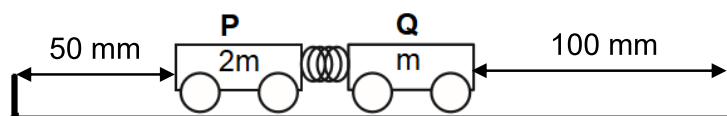
When a horizontal force of magnitude 165 N is applied to the 220 kg block, both blocks accelerate to the left at  $0,40 \text{ m}\cdot\text{s}^{-2}$ . The 220 kg block experiences a constant frictional force of 35 N while moving.

- 2.1 Draw a labelled free-body diagram indicating ALL the forces acting on the 220 kg block while it is accelerating. (5)
  - 2.2 State Newton's Second Law of Motion in words. (2)
  - 2.3 Calculate the magnitude of the tension in the string. (4)
  - 2.4 Calculate the coefficient of kinetic friction,  $\mu_k$ , of the 75 kg block. (7)
  - 2.5 How will the magnitude of the frictional force of the 75 kg block be affected if the string that joined the blocks was horizontal? Write down INCREASES, DECREASES or REMAINS THE SAME. (1)
  - 2.6 Explain the answer to QUESTION 2.5 above. (2)
- [21]**



**QUESTION 3 (Start on a new page.)**

- 3.1 Grade 12 learners are investigating the principle of conservation of linear momentum for an isolated system. Two trolleys, **P** and **Q**, with masses **2m** and **m** respectively, with a spring between them, are held **STATIONARY** on a frictionless horizontal surface. When the spring is released, it takes both trolleys 0,5 s to reach the barriers.



- 3.1.1 State the principle of conservation of linear momentum in words. (2)
- 3.1.2 Calculate the average speeds of trolleys **P** and **Q** respectively, after the release of the spring. (5)
- 3.1.3 Calculate the total momentum after the release of the spring. (3)
- 3.1.4 Is the total momentum conserved or not? Write only **CONSERVED** or **NOT CONSERVED**. Explain the answer. (2)
- 3.2 A basketball, of mass 600 g, hits the floor with a speed of  $15 \text{ m}\cdot\text{s}^{-1}$ . The ball is in contact with the floor for 0,05 seconds, after which the ball bounces off the floor with a speed of  $10 \text{ m}\cdot\text{s}^{-1}$ .

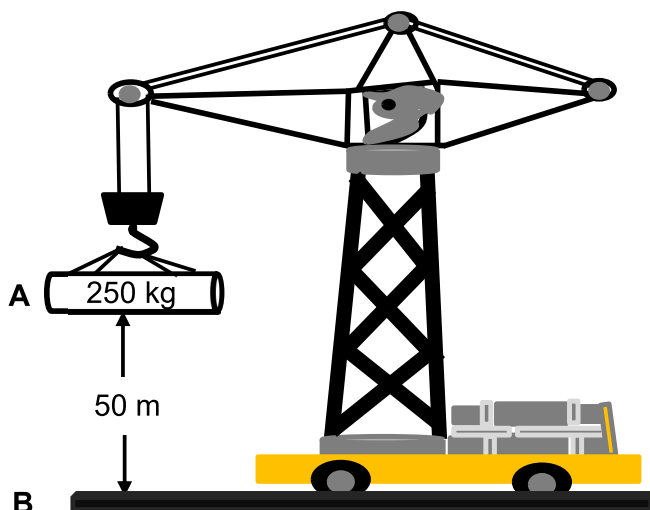


- 3.2.1 Define the term *impulse*. (2)
- 3.2.2 Calculate the net force experienced by the ball. (5)
- 3.3 Name **THREE** safety features in modern cars that make injuries less severe during collisions. (3)

**[22]**

**QUESTION 4 (Start on a new page.)**

A crane was used to lift an object of mass 250 kg vertically upwards to point **A**, which is 50 m above the ground, at a **CONSTANT VELOCITY**, as shown in the diagram below.



4.1 Define the term *work*. (2)

4.2 Calculate the work done by the crane in lifting the object. (3)

4.3 The object was moving at a constant velocity of  $25 \text{ m}\cdot\text{s}^{-1}$  as it was lifted up.

Calculate the average power used by the crane in lifting the object up to a height of 50 m. Convert the answer from watt to horsepower. (4)

4.4 The cable holding the 250 kg object at rest at point **A** snaps and it begins to fall.

4.4.1 State the principle of conservation of mechanical energy in words. (2)

4.4.2 How would the total mechanical energy of the object at 50 m above the ground compare to its mechanical energy on the ground? Write only GREATER THAN, SMALLER THAN or REMAINS THE SAME. (2)

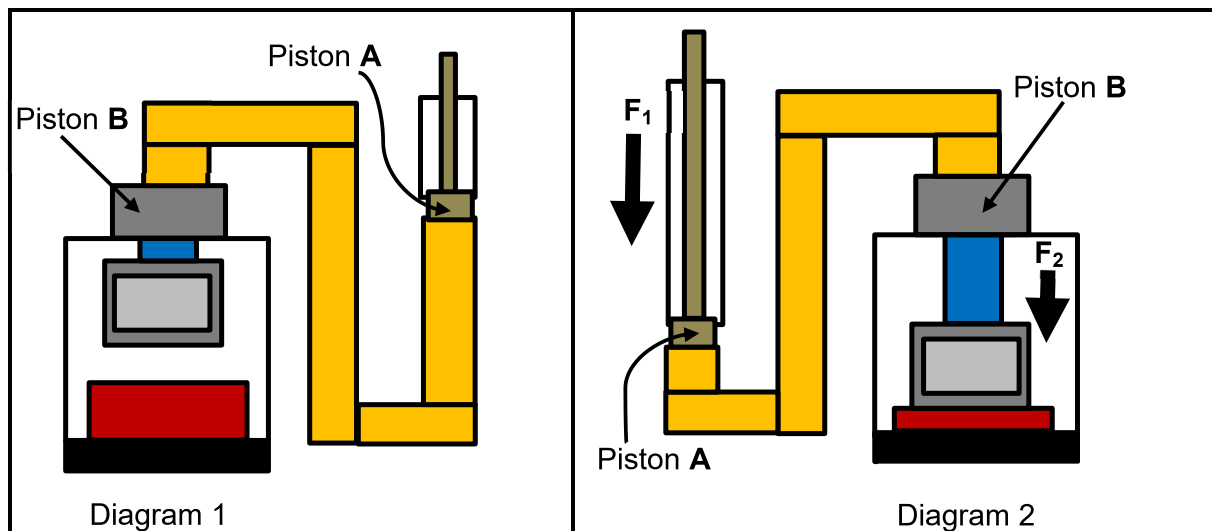
4.4.3 Give a reason for the answer to QUESTION 4.4.2. (2)

4.4.4 Calculate the velocity of the object when it hits the ground. (4)

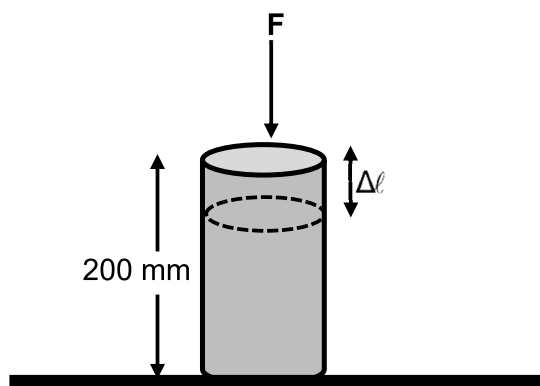
**[19]**

**QUESTION 5 (Start on a new page.)**

- 5.1 The diagrams below show a hydraulic press that is used to press a work piece. An output force of 20 kN is required to press the work piece. The input force,  $F_1$ , of 1 000 N is applied on piston **A** which has an area of  $1,96 \times 10^{-3} \text{ m}^2$ . The area of piston **B** is  $4,91 \times 10^{-2} \text{ m}^2$ .



- 5.1.1 Calculate the output force,  $F_2$ , of this hydraulic system. (4)
- 5.1.2 Will the output force be sufficient to press the work piece flat? Write only YES or NO. Explain the answer. (2)
- 5.2 A force,  $F$ , of 4 kN is applied to a 200 mm long round bar, with a diameter of 30 mm. This changes the length of the round bar to 188 mm.

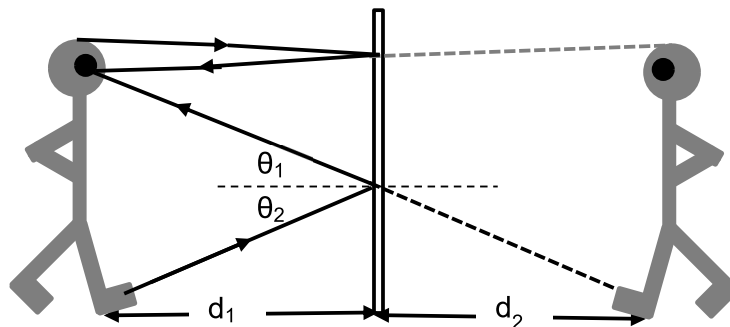


- 5.2.1 Define the term *stress*. (2)
- Calculate:
- 5.2.2 Stress experienced by the bar (4)
- 5.2.3 Strain in the bar (3)
- 5.2.4 Young's modulus of elasticity (3)
- 5.3 Write down ONE disadvantage of using monograde oil in modern cars. (2)

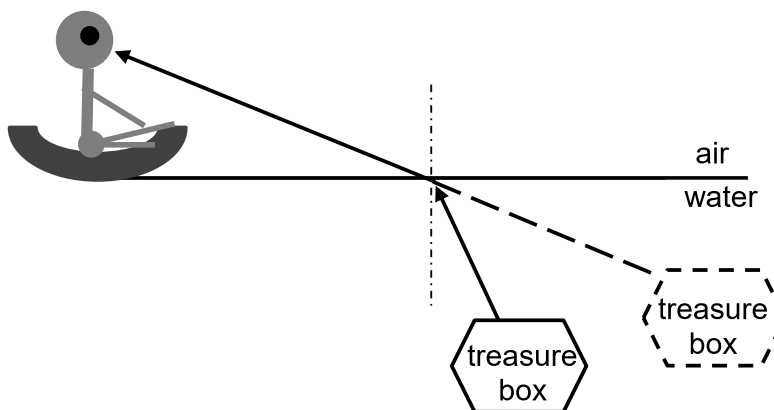
**[20]**

**QUESTION 6 (Start on a new page.)**

- 6.1 The diagram below represents an object and its image that is formed on a flat mirror.

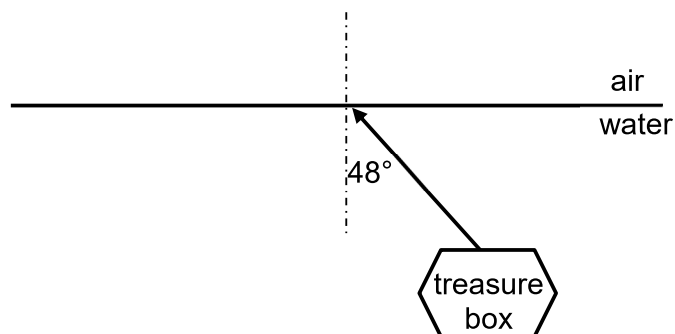


- 6.1.1 Write down the name of the physical phenomenon that is illustrated in the diagram above. (1)
- 6.1.2 What is the relationship between angles  $\theta_1$  and  $\theta_2$ ? (1)
- 6.1.3 State TWO properties of an image formed on a flat mirror. (2)
- 6.2 A man is sitting in a boat and sees a treasure box under the water. The position of the box appears to be higher up than where it actually is.



- 6.2.1 Write down TWO changes that occur to the light ray at the water-air interface. (2)
- 6.2.2 The critical angle for water-air interface is  $48,6^\circ$ . How would the path of the light ray change if the angle of incidence is increased to  $50^\circ$ ? (1)

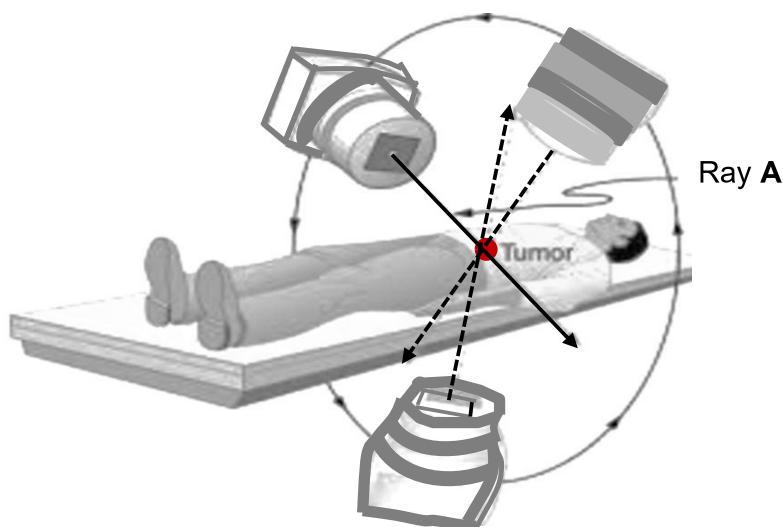
- 6.2.3 Illustrate the answer to QUESTION 6.2.2 on the previous page by redrawing the following diagram in your ANSWER BOOK and completing it. Label ALL light rays and indicate ALL angles in the diagram.



(3)  
[10]

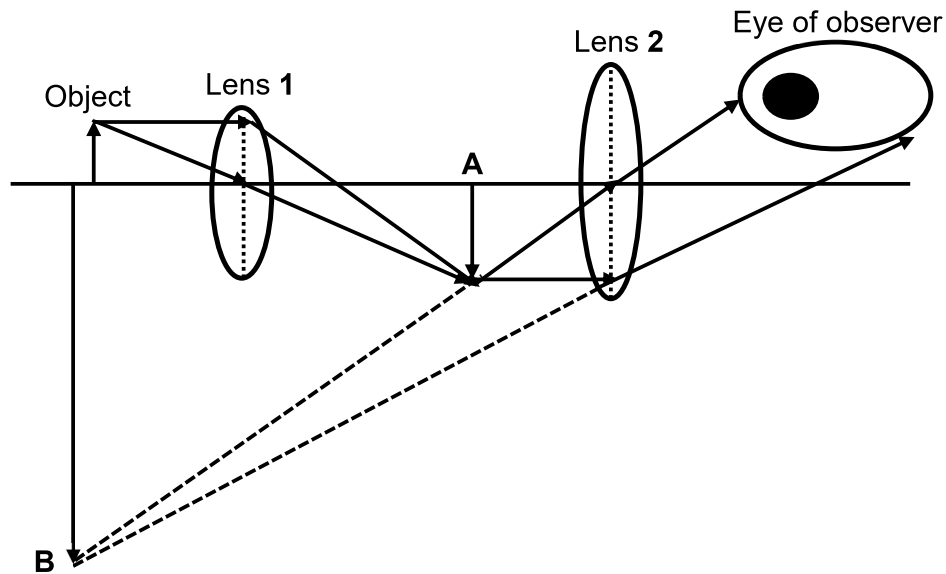
**QUESTION 7 (Start on a new page.)**

- 7.1 The diagram below shows one type of electromagnetic radiation that is used to kill cancer cells and remove tumours.



- 7.1.1 Identify the type of electromagnetic radiation that is used in the diagram above. (1)
- 7.1.2 Write down ONE property of this type of electromagnetic radiation that makes it suitable for use in hospitals to kill cancer cells. (1)
- The wavelength of ray **A** is  $5 \times 10^{-12}$  m.
- 7.1.3 Calculate the energy of a photon of light of this wavelength. (3)

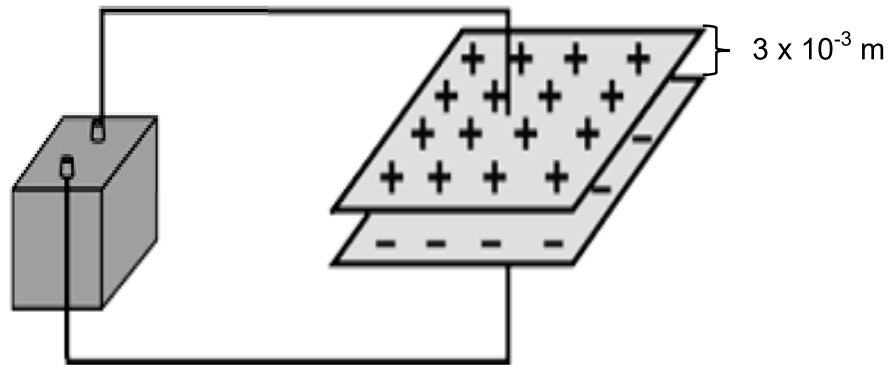
- 7.2 Study the diagram of a compound microscope below and then answer the questions that follow.



- 7.2.1 Write down the TYPE of lenses **1** and **2**. (1)
- 7.2.2 What type of image is formed at point **B**? Write down only VIRTUAL or REAL. (1)
- 7.2.3 Explain the answer to QUESTION 7.2.2. (2)
- 7.3 Write down ONE **other** practical application of this type of lens. (1)
- [10]**

**QUESTION 8 (Start on a new page.)**

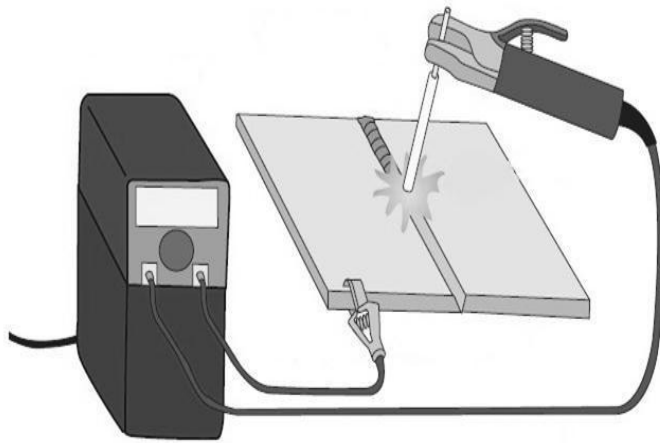
Two parallel plates of a capacitor are  $3 \times 10^{-3} \text{ m}$  apart and have an area of  $1 \times 10^{-2} \text{ m}^2$ . The charge on each plate is  $7,08 \times 10^{-9} \text{ C}$ . Air is used as dielectric material.



- 8.1 Calculate the potential difference across the plates. (5)
- 8.2 Give THREE examples of the use of capacitors in technology. (3)
- [8]**

**QUESTION 9 (Start on a new page.)**

The specifications of an electric welding machine are listed in the table below. Assume that the machine is NOT operating at 100% efficiency.



Input current	24,3 A
Input power	5,3 kW
Input voltage	220 V

**Electric welding machine**

9.1 The electric welding machine is specified as 5,3 kW, 220 V.

Fully explain the meaning of this statement. (2)

9.2 This electric welding machine is now operated at a voltage of 218,11 V.

Use the information in the table above to calculate the following:

9.2.1 Resistance of the electric welding machine (3)

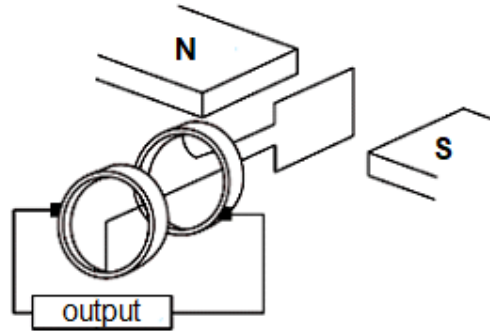
9.2.2 Energy that would be dissipated if the machine is used for a period of 30 minutes (3)

9.2.3 Cost of operating the machine for 30 minutes if the unit price is R0,75 per kWh (3)  
[11]

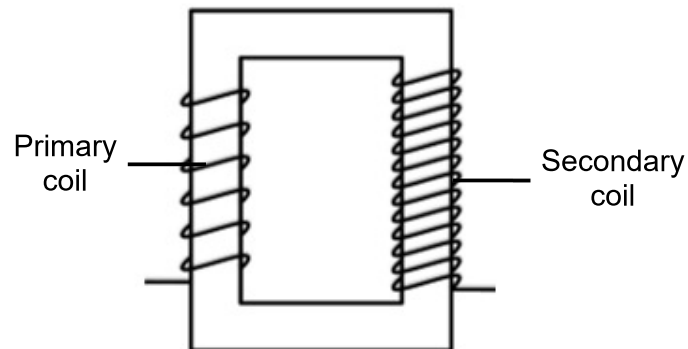


**QUESTION 10 (Start on a new page.)**

Study the diagram of a generator below and answer the questions that follow.



- 10.1 Define the term *generator*. (2)
- 10.2 State whether this is a DC or an AC generator. (1)
- 10.3 Give a reason for the answer to QUESTION 10.2. (1)
- 10.4 A diagram of a transformer is shown below. The transformer has 40 turns on the primary coil and 80 turns on the secondary coil. The voltage on the primary coil is 120 volt.



- 10.4.1 Explain why this is a *step-up transformer*. (2)
- 10.4.2 Calculate the value of the secondary voltage. (3)
- [9]**

**TOTAL: 150**

**DATA FOR TECHNICAL SCIENCES GRADE 12  
PAPER 1**

**GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12  
VRAESTEL 1**

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

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	9,8 m·s <sup>-2</sup>
Speed of light in a vacuum <i>Spoeed van lig in 'n vakuum</i>	c	3,0 x 10 <sup>8</sup> m·s <sup>-1</sup>
Planck's constant <i>Planck se konstante</i>	h	6,63 x 10 <sup>-34</sup> J·s
Electron mass <i>Elektronmassa</i>	m <sub>e</sub>	9,11 x 10 <sup>-31</sup> kg
Permittivity of free space <i>Permittiwiteit van vrye ruimte</i>	ε <sub>0</sub>	8,85 x 10 <sup>-12</sup> F·m <sup>-1</sup>

**TABLE 2: FORMULAE/TABEL 2: FORMULES**

**FORCE/KRAG**

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$F_g = mg$
$v = \frac{\Delta x}{\Delta t}$	$a = \frac{\Delta v}{\Delta t}$

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

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$M_E = E_k + E_p$
$P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$	$P = \frac{W}{\Delta t}$

**ELASTICITY, VISCOSITY AND HYDRAULICS/ELASTISITEIT, VISKOSITEIT EN HIDROULIKA**

$\sigma = \frac{F}{A}$	$\varepsilon = \frac{\Delta \ell}{L}$
$\frac{\sigma}{\varepsilon} = K$	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$
$P = \frac{F}{A}$	$P = \rho gh$

**ELECTROSTATICS/ELEKTROSTATIKA**

$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$
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**CURRENT ELECTRICITY/STROOMELEKTRISITEIT**

$R = \frac{V}{I}$	$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$W = VQ$ $W = VI\Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

**ELECTROMAGNETISM/ELEKTROMAGNETISME**

$\phi = BA$	$\varepsilon = N \frac{\Delta\phi}{\Delta t}$
$\frac{V_s}{V_p} = \frac{N_s}{N_p}$	

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

$v = f \lambda$	$T = \frac{1}{f}$
$E = hf$ or/of $E = h \frac{c}{\lambda}$	