



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

TECHNICAL SCIENCES P1

2021

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages and 2 data sheets.

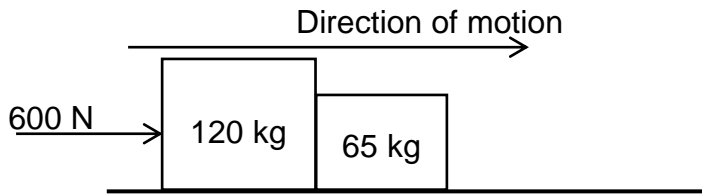
INSTRUCTIONS AND INFORMATION

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

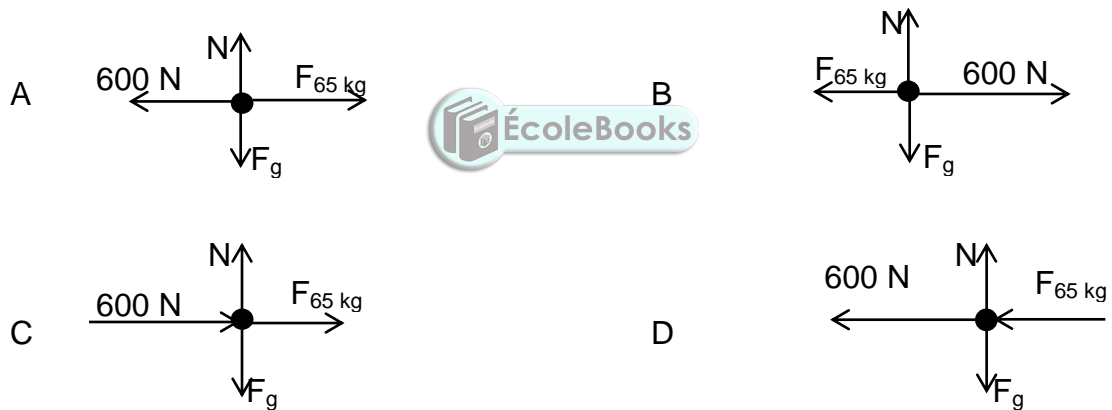
Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

- 1.1 Two crates of masses 120 kg and 65 kg are resting on a smooth horizontal surface. When a force of 600 N is applied on the 120 kg crate, the whole system accelerates, as shown in the diagram below.



$F_{65\text{ kg}}$ is the force exerted by the 65 kg crate on the 120 kg crate.

Which ONE of the following diagrams BEST represents a free-body diagram of ALL the forces acting on the 120 kg crate?



(2)

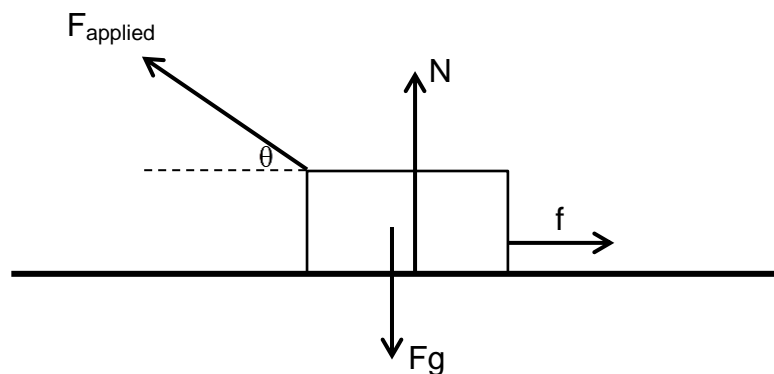
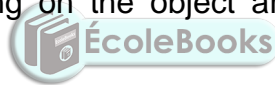
- 1.2 A man of 85 kg and a boy of 35 kg on roller skates are standing facing each other on a frictionless horizontal surface. They put their hands together and push against each other so that they move apart.

How do the velocities at which they move away from each other compare? The velocity of the man is ... the velocity of the boy.

- A equal to
- B greater than
- C less than
- D double

(2)

- 1.3 Which ONE of the following statements BEST explains why the momentum of an object is a vector quantity?
- A It has the same direction as the velocity of the object.
 - B It always opposes the direction of motion.
 - C It has a magnitude equal to the velocity of the object.
 - D It has a magnitude smaller than the velocity of the object. (2)
- 1.4 When a change in the momentum of an object remains constant while the contact time increases, the net force ...
- A increases.
 - B remains constant.
 - C equals the change in momentum.
 - D decreases. (2)
- 1.5 A boy is pulling an object to the left along a straight horizontal surface without lifting it. All the forces acting on the object are shown in the force diagram below.



Which ONE of the following forces does positive work on the object?

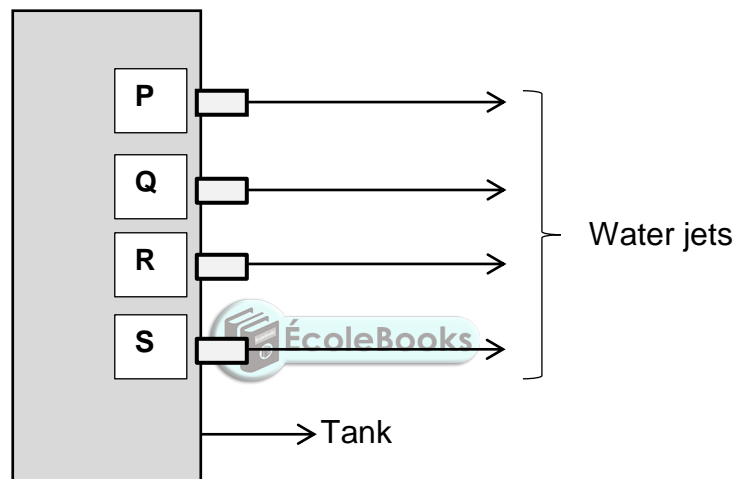
- A N
- B F_g
- C F_x
- D F_y (2)

1.6 Strain is defined as...

- A the division of the load by the smallest cross-sectional area of the test specimen.
- B the ratio between the change in length and the original length.
- C the amount of stress that a material can absorb without exceeding its breaking stress.
- D a measurement of the deformation produced by the application of external force.

(2)

1.7 The diagram below shows a water tank with water jets at different heights. At which point will the pressure be the **highest**?



- A Point **P**
- B Point **R**
- C Point **S**
- D Point **Q**

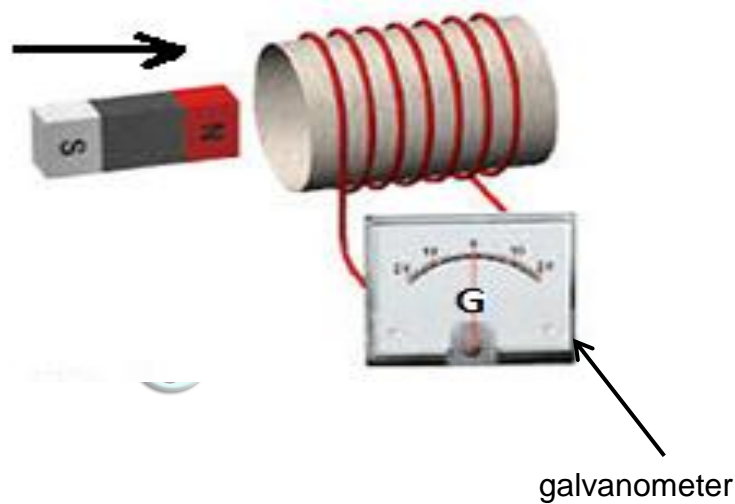
(2)

1.8 The SI unit for capacitance is ...

- A farad
- B coulomb
- C volt
- D ohm

(2)

- 1.9 The magnitude of the magnetic flux is determined by the number of ...
- A magnetic field lines projected to the surface at different angles.
 - B perpendicular magnetic field lines that pass through the surface.
 - C magnetic field lines that are parallel to the surface.
 - D magnetic field lines that are reflected from the surface. (2)
- 1.10 A coil of wire around a carton roll is connected to a galvanometer. A bar magnet is placed next to the coil, as shown in the diagram below. What will one observe when the magnet is moved into the coil?



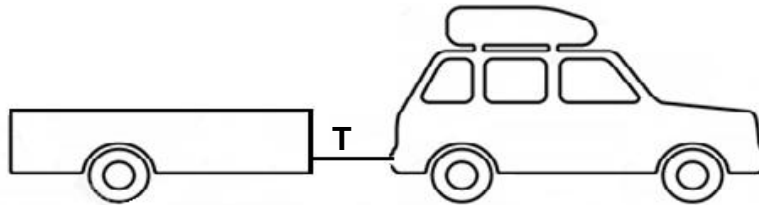
The needle will ...

- A move towards the right.
- B remain in the same position.
- C move to the left and to the right.
- D move towards the left.

(2)
[20]

QUESTION 2 (Start on a new page.)

A car is pulling a trailer with a mass of 650 kg at a constant velocity of $30 \text{ m}\cdot\text{s}^{-1}$ towards the east on a rough surface. The car's engine applies a force to move both the car and the trailer at a constant velocity.

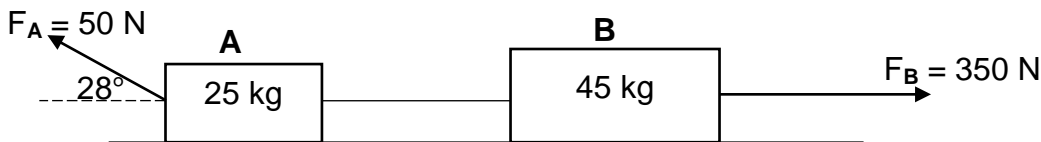



- 2.1 State Newton's First Law of Motion in words. (2)
- 2.2 Define the term *tension*. (2)
- 2.3 If the trailer is replaced by another trailer with a mass of 750 kg, how will this impact on the tension in the rope? Write down only INCREASES, DECREASES or REMAINS THE SAME. (2)
- 2.4 The driver puts her book on the passenger seat while driving. She then sees a donkey in the middle of the road and suddenly applies the brakes.
- 2.4.1 What will happen to the book as the brakes are applied? Write only MOVES FORWARD, MOVES BACKWARD or REMAINS IN THE SAME POSITION. (2)
- 2.4.2 Use a science law/principle to explain your answer to QUESTION 2.4.1. (2)

[10]

QUESTION 3 (Start on a new page.)

Two blocks, **A** and **B**, of masses 25 kg and 45 kg respectively, joined by a light inextensible string, are moved towards the east on a rough horizontal surface. Forces of different magnitudes are applied to the two blocks, as shown in the diagram below. Block **A** experiences a kinetic frictional force of 5,82 N, while block **B** experiences a kinetic frictional force of 8,35 N.




- 3.1 Define the term *normal force*. (2)
 - 3.2 Draw a labelled free-body diagram of ALL the forces acting on block **A**. (5)
 - 3.3 State Newton's Second Law of Motion in words. (2)
 - 3.4 Calculate the magnitude of the:
 - 3.4.1 Coefficient of kinetic friction between the surface and block **A** (5)
 - 3.4.2 Tension in the string  (5)
- [19]**

QUESTION 4 (Start on a new page.)

A car of mass 1 120 kg, moving to the right at a velocity of $25 \text{ m}\cdot\text{s}^{-1}$, collides with the back of a construction vehicle loaded with cement bags and moving in the same direction at a velocity of $6,25 \text{ m}\cdot\text{s}^{-1}$. After the collision, the car moves at a velocity of $7,45 \text{ m}\cdot\text{s}^{-1}$ and the construction vehicle moves at a velocity of $8,45 \text{ m}\cdot\text{s}^{-1}$. Both move towards their original directions. Assume that the system is isolated.



- 4.1 Define the term *momentum*. (2)
- 4.2 State the principle of conservation of linear momentum in words. (2)
- 4.3 What is the magnitude of the net external force acting on the system above? (2)
- 4.4 Calculate the mass of the construction vehicle if the cement bags have a mass of 100 kg. (5)
- 4.5 Use calculations to determine whether the collision is elastic or inelastic. (5)
- 
- [16]**

QUESTION 5 (Start on a new page.)

A small car of mass 950 kg, travelling to the left at a velocity of $6 \text{ m}\cdot\text{s}^{-1}$, collided with a stationary truck. The car was in contact with the truck for 1,28 s during the collision, after which it moved backwards at $1,24 \text{ m}\cdot\text{s}^{-1}$.

- 5.1 Define the term *impulse*. (2)
- 5.2 Calculate the net force exerted by the truck on the car. (4)
- [6]**

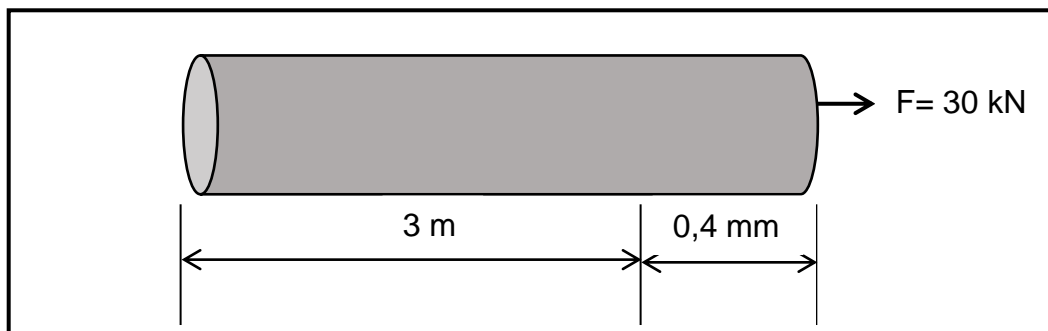
QUESTION 6 (Start on a new page.)

A learner demonstrates the effectiveness of her robotic arm. She lets it lift her cellphone, with a mass of 145 g, to a height of 50 cm above the floor. The robotic arm applies a force of 4,9 N to lift the cellphone. Ignore the effects of friction.

- 6.1 Define the term *work*. (2)
- 6.2 Calculate the work done by gravitational force on the cellphone. (3)
- 6.3 Define the term *power*. (2)
- 6.4 If it took the robotic arm 4 s to lift the cellphone to the height of 50 cm above the floor, calculate the power dissipated by the robotic arm. (4)
- 6.5 State the *principle of the conservation of mechanical energy* in words. (2)
- 6.6 The robotic arm releases the cellphone from the height of 50 cm. Use the principle of the conservation of mechanical energy to calculate the velocity at which the cellphone will hit the floor. (4)
- [17]**

QUESTION 7 (Start on a new page.)

- 7.1 A 3 m long steel bar has a diameter of 80 mm. It is stretched with a force of 30 kN and extends by 0,4 mm, as shown in the diagram below.



Calculate the:

- 7.1.1 Stress of the steel bar (4)
- 7.1.2 Strain experienced by the bar (3)

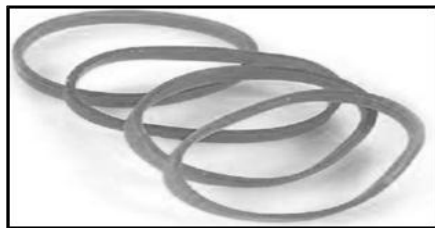
7.2 Study the pictures below. Classify each picture as either a PERFECTLY ELASTIC BODY or a PERFECTLY PLASTIC BODY.



7.2.1 Play dough




7.2.2 Wax



7.2.3 Elastic band



7.2.4 Clay

- 7.3 How does temperature affect the viscosity of oil? (2)
- 7.4 State Pascal's law in words.  (2)
- 7.5 Give TWO examples of practical applications of Pascal's law in hydraulics. (2)
- 7.6 A force of 2 000 N is exerted on the smaller piston with a cross-sectional area of $2,827 \times 10^{-3} \text{ m}^2$. The larger piston has diameter of 120 mm. Calculate the output force of the larger piston. (5)

[22]

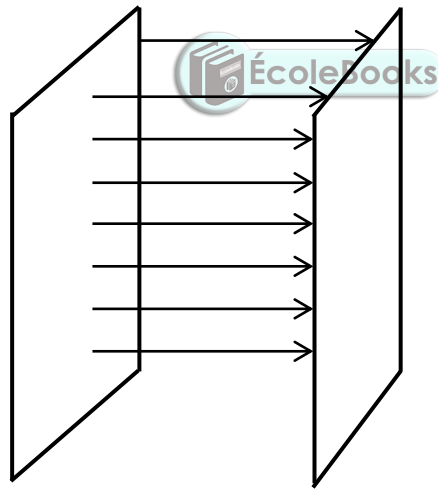
QUESTION 8 (Start on a new page.)

- 8.1 What makes silicon different from a metal in terms of conducting electricity? Name ONE difference. Refer to the electron arrangement. (2)
- 8.2 Name and define the process through which silicon could become a better conductor of electricity. (3)
- 8.3 Define a *P-N junction diode*. (2)

- 8.4 The plates of a capacitor are 0,8 mm apart and store a charge of 2 C on each plate. The capacitance of the capacitor is 4×10^{-6} F.
- 8.4.1 Calculate the potential difference between the plates. (3)
- 8.4.2 Calculate the area of the plate. (4)
- 8.4.3 State the relationship between the capacitance and the area of the plate of a capacitor. (1)
- 8.5 A 5Ω and a 12Ω resistor are connected in parallel to a 9 V cell in a circuit.
- 8.5.1 Draw a neat labelled circuit diagram representing the circuit above. (3)
- 8.5.2 Calculate the power dissipated by EACH resistor. (5)
- [23]**

QUESTION 9 (Start on a new page.)

A total magnetic flux of 9 Wb passes through a rectangular coil with a length of 150 mm and a width of 90 mm.



- 9.1 Define *magnetic flux density*. (2)
- 9.2 Calculate the magnetic flux density that passes through this rectangular coil with length 150 mm and width 90 mm. (4)
- [6]**

QUESTION 10 (Start on a new page.)

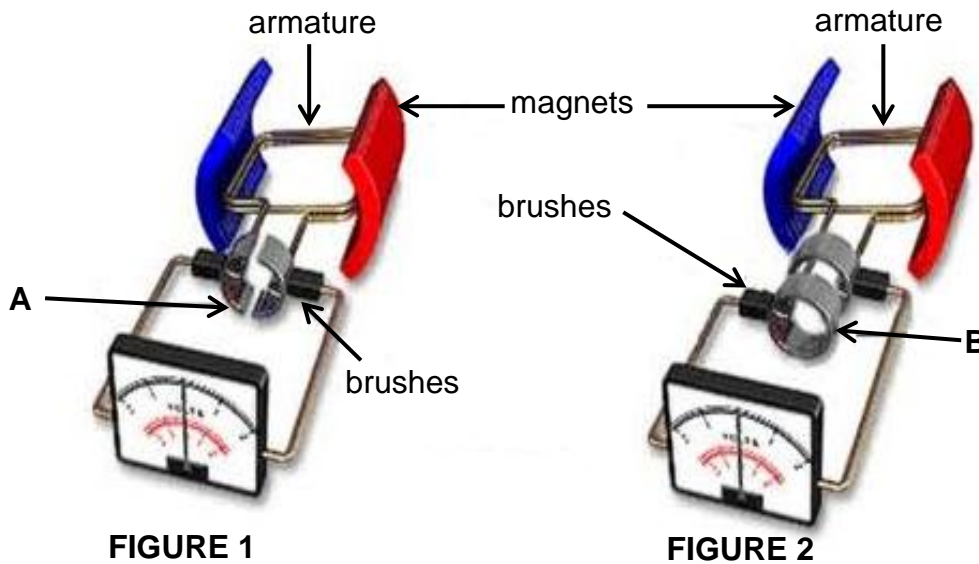
A diagram of a transformer is shown below. The transformer has 1 500 turns on the secondary coil and 80 turns on the primary coil. The primary voltage is 120 V.



10.1 Define a *transformer*. (2)

10.2 Determine the value of the secondary voltage. (3)

10.3 Study the diagram below and answer the questions that follow.



Identify the type of generator represented by:

10.3.1 FIGURE 1 (1)

10.3.2 FIGURE 2 (1)

Label component:

10.3.3 **A** (1)

10.3.4 **B** (1)

10.3.5 State the function of component **A**. (2)

[11]

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 ⁻²
Permittivity of free space <i>Permittiwiteit van vry ruimte</i>	ε ₀	8,85 x 10 ⁻¹² F.m ⁻¹

TABLE 2: FORMULAE/TABEL 2: FORMULES

FORCE/KRAG

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



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 $E_k = \frac{1}{2} mv^2$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	$M_E = E_k + E_p$

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

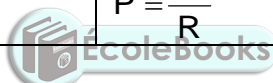
$\sigma = \frac{F}{A}$ / Stress = $\frac{\text{Force}}{\text{Area}}$ Spanning = $\frac{\text{Krag}}{\text{Area}}$	$\epsilon = \frac{\Delta \ell}{L}$ / Strain = $\frac{\text{change in length}}{\text{original length}}$ Vervorming = $\frac{\text{verandering in lengte}}{\text{oorspronklike lengte}}$
$P = \rho gh$	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$
$\frac{\sigma}{\epsilon} = K$ / modulus of elasticity = $\frac{\text{stress}}{\text{strain}}$ modulus van elastisiteit = $\frac{\text{spanning}}{\text{vervorming}}$	Pressure (P) = $\frac{\text{Force (F)}}{\text{Area}}$ Druk (P) = $\frac{\text{Krag (F)}}{\text{Area}}$

ELECTROSTATICS/ELEKTROSTATIKA

$C = \frac{Q}{V}$	$C = \frac{\epsilon_0 A}{d}$
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CURRENT ELECTRICITY/ELEKTRIESE STROOMBANE

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



ELECTROMAGNETISM/ELEKTROMAGNETISME

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