LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2022

MARKS: 150

TIME: 3 hours

EPHSCP1

This question paper consists of 17 pages and 3 data sheets.

Copyright reserved

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space 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. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

Copyright reserved

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 A body is moving at CONSTANT velocity. The net force acting on it is...

A constant.

B zero.

C increasing.

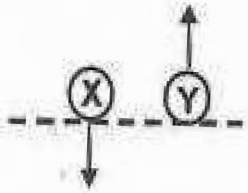
D decreasing. (2)

1.2 An astronaut has mass **m** and weight **w** on Earth. Planet **X** has TWICE the mass and TWICE the radius of Earth. Which ONE of the following combinations best describes the mass and weight of the astronaut on planet X?

	MASS	WEIGHT
A	m	$\frac{w}{2}$
B	m	w
C	2m	2w
D	$\frac{m}{2}$	$\frac{w}{2}$

(2)

1.3 Two IDENTICAL balls, X and Y, are thrown from a certain height, EACH with the SAME speed. Ball X is thrown vertically downwards and ball Y vertically upwards, as shown in the diagram below.



Ground

How do the speeds and the kinetic energies of the balls compare when they strike the ground?

	SPEEDS	KINETIC ENERGIES
A	$v_X < v_Y$	$E_{k(X)} > E_{k(Y)}$
B	$v_X > v_Y$	$E_{k(X)} > E_{k(Y)}$
C	$v_X = v_Y$	$E_{k(X)} = E_{k(Y)}$
D	$v_X < v_Y$	$E_{k(X)} < E_{k(Y)}$

(2)

1.4 Two masses of 1 kg and 4 kg are moving with EQUAL kinetic energies. The ratio of the magnitudes of their momenta is ...

A 1 : 2.

B 4 : 1.

C $\sqrt{2}$: 1.

D 1 : 16.

(2)

1.5 When the NET work done on a moving object is ZERO, the kinetic energy of the object is ...

A zero.

B constant.

C increasing.

D decreasing.

(2)

1.6 Spectral lines from the distance star (from a galaxy) moving **away** from Earth are shifted towards:

I lower frequencies.

II high frequencies.

III shorter wavelength.

IV longer wavelength.

Which of the statements above are CORRECT?

A I and II only

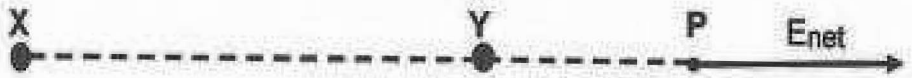
B II and III only

C II and IV only

D I and IV only

(2)

1.7 Two point charges, X and Y, produce a net electric field (E_{net}) at point P which is directed to the RIGHT, as shown in the diagram below.

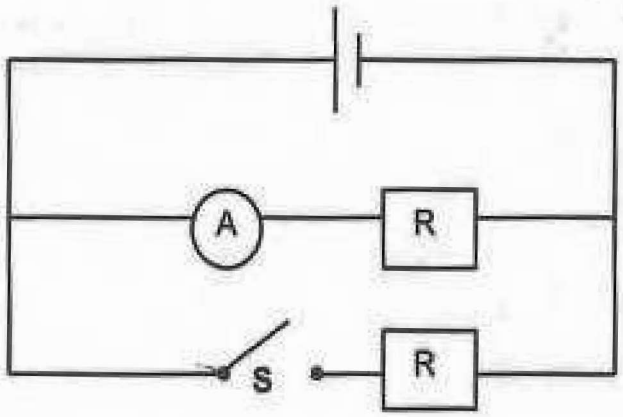


Which ONE of the following combination of charges X and Y CANNOT have?

	X	Y
A	+	+
B	–	+
C	+	–
D	–	–

(2)

1.8 Two IDENTICAL resistors are connected in parallel as shown in the circuit diagram below. The internal resistance of the cell and resistance of the connecting wires can be ignored.



When switch S is open, the reading of the ammeter is I.
When the switch S is closed, the reading of ammeter will be ...

A I.

B 2I.

C $\frac{I}{2}$.

D 0.

(2)

1.9 The following information is given on a house hold electric appliance: 230 V, 500 W.
The value of **230 V** refers to the ...

A peak value of the voltage.

B half the value of peak voltage.

C rms value of the voltage.

D maximum energy dissipated. (2)

1.10 On which ONE of the following does the number of photoelectrons ejected per unit time depend?

A intensity of the incident light.

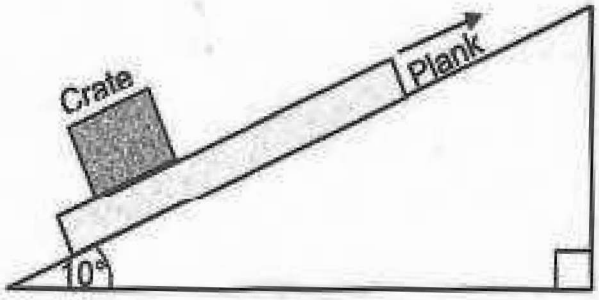
B frequency of the incident light.

C wavelength of the incident light.

D threshold frequency of the metal. (2)
[20]

QUESTION 2 (Start on a new page)

2.1 A crate is placed on a wooden plank which is pulled along a surface inclined at an angle of 10° by a force acting parallel to the incline, as shown in the diagram below.



The diagram is not drawn to scale.

The maximum coefficient of static friction between the plank and the crate is 0,35.

2.1.1 Define the term *static frictional force* in words. (2)

2.1.2 Draw a labelled free-body diagram for the crate as the plank accelerates up the incline. (3)

2.1.3 Calculate the magnitude of the maximum acceleration that the plank can attain before the crate begins to slip backward. (5)

2.2 The radius of Earth is **5 times** and the mass is **153 times** that of planet **X**.

2.2.1 State *Newton's law of universal gravitational* in words. (2)

2.2.2 Calculate the acceleration due to gravity on the surface of planet **X**. (3)

2.2.3 How does the gravitational constant **G** on planet **X** compare with that on the surface of EARTH? Write down only GREATER THAN, LESS THAN, or EQUAL TO. (1)

[1

QUESTION 3 (Start on a new page)

A stone **X** is projected vertically upwards from the ground with a speed of **3v**. Stone **Y** is also projected vertically upwards with a speed **v**.

Ignore the effects of air resistance.

3.1 Define the term *free fall.* (2)

Stone **X** takes 10 seconds to return to the ground.

3.2 Calculate the time that stone **Y** takes to return to the ground. (4)

Stone **Y** reaches a maximum height of **H** meters.

3.3 Use an appropriate calculation to show that the height (in terms of **H**) that stone **X** reaches is **9H**. (5)

3.4 Sketch a velocity-time graph for the entire motion of stone **X**.

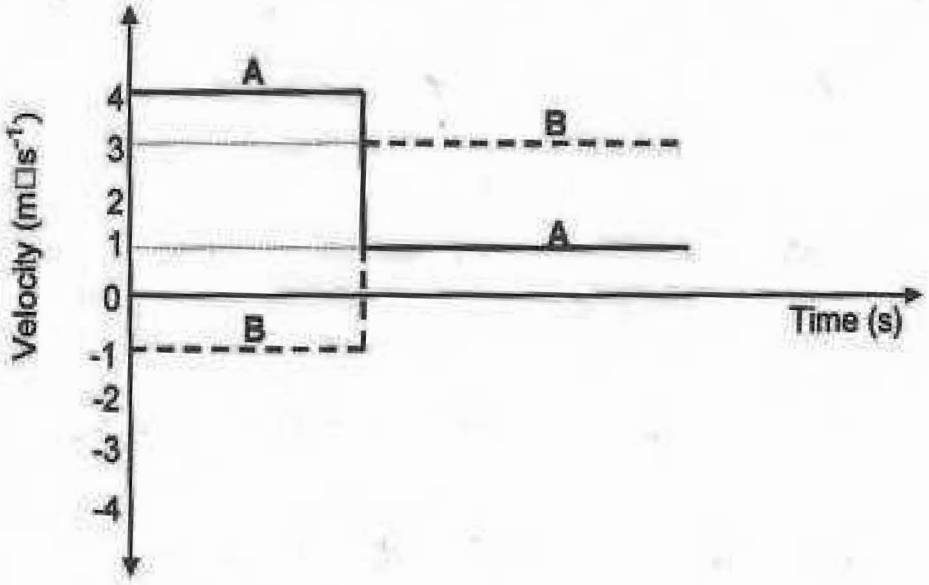
Clearly show the VALUES of the following on the graph:

- Initial and final velocities
- Time when it reaches the maximum height

(3)
[14]

QUESTION 4 (Start on a new page)

Two objects, A and B, collide in a straight line on a frictionless surface.
In the velocity versus time sketch graph below, the solid line represents the motion of object A and the broken line represents the motion of object B.



4.1 Define the term *momentum* in words. (2)

4.2 State the *principle of conservation of linear momentum* in words. (2)

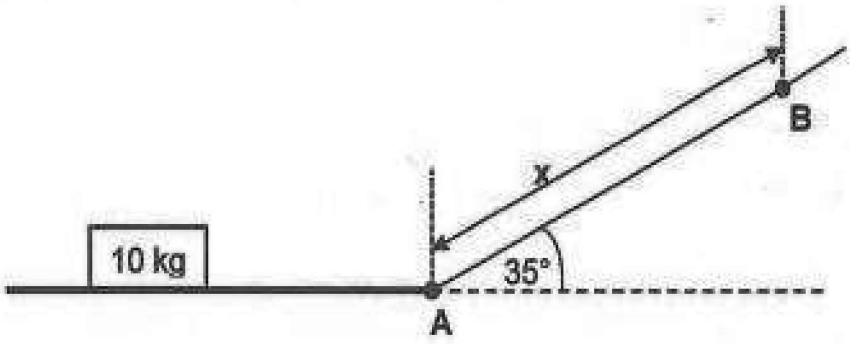
4.3 Show, by means of a suitable calculation, that the ratio of the masses of the two objects ($m_A : m_B$) is **4 : 3**. (4)

4.4 Draw vector diagrams (not to scale) to illustrate the relationship between the initial momentum (p_i), final momentum (p_f) and the change in momentum (Δp) for object A. (3)

[11]

QUESTION 5 (Start on a new page)

A 10 kg block is sliding along a ROUGH surface. The portion of the surface **AB** is inclined at an angle of 35° to the horizontal, as shown in the diagram below.



The block reaches point **A** at a speed of 8,84 m□s^{-1}. It slides up the incline and comes to REST at point **B** after covering on distance **x**. A constant frictional force of 45 N acts on the block as it moves from **A** to **B**.

5.1 State the *work-energy theorem* in words. (2)

5.2 Use the ENERGY PRINCIPLES **only** to calculate the distance **x**, shown in the diagram. (4)

At point **B**, the block ONLY just manages to **remain at rest.**

5.3 Draw a labelled free-body diagram for the block when it is at point **B.** (3)

5.4 Calculate the magnitude of the frictional force acting on the block at point **B.** (3)
[12]

QUESTION 6 (Start on a new page)

A siren of a STATIONARY police car emits sound with frequency 300 Hz. The speed of sound in air is 340 m□s^{-1}.

6.1 State the *Doppler Effect* in words. (2)

6.2 Calculate the wavelength of the sound waves. (3)

6.3 Write down ONE application of the Doppler effect in the medical field. (1)

The police car moves at 30 m□s^{-1} between two stationary observers, **A** and **B**, with its siren on, as shown in the diagram below.



6.4 Calculate the wavelength of the sound as perceived (heard) by:

6.4.1 Observer **B** (4)

6.4.2 Observer **A** (3)

The police car stops with its siren on and observer **B** moves away from it.

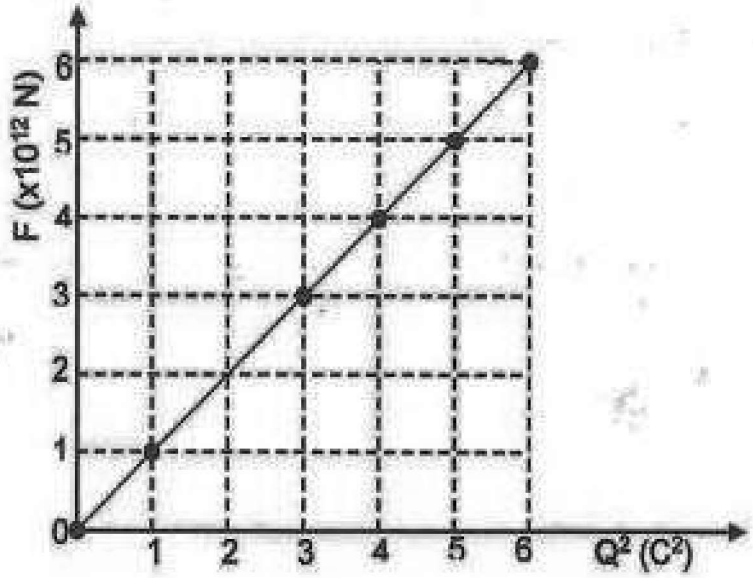
6.5 Is the frequency of the sound that observer **B** hears GREATER THAN, LESS THAN, or EQUAL TO the frequency of the source? (1)
[14]

QUESTION 7 (Start on a new page)

7.1 An investigation is conducted with pairs of IDENTICAL point charges, all placed a distance r meters from each other, as shown in the diagram below.



The graph below shows the relationship between the electrostatic FORCE F, exerted by one point charge on the other, and the PRODUCT of the two charges, Q^2.



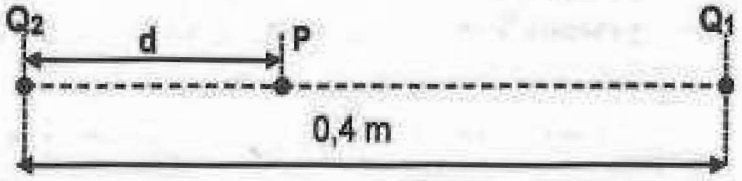
7.1.1 For this investigation, write down the controlled variable. (1)

7.1.2 Write down the relationship between the electrostatic force F and the product of the two point charges, Q^2. (1)

7.1.3 Calculate the **gradient** of the graph. (3)

7.1.4 Use the answer in QUESTION 7.1.3 to calculate the distance r between the charges. (4)

7.2 Two point charges, $Q_1 = +8\ \mu C$ and $Q_2 = +2\ \mu C$, are separated by a distance of 0,4 m, as shown in the diagram below.



7.2.1 Describe what an *electric field* is. (2)

The net electric field at P, a point between the two charges, is ZERO.

7.2.2 Calculate the distance d between point P and point charge Q_2, as shown in the diagram above. (4)

The two point charges are allowed to touch, and returned to their original positions.

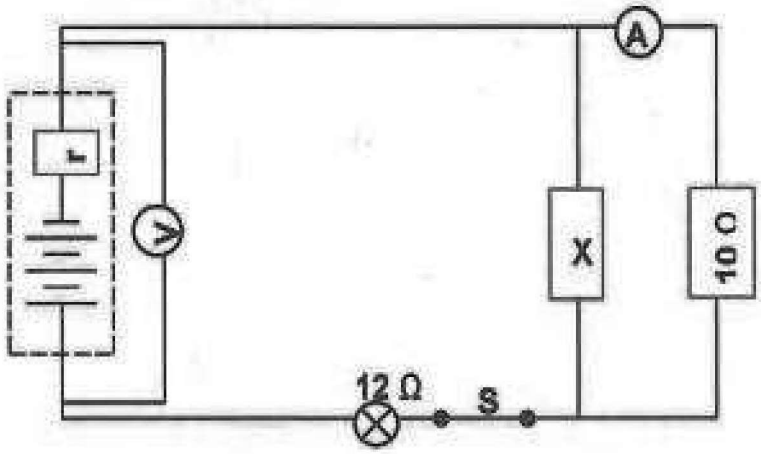
7.2.3 Calculate the number of electrons transferred upon contact. (4)

[19]

QUESTION 8 (Start on a new page)

In the circuit diagram below; an unknown resistor X is connected to a 10 Ω resistor, and a 12 Ω light bulb. This combination is connected to a battery with an internal resistance of 2 Ω.

The resistance of the connecting wires and the ammeter may be ignored.



When switch **S** is closed, the reading on voltmeter, decreases from 24 V to 21,6 V.

8.1 Write down the term used to describe **"24 V"** (the voltmeter reading). (1)

8.2 Calculate the:

8.2.1 Reading on the ammeter (5)

8.2.2 Resistance of resistor **X** (4)

8.3 Calculate the *rate at which energy is dissipated* in the light bulb. (4)

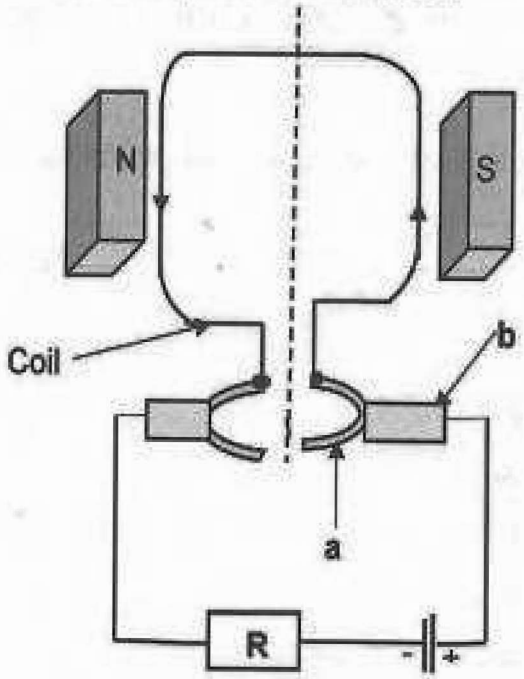
8.4 How would the brightness of the bulb change if resistor **X** burns out? Write down only INCREASE, DECREASE or REMAIN THE SAME.

Explain the answer with reference to a relevant *power formula*. (4)

[18]

QUESTION 9 (Start on a new page)

9.1 A diagram below shows a simplified electric motor.



9.1.1 Write down the energy conversion which takes place in an electric motor. (1)

9.1.2 In which direction is the coil rotating? Choose from CLOCKWISE or ANTICLOCKWISE. (2)

9.1.3 Name the component **b**. (1)

9.1.4 Write down the function of component **a**. (1)

9.1.5 The resistance **R** is now decreased. What is the effect of this change on the speed of the motor? Choose from INCREASES, DECREASES or STAYS THE SAME. Give a reason for the answer. (2)

9.2 A municipality experiences a temporary power shortage. During this period the root mean square (rms) voltage reduced from 220 V to 200 V.

9.2.1 Define the term *rms voltage*. (2)

9.2.2 Calculate the maximum (peak) voltage during the power shortage. (3)
[12]

Copyright reserved

QUESTION 10 (Start on a new page)

10.1 Photoelectric effect confirms the particle nature of light.

10.1.1 Describe the term *photoelectric effect* in words. (2)

The work function of a metal surface is $5,6 \times 10^{-19}$ J. Light of wavelength 450 nm is incident on the metal surface.

10.1.2 Define the term *work function* of a metal in words. (2)

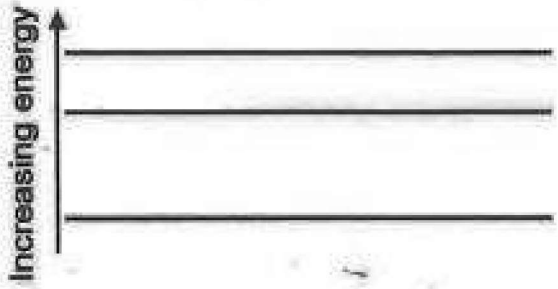
10.1.3 State the property of light that determines:

(a) Whether electrons are ejected or not (1)

(b) The kinetic energy of the ejected electrons (1)

10.1.4 Determine, by means of an appropriate calculation, whether electrons will be ejected from this metal surface. (5)

10.2 Three electron energy levels in an atom are represented in the diagram below.



The wavelength of the spectral lines produced by electron transitions between these three energy levels during emission are 486 nm, 656 nm and 1 880 nm.

Copy the diagram above and, draw arrows to show the electron transitions between the energy levels that would give rise to these wavelengths. Label each arrow with the wavelength of the emitted photon. (3)

[14]

GRAND TOTAL: [150]

Copyright reserved

DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS:

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity	g	9,8 $m \cdot s^{-2}$
Gravitational constant	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Radius of Earth	R_E	6,38 x 10^6 m
Mass of the Earth	M_E	5,98 X 10_{24} kg
Coulomb's constant	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Plank's constant	h	6,63 x 10_{34} J□s
Speed of light in a vacuum	c	3,0 x 10^8 $m \cdot s^{-1}$
Charge on electron	e	-1,6 x 10^{-19} C
Electron mass	m_e	9,11 x 10^{-31} kg

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ *or/of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ *or/of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ *or/of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

Copyright reserved

FORCE

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$F_k = \mu_k N$
$F_{net}\Delta t = m\Delta v$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or $F = G\frac{m_1 m_2}{r^2}$	$g = \frac{GM}{r^2}$

WORK ENERGY AND POWER

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

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or $F_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = \frac{hf}{\lambda}$
$E = W_o + K_{max}$ or $E = W_o + E_{k(max)}$ where $E = hf$ and $W_0 = hf_0$ and $K_{max} = \frac{1}{2}mv_{max}^2$ / $E_{k(max)} = \frac{1}{2}mv_{max}^2$	
$E = W_o + K_{max}$ *of* $E = W_o + E_{k(max)}$ where $E = hf$ and $W_0 = hf_0$ *en* $K_{max} = \frac{1}{2}mv_{max}^2$ / $E_{k(max)} = \frac{1}{2}mv_{max}^2$	

Copyright reserved

ELECTROSTATICS

$F = \frac{K_{Q1}K_{Q2}}{r^2}$	$E = \frac{KQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	Emf $(\varepsilon) = I(R + r)$
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\Delta t$

$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = Vi$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ $P_{ave} = I_{rms}^2R$ $P_{ave} = \frac{V_{rms}^2}{R}$

Copyright reserved