CAPE WINELANDS EDUCATION DISTRICT

CURRICULUM AND ASSESSMENT POLICY STATEMENT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2015

MARKS 150

TIME 3 hours

This question paper consists of 18 pages including data sheets.

INSTRUCTIONS AND INFORMATION.

1. Write your name on the top of your ANSWER PAGE.
2. Answer ALL the questions on your ANSWER BOOK.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
7. Give brief motivations, discussions, et cetera where required.
8. Round off your final numerical answers to a minimum of TWO decimal places.
9. Start EACH question on a new page.
10. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2
11. Show the formulae and substitutions in ALL calculations.
12. Round off your final numerical answers to a minimum of TWO decimal places

QUESTION 1

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) on your ANSWER PAGE.

1.1 When a spaceship moves at constant velocity, it means that the resultant force acting on the body is zero. This phenomenon is best explained by

A Newton's First Law.

B Newton's Second Law.

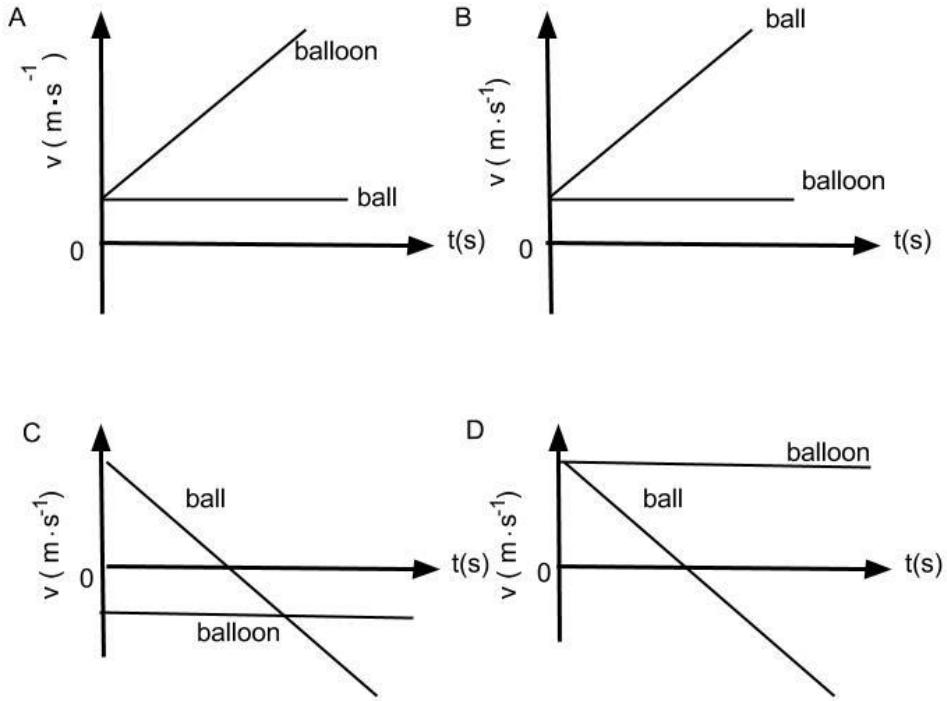
C Newton's Third Law.

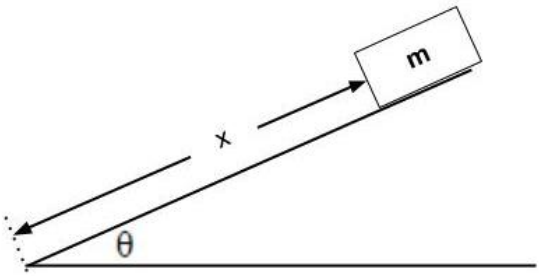
D Newton's Universal Gravitational Law. (2)

1.2 An ELASTIC collision occurs between two bodies in an isolated system. Which ONE of the following combinations of momentum and kinetic energy of the system is CORRECT?

	MOMENTUM	KINETIC ENERGY
A	conserved	conserved
B	conserved	not conserved
C	not conserved	conserved
D	not conserved	not conserved.

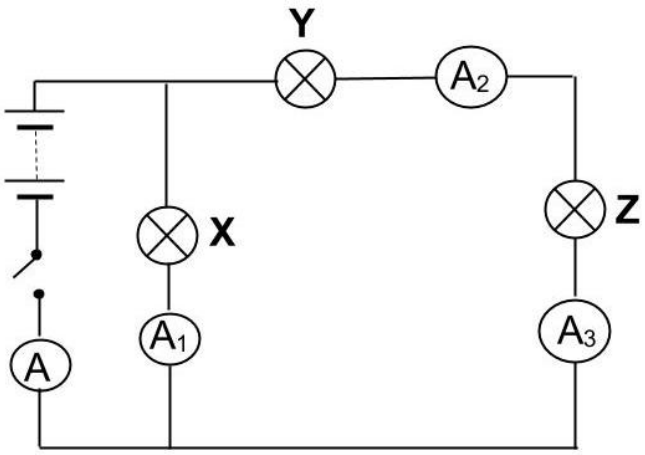
(2)

1.3	A ball is dropped from a hot air balloon that is ascending at a constant velocity. Take UPWARDS as the POSITIVE direction. The correct velocity vs time graph for the motion of the ball and the balloon is:			
				(2)
1.4	An object with mass **m** is lifted at a constant velocity **v** through a height of **h** meter. The magnitude of the net work done on the object is			
	A	0		
	B	mgh		
	C	$\frac{1}{2}mv^2$		
	D	$mgh + \frac{1}{2}mv^2$		(2)

1.5	A block, with mass **m**, is sliding down a rough surface that makes an angle θ with the horizontal, through a distance **x** as indicated in the sketch below. The net work done on the block will increase if...  			
	A	a greater frictional force acts on the block.		
	B	the mass of the block is decreased.		
	C	the distance **x** is decreased.		
	D	the angle θ is increased.		(2)
1.6	Which one of the following can be explained by the *Doppler effect?*			
	A	As a source of sound moves closer to a listener, the sound observed by the listener becomes louder.		
	B	If light shining on a metal has a frequency that is high enough, electrons will be be emitted from the metal.		
	C	A spectrum will be shifted towards shorter wavelengths than expected if the light comes from distant celestial objects moving towards the observer.		
	D	A spectrum of frequencies of electromagnetic radiation is emitted when an atom makes a transition from a high energy state to a lower energy state.		
1.7	An electric field….			
	A	is a region in which a charged particle experiences an electric force.		
	B	is the energy per unit charge experienced by a charged particle.		
	C	is directly proportional to the product of current and resistance in a circuit.		
	D	is the rate of work done by an electrical appliance.		(2)

1.8 Three light bulbs, **X**, **Y** and **Z**, are connected in a circuit as shown below. **X** and **Y** are identical and both has a resistance **R**, while the resistance of **Z** is **2R**. The battery has negligible internal resistance.

When switch **S** is closed, all the bulbs glow. The reading on ammeter **A** is 2,0 A.



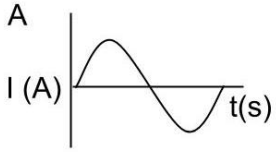
Which ONE of the following correctly describes the readings on the ammeters (in amperes) when bulb **Z** burns out?

	A	**A_1**	**A_2**	**A_3**
A	2	2	0	0
B	1,5	1,5	0	0
C	1	0,5	0,5	0
D	0,6	0,2	0,2	0,2

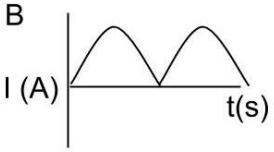
(2)

1.9 Which one of the following graphs is the correct representation for the current vs time created by a **DC (DIRECT CURRENT)** generator?

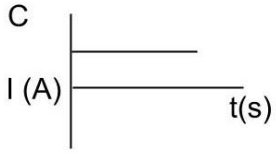
A



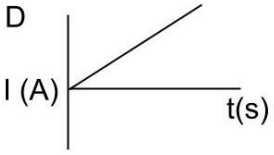
B



C



D

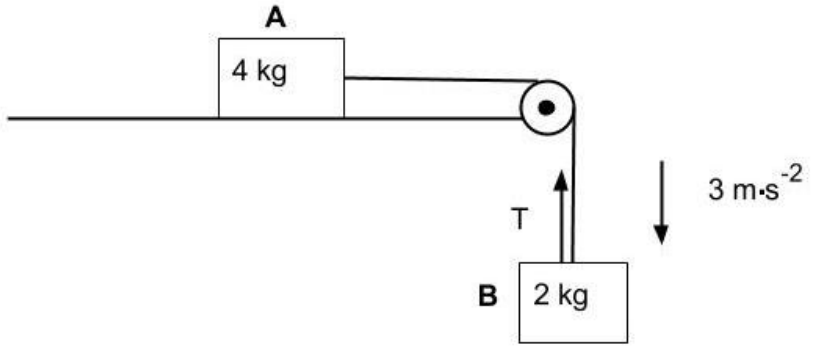


(2)

1.10	Light of a certain frequency is incident on a metal surface and photoelectrons are emitted from the surface. If the INTENSITY of the same light is increased, the ...			
	A	kinetic energy of the emitted photoelectrons increases.		
	B	kinetic energy of the emitted photoelectrons decreases.		
	C	number of photoelectrons emitted per second increases.		
	D	number of photoelectrons emitted per second decreases.		(2)
				[20]

QUESTION 2 [START ON A NEW PAGE]

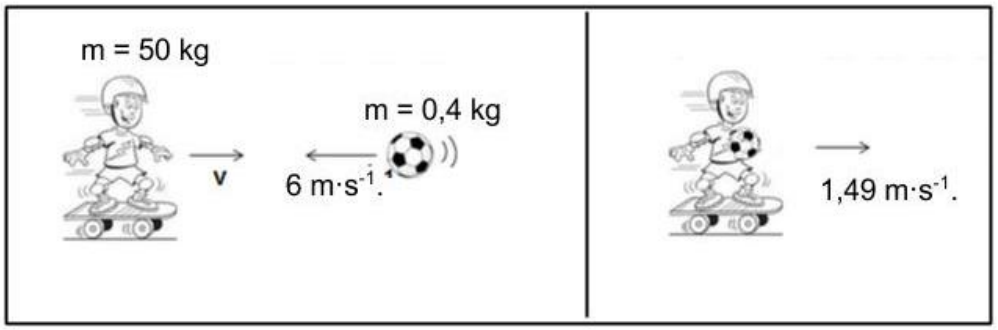
An object A of mass of **4** kg, is connected via a light string of negligible mass over a light, frictionless pulley to object B, with a mass of 2 kg. Object A slides horizontally on a rough surface, while object B accelerates vertically downwards at 3 $m \cdot s^{-2}$ as shown in the diagram below. (Ignore air friction)



2.1	State Newton's Second law of motion in words.		(2)
2.2	Draw a free body diagram of all the forces that acts on object **B.**		(3)
2.3	Calculate the magnitude of the tension **T** in the string between object **A** and **B.**		(3)
2.4	Calculate the magnitude of the kinetic frictional force that is acting on object **A.**		(3)
2.5	Identify one action-reaction force pair that is acting on object **B.**		(2)
			[13]

QUESTION 3 [START ON A NEW PAGE]

A boy on a skateboard moves to the right at constant velocity. The joint mass of the boy and skateboard is 50 kg. He catches a ball with of mass 0,4 kg that is travelling horizontally to the left at a velocity of 6 $m \cdot s^{-1}$. After the boy catches the ball, they both move to the right at 1,49 $m \cdot s^{-1}$.

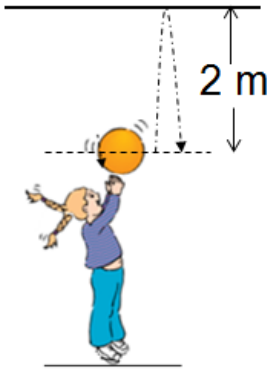


Before boy catches ball After boy catches ball

3.1	Define the term **impulse.**		(2)
3.2	Calculate the magnitude of the average force that the boy exerts on the ball when he catches it, if he and the ball exert a force for a period of 0,1 s on each other.		(3)
3.3	Write down the Principle of Conservation of Momentum.		(2)
3.4	Calculate the magnitude of the velocity **v** of the boy before he catches the ball.		(3)
3.5	Prove with the necessary calculation that this is an *inelastic* collision.		(5)
			[15]

QUESTION 4 [START ON A NEW PAGE]

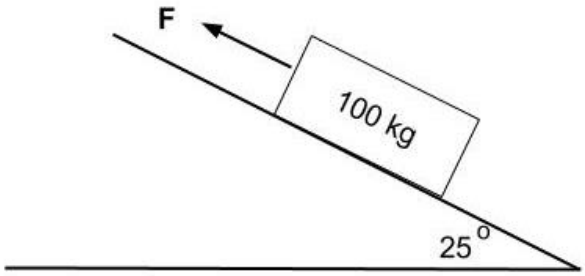
A girl throws a ball vertically upwards with an initial velocity of 8 m•s^{-1}. It bounces against the ceiling after travelling 2 m. She catches the ball again 0,65 s after it has left her hand. Assume that the contact time of the ball with the ceiling is negligible. Ignore air friction. Take upwards as positive.



4.1	Calculate the speed of the ball when it reaches the ceiling for the first time.	(3)
4.2	Calculate the speed of the ball immediately after it bounces off the ceiling.	(6)
4.3	Draw a velocity vs time graph for the motion of the ball from the moment it leaves her hand until the moment she catches it again. Indicate the velocity of the ball as it leaves the girl's hand, as well as the velocity of the ball immediately before and after it bounces off the ceiling. Choose upwards as the positive direction.	(5)
		[14]

QUESTION 5 [START ON A NEW PAGE]

The diagram below shows a heavy block of mass 100 kg sliding **down** a rough 25^{o} inclined plane. A constant force **F** is applied on the block parallel to the inclined plane as shown in the diagram below. The block slides down at a **constant velocity**.



The magnitude of the kinetic frictional force (f_k) between the block and the surface of the inclined plane is **266 N**.

5.1	Friction is a non-conservative force. What is meant by the term *non-conservative force*?		(2)
5.2	Write down the net work done on the block.		(1)
5.3	Calculate the magnitude of the force **F**.		(4)

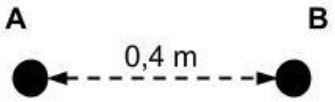
If the block is released from rest without the force **F** being applied, it moves **3 m** down to the bottom of the inclined plane.

5.4	Calculate the speed of the block at the bottom of the inclined plane.		(6)
			[13]

QUESTION 6 [START ON A NEW PAGE]				
6.1	A burglar alarm is wailing with a frequency of 1200 hertz. The speed of sound in air is 340 $m \bullet s^{-1}$.			
	6.1.1	Explain what is meant by the **Doppler Effect**.		(2)
	6.1.2	If a police officer drives towards the alarm at constant velocity, would he observe an INCREASE, DECREASE or NO CHANGE in the frequency of the sound?		(1)
	6.1.3	Explain the answer in QUESTION 6.1.2 by referring to the WAVELENGTH of the sound observed by the officer.		(2)
	6.1.4	Calculate the frequency the police officer will observe if he is driving towards the alarm at a constant speed of 40 $m \bullet s^{-1}$.		(4)
6.2	Absorption spectra from the Sun and the Andromeda galaxy is shown below: Study the atomic absorption spectra and answer the question that follows: Spectrum from the Sun Violet Red  Spectrum from Andromeda Violet Red 			
	6.2.1	Explain the difference between an atomic *absorption spectrum* and an atomic *emission spectrum.*		(4)
	6.2.2	By referring to the frequencies of the absorbed electromagnetic radiation, explain how the spectrum of light from Andromeda differs from the spectrum of light from the Sun.		(1)
	6.2.3	Does the spectrum of Andromeda constitutes a RED SHIFT or a BLUE SHIFT?		(1)
				[15]

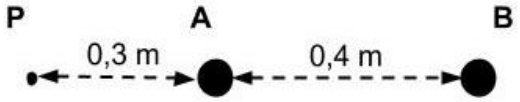
QUESTION 7 [START ON A NEW PAGE]

Two identical spheres, **A** and **B,** both negatively charged**,** are placed 0,4 m apart in a vacuum. The charge on sphere **B** is -16 nC. The magnitude of the electrostatic force that one sphere exerts on the other is 7,2 x 10^{-6} N.



7.1	State Coulomb's law in words.		(2)
7.2	Calculate the charge on sphere A.		(3)

Point P is a point 0,3 m to the left of A as shown below:



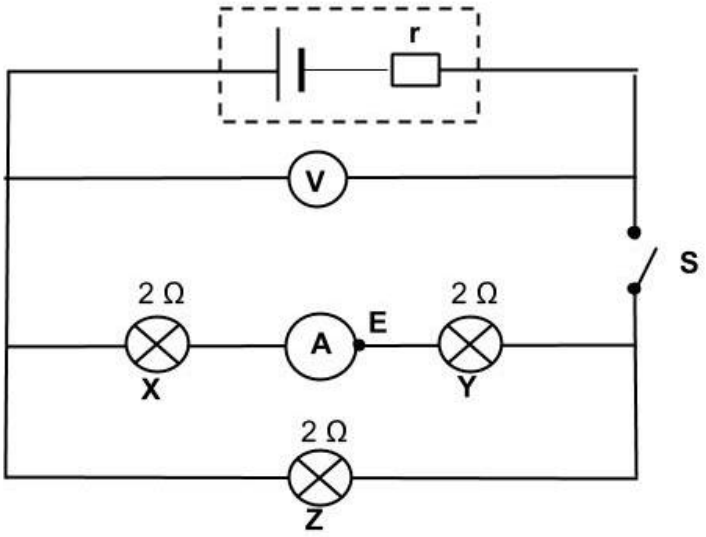
7.3	Calculate the net electric field at the location of **P** due to **A** and **B**. (Treat the spheres as if they were point charges.)		(6)

The spheres are brought together, allowed to touch, and then moved back to their original positions, 0,4 m apart.

7.4	When the spheres touch, are electrons transferred from **A to B** or from **B to A?**		(1)
7.5	Calculate the number of electrons transferred from one sphere to the other.		(4)
			[16]

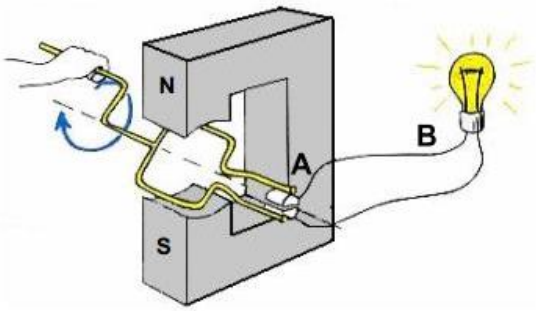
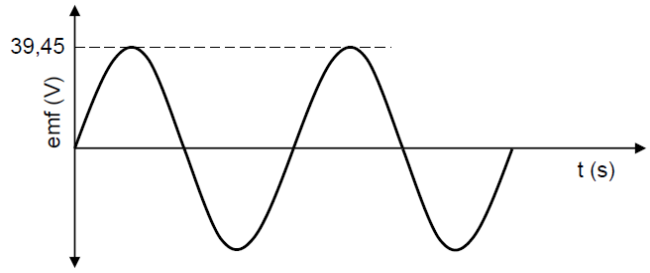
QUESTION 8 [START ON A NEW PAGE]

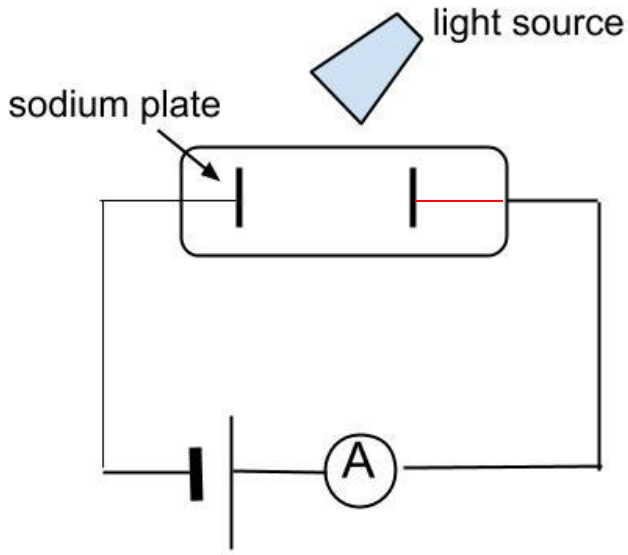
A cell with unknown internal resistance, **r**, is connected to three identical light bulbs, each of resistance 2 Ω, a high resistance voltmeter **V**, a low resistance ammeter **A** and a switch **S** as shown below.



When switch **S** is open, the reading on the voltmeter is **6 V**. When switch **S** is closed, the reading on the voltmeter is **3,9 V**.

8.1	State Ohm's law in words.		(2)
8.2	Which terminal of the ammeter is represented by point **E**? Write down only POSITIVE or NEGATIVE		(1)
8.3	Calculate the total external resistance in the circuit.		(3)
8.4	Calculate the internal resistance, **r**, of the battery.		(6)
8.5	Calculate the reading on **A** when switch **S** is closed.		(2)
8.6	If light bulb **Z** burns out, how will this affect the following values? (Write down INCREASE, DECREASE or STAY THE SAME.)		
8.6.1	The reading on voltmeter **V**.		(1)
8.6.2	The total emf of the battery.		(1)
8.7	Calculate the new reading on ammeter **A**, after light bulb **Z** has burnt out.		(3)
			[19]

QUESTION 9 [START ON A NEW PAGE]				
9.1	A learner is turning a lever connected to a metal coil with a commutator that rotates inside a magnetic field as shown in the diagram below.			
				
	9.1.1	Write down the name of the TYPE of electrical machine represented by the diagram.		(1)
	9.1.2	Write down the energy conversion that occurs in the diagram.		(2)
	9.1.3	In which direction will the current flow in the wire that is connected to the light bulb? Only write A to B OR B to A.		(1)
	9.1.4	What type of current will be generated in the diagram above? Only write DIRECT CURRENT or ALTERNATING CURRENT.		(1)
	9.1.5	Explain the answer to QUESTION 9.1.4		(2)
	9.1.6	Except for increasing the speed with which the handle is turned, write down two changes that could be made to this setup to increase its output.		(2)
9.2	The graph of the output emf versus time of a AC generator is shown below: 			
	9.2.1	Define the term **root mean square value** (rms) of an AC voltage.		(2)
	9.2.2	Calculate the rms voltage for the generator.		(3)
9.3	Give ONE reason why AC voltage is preferred to DC voltage for everyday use.			(1) **[15]**

QUESTION 10 [START ON A NEW PAGE]				
10.1	A photodiode consisting of a sodium plate and an anode is connected in a circuit diagram as shown below. A learner shines light of different frequencies on the metal plate. He observes that the ammeter connected in the circuit only registers a reading when light with a frequency of 4,389 x 10^{14} Hz or more shines on the sodium plate.			
				
	10.1.1	Write down the correct scientific term that describes the phenomenon where electrons are ejected from a metal surface when light of a suitable frequency shines on the metal.		(1)
	10.1.2	Calculate the work function for sodium		(3)
	10.1.3	Calculate the velocity of an **electron** that is ejected from sodium if light with a frequency of 4,83 x 10^{14} Hz shines on the metal.		(4)
10.2	Electrons are ejected from a metal with a velocity **v** when light shines on it**.** Will the velocity INCREASE, DECREASE or STAY THE SAME if:			
	10.2.1	light with a greater frequency is used.		(1)
	10.2.2	a different metal, with a lower work function, is used.		(1)
				[10]
		TOTAL		**[150]**

INFORMATION SHEET

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 $m \cdot s^{-2}$
Universal gravitational constant	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant	h	6,63 x 10^{-34} J·s
Coulomb's constant	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
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 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ OR $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ OR $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

$$F_s = \mu_s N$$
$$F_k = \mu_k N$$

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ OR $E = h\frac{c}{\lambda}$
$E = W_o + K_{max}$ OR $E = W_o + E_{k(max)}$ where $E = hf$ and $W_o = hf_o$ and $K_{max} = \frac{1}{2}mv^2_{max}$ OR $E_{k(max)} = \frac{1}{2}mv^2_{max}$	

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ OR $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	emf (E) = 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

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