GRADE 12 EXAMINATION
AUGUST 2017

PHYSICAL SCIENCES PAPER 1

PHYSICS

Time: 3 hours

Marks: 200

EXAMINER: Mr. T. van Niekerk

MODERATOR: Mr. N. Robert

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of 20 pages. **This includes an answer sheet consisting of two pages with sketch graph templates (pages 17 and 18) and a Data Sheet (pages 19 and 20).**
2. Please check that your question paper is complete.
3. **Write your Examination Number on the answer sheet (page 17). Detach the answer sheet and insert it into your answer booklet when handing in your script.**
4. Read the questions carefully.
5. It is in your interest to write legibly and present your work neatly.

QUESTION 4 : MULTIPLE CHOICE

There is only one correct answer to each of the Multiple Choice questions. Mark the letter corresponding to the answer you think is correct with a cross as illustrated below.

A	B	☒ C	D

Here “C” has been marked

SECTION B:

1. All questions in this section must be answered in your answer book.
2. Number your answers exactly as the questions are numbered.
3. All working must be shown and units given with your answers. Work to two decimal places.
4. Units need not be used in calculations. They MUST however be shown in the answers.

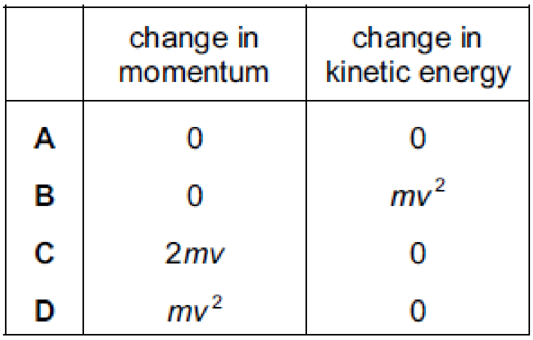
QUESTION 1 *Multiple Choice Questions – Answer these questions on the front inside flap of your answer booklet.*

1.1 Which pair contains one vector and one scalar quantity?

A	displacement	acceleration
B	momentum	kinetic energy
C	force	velocity
D	power	speed

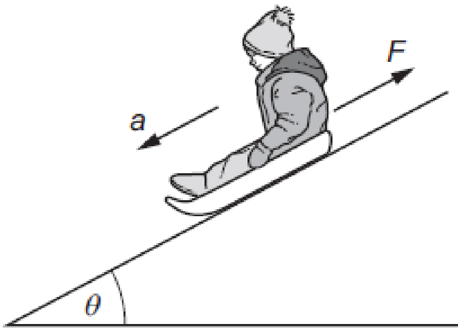
1.2 A molecule of mass m travelling at speed v hits a wall in a direction perpendicular to the wall. The collision is elastic.

What are the changes in the momentum and in the kinetic energy of the molecule caused by the collision?



	change in momentum	change in kinetic energy
A	0	0
B	0	mv^2
C	$2mv$	0
D	mv^2	0

1.3 A child on a sledge slides down a hill with acceleration ***a***. The hill makes an angle **θ** with the horizontal.



The total mass of the child and the sledge is ***m***. The acceleration of free fall is ***g***.

What is the friction force ***F*** ?

A	mgcosθ – ma
B	mgcosθ + ma
C	mgsinθ + ma
D	mgsinθ – ma

1.4 Which statement below most closely matches the **DEFINITION** of the net force acting on a body?

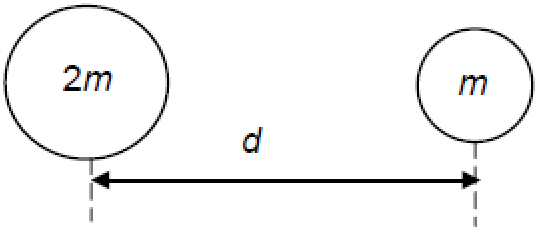
A the work done on the body divided by its displacement

B the mass of the body multiplied by its acceleration

C the power input to the body divided by its velocity

D the rate of change of momentum of the body

1.5 Two objects of masses 2*m* and *m* are arranged as shown in the diagram below.



Which ONE of the changes below will produce the GREATEST increase in the gravitational force exerted by the one mass on the other?

A Halve the distance between the masses.

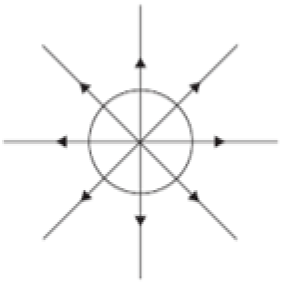
B Halve the smaller mass.

C Double the distance between the masses.

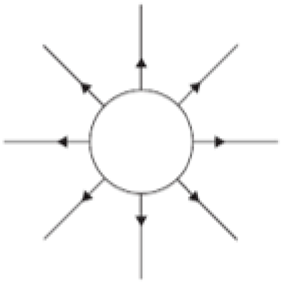
D Double the larger mass.

1.6 Which diagram best represents the electric field due to a negatively charged conducting sphere?

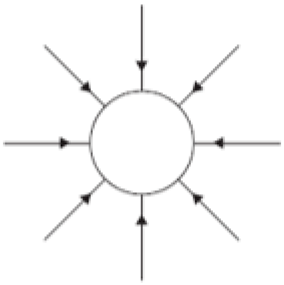
A



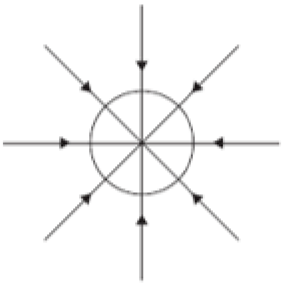
B



C



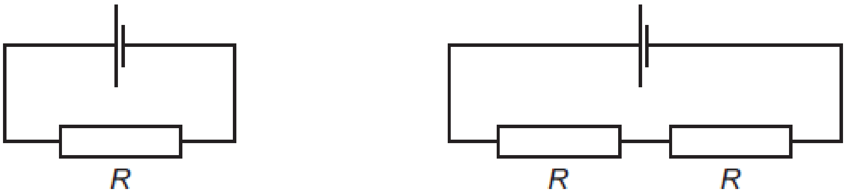
D



1.7 Conducting sphere P carries a charge of +6 nC and conducting sphere Q carries a charge of +14 nC. They are brought together and touch and then are separated again. Which of the following statements is true?

A During contact, – 4 nC of charge is transferred from sphere P to Q.
B During contact, + 4 nC of charge are transferred from sphere P to Q.
C During contact, – 4 nC of charge is transferred from sphere Q to P.
D During contact, + 4 nC of charge is transferred from sphere Q to P.

1.8 The diagrams show two different circuits.



The cells in each circuit have the same emf and zero internal resistance.
The three resistors each have the same resistance R.

In the circuit on the left, the power dissipated in the circuit is P (i.e. the power dissipated in the resistor is P).

What is the **total** power dissipated in the circuit on the right?

A P

B $\frac{P}{2}$

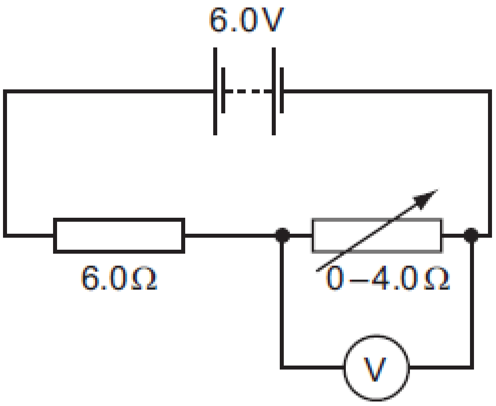
C 2P

D $\frac{P}{4}$

1.9 A battery of emf 6,0 V and negligible internal resistance is connected in series with a resistor of resistance 6,0 Ω and a variable resistor of resistance from zero to 4,0 Ω.

A voltmeter is connected across the variable resistor.

The resistance of the variable resistor is changed.



What is the range of the voltmeter reading?

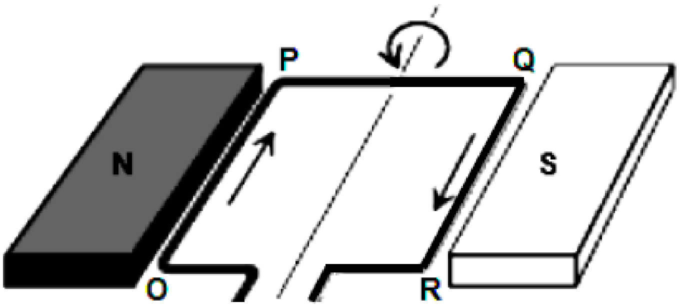
A 0 V to 2,4 V

B 0 V to 3,6 V

C 2,4 V to 6,0 V

D 3,6 V to 6,0 V

1.10 A DC current passes through a rectangular wire loop OPQR placed between two pole pieces of a magnet, as shown below.



Which TWO segments of the loop will experience an electromagnetic force when the loop is in the position above?

A OP and PQ

B QR and RO

C OP and QR

D RO and QP **[20]**

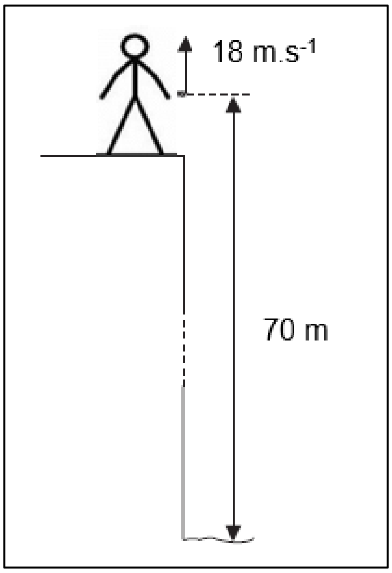
SECTION B *Remember to show all working for calculations, starting from given equations where possible.*

QUESTION 2 KINEMATICS

2.1 Chizembi stands on the edge of a vertical cliff and throws a stone vertically upwards.

The stone leaves his hand with a speed of 18 m.s^{-1} at the instant his hand is 70 m above the surface of the sea.

Air resistance is negligible.



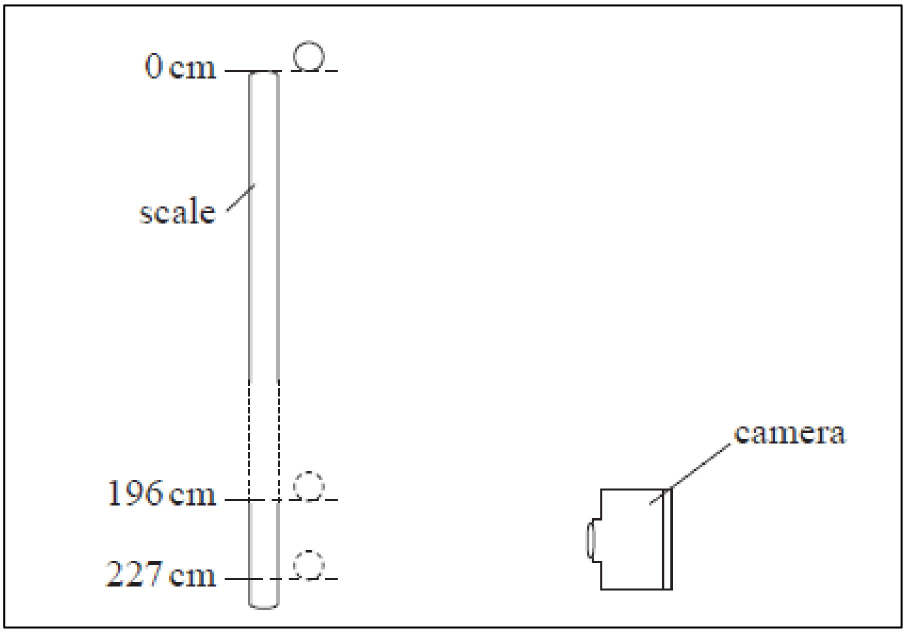
2.1.1 Calculate the maximum height reached by the stone as measured from the **surface of the sea**. (5)

2.1.2 Determine the time for the stone to reach the surface of the sea after leaving Chizembi's hand. (4)

2.2 The shutter speed of a camera is the time that the film is exposed to light.

In order to determine the shutter speed of a camera, a metal ball is held at rest at the zero mark of a vertical scale, as shown below.

The ball is released. The shutter of a camera is opened as the ball falls.



The photograph of the ball shows that the shutter opened as the ball reached the 196 cm mark on the scale and closed as it reached the 227 cm mark.

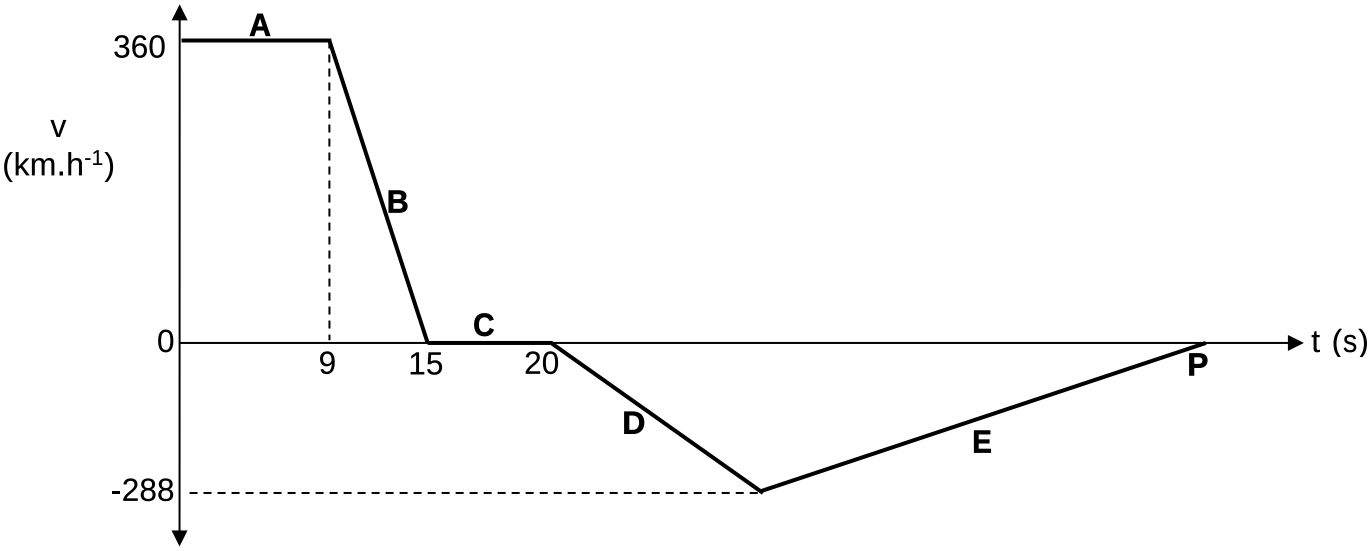
Air resistance is negligible and the acceleration due to gravity is 9,8 m.s^{-2}.

Determine the time for which the shutter was open. That is, the time for the ball to fall from the 196 cm mark to the 227 cm mark. (6)

2.3 Graham Curtis would love an opportunity to test drive the fastest supercar in production – the Bugatti Chiron.

Bugatti claims the Chiron will hit 100 km/h from a standing start in less than 2,5 seconds. Also, the sprint to 200km/h will take less than 6,5 seconds, while 0-to-300 km/h will be achieved in under 13,6 seconds. The car has a reported top speed of close to 500 km/h.

The velocity-time graph below represents the motion of the car, initially travelling **east**, on a straight road. Note that the velocities are indicated in km/h on the graph.



2.3.1 Convert the values of 360 km.h^{-1} and 288 km.h^{-1} to m.s^{-1}. (2)

2.3.2 State the definition of *acceleration*. (2)

2.3.3 Calculate the magnitude of the acceleration of the car during section B. (3)

2.3.4 Describe the motion of the car during section E of the graph. (3)

2.3.5 Calculate the distance travelled by the car during the first 15 s. (4)

2.3.6 At time **P** the car is back at its starting point (i.e. it is back where it was at time t = 0 s). Use information from the graph to calculate time **P**. (4)

2.3.7 On the answer sheet provided, draw an acceleration-time sketch graph for the car, clearly labelling sections A, B, C, D and E.
It is not necessary to show any numbers. (5)

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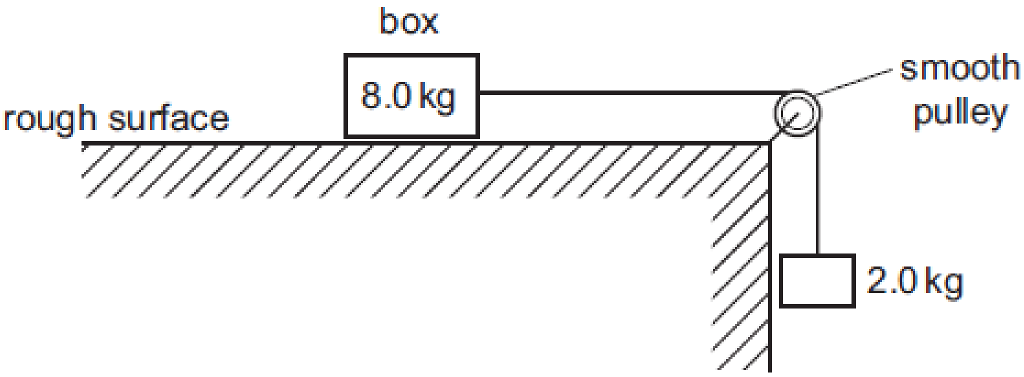
QUESTION 3 NEWTON'S LAWS

A box of mass 8,0 kg rests on a horizontal rough surface.

A string attached to the box passes over a smooth pulley and supports a 2,0 kg mass at its other end.



When the box is **released**, a frictional force of 6,0 N acts on it.

3.1 State the definition of *weigh*t. (2)

3.2 Calculate the weight of the 2 kg mass. (2)

3.3 Draw two separate free-body diagrams of the 8kg box and the 2 kg mass. Full labels (words) must be provided and the relative size of vectors must be considered. (6)

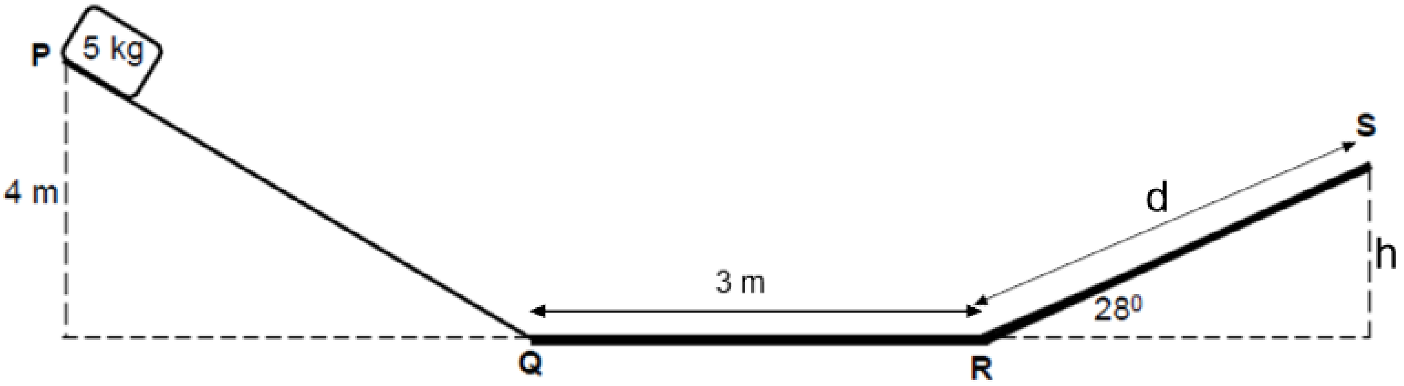
3.4 State *Newton's Second Law of Motion*. (2)

3.5 Calculate the magnitudes of the acceleration of the box and the tension in the string. (7)

[19]

QUESTION 4 FORCE, WORK, ENERGY AND POWER

A 5 kg block is released from rest from a height of 4 m and slides down a **frictionless** incline from point **P** to point **Q** as shown in the diagram below. It then moves along a rough horizontal portion **QR** of length 3 m and finally moves up a second rough inclined plane **RS** which is inclined at 28^{o} to the horizontal. It comes to a stop at point **S**.



4.1 Using ENERGY PRINCIPLES only, calculate the speed of the block at point Q. (4)

The frictional force acting on the block as it slides **from Q to R** is **32,5 N**.

4.2 State the *work-energy theorem*. (2)

4.3 Calculate the speed of the block (v) as it reaches point R. (5)

The block slides up the incline from R and comes to rest at S. The frictional force acting on the block as it slides **from R to S** is **19,0 N**.

4.4 Write an expression for the gravitational potential energy of the block at S in terms of **d** (the distance along the slope from R to S). (2)

4.5 Calculate the distance, **d**, that the block slides up the slope before coming to rest at S. (5)

4.6 The frictional force experienced by the block on the inclined plane is less than the frictional force experienced on the horizontal surface even though the surfaces are made of the same material. Explain by making use of a relevant equation. (3)

At point C, the object **only just** manages to remain at rest.

4.7 Draw a labelled free-body diagram of the block at rest at S. (3)

4.8 Calculate the frictional force acting on the block at S. (3)

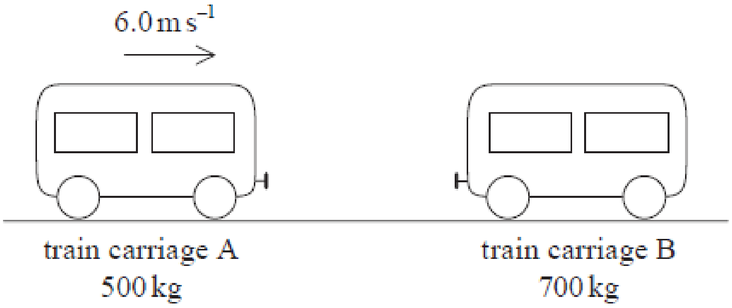
4.9 Hence calculate the coefficient of friction. (3)

4.10 Explain why the frictional force calculated in Question 4.8 is greater than the frictional force of 19,0 N acting while the block was sliding. (2)

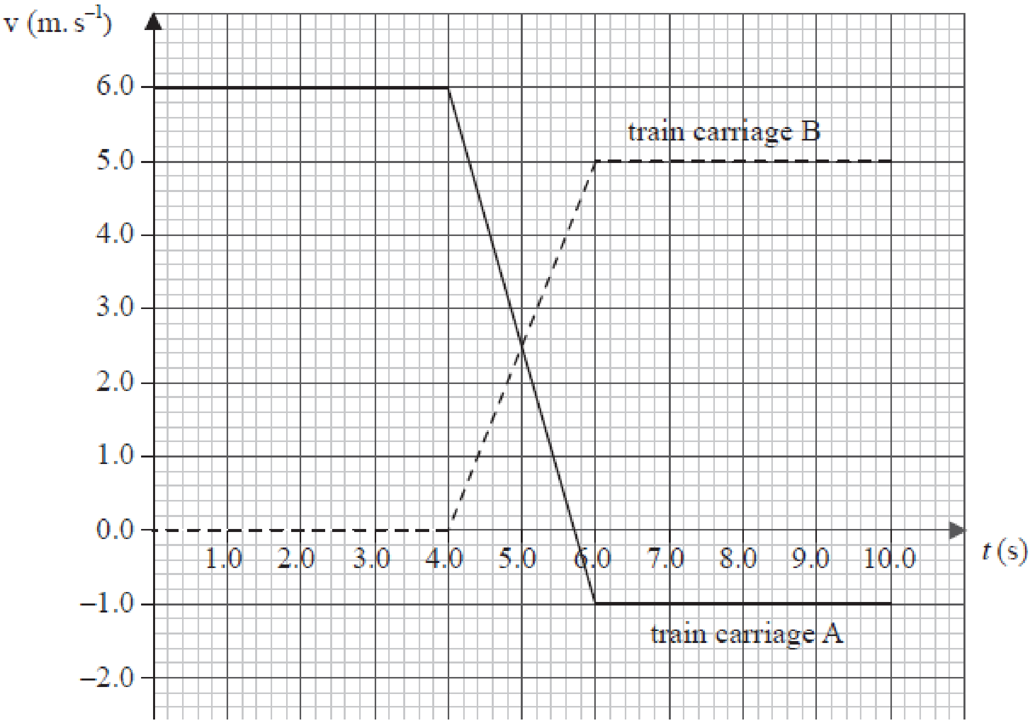
[32]

QUESTION 5 MOMENTUM

A train carriage A of mass 500 kg is moving horizontally at 6,0 m s^{-1}. It collides with another train carriage B of mass 700 kg that is initially at rest, as shown in the diagram below.



The graph below shows the variation with time *t* of the velocities of the two train carriages before, during and after the collision.



5.1 State the definition of *momentu*m. (2)

5.2 Use the graph and values given above to:

5.2.1 Calculate the total momentum before the collision. (3)

5.2.2 Calculate the total momentum after the collision. (2)

5.2.3 Hence, decide if the total momentum is conserved in the collision. (1)

5.3 Use the graph and necessary calculations to check if the collision is elastic. (5)

5.4 Calculate the magnitude of the average force experienced by train carriage B on A. (5)

[18]

QUESTION 6 FIELDS

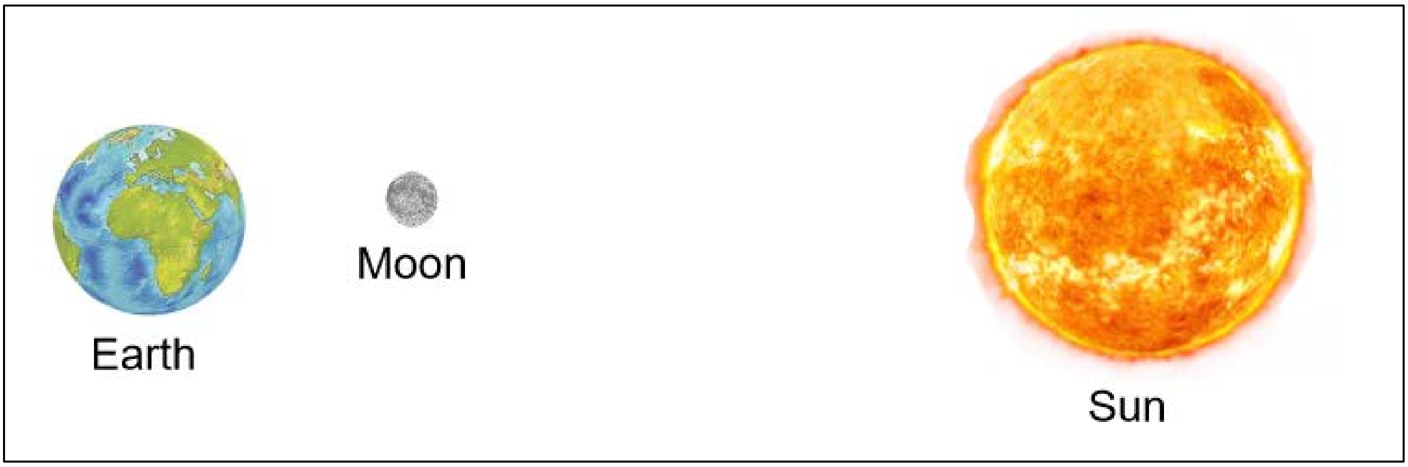
6.1 The mass of the Earth is 5,97 x10^{24} kg and the mass of the Moon is 7,35 x 10^{22} kg.

The distance between the centres of the Earth and Moon is 3,84x10^{8} m.

6.1.1 State *Newton's Law of Universal Gravitation*. (2)

6.1.2 Calculate the gravitational force of attraction between the Moon and the Earth. (4)

As the Earth, with its Moon, orbits the sun; a "new moon" is observed once a month, when all 3 bodies line up.



When the "new moon" is observed, the Moon experiences a **net zero gravitational force**.

The mass of the Sun can be taken as 1,99 x 10^{30} kg.

6.1.3 Calculate the distance between the centres of the Sun and the Moon during a new moon. (4)

6.2 A small metal sphere has a charge of + 2,7 nC. The electric field is measured to have a magnitude of 500 N·C^{-1} at an unknown distance from the charge.

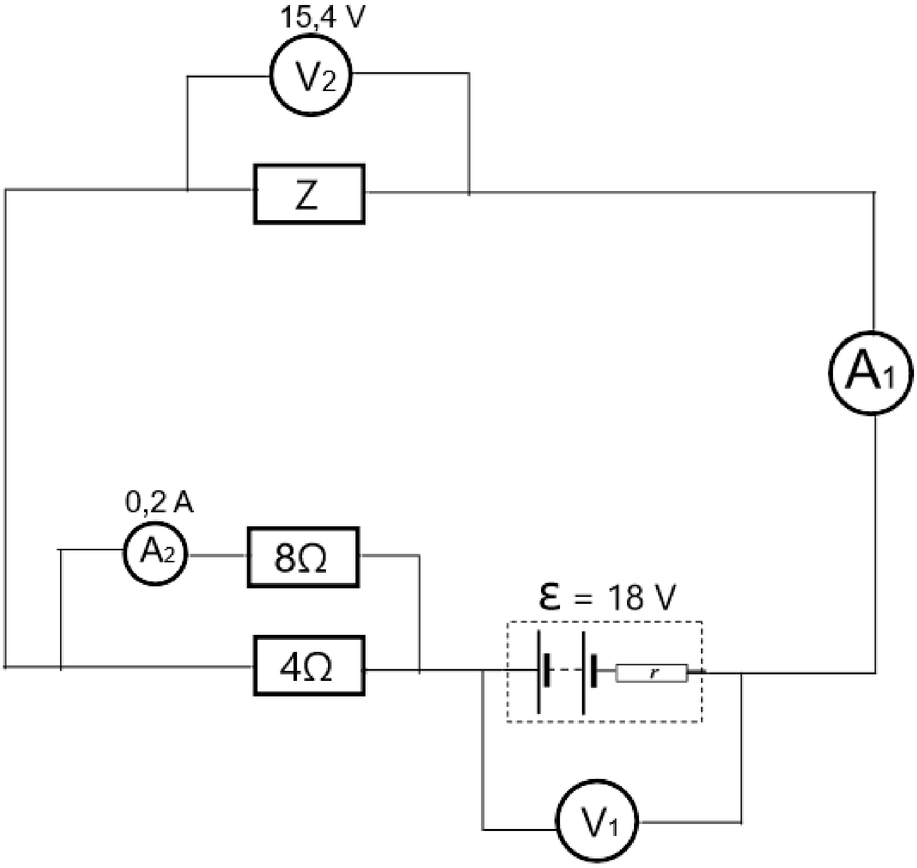
6.2.1 Define the magnitude of the *electric field* at a point. (2)

6.2.2 Calculate the distance from the charge where the electric field strength was measured. (3)

[15]

QUESTION 7 ELECTRIC CIRCUITS

7.1 An electric circuit is set up as shown in the diagram below. The resistances of the switch, ammeters and connecting wires are negligible. The voltmeters have very high resistance. The battery has an emf (ε) of 18 V and has significant internal resistance (*r*).



The ammeter A_2 reads 0,2 A and the voltmeter V_2 reads 15,4 V.

7.1.1 Define *emf*. (2)

7.1.2 Calculate the reading on ammeter A_1. (4)

7.1.3 Calculate the resistance of resistor **Z**. (3)

7.1.4 Calculate the total external resistance of the circuit. (3)

7.1.5 Calculate the internal resistance (*r*) of the battery. (4)

7.1.6 Resistor **Z** is replaced by a new resistor of **smaller** resistance than that of **Z**.

(a) Will the reading on the voltmeter $\mathbf{V_1}$ connected across the terminals of the battery *increase, decrease or remain the same?* (1)

(b) Explain your answer to Question 7.1.6 (a), making reference to relevant formulae. (4)

7.2 An electric kettle is rated 220 V; 1 500 W.

7.2.1 What does 'rated 220 V; 1 500 W' mean in regard to how this kettle works? (2)

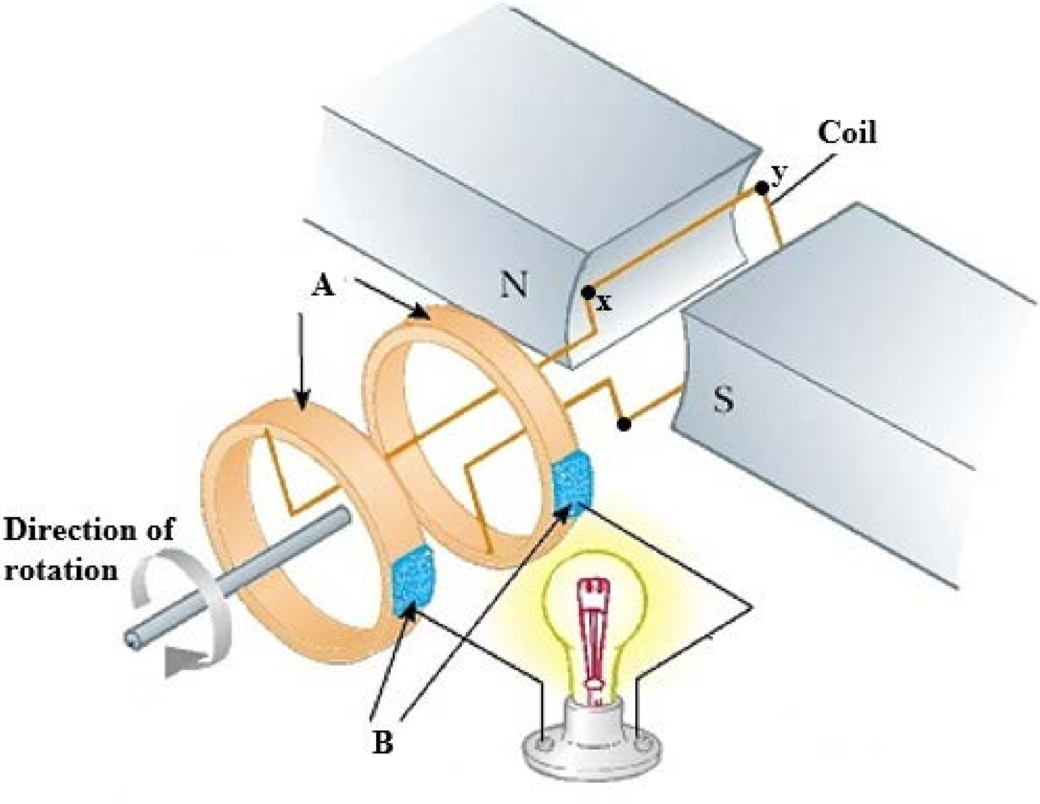
7.2.2 Calculate the current drawn by the kettle when connected to a 220 V source. (3)

7.2.3 Calculate the cost of using the kettle for 20 minutes if electricity costs R2,50 per kWh. (3)

[29]

QUESTION 8 ELECTRODYNAMICS

Consider the diagram shown below of a simple AC generator.



8.1 Name the parts labelled **A** and **B**. (2)

8.2 Consider the position of the rotating coil in the above diagram. State the direction of the current (**x to y, or y to x**) in segment **xy** of the coil as it is rotated clockwise. (1)

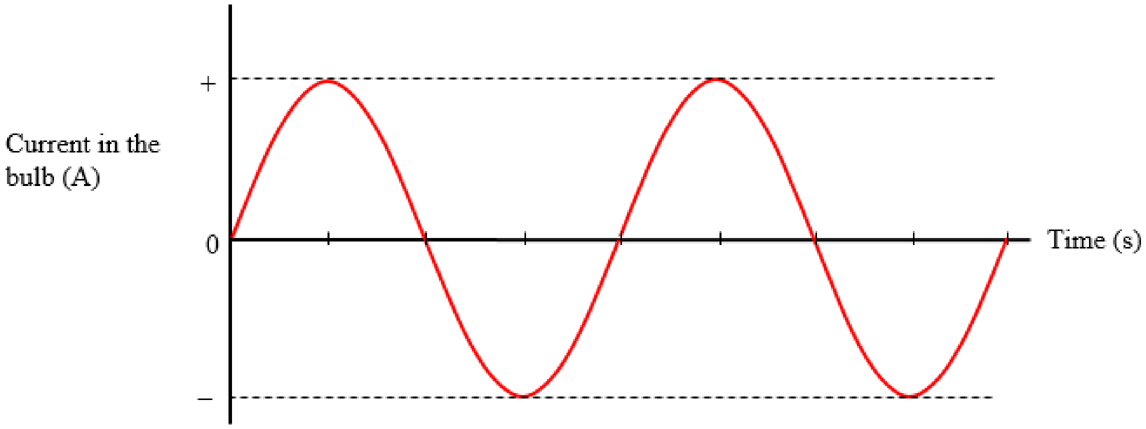
8.3 State the energy conversion taking place in the generator. (2)

8.4 State the definition of *magnetic flux linkage*. (2)

8.5 Write down **two** improvements that can be brought about to increase the power output of this generator. (2)

8.6 What changes must be made to this AC generator to make it function as a DC motor? (2)

8.7 The graph of current in the **bulb** versus time for this AC generator is shown below:



Sketch a graph on similar axes on the **provided answer sheet** to show how the above wave form changes when:

8.7.1 the coil is rotated at half the original speed. (2)

8.7.2 a diode is placed in series with the bulb in the external circuit. (2)

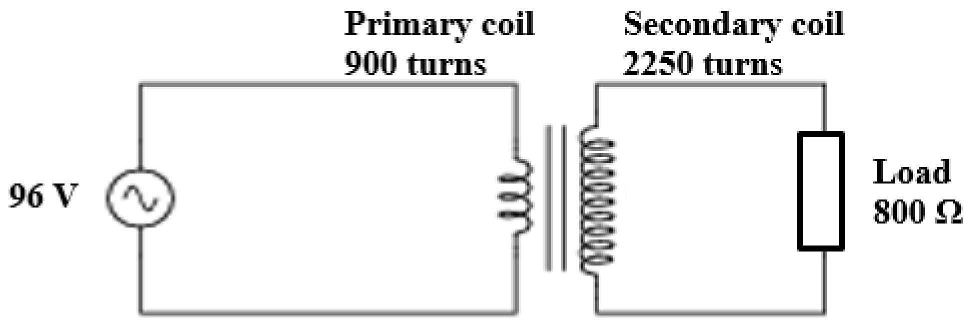
8.8 State one advantage of using AC over DC for the long-distance transmission of electrical power? (1)

8.9 State *Faraday's law of electromagnetic induction*. (2)

[18]

QUESTION 9 ELECTRODYNAMICS

Consider the diagram below of a transformer.



9.1 State *Lenz's Law*. (2)

9.2 State whether the transformer above is a *step-down* or a *step-up* transformer. Explain your choice. (2)

9.3 The diagram above shows an AC input voltage of 96 V across the primary coil. There are 900 turns in the primary coil and 2250 turns in the secondary coil.

9.3.1 Can a transformer function properly using a DC battery as an input voltage? Give a brief reason for your answer. (2)

9.3.2 Calculate the current in the 800 Ω load resistor connected to the secondary coil. (5)

[11]

End of Question Paper : Total = 200 marks

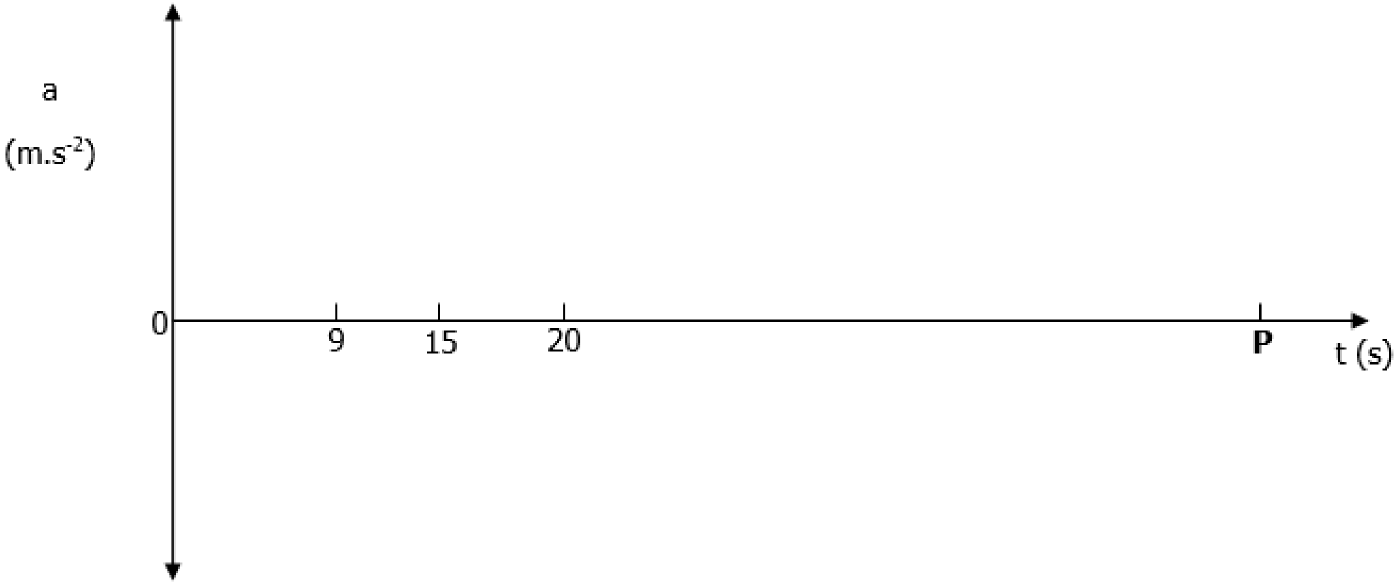
GRADE 12 EXAMINATION
AUGUST 2017

PHYSICAL SCIENCES PAPER 1
PHYSICS

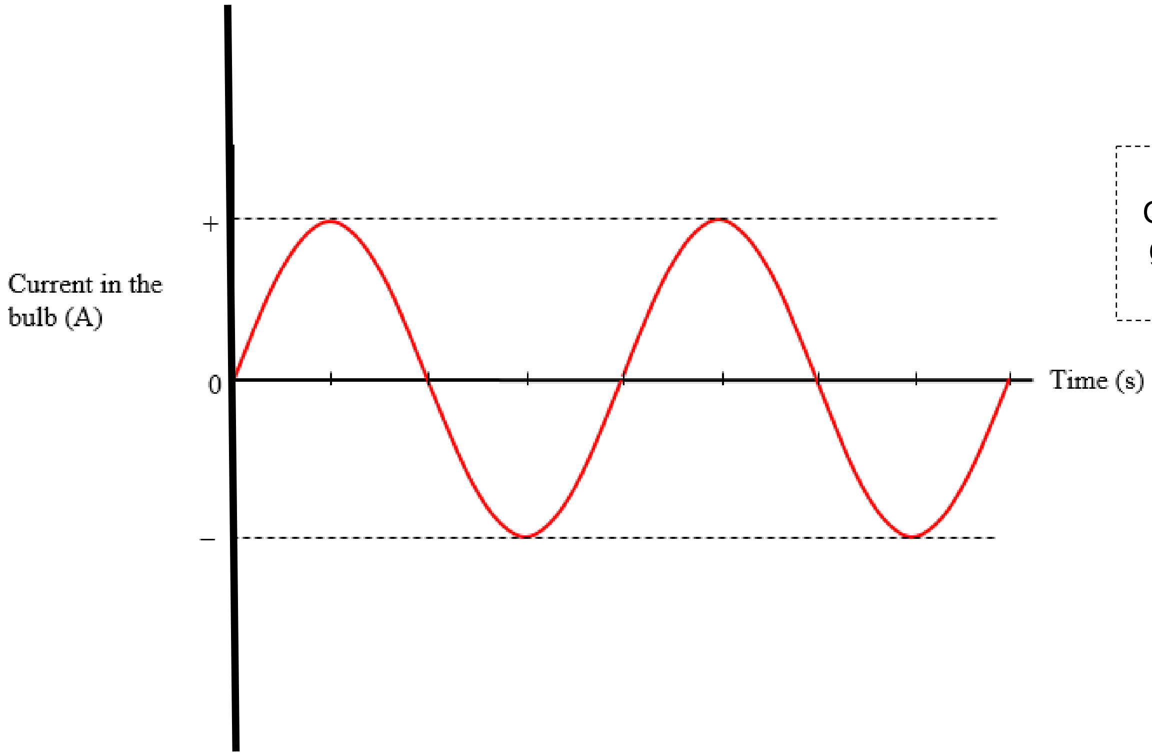
EXAMINATION NUMBER:

ANSWER SHEET

Question 2.3.7

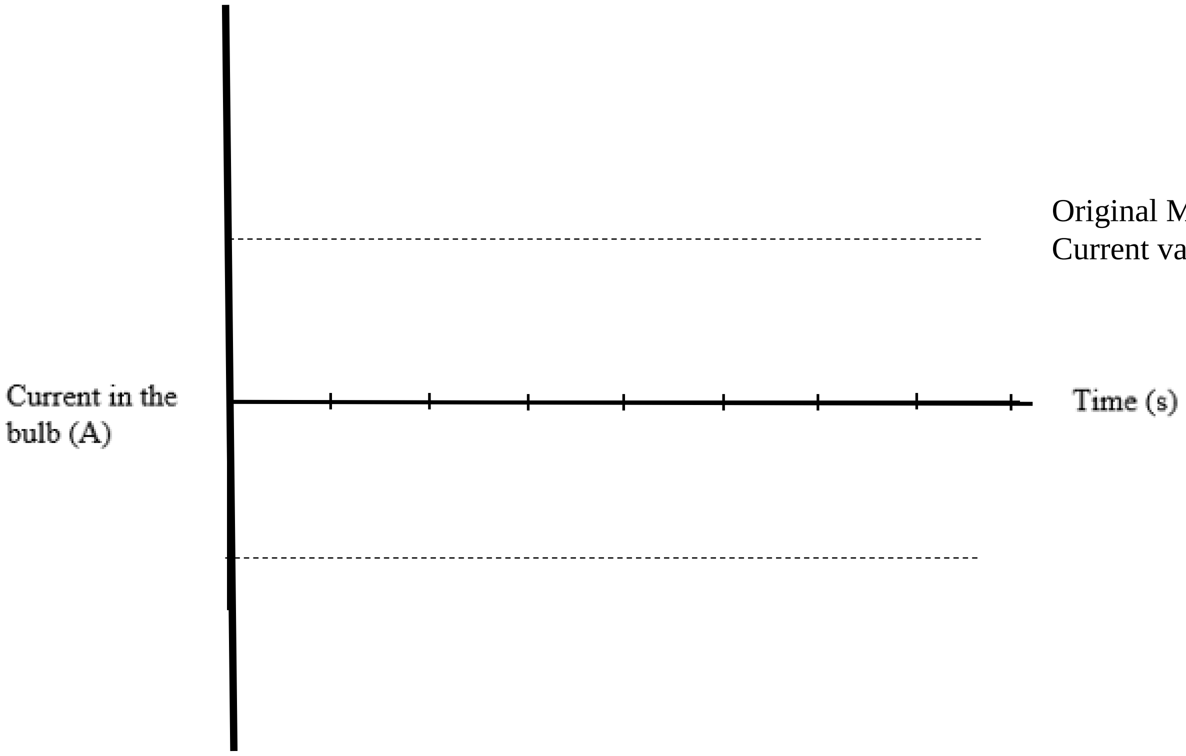


Question 8.7.1



The original Current vs Time graph is shown here

Question 8.7.2



Original Max Current value

EXAMINATION DATA SHEET FOR THE PHYSICAL SCIENCES (PHYSICS)

TABLE 1 PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 m.s^{-2}
Speed of light in a vacuum	c	3,0 × 10^{8} m.s^{-1}
Universal gravitational constant	G	6,7 × 10^{-11} N.m^{2}.kg^{-2}
Coulomb's constant	k	9,0 × 10^{9} N.m^{2}.C^{-2}
Magnitude of charge on electron	e	1,6 × 10^{-19} C
Mass of an electron	m_e	9,1 × 10^{-31} kg
Planck's constant	h	6,6 × 10^{-34} J.s
1 electron volt	eV	1,6 × 10^{-19} J

TABLE 2 PHYSICS FORMULAE

MOTION

$v = u + at$ **or** $v_f = v_i + a\Delta t$	$s = \left(\frac{v+u}{2}\right)t$ **or** $\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$
$v^2 = u^2 + 2as$ **or** $v_f{}^2 = v_i{}^2 + 2a\Delta x$	$s = ut + \frac{1}{2}at^2$ **or** $\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$

FORCE AND MOMENTUM

$F_{net} = ma$	$F_{net} = \frac{\Delta p}{\Delta t}$ **or** $F_{net}\Delta t = m\Delta v$	$\Delta p = mv - mu$ **or** $\Delta p = mv_f - mv_i$
$p = mv$	$w = F_g = mg$	$F_f^{max} = \mu F_N$

WORK, ENERGY AND POWER

<table>
<tr><td colspan="2">$W = Fs$ or $W = F\Delta x$
or $W = F\Delta x \cos\theta$</td><td colspan="2">$P = \frac{W}{t}$</td><td colspan="2">$P = Fv$</td></tr>
<tr><td>$E_p = mgh$</td><td colspan="2">$E_k = \frac{1}{2}mv^2$</td><td colspan="2">$W_{net} = \Delta E_K$</td><td>$efficiency = \frac{power_{out}}{power_{in}}$</td></tr>
</table>

GRAVITATIONAL AND ELECTRIC FIELDS

<table>
<tr><td colspan="3">$F = G\frac{m_1m_2}{r^2}$</td><td colspan="3">$g = G\frac{M}{r^2}$</td></tr>
<tr><td colspan="2">$F = k\frac{q_1q_2}{r^2}$</td><td colspan="2">$E = \frac{F}{q}$</td><td colspan="2">$E = \frac{kQ}{r^2}$</td></tr>
</table>

ELECTRIC CIRCUITS

<table>
<tr><td>$I = \frac{Q}{t}$</td><td>$V = \frac{W}{q}$</td></tr>
<tr><td>$R = \frac{V}{I}$</td><td>$emf = I(R_{ext} + r)$</td></tr>
<tr><td>$R_S = R_1 + R_2 + \ldots\ldots$</td><td>$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$</td></tr>
<tr><td colspan="2">$P = \frac{W}{t}$ **or** $W = Pt$</td></tr>
<tr><td colspan="2">$W = VIt$ **or** $W = I^2Rt$ **or** $W = \frac{V^2}{R}t$</td></tr>
<tr><td colspan="2">$P = VI$ **or** $P = I^2R$ **or** $P = \frac{V^2}{R}$</td></tr>
</table>

ELECTRODYNAMICS

$\Phi = BA\cos\theta$	$emf = -\frac{N\Delta\Phi}{\Delta t}$
$V_pI_p = V_sI_s$	$\frac{N_s}{N_p} = \frac{V_s}{V_p}$

PHOTONS AND ELECTRONS

<table>
<tr><td colspan="3">$c = f\lambda$</td><td colspan="3">$E = hf$ **or** $E = \frac{hc}{\lambda}$</td></tr>
<tr><td colspan="2">$E = W_0 + E_{K(max)}$</td><td colspan="2">$W_0 = hf_0$</td><td colspan="2">$E_{K(max)} = \frac{1}{2}mv_{max}^2$</td></tr>
</table>