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KEARSNEY COLLEGE TRIAL EXAMINATION

04 SEPTEMBER 2017

PHYSICAL SCIENCES: PAPER 1 (PHYSICS)

Time: 3 hours

200 marks

EXAMINATION NUMBER

1	7	1	0	6	8	0	2				
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Examiner: Mrs Murray

Moderators: Mr Moerdyk and Mr Thompson

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

- This paper consists of:
 - a question paper of 13 pages and
 - an Answer Sheet (pages 14 and 15); and
 - a Data and Formulae sheet of 2 sides.

Please make sure that your question paper is complete.
- Write your examination number on the Answer Sheet, Answer Book and Question Paper.**
- Read the questions carefully.
- Question 1 consists of 10 multiple-choice questions. There is only one correct answer to each question. The questions are answered on the Answer Grid provided on the inside cover of your Answer Book. The letter that corresponds with your choice of the correct answer must be marked with a cross as shown in the example below:

A	B	☒ C	D
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Here the answer C has been marked.

- Use the data and formulae whenever necessary.
- START EACH QUESTION ON A NEW PAGE.**
- Show your working in all calculations.
- Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
- Where appropriate express answers to TWO decimal places.
- It is in your own interest to write legibly and to set your work out neatly.

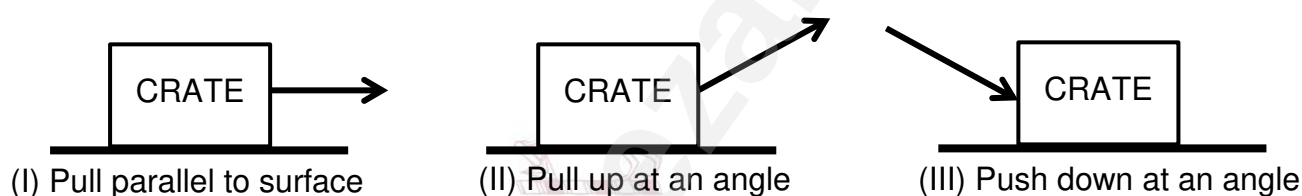
.QUESTION 1 MULTIPLE CHOICE

Answer these questions on the Multiple-choice Answer Grid inside the front cover of your Answer Book. Make a cross (X) in the box corresponding to the letter which you consider to be the most correct.

1.1 Which pair contains one vector quantity and one scalar quantity?

- A time, power
- B momentum, acceleration
- C mass, charge
- D electric field, kinetic energy

1.2 A heavy crate is at rest on a rough horizontal surface. The diagrams indicate 3 different attempts at trying to move the crate. In each situation the crate is just on the point of sliding.



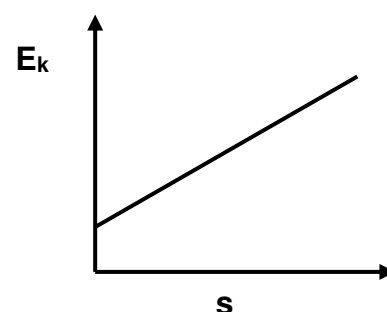
The maximum force of static friction is the ...

- A greatest in situation (I)
- B greatest in situation (II)
- C greatest in situation (III)
- D same in all three situations

1.3 The adjacent graph shows the kinetic energy (E_k) of an object vs. distance (s).

The gradient of the graph represents:

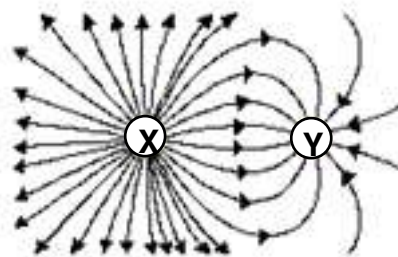
- A the net force acting on the object
- B the acceleration of the object
- C the momentum of the object
- D the power of the object



1.4 On the Earth a man has a mass, m , and a weight, w . What is the man's mass and weight on a planet which has twice the mass of the Earth and the same radius as the Earth?

	Mass	Weight
A	m	w
B	$2m$	w
C	$2m$	$2w$
D	m	$2w$

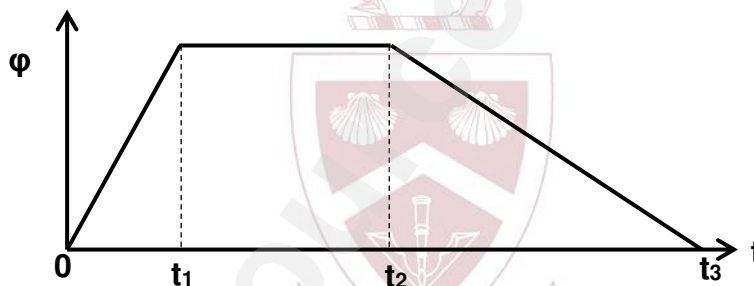
1.5 The electric field diagram for two point charges, **X** and **Y**, is shown below.



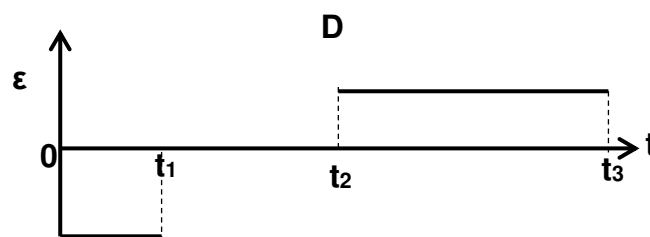
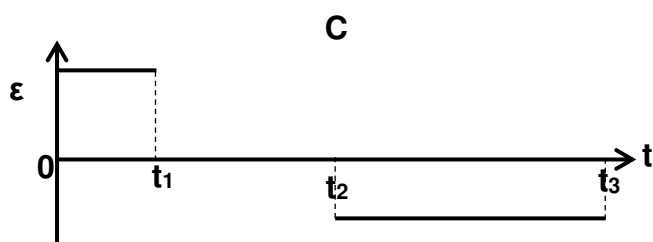
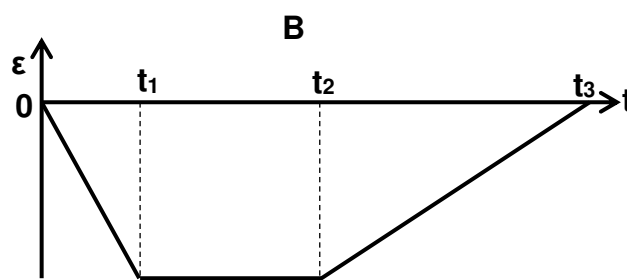
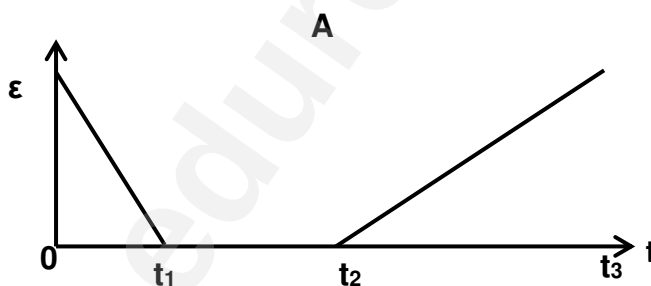
Which one of the following gives the charges on **X** and **Y**?

	Sign of charge on X (Q_X)	Sign of charge on Y (Q_Y)	Relative size of charges
A	-	+	Q_X less than Q_Y
B	+	-	Q_X greater than Q_Y
C	+	-	Q_X less than Q_Y
D	-	+	Q_X greater than Q_Y

1.6 The graph shows how the magnetic flux (ϕ) through a coil varies with time (t).



Which one of the following graphs shows how the emf (ϵ) induced in the coil varies with time (t)?



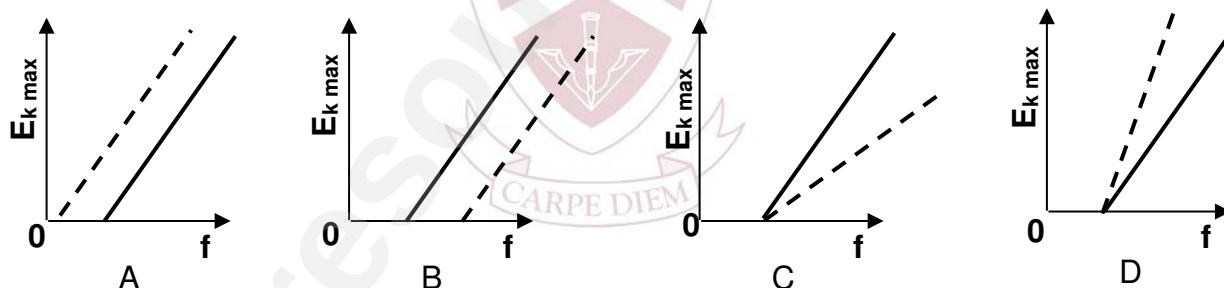
- 1.7 Which option correctly gives the energy conversion in the direct current motor as well as the component(s) connected to the ends of the coil?

	Energy conversion	Component
A	Electrical to mechanical	Split ring commutator
B	Mechanical to electrical	Slip rings
C	Electrical to mechanical	Slip rings
D	Mechanical to electrical	Split ring commutator

- 1.8 Energy losses, in the form of heat, in the power lines of the national grid are reduced by transmitting electrical energy at:

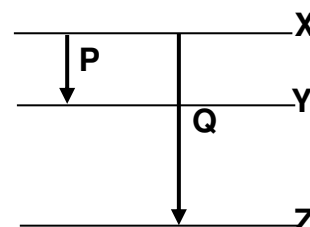
	Voltage	Current
A	High	High
B	Low	High
C	High	Low
D	Low	Low

- 1.9 The graphs below show the relationship between the maximum kinetic energy ($E_{k \max}$) of the emitted photoelectrons and the frequency (f) of the incident radiation on a sodium plate (—) and on a zinc plate zinc (- - -). The work function of sodium is lower than the work function of zinc. Which one of the graphs is correct?



- 1.10 The adjacent diagram represents 3 energy levels, **X**, **Y** and **Z**, in a certain atom.

The energy difference between levels **Y** and **Z** is twice the energy difference between levels **X** and **Y**. If the wavelength of a photon emitted as a result of transition **P**, from level **X** to **Y**, is λ , then what is the wavelength of the photon emitted during transition **Q**, from level **X** to **Z**?



- A $\lambda/2$
- B $\lambda/3$
- C 2λ
- D 3λ

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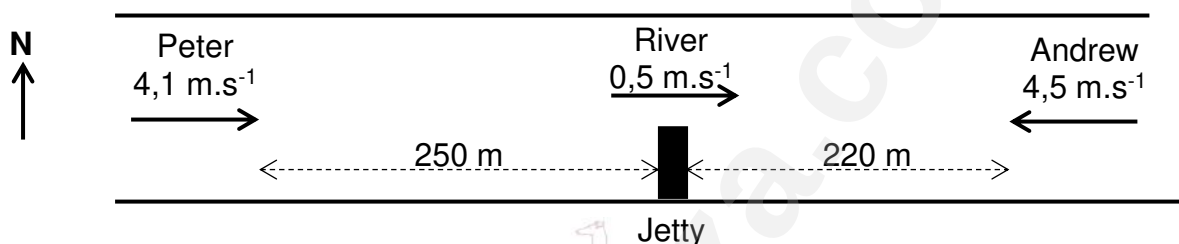
QUESTION 2 KINEMATICS

2.1 A canoeist, Steve, paddles a distance of 200 m in still water in a time of 38 s.

2.1.1 Define *speed*. (2)

2.1.2 Calculate Steve's average speed. (3)

Andrew and Peter are paddling in a river where the water is flowing at $0,5 \text{ m}\cdot\text{s}^{-1}$ east. Andrew who is 220 m east of the jetty paddles at $4,5 \text{ m}\cdot\text{s}^{-1}$ west towards the jetty. Peter who is 250 m west of the jetty paddles at $4,1 \text{ m}\cdot\text{s}^{-1}$ east towards the jetty.



2.1.3 Define *resultant vector*. (2)

2.1.4 Determine Andrew's resultant velocity. (3)

2.1.5 By means of suitable calculations determine which paddler reaches the jetty first. Assume they both start paddling towards the jetty at the same time. (6)

2.2 A car is accelerated uniformly from rest at $4,2 \text{ m}\cdot\text{s}^{-2}$ north. At the instant the car starts to accelerate there is a truck moving at a constant speed of $7,8 \text{ m}\cdot\text{s}^{-1}$ north in the same lane a distance " x " metres ahead of the car. It takes the car exactly 8 s to catch up to the truck.

2.2.1 Calculate the speed reached by the car in 8 s. (3)

2.2.2 Calculate the distance travelled by the car in 8 s. (3)

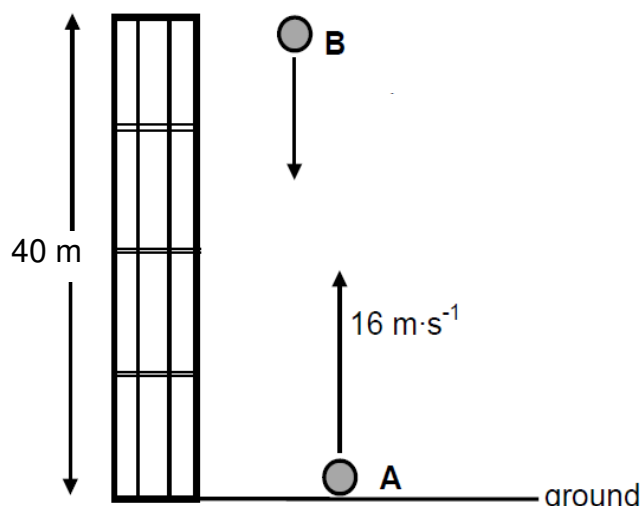
2.2.3 Calculate the original distance " x " between the car and the truck. (3)

2.3 Ball **A** is projected vertically upwards from the ground at a velocity of $16 \text{ m}\cdot\text{s}^{-1}$.

AT THE SAME TIME a second ball, **B**, is dropped from a balcony 40 m above the ground. Refer to the diagram opposite.

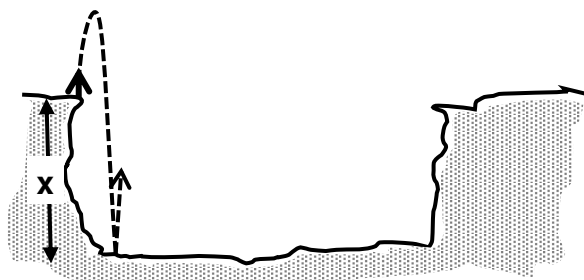
Ignore the effects of air resistance.

Calculate how high above the ground ball **A** will be at the instant the two balls pass each other. (6)



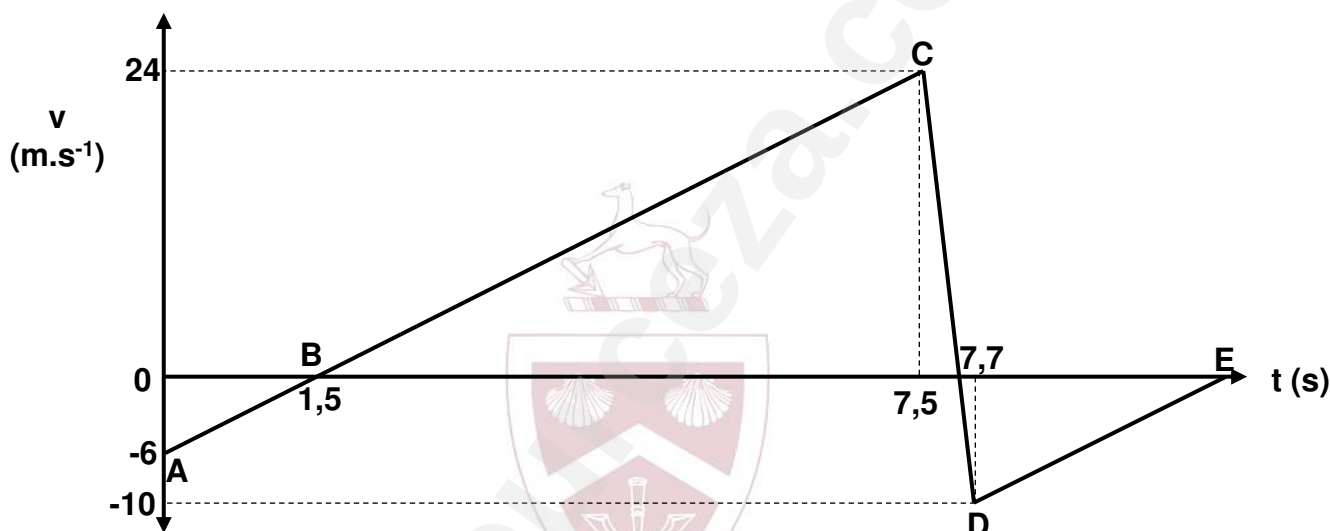
QUESTION 3 KINEMATICS

An object is projected vertically upwards from the top of a crater on an unknown planet. The object hits the ground at the base of the crater and bounces upwards as shown in diagram 1 below.

Diagram 1

The object's vertical velocity is represented on the velocity-time graph below.

Define down as positive.



- 3.1 For the time interval **A** to **B** describe the object's:
- 3.1.1 velocity. (2)
- 3.1.2 acceleration. (2)
- 3.2 Calculate the magnitude of the acceleration due to gravity on the planet. (3)
- 3.3 Calculate the depth of the crater (distance **x** in diagram 1). (4)
- 3.4 **Complete** the position-time sketch graph for the ball on the **Answer Sheet**. The time interval **A** to **B** has been completed for you. It is not necessary to show position values. (3)
- 3.5 Define *impulse*. (2)
- 3.6 Calculate the net force acting on the object, of mass 400 g, while in contact with the ground at the base of the crater. (5)

A confused student makes the following observation:

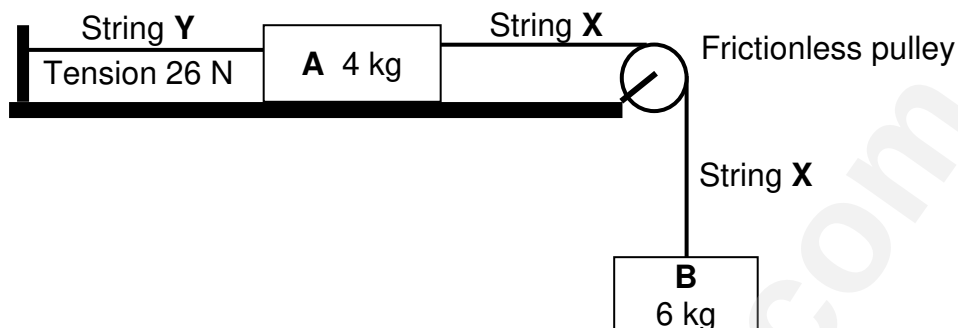
"According to Newton's 3rd law the downward force of the object on the ground is equal in magnitude to the upward force of the ground on the object, therefore the net force on the object should be zero and it should not leave the ground."

- 3.7 Correct the error(s) in the student's reasoning and explain why the object does bounce up from the ground. (3)

[24]

QUESTION 4 NEWTON'S LAWS

Block A (mass 4 kg) and Block B (mass 6 kg) are connected via a light, inextensible string, **X**, over a frictionless pulley. Block A, which is at rest on a rough horizontal surface, is tied via a light inextensible string, **Y**, to a fixed post as shown in the diagram. The tension in string **Y** is 26 N.



Block A as shown in the diagram is only just at rest and is on the limit of sliding to the **RIGHT**.

- 4.1 State *Newton's first law*. (2)
- 4.2 State the magnitude of the net force acting on Block **B**. (1)
- 4.3 Calculate the magnitude of the tension in string **X**. (2)
- 4.4 Draw a labelled force diagram to represent the horizontal forces acting on Block **A**. (4)
- 4.5 Calculate the magnitude of the maximum force of static friction acting on block **A**. (2)
- 4.6 Calculate the co-efficient of static friction between Block **A** and the surface. (3)

String **Y** is cut and the system starts accelerating. The tension in string **X** is now 40,2 N.

- 4.7 State *Newton's second law*. (2)
- 4.8 Calculate the magnitude of the acceleration of the system. (4)
- 4.9 Calculate the magnitude of the frictional force acting on Block **A** while it is accelerating. (4)

[24]

QUESTION 5 MOMENTUM, WORK, ENERGY AND POWER

- 5.1 Cart A, of mass 2,8 kg moves with a constant speed of 3 m.s^{-1} along a frictionless track and collides with and sticks to stationary cart B which has a mass of 1,2 kg.



- 5.1.1 Calculate the speed of the carts immediately after the collision. (4)

Immediately after the collision the two carts move together over a rough section of the track where they experience a constant frictional force of 12 N.

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

- 5.1.3 Calculate the distance the carts travel before coming to rest. (4)

- 5.2 A 200 W motor operating at 75% efficiency pulls a crate of mass 80 kg up a slope at a constant speed of $0,5 \text{ m.s}^{-1}$. It takes 30 s to raise the crate from the bottom (X) to the top (Y) of the slope.



- 5.2.1 Calculate the energy supplied by the motor to the crate in 30 s. (4)

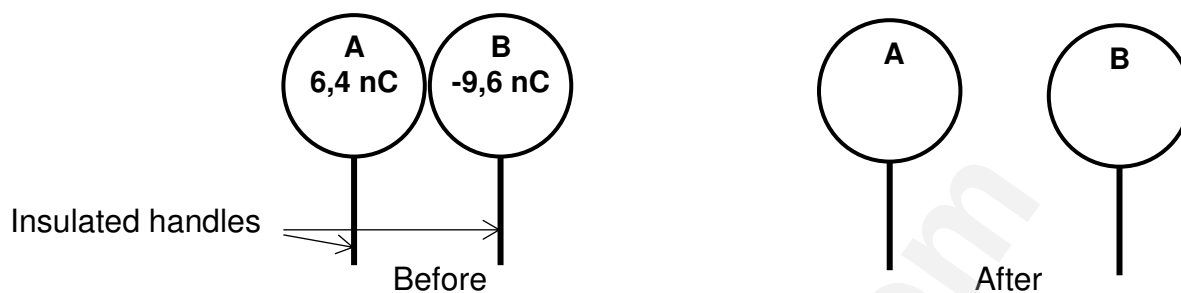
- 5.2.2 Calculate the gain in gravitational potential energy of the crate between X and Y. (3)

- 5.2.3 Calculate the magnitude of the frictional force acting on the crate between X and Y. (5)

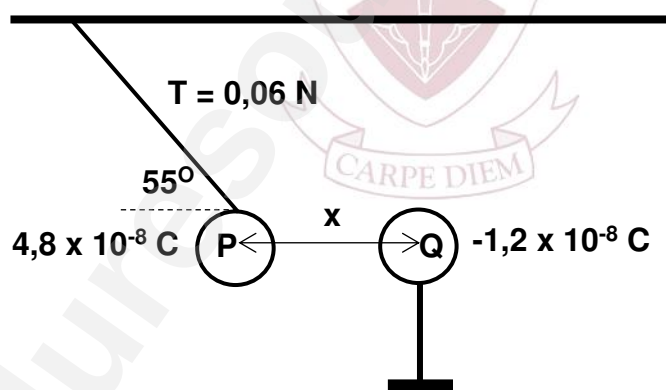
[22]

QUESTION 6 FIELDS

- 6.1 Sphere A which has a charge of $6,4 \text{ nC}$ is brought into contact with sphere B which has a charge of $-9,6 \text{ nC}$. The spheres are separated after contact as shown in the diagram.



- 6.1.1 Calculate the charge (in Coulombs) on either sphere after separation. (3)
- 6.1.2 Calculate the number of electrons transferred from sphere B to sphere A while they were in contact. (3)
- 6.2 Sphere **P**, which has a charge of $4,8 \times 10^{-8} \text{ C}$, is suspended by a light thread. Sphere **Q**, which has a charge of $-1,2 \times 10^{-8} \text{ C}$, is positioned on an insulated stand near sphere **P**. Sphere **P** is attracted to sphere **Q** and comes to rest at distance x from sphere **Q** as shown in the diagram below. When sphere **P** is in this equilibrium position the angle between the thread and the horizontal is 55° . The tension (T) in the thread is $0,06 \text{ N}$.



- 6.2.1 State *Coulomb's Law*. (2)
- 6.2.2 Draw a labelled free body diagram to represent the forces acting on sphere **P**. (4)
- 6.2.3 Calculate the magnitude of the horizontal component of the tension in the thread. Take your answer to 3 decimal places. (2)
- 6.2.4 Calculate distance x between the centres of spheres **P** and **Q**. Take your answer to 3 decimal places. (4)

[18]

QUESTION 7 EXPERIMENT

A group of students conduct an experiment to determine how the power output from a resistor depends on the resistance of the resistor. A constant potential difference is maintained across the resistor. The results are recorded in the table below.

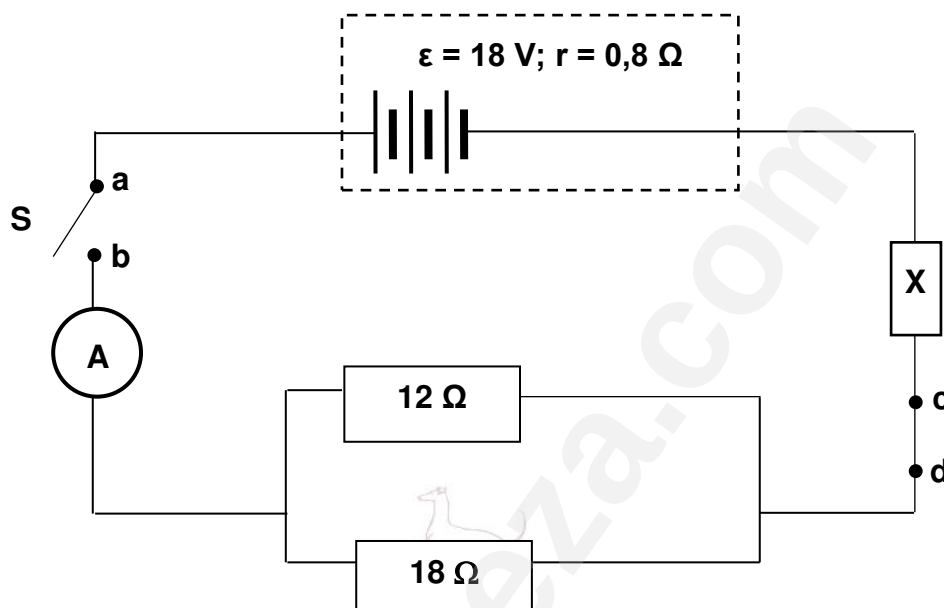
R (Ω)	1/R (Ω^{-1})	P (W)
0,8	1,25	40,5
1,2	0,83	25,0
2,0	0,50	16,0
2,8	0,36	12,5
4,5	0,22	7,0
6,7	0,15	4,0

- 7.1 Use the data in the table to plot a graph of power (**P**) (y -axis) vs the inverse of resistance (**1/R**) (x -axis) on the graph paper provided on the **Answer Sheet**. (6)
- 7.2 State the relationship between power (**P**) and resistance (**R**) as shown by the graph. (2)
- 7.3 In order to meaningfully analyse the data explain why it is necessary to plot a graph of **P** vs **1/R** rather than **P** vs **R**. (2)
- 7.4 Calculate the gradient of the graph. Indicate the values you used for this calculation on your graph. (4)
- 7.5 Use your **answer from Question 7. 4**, your knowledge of electrical power and that the equation $y = mx + c$ describes a straight line to determine the potential difference maintained across the resistor. Show all working/reasoning. (3)

[17]

QUESTION 8 ELECTRIC CIRCUITS

In the circuit shown in the diagram below the battery has an emf (ϵ) of 18 V and an internal resistance of $0,8 \Omega$. There are three resistors in the circuit. The resistance of resistor X is unknown. The connecting wires, switches and ammeter have negligible resistances.

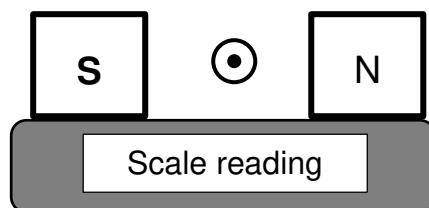


- 8.1 Define *emf*. (2)
- 8.2 Switch **S** is OPEN. A high resistance voltmeter is connected across **a** and **b**. What will the reading on the voltmeter be? (1)
- 8.3 Switch **S** is now CLOSED. The same voltmeter is connected across **c** and **d**. What will the reading on the voltmeter be? (1)
- 8.4 When switch **S** is CLOSED the potential difference across the terminals of the battery is **16,8 V**.
Calculate the:
- 8.4.1 Reading on the ammeter. (3)
- 8.4.2 Effective resistance of the parallel combination of resistors. (2)
- 8.4.3 Resistance of resistor **X**. (4)
- 8.4.4 Energy dissipated (lost) as heat per minute in the battery due to its internal resistance. (4)

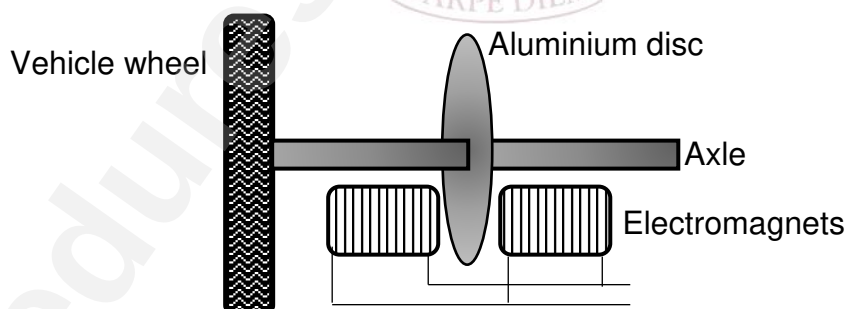
[17]

QUESTION 9 ELECTRODYNAMICS

- 9.1 The force on a current carrying conductor placed in a magnetic field can be measured using the apparatus given below. The conductor (wire) is fixed in place between the poles of a magnet which is placed on a scale.



- 9.1.1 State the direction of the force experienced by the conductor in the magnetic field. (1)
- 9.1.2 Explain the origin of the force on the conductor in the magnetic field (i.e. explain why it experiences a force). (2)
- 9.1.3 The reading on the scale when there is no current in the conductor is 2,0 N. State whether the reading on the scale INCREASES or DECREASES when a current passes through the conductor in the direction shown in the diagram. (1)
- 9.1.4 Explain your answer to Question 9.1.3. (2)
- 9.1.5 State two ways of increasing the force experienced by the conductor in the magnetic field. (2)
- 9.2 A vehicle brake consists of an aluminium disc attached to an axle. As the wheel turns the aluminium disc rotates between a pair of electromagnets. An emf is induced in the aluminium disc and as a result the rotation speed of the disc is decreased, thus slowing down the rotation of the axle and the wheel.



- 9.2.1 Why is an emf induced in the rotating aluminium disc? (2)
- 9.2.2 State *Lenz's law*. (2)
- 9.2.3 Why does the rotation speed of the aluminium disc decrease? (2)
- 9.2.4 Explain why the braking effect increases when the speed of the vehicle increases. (2)

[16]

QUESTION 10 PHOTONS AND ELECTRONS

When ultra violet light with a frequency of $3,8 \times 10^{15}$ Hz is shone onto a zinc plate electrons are ejected from the plate. This process is known as the photoelectric effect.

10.1 State the significance of the photoelectric effect. (TWO points are required.) (2)

10.2 Calculate the wavelength of ultraviolet light. (3)

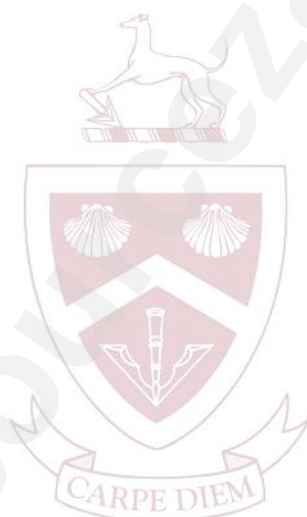
The work function of zinc is $6,88 \times 10^{-19}$ J.

10.3 Define *work function*. (2)

10.4 Calculate the maximum kinetic energy of the electrons emitted from the zinc plate. (4)

[11]

Total: 200 marks



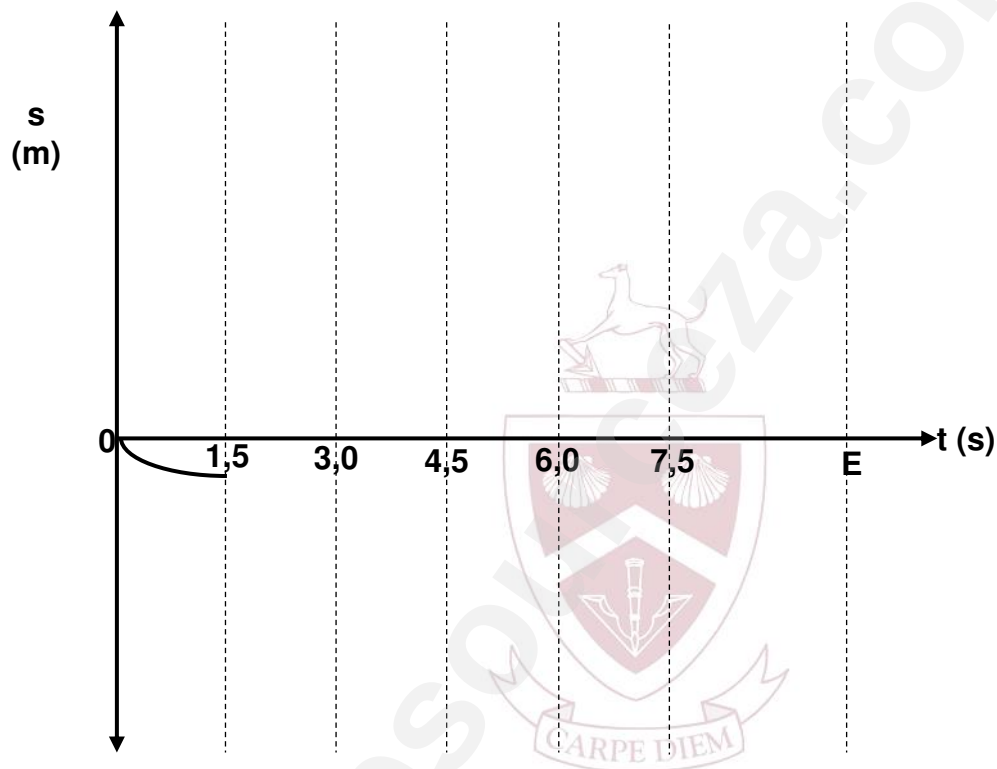
PHYSICAL SCIENCES PAPER 1

EXAMINATION NUMBER

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ANSWER SHEET

QUESTION 3.4



QUESTION 7.1