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GLENWOOD
HOUSE
SCHOOL

PHYSICAL SCIENCES
Preliminary Examinations
Paper 1

Grade: 12
Date: 3 September 2018
Examiner: Mr Baehnisch

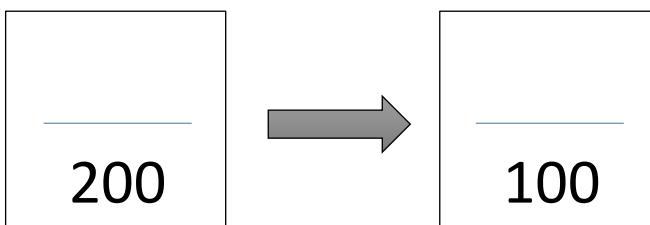
Time: 180 minutes
Marks: 200
Moderator: Mrs Baehnisch

Name: _____

INSTRUCTIONS

1. Staple your answer script to the back of this question paper.
2. Answer ALL the questions
3. **START EACH QUESTION ON A NEW PAGE.**
4. It is in your own interest to write legibly and to present your work neatly. Please leave a line open after every sub question.
5. Ensure that the numbering of your answers is correct.
6. Show all your working, where necessary.
7. A data sheet is provided which may be used to assist you in answering the questions.
8. Round off your final answers to two decimal places. Use scientific notation where appropriate.

QUESTION	1	2	3	4	5	6	7	8	9	10	11	TOTAL
MARK												
MAXIMUM MARK	20	16	29	15	17	15	9	19	24	21	15	200



QUESTION 1 Multiple choice

In each of the following questions, four possible answers are provided. Write down the letter of the correct answer next to the question number. Leave a line open between answers.

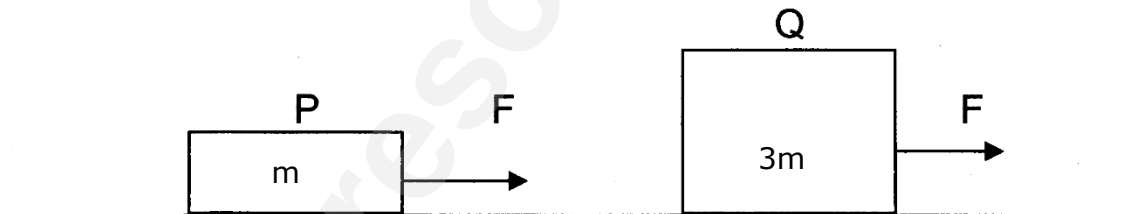
1.1 Which of the following statements is TRUE of a body that accelerates uniformly?

- A Its rate of change of position remains constant.
- B Its position changes by the same amount in equal time intervals.
- C Its velocity increases by the same amount in equal time intervals.
- D Its velocity increases by increasing amounts in equal time intervals.

1.2 Which one of the following is also a unit of momentum?

- A N.s
- B N.m
- C J.s
- D J.s^{-1}

1.3 A net force F acts on each of two isolated objects, P and Q, as shown below. The mass of Q is three times that of P. (Ignore the effect of friction.)



If the rate of change of velocity of object Q is x , then the rate of change of velocity of object P is as follows:

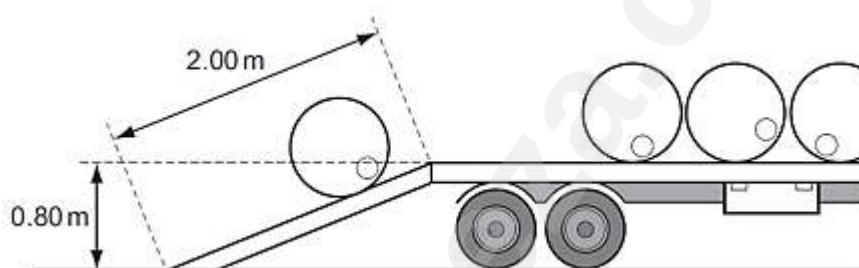
- A. $\frac{1}{9}x$
- B. $\frac{1}{3}x$
- C. x
- D. $3x$

- 1.4 A half-brick is thrown vertically upwards and reaches a height h above the ground. A full brick is also thrown vertically upwards and reaches the same height h . Ignore all effects of friction.

Which of the following is TRUE concerning the bricks which were thrown?

- A The half-brick will take a shorter time to reach the builder.
- B Both bricks have the same kinetic energy when they are thrown.
- C Both bricks have the same velocity when they are thrown.
- D Both bricks have the same momentum when they are thrown.

- 1.5 A workman rolls a barrel of weight 2000 N up a plank of length 2 m and on to a lorry. The back of the lorry is 0,8 m above the horizontal surface of the road.



What amount of energy is transferred from the barrel by the gravitational force?

- A. 1000 J B. 1600 J C. 2500 J D. 4000 J
- 1.6 Two identical bullets, X and Y, with identical velocities strike a steel block and wooden block respectively.

Bullet X bounces 180° back from the steel block. Bullet Y penetrates and becomes embedded inside the wooden block.

Which one of the following statements about the impulse of the bullets is correct?

Impulse of bullet X...

- A. is smaller than the impulse of bullet Y.
- B. is greater than the impulse of bullet Y.
- C. is equal to the impulse of bullet Y.
- D. and bullet Y are zero.

- 1.7 The position vs. time graphs for two objects, A and B, are straight lines inclined at angles 30° and 60° respectively with the time axis.

The ratio of the magnitude of their velocities $v_A:v_B$ is

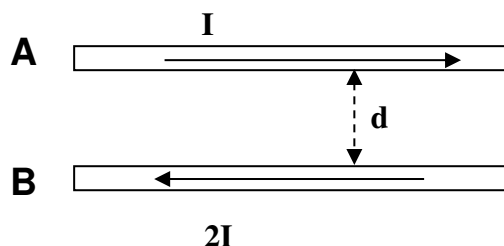
- A $1:\sqrt{3}$
 B $1:2$
 C $1:3$
 D $\sqrt{3}:1$
- 1.8 An astronaut on a strange planet finds that acceleration due to gravity is twice that on the surface of Earth. Which of the following could explain this?
- A. Both the mass and radius of the planet are twice as big as that of Earth.
 B. The mass of the planet is half that of Earth, but the radius is same as that of the Earth.
 C. Both the mass and radius of the planet are half that of the Earth's.
 D. Radius of the planet is half as that of Earth's, but the mass is the same as that of Earth.
- 1.9 Two point charges (X and Y) are placed a distance d apart from each other. The net/resultant electric field intensity (strength) at point P is zero.



Which of the following statements concerning X and Y is correct?

	Charge on X	Charge on Y	
A	Positive	Positive	Charge on Y > charge on X
B	Positive	Negative	Charge on Y > charge on X
C	Positive	Positive	Charge on X > charge on Y
D	Positive	Negative	Charge on X > charge on Y

- 1.10 Two parallel current-carrying conductors are placed a distance d apart from each other. Conductor A carries a current of I and conductor B carries a current of $2I$. Conductor B is in the magnetic field due to conductor A. The arrows show the direction of conventional current in these conductors.



Which of the following statements about the force that current-carrying conductor A exerts on current-carrying conductor B is correct?

	Magnitude of force of A on B	Direction of force on B
A	Less than the force that B exerts on A	Downwards
B	Less than the force that B exerts on A	Upwards
C	Equal to the force that B exerts on A	Downwards
D	Equal to the force that B exerts on A	Upwards

(10 x 2) = [20]

QUESTION 2

Dané is riding her scooter along a straight horizontal road. She accelerates uniformly from a velocity of $4,75 \text{ m.s}^{-1}$, North to $8,25 \text{ m.s}^{-1}$ North over a distance of 30 metres.

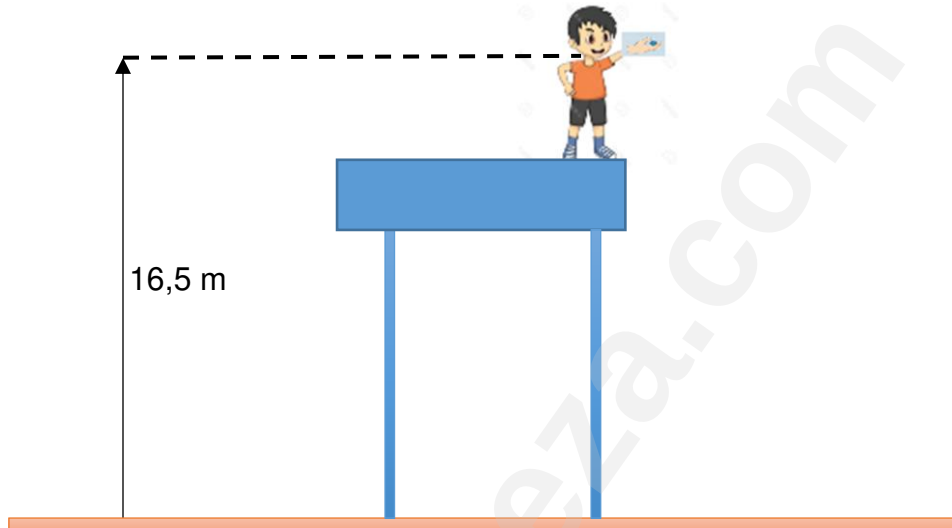


- 2.1 Define (1)
- 2.1.1 *distance*. (1)
- 2.1.2 *displacement*. (2)
- 2.2 Calculate how long (in seconds) Dané accelerated for. (3)
- 2.3 Dané travels along the road at a constant velocity of $8,25 \text{ m.s}^{-1}$ North, when she sees Keighan juggling in the middle of the road 6 metres away. Her scooter has a maximum braking acceleration of $7,54 \text{ m.s}^{-2}$. What is the slowest reaction time she can have in order for her to stop just in time? Show all steps. (5)
- 2.4 Sketch a position versus time graph for Dané's motion, from the moment she saw Keighan until she stopped. No time values need to be shown on the graph. Let the origin be the position of Dané when she first sees Keighan and show all relevant position values. Use the system of axes labelled **Question 2.4** on the **answer sheet**. (4)
- 2.5 Convert $8,25 \text{ m.s}^{-1}$ to kilometres per hour. (1)

[16]

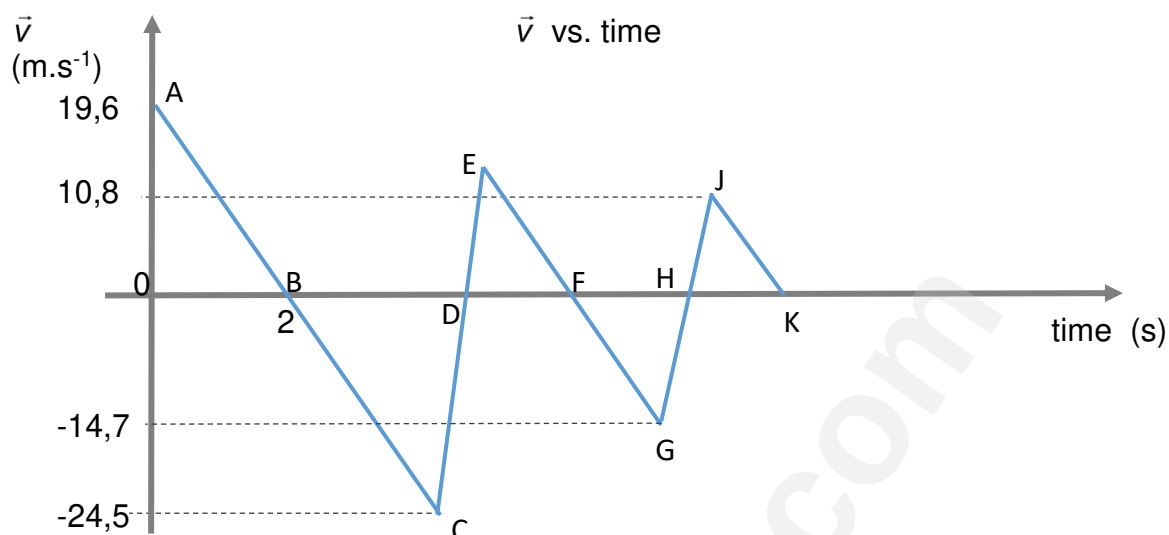
QUESTION 3

- 3.1 Ruben stands on a platform and throws a marble vertically upwards from a height of 16,5 m above the ground. The marble strikes the ground 4,784 seconds after leaving Ruben's hand. Ignore air resistance.



- 3.1.1 Define *velocity*. (2)
- 3.1.2 Calculate the launch velocity of the marble. (4)
- 3.1.3 Calculate the maximum height above the ground reached by the marble. (3)
- 3.1.4 Sketch an acceleration versus time graph for the marble while it is in the air. Use The graph paper labelled **Question 3.1.4** on the **answer sheet**. No time values are required.
NOTE: $t_{\text{max height}}$ represents the time at which the marble was at maximum height. This value need not be calculated. Take upwards as the positive direction. (2)

- 3.2 Consider the velocity-time graph below which represents the vertical motion of a bouncing Ping-Pong ball (mass 2,50 grams). Ignore air resistance.

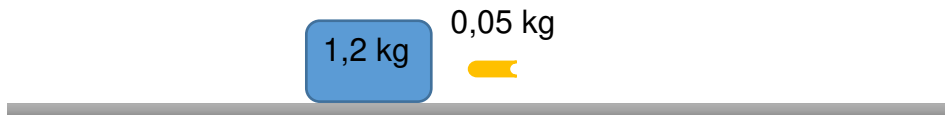


- 3.2.1 Which direction was taken as positive when the graph was plotted? (1)
- 3.2.2 Calculate the displacement of the Ping-Pong ball during the first 2 seconds after being hit at $t=0\text{s}$. (3)
- 3.2.3 Calculate the height above the ground of the ball at $t=0\text{s}$. (4)
- 3.2.4 How many times did the ball bounce? (1)
- 3.2.5 Sketch a position vs. time graph for A to F of the motion. No position or time values need to be shown but the letters A to F must be indicated on the time axis of your graph. Use the axes on the answer sheet for question 3.2.5. Take the ground as the reference height. (4)
- 3.2.6 The ball was in contact with the ground for 0,04 s during the second bounce. Calculate the net force acting on the ball during the second bounce. (5)

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QUESTION 4 (Start on a new page.)

In the diagram below, a wooden block of mass $1,2 \text{ kg}$ is sliding at a constant velocity of $6,2 \text{ m}\cdot\text{s}^{-1}$ to the right when a bullet, of mass $0,05 \text{ kg}$ is shot into it from the right. The bullet was shot from a rifle with a claimed muzzle velocity of $300 \text{ m}\cdot\text{s}^{-1}$. The horizontal surface is frictionless. The bullet becomes lodged inside the block. Ignore air resistance.

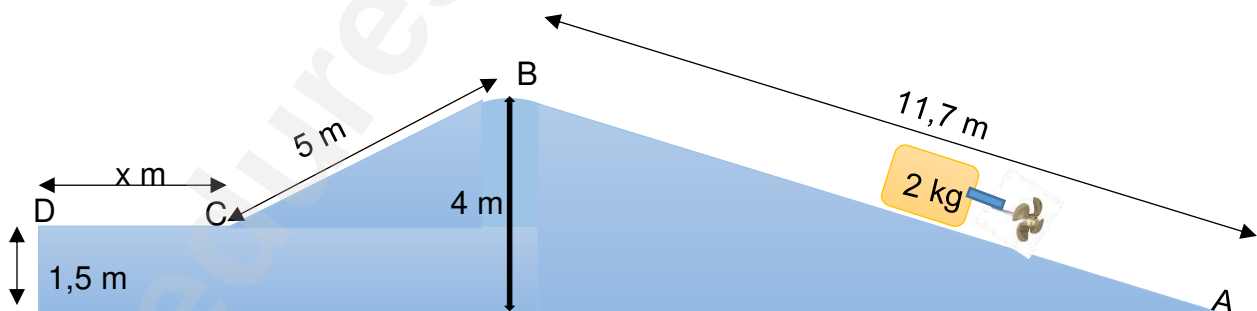


- 4.1 Explain why the block and the bullet together may be considered an isolated system in the horizontal direction. (2)
- 4.2 Calculate the velocity of the bullet-block system after the bullet becomes lodged inside the block. (4)
- 4.3 Calculate the impulse experienced by the block. (3)
- 4.4 The experiment is repeated, this time a $1,2 \text{ kg}$ block of softer wood is used. Once again, the bullet becomes lodged inside block. State how each of the following will be affected.
 - 4.4.1 the magnitude of the final velocity of the bullet-block system. (1)
 - 4.4.2 the depth that the bullet penetrates the block. (1)
 - 4.4.3 the net force that the bullet experienced during the collision. (1)
- 4.5 Explain your answer to 4.4.3. Refer to appropriate Physics principles and/or formulae. (3)

[15]

QUESTION 5

A 2 kg object starts from rest at A and slides along a course ABCD. It uses a propeller which exerts a constant propulsion force of $16,5 \text{ N}$ parallel to the surface the object is sliding on. The object experiences a 7 N frictional force on section AB, while BC and CD are frictionless.

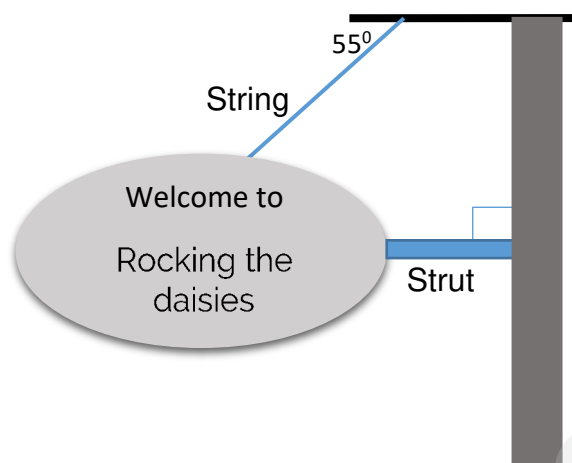


- 5.1 Draw a labelled free-body diagram that shows all the forces acting on the object while sliding along CD. (3)
- 5.2 Define *work done by a force*. (2)
- 5.3 State, in words, the *work-energy theory*. (2)
- 5.4 Calculate the kinetic energy of the object at B. (5)
- 5.5 The object reaches D with a speed of $16,71 \text{ m}\cdot\text{s}^{-1}$. Calculate the length of section CD. (5)

[17]

QUESTION 6

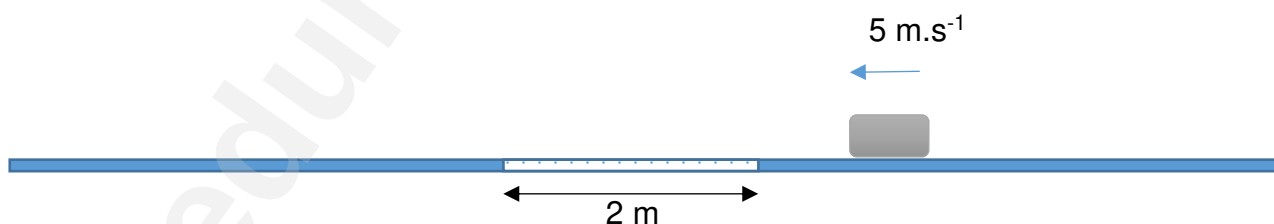
The sign in the diagram below has a mass of 4 kg. It is held stationary by a horizontal wooden strut and a massless string at angles as shown.



- 6.1 Sketch a labelled free body diagram showing all the forces acting on the sign. (3)
- 6.2 State, in words, *Newton's First Law of motion*. (2)
- 6.3 Define *weight of the sign*. (2)
- 6.4 Describe the force that together with the weight of the sign forms a Newton 3 action-reaction pair of forces. (2)
- 6.5 Calculate the tension in the string. (3)
- 6.6 The wooden strut will break when the compression force on it exceeds 40 N. Calculate the maximum mass that the sign can have before the strut will break. You may assume that the string will not break. (3)

[15]**QUESTION 7**

A block of unknown mass slides to the left along a horizontal frictionless surface at 5 m.s^{-1} . It then encounters a rough section which is 2 metres long.



When it gets onto the frictionless section beyond its speed is 3 m.s^{-1} .

- 7.1 State, in words, *Newton's Second Law of motion*. (2)
- 7.2 Define *normal force*. (2)
- 7.3 Calculate the coefficient of kinetic friction between the block and the rough surface. (5)

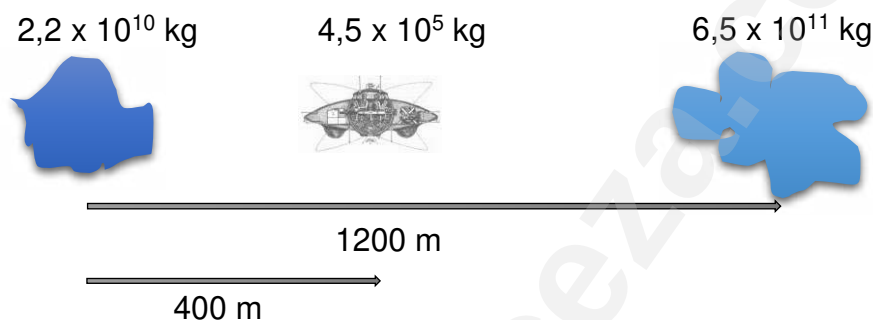
[9]

QUESTION 8

Daniel and Sue visited Planet X during the July holidays. Sue's 'Lonely planet' guidebook listed Planet X's gravitational acceleration as 14 m.s^{-2} .

- 8.1 State, in words, *Newton's Universal Law of Gravitation*. (3)
- 8.2 The gravitational force that Daniel exerts on Planet X while on vacation on its surface is 1008 N. Calculate Daniel's mass. (3)
- 8.3 Daniel googled 'Planet X' on his new phone. The mass of Planet X was given as 10^{23} kg . Calculate the radius of Planet X. (3)

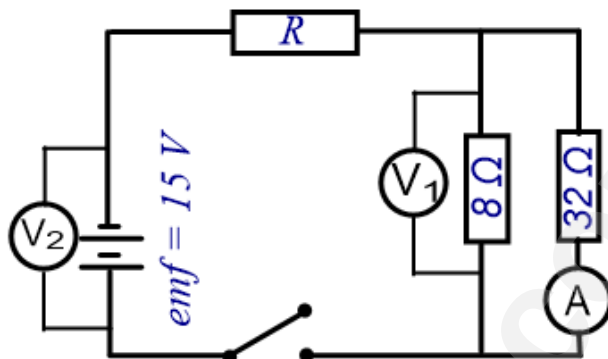
On the way back to Earth their spaceship, mass $4,5 \times 10^5 \text{ kg}$, stopped between two asteroids in an isolated part of the galaxy, as shown in the diagram below.



- 8.4 Calculate the net force experienced by the spaceship. (6)
- 8.5 Calculate how long after stopping there the spaceship bumps into one of the asteroids. Assume that the asteroids do not move. (4)
- [19]**

QUESTION 9

A battery with an emf of 15 V and an internal resistance r is connected in a circuit as shown in the diagram below.



While the switch is open

9.1 Write down the reading on voltmeter

9.1.1 V_1

(1)

9.1.2 V_2

(1)

9.2 Define

9.2.1 *emf*

(2)

9.2.2 *current*

(1)

The switch is closed and the reading on V_1 is 11,01 V and the reading on V_2 is 12,97 V.

9.3 Calculate the reading on the ammeter.

(3)

9.4 Determine r .

(4)

9.5 Calculate the resistance of resistor R .

(4)

9.6 How much thermal energy is generated in the $8\ \Omega$ resistor each minute?

(3)

9.7 The $32\ \Omega$ resistor burns out. How does this affect the reading on voltmeter V_2 ?

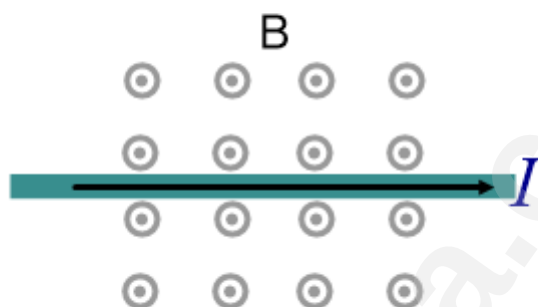
Explain your answer by referring to appropriate formulae.

(5)

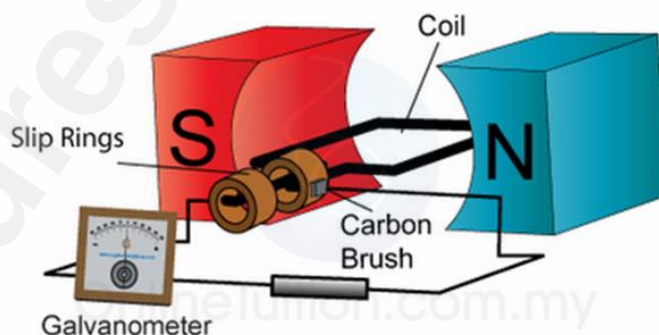
[24]

QUESTION 10

- 10.1 Sketch the magnetic field pattern around a current carrying conductor. Let current flow into the page. (3)
- 10.2 In which direction, if at all, will the conductor in the diagram below experience a force. The magnetic field is coming out of the page while current is flowing left to right inside the conductor.

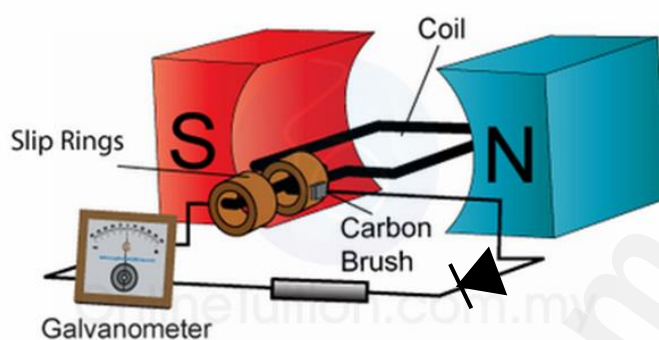


- (2)
- 10.3 Define *magnetic flux linkage*. (2)
- 10.4 State *Faraday's Law of electromagnetic induction*. (2)
- 10.5 Consider the diagram below.



- 10.5.1 Identify this device as an AC or DC generator. (1)
- 10.5.2 State the energy conversion that takes place in the device pictured. (2)
- 10.5.3 In which direction will current flow through the resistor (left or right) when the coil is rotated clockwise (when viewed from the slip rings)? (1)
- 10.5.4 Sketch a voltage vs. time graph for one full rotation of the device. Start your graph with the coil in the position as shown in the diagram. Use the axes provided on the answer sheet. (2)

10.5.5 A diode is placed next to the resistor in the circuit.



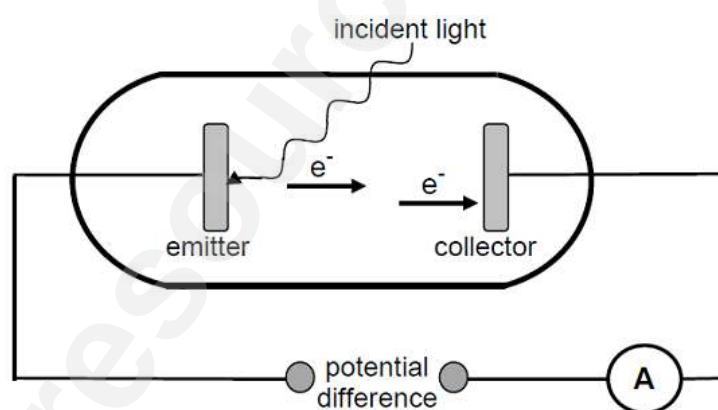
- (a) Define a *diode*. (2)
- (b) Sketch another voltage vs. time graph to show what the voltage output looks like now. Use the axes provided on the answer sheet. (2)

10.5.6 Write down the correct scientific term for the process that took place in question 10.5.5. (2)

[21]

QUESTION 11

11.1 The apparatus below is used to demonstrate the photoelectric effect.



The wavelength of the photons in the incident light is 400 nm, while the work function of the emitter is 3 eV.

- 11.1 Calculate the energy of a photon of the incident light. (3)
- 11.2 Define *threshold frequency*. (2)
- 11.3 Calculate the threshold frequency of the emitter. (3)
- 11.4 Calculate the maximum kinetic energy of a photo electron. (3)
- 11.5 The emitter is replaced with a metal with a lower work function. Will the number of photo electrons emitted by the new metal be more, less or the same as the original emitter? (2)
- 11.6 How is the reading on the ammeter affected by increasing:
(Answer only INCREASES, DECREASES or NO CHANGE)
- 11.6.1 The intensity of the incident light? (1)
- 11.6.2 The wavelength of the incident light? (1)

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

$W = Fs$ or $W = F\Delta x$ or $W = F\Delta x \cos \theta$	$P = \frac{W}{t}$	$P = Fv$
$E_p = mgh$	$E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta E_K$
		$efficiency = \frac{power_{out}}{power_{in}}$

$F = G \frac{m_1 m_2}{r^2}$		$g = G \frac{M}{r^2}$
$F = k \frac{q_1 q_2}{r^2}$	$E = \frac{F}{q}$	$E = \frac{kQ}{r^2}$

ELECTRIC CIRCUITS

$I = \frac{Q}{t}$	$V = \frac{W}{q}$
$R = \frac{V}{I}$	$emf = I(R_{ext} + r)$
$R_s = R_1 + R_2 + \dots$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$P = \frac{W}{t} \quad \text{or} \quad W = Pt$	
$W = VIt$	$\text{or} \quad W = I^2 R t \quad \text{or} \quad W = \frac{V^2}{R} t$
$P = VI$	$\text{or} \quad P = I^2 R \quad \text{or} \quad P = \frac{V^2}{R}$

ELECTRODYNAMICS

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

PHOTONS AND ELECTRONS

$c = f \lambda$		$E = hf$ or $E = \frac{hc}{\lambda}$
$E = W_0 + E_{K(max)}$	$W_0 = hf_0$	$E_{K(max)} = \frac{1}{2} m v_{max}^2$

ANSWER SHEET

NAME: _____

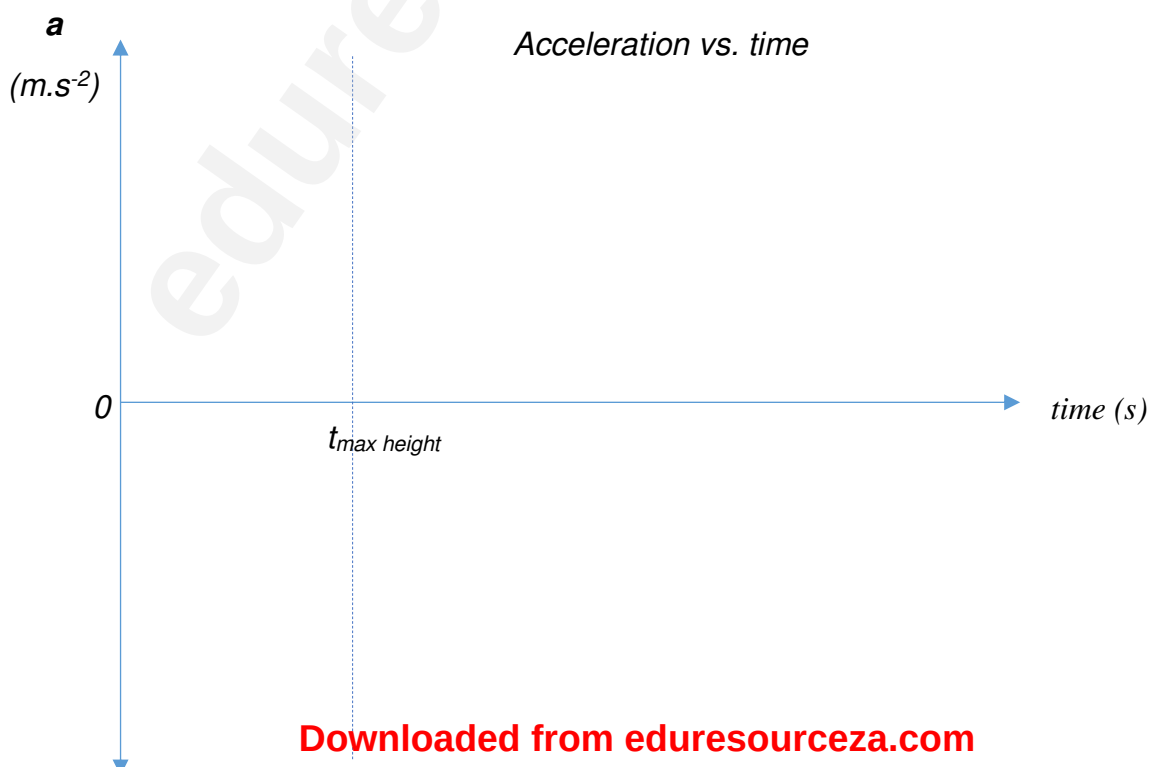
QUESTION 2.4

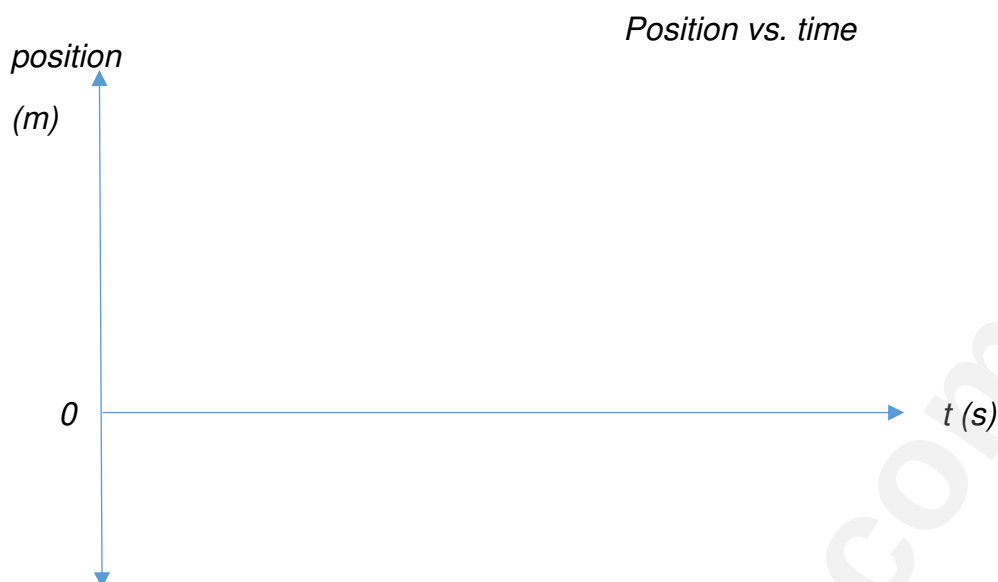
Position vs. time



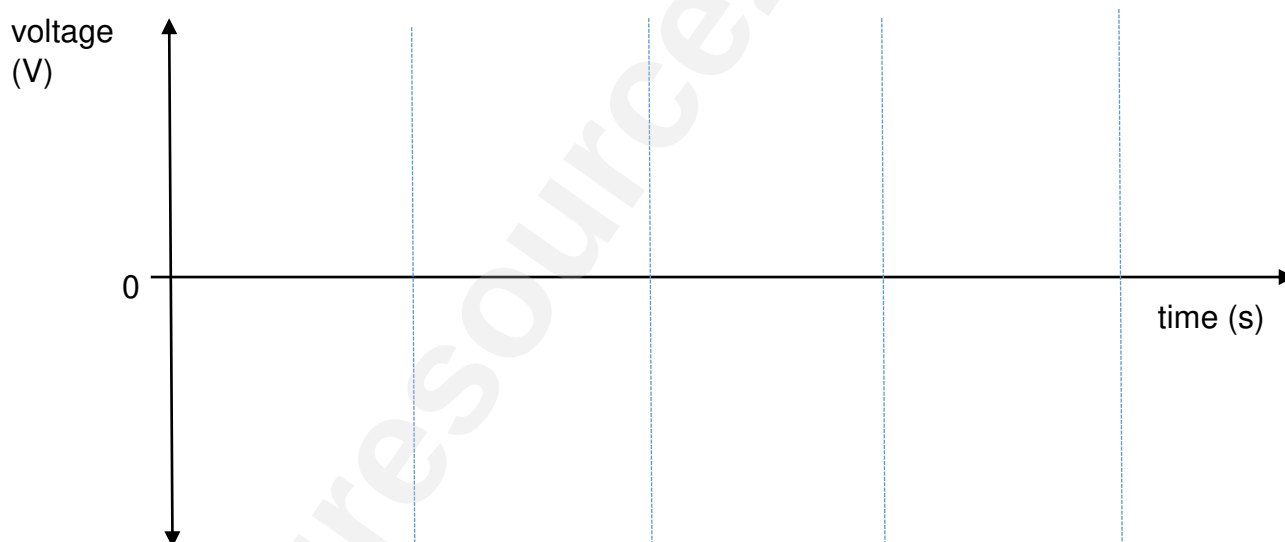
QUESTION 3.1.4

Acceleration vs. time





Question 10.5.4



Question 10.5.5 (b)

