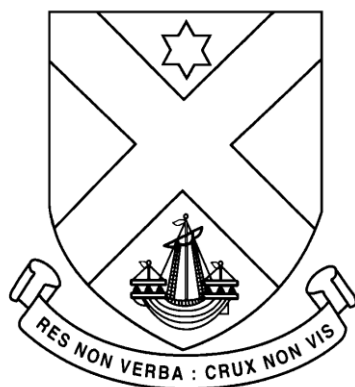




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Exam number/name: _____

**ST ANNE'S DIOCESAN COLLEGE****TRIAL EXAMINATION 2016****PHYSICAL SCIENCES****PAPER 1 PHYSICS**

Time: 3 hours

200 Marks

Examiner: S Schwartz

Moderator: M Schwartz (MHS)

The use of other IEB teachers' questions, in whole or in part, is gratefully acknowledged.

- Weighting of knowledge areas (**Target**):
Kinematics 23%(**25%**) / Newton's Laws 14.5%(**15%**) / p,W,E,P 15.5%(**15%**) / Gravitational & Electric Fields 13%(**10%**) /
Electric Circuits 15.5%(**15%**) / Electrodynamics 11%(**12%**) / Photons & Electrons 7.5%(**8%**)
- Cognitive Levels (**Target**): 1 – 10.5%(**15%**); 2 – 40%(**35%**); 3 – 38%(**40%**); 4 – 11.5%(**10%**)

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:

- p2-13: Questions 1 to 8;
- p15 and 16: Table 1: Physical Constants and Table 2: Physics Formulae
- p17: APPENDIX Multiple Choice answer grid.
- p18: one piece of graph paper for Question 6.4 (you will NOT get any additional pieces – use a pencil);

Please make sure that your question paper is complete.

- You may detach the data sheet if necessary.
- Read the questions carefully and answer in any order, with clear numbering.
- Show your working in all calculations, including the equations used.
- Units need not be included in the working of calculations, but appropriate **units must be shown in the answer.**

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	TOTAL	
/20	/26	/20	/44	/26	/20	/29	/15	/200	%

QUESTION 1

MULTIPLE CHOICE QUESTIONS

- Four options are provided as possible answers to the following questions.

- Each question has only ONE correct answer.

- Use the Multiple Choice Answer Grid provided ON THE APPENDIX.

1.1 Forces of 30 N on a bearing of 0° and 50 N on bearing 180° act at the same point. The effect of these two forces will be cancelled by a force of...

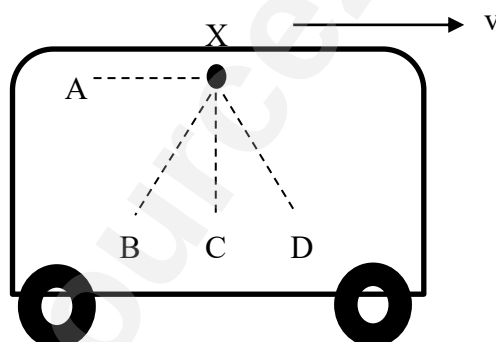
A 20 N on bearing 0°

B 80 N on bearing 180°

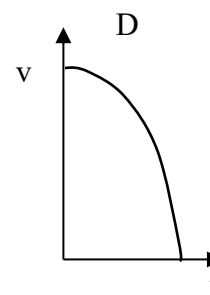
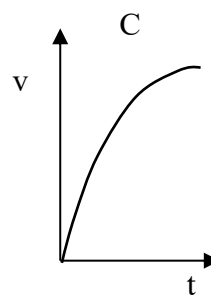
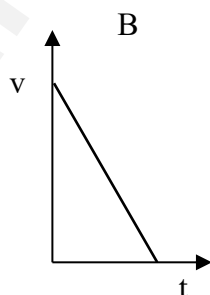
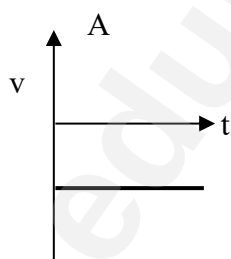
C 20 N on bearing 180°

D 80 N on bearing 0°

1.2 A ball is dropped from point X near the ceiling of a railway coach travelling at constant speed v . The ball will most probably land at...



1.3 An object undergoes a constant negative acceleration. Which v-t graph below best describes this motion?



1.4 After falling for a while, a parachutist attains a constant velocity. This means that she ...

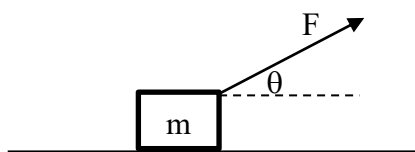
A falls at a constant acceleration

B is in equilibrium

C has no weight

D is in free fall

- 1.5 A box of mass **m** is pulled at a constant velocity along a horizontal surface by a force **F** acting at an angle θ .



The coefficient of kinetic friction can be calculated as follows:

A $\mu = \frac{F \cos \theta}{mg - F \sin \theta}$

B $\mu = \frac{F \cos \theta}{mg + F \sin \theta}$

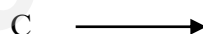
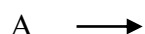
C $\mu = \tan \theta$

D $\mu = \frac{F \sin \theta}{mg}$

- 1.6 Particles P and Q are a long way from the rest of the universe but quite close to each other. The mass of particle P is **half** that of particle Q and the two particles exert gravitational forces on each other.



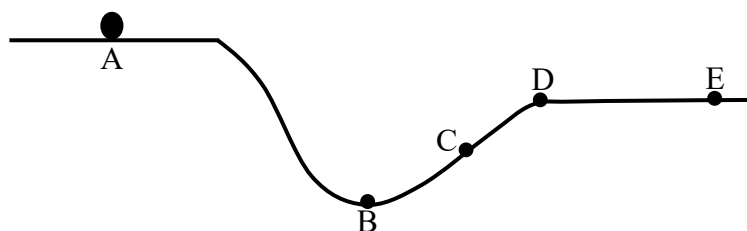
If the arrow above represents the force exerted by Q on P, which one of the following arrows represents the force exerted by P on Q?



- 1.7 Consider the following diagram with a ball passing point A at a constant speed. It rolls down the slope past B, and then up to C, D and E. Ignore any resistant forces.

The ball's kinetic energy at point C is **less** than its kinetic energy...

- A at point A only
B at points A, D and E
C at point B only
D at points D and E

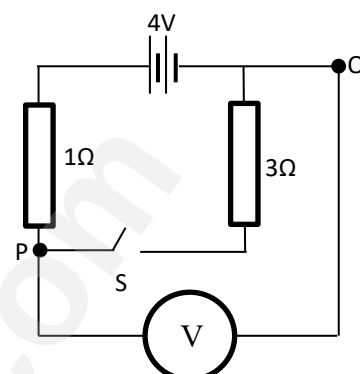


- 1.8 The amount of work you have to do against gravity to push your car on a level road...
- A depends on the speed with which it is pushed
B is zero
C depends on the frictional force acting on the car
D depends on the force you apply

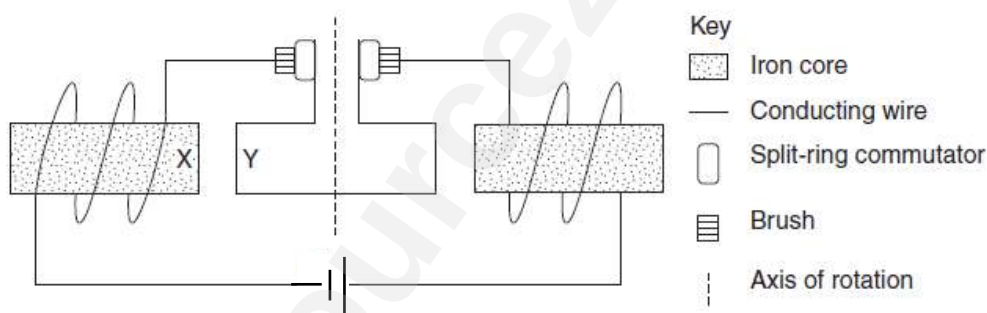
- 1.9 In the circuit shown below, the battery has an emf of 4 V and no internal resistance. The two resistors have the values shown. S is a switch (shown open) and V is a high resistance voltmeter connected between P and Q.

The readings on the voltmeter when S is open and then when it is closed are as follows:

	V when S open (V)	V when S closed (V)
A	0	4
B	0	3
C	4	4
D	4	3



- 1.10 Refer to the following diagram showing a simple D.C. electric motor in cross section:



What is the polarity of the electromagnet at X and the direction of motion of wire Y?

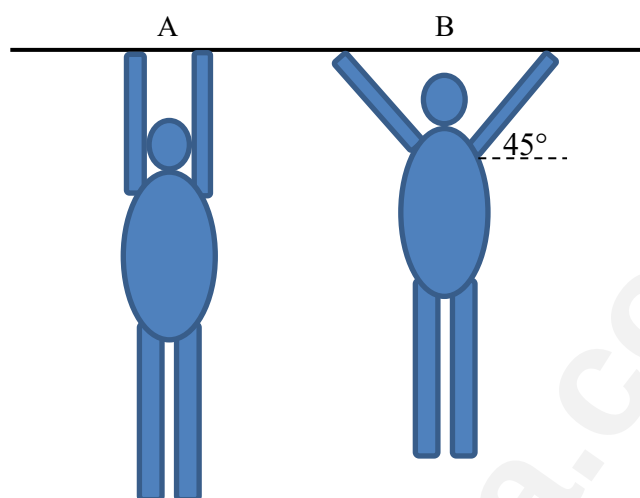
	Polarity of electromagnet at X	Direction of motion of wire Y
A	South	Into page
B	South	Out of page
C	North	Into page
D	North	Out of page

[10 X 2 = 20]

QUESTION 2

FORCES & NEWTON'S LAWS

- 2.1 Make use of calculations to explain why it is harder for an 80 kg man to hang with his arms at an angle of 45° (as in B) than to hang with his arms vertically (as in A).



(6)

- 2.2 Forces of 16 N and 12 N act in directions 60° and 150° respectively.

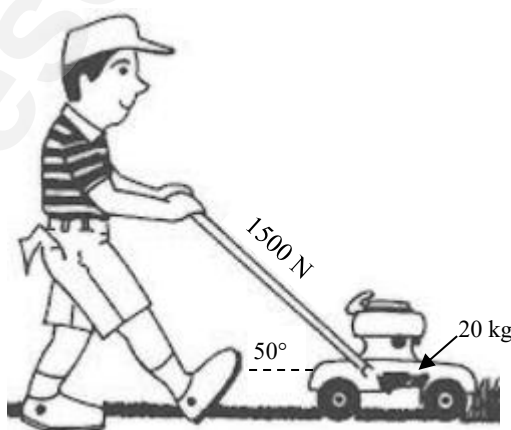
2.2.1 Define: *resultant vector*.

(2)

2.2.2 Use any method to determine the magnitude and direction of the **equilibrant** of the two forces.

(7)

- 2.3 A man pushes a 20 kg lawn mower so that the handle exerts a force of 1500 N at 50° to the horizontal.



2.3.1 Hannah has just learned Newton's 3rd Law and wonders how it is possible for the lawnmower to move if the force of the lawnmower on the man is 1500 N in the opposite direction. Clearly explain Hannah's misconception.

(5)

2.3.2 If the lawn mower is moving at a constant velocity, calculate the coefficient of kinetic friction between the grass and the lawn mower.

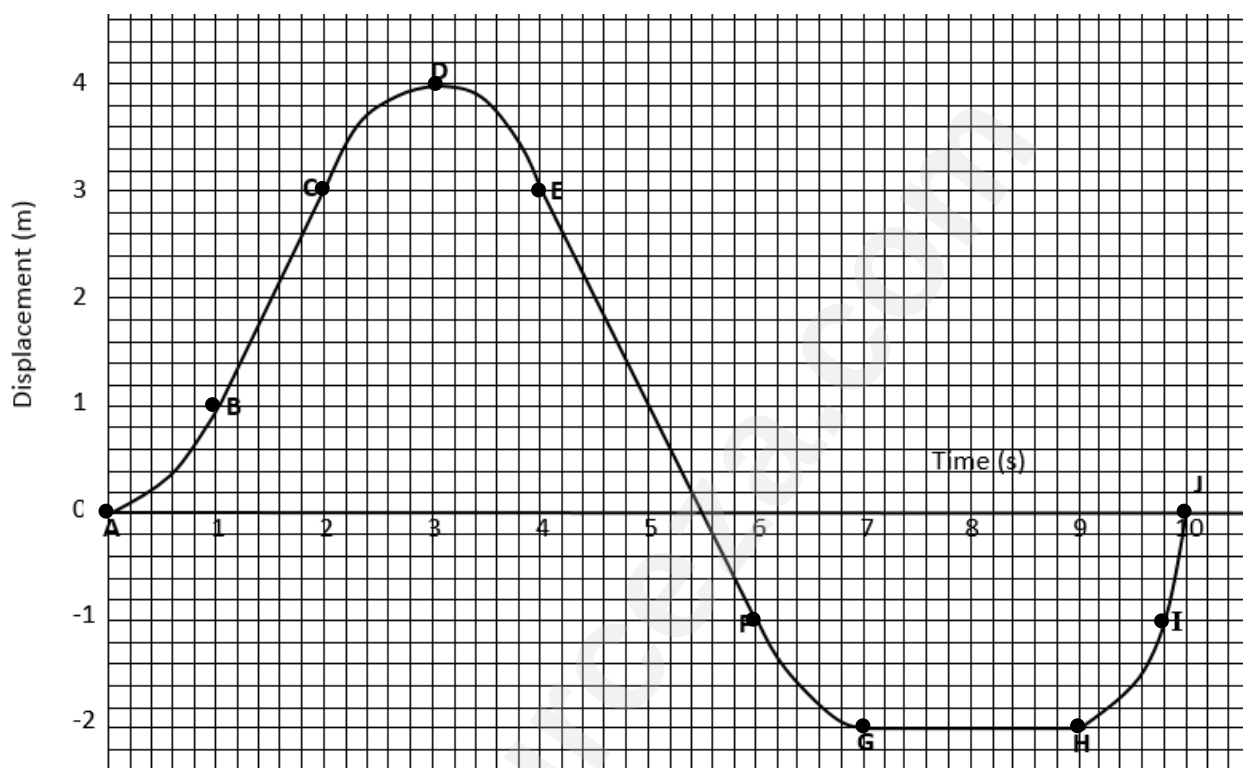
(6)

[26]

QUESTION 3

KINEMATICS

The graph shows the **displacement** of an object to the **right** of its initial position as a function of time.

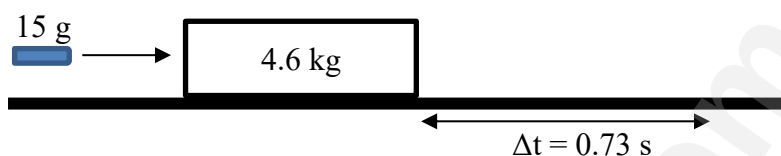


- 3.1 Make use of the letters on the graph to indicate between which times the object is...
- 3.1.1 Stationary for a length of time (2)
 - 3.1.2 Moving with greatest speed (2)
 - 3.1.3 Slowing down to the left (2)
- 3.2 Use the graph to determine the following:
- 3.2.1 The total distance travelled by the object from A to J ($t = 0$ s to $t = 10$ s) (3)
 - 3.2.2 The displacement of the object from D to J ($t = 3$ s to $t = 10$ s) (3)
 - 3.2.3 The instantaneous velocity of the object at position D. (2)
 - 3.2.4 Whether the acceleration of the object at position D is zero or non-zero. Give a reason for your answer. (3)
 - 3.2.5 The velocity of the object between E and F ($t = 4$ s to $t = 6$ s). (3)

[20]

QUESTION 4 MOMENTUM, IMPULSE, WORK, ENERGY AND POWER

- 4.1 A ballistics experiment to determine the speed of a bullet was performed in the following way:



- A 4.6 kg wooden block is set up on a rough level runway.
- A 15 g bullet is fired into the block and becomes embedded in it, moving the block along the runway.
- An electronic timer records that the block is in motion for 0.73 s before it stops.
- The frictional force between the block and the runway is 7 N when the block is sliding.

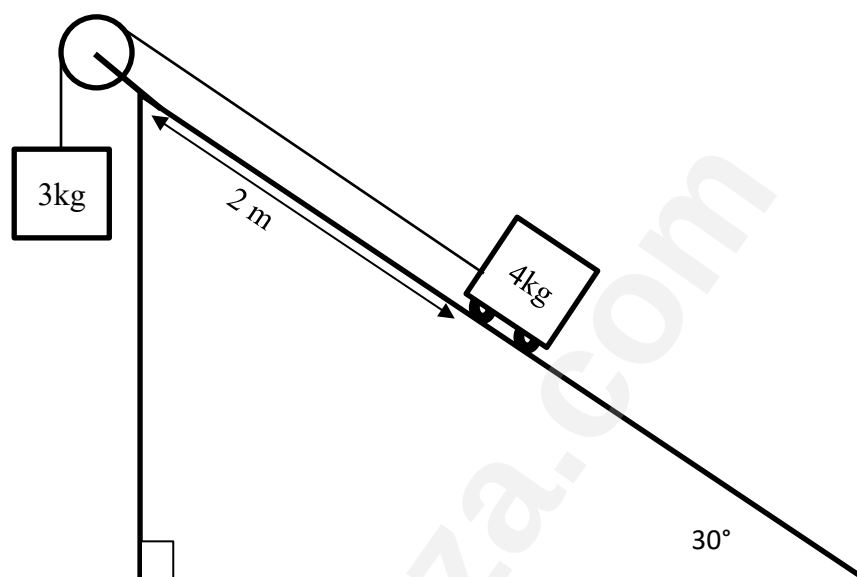
4.1.1 State Newton's 2nd Law in terms of momentum. (2)

4.1.2 Calculate the speed of the block + bullet after the collision and before it starts sliding. (5)

4.1.3 Calculate the initial speed of the bullet. (5)

Question 4 continues overleaf.

- 4.2 In the diagram shown below, ignore all frictional effects. Consider the string attaching the mass block and the trolley to be inextensible and to have negligible mass.



The system is initially held stationary. When the suspended 3 kg mass is released, it falls and accelerates the 4 kg trolley 2 m up the slope.

- 4.2.1 Draw labelled free body diagrams showing all the forces acting on the 3 kg mass and the 4 kg trolley while the system is moving. The lengths of the arrows should be representative of the relative magnitudes of the forces. (8)
- 4.2.2 Calculate the component of the force of gravity acting on the trolley parallel to the slope ($F_{g//}$). (2)
- 4.2.3 Set up separate force equations for each mass and then solve simultaneously for the tension in the string and the acceleration of the system. (7)
- 4.2.4 Prove that the vertical rise in height of the trolley is equal to 1 m. (2)
- 4.2.5 Calculate the gain in potential energy of the trolley. (3)
- 4.2.6 Calculate the work done on the trolley by the string. (3)
- 4.2.7 State the Work-Energy theorem. (2)
- 4.2.8 Make use of the Work-Energy theorem to calculate the speed of the trolley after travelling the 2 m up the ramp. (5)

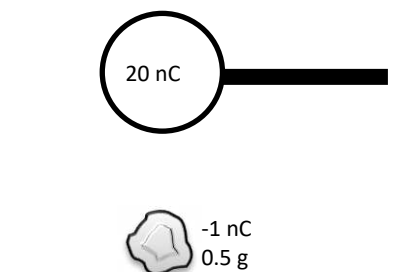
[44]

QUESTION 5

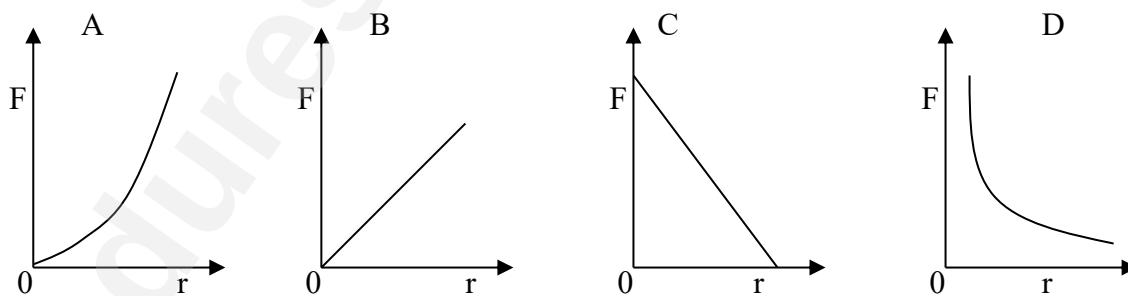
ELECTRIC AND GRAVITATIONAL FIELDS

A small charged sphere on the end of an insulated handle carries a charge of 20 nC.

It is brought close to a piece of tissue paper of mass 0.5 g.



- 5.1 If the charge on the piece of tissue paper is -1 nC , what is the maximum distance at which the sphere will be able to pick up the piece of paper? (6)
- 5.2 Suppose the mass of the charged sphere and handle is 40 g. Calculate the gravitational force of attraction between the sphere and the tissue paper when they are 1 cm apart. (5)
- 5.3 State why the force calculated in 5.2 can be ignored in the calculation in 5.1. (1)
- 5.4 Calculate how many electrons are transferred once the sphere picks up the piece of paper. (5)
- 5.5 Which one of the following graphs is a correct representation of the force between the sphere and the tissue paper as a function of the distance between them? (2)



The planet Mars has a radius of $3.5 \times 10^6 \text{ m}$ and a mass of $6 \times 10^{23} \text{ kg}$.

- 5.6 Calculate the gravitational acceleration on the surface of Mars. (4)
- 5.7 Deduce and explain whether the distance calculated in 5.1 would be *the same*, *greater* or *less* if the charged sphere was used to pick up the tissue paper on Mars. (3)

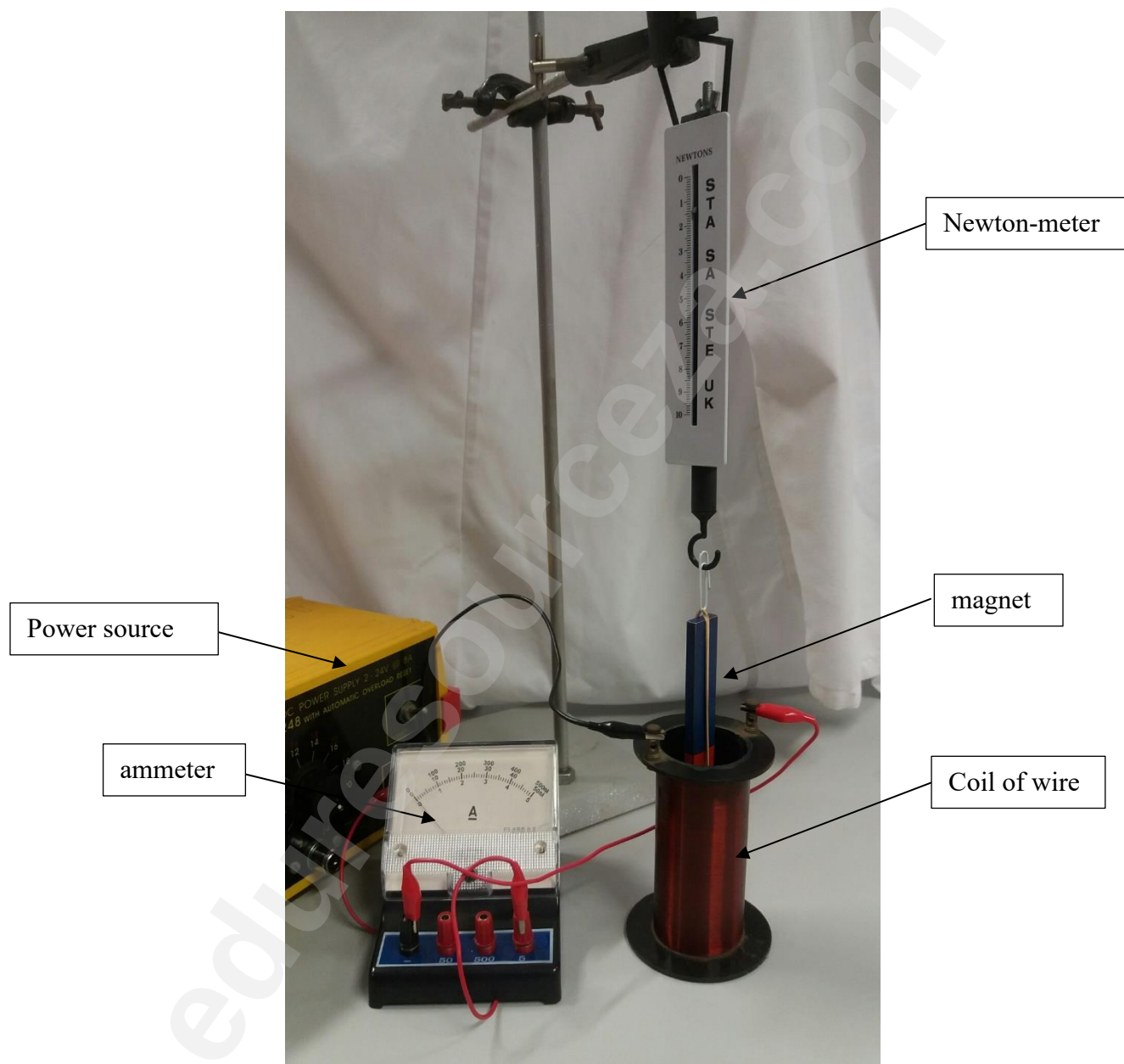
[26]

QUESTION 6

ELECTRODYNAMICS

Chelsea and Holly carry out an investigation to find out how the force acting on a bar magnet placed in a current carrying coil is related to the current in the coil.

A magnet was suspended from a newton-meter as shown. The position of the magnet was adjusted to ensure that the magnet was inside the coil and the line at the centre of the magnet coincided with the top of the coil.



The coil was connected to a d.c supply and the current in the coil was adjusted to ensure values between 0 A and 3 A.

- 6.1 Supply the correct name for the “coil of wire”. (1)
- 6.2 Consider the North side of the magnet to be inside the coil. When viewed from the top of the coil, briefly explain whether the current needs to flow clockwise or anti-clockwise to ensure that the reading on the newton-meter increases. (3)

- 6.3 Draw a labeled force diagram showing all the forces acting on the magnet. (3)

The girls obtained the following results:

Current (A)	Force (N)
0.5	4.0
1.0	6.9
1.5	9.8
2.0	12.6
2.5	15.5

- 6.4 Plot a graph of the data, ensuring that the independent variable is on the x-axis. (7)

- 6.5 Determine the y-intercept on the graph. (1)

The girls decided to repeat the experiment, but this time they zeroed the newton-meter before switching on the current. They found that their graph now passed through zero.

- 6.6 Deduce the mass of the magnet. (2)

- 6.7 Chumisa and Emma used an a.c. supply instead of the specified d.c. supply. They did not manage to take any measurements for the experiment. State and explain what you would expect them to have observed while trying to take force readings. (3)

[20]

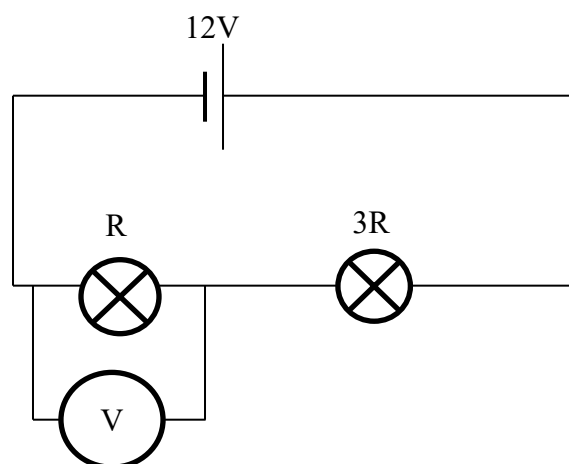
QUESTION 7 ELECTRIC CIRCUITS

- 7.1 Define *emf*. (2)

- 7.2 The light bulbs in this circuit have resistances R and $3R$.
The emf of the battery is 12 V and the internal resistance of the battery is negligible.

- 7.2.1 Find the reading on V . (2)

- 7.2.2 Explain using an equation which light bulb will burn more brightly. (3)



Question 7 continues overleaf.

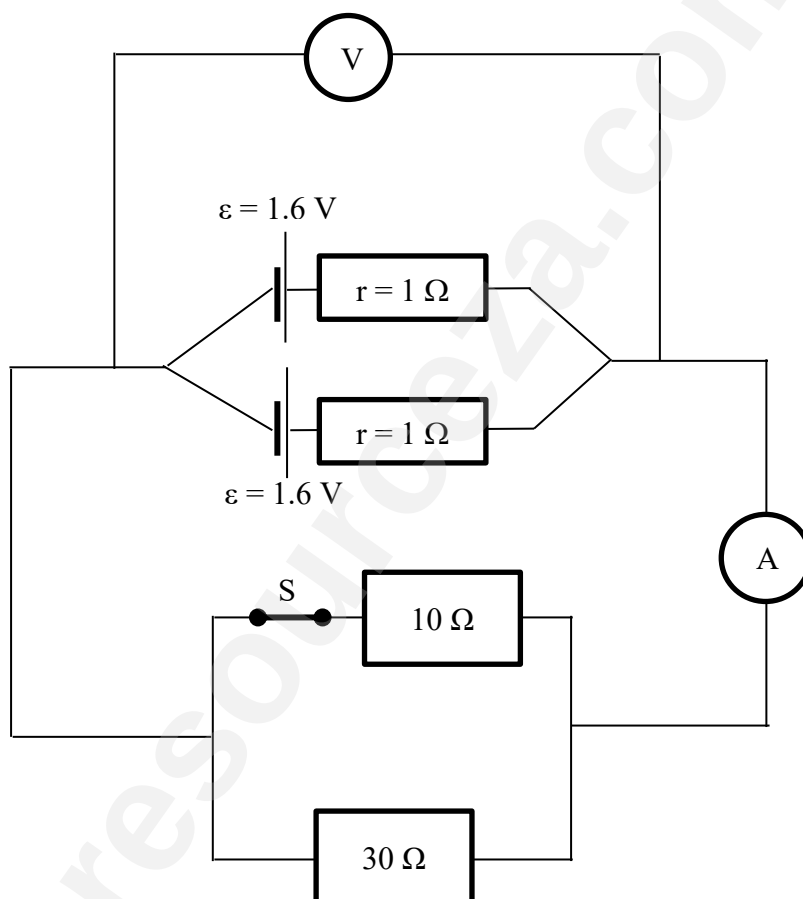
7.3 German physicist Georg Ohm published his work on circuits in 1827.

7.3.1 State Ohm's Law. (2)

7.3.2 On the Appendix, draw sketch graphs of current vs potential difference for...

(a) an Ohmic conductor and (b) a light bulb. (4)

7.4 A circuit is set up as shown in the diagram below. Each cell has an emf of 1.6 V and an internal resistance of $1\ \Omega$.



7.4.1 State two advantages of connecting cells in parallel. (2)

7.4.2 Explain what is meant by internal resistance. (2)

With switch S closed as shown, calculate the reading on the...

7.4.3 ammeter (5)

7.4.4 voltmeter (3)

Switch S is now opened.

7.4.5 Explain how this will affect the reading on the voltmeter. (4)

[29]

QUESTION 8

PHOTOELECTRIC EFFECT AND SPECTRA

8.1 What important property of light does the photoelectric effect provide evidence for? (1)

8.2 The work function of zinc metal is 4.3 eV.

8.2.1 Calculate the maximum speed of an electron emitted from zinc metal when light of frequency 1.14×10^{15} Hz shines on its surface. (5)

8.2.2 Brighter light of the same frequency is now used. How will the following be affected? State only INCREASE, DECREASE or NO EFFECT.

(a) the speed of the photons of light (1)

(b) the speed of the ejected electrons (1)

8.3 An energy level diagram for a particular element is drawn to scale below. The only positions that the outer electron can occupy are the energy levels E_1 , E_2 and E_3 .



8.3.1 State two facts about atomic structure that have been deduced by observing the line spectra of elements. (2)

For this energy level diagram, the longest wavelength of light released is 628 nm.

8.3.2 Which transition would be responsible for releasing this wavelength of light? (2)

8.3.3 Calculate the energy that corresponds to this wavelength of light. (3)

[15]

TOTAL FOR THIS PAPER: 200 MARKS

Be sure to hand in **ALL** your work, including your graph paper and Appendix sheet.

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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 $v_f = v_i + a\Delta t$	$s = \frac{v+u}{2} t$ 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 $W = F\Delta x \cos \theta$	$P = \frac{W}{t}$	$P = Fv$
$E_p = mgh$	$E_k = \frac{1}{2} mv^2$	$W_{net} = \Delta E_K$
		$efficiency = \frac{power_{out}}{power_{in}}$

GRAVITATIONAL AND ELECTRIC FIELDS

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

ELECTRIC CIRCUITS

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

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

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

APPENDIX ANSWER SHEET

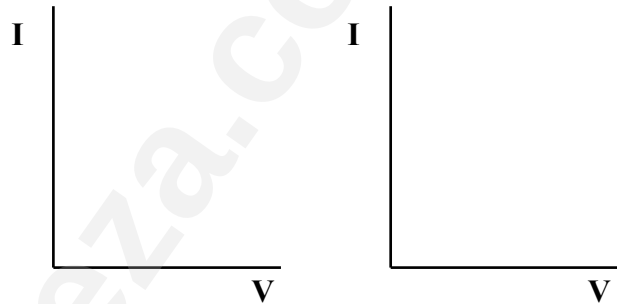
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QUESTION 1
MARK THE CORRECT ANSWER
WITH A CROSS.

Eg	A	~~B~~	C	D
----	---	--------------	---	---

1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

Question 7.3.2



(a) OHMIC CONDUCTOR (b) LIGHT BULB

QUESTION 6.4

Exam number/name:

