



eduresourceza.com



ST ANNE'S DIOCESAN COLLEGE

TRIALS EXAMINATION

PHYSICAL SCIENCES

PHYSICS

August 2021

Time: 3 hours

200 Marks

Adjusted to 198

Examiner : K SANDERS

Moderator : J FORREST

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

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:

- Pages 2-16 : Questions 1 to 9;
- Pages 17 and 18: Table 1: Physical Constants and Table 2: Physics Formulae
- Page 19 and 20: ANSWER sheet and GRAPH PAPER for Question 7.

Please make sure that your question paper is complete.

2. You may detach the data sheet and answer sheet if necessary.
3. Read the questions carefully and answer in any order, with **clear** numbering.
4. Start each question on a new page.
5. Show your working in all calculations, including the equations used.
6. Units need not be included in the working of calculations, but appropriate **units must be shown in the answer**.
7. Where appropriate, round off your answers to two decimal places.

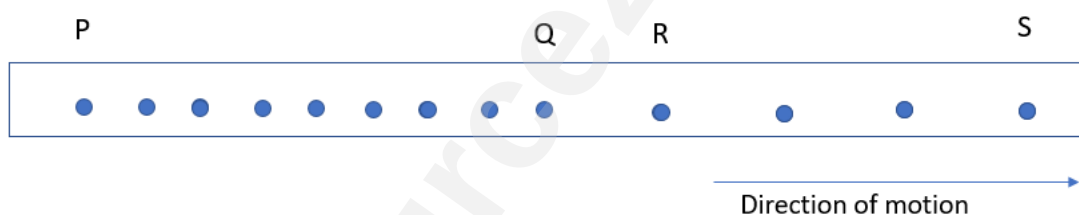
Question 1 Multiple Choice

1. Answer on the Answer sheet. For each question choose the most correct answer and indicate this by putting a cross over the relevant letter on the multiple choice grid in the answers sheet.

1.1. Which of the following list contains only scalar quantities?

- A Weight, speed, temperature, time
- B Time, displacement, pressure, energy
- C Mass, distance, pressure
- D Energy, momentum, impulse, distance

1.2. The ticker tape below is produced in a motion experiment. During which interval was the greatest force acting on the object? In the interval PQ the dots are equally spaced. In the interval RS the dots are equally spaced (but further apart than in PQ).

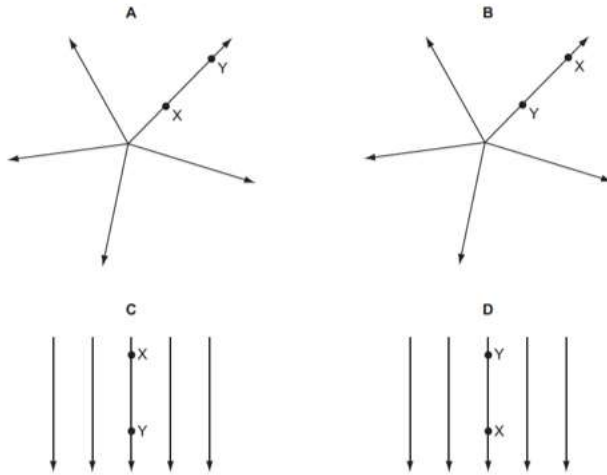


- A. P to Q
- B. Q to R
- C. R to S
- D. There is no force acting as the object is always going at a constant velocity.

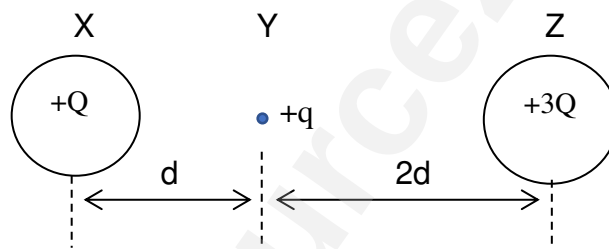
1.3. Which of the following statements about momentum is INCORRECT?

- A. Momentum is the product of mass and velocity of an object.
- B. The momentum of an object changes if its velocity changes.
- C. Momentum is a scalar quantity with units kg.m.s^{-1}
- D. The change in momentum is equal to the net force multiplied by the contact time.

- 1.4. In each electric field diagram, a positively charged particle is moved from X to Y. In which diagram would the particle experience an increasing repulsive force?



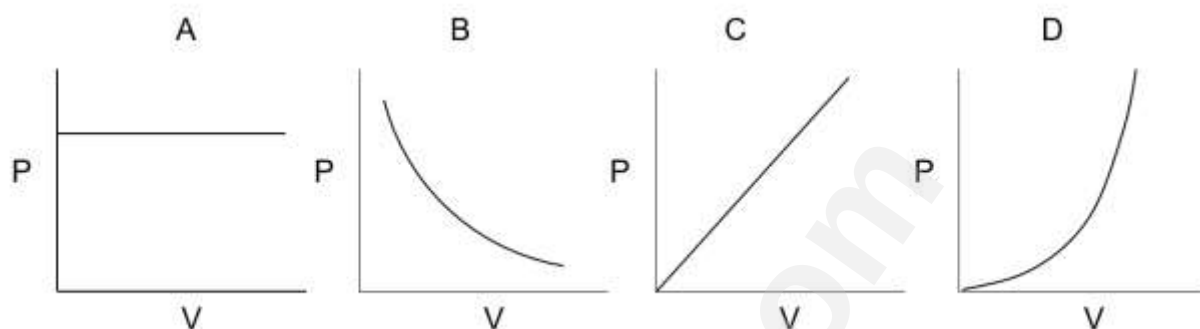
- 1.5. A test charge $+q$ is placed between two positive charges $+Q$ and $+3Q$ as shown.



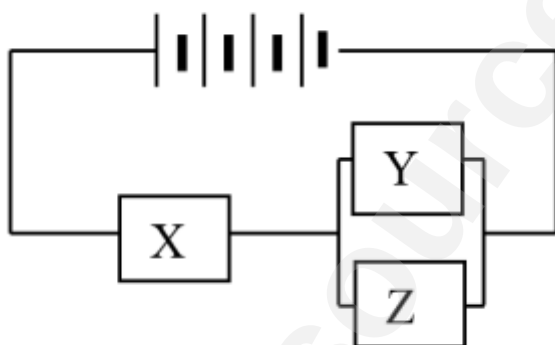
The test charge q will...

- A. remain where it is.
- B. move towards X.
- C. move towards Z.
- D. move vertically downwards

- 1.6. Which ONE of the following graphs best represents the relationship between the electrical power and the potential difference across a given ohmic conductor?



- 1.7. Consider the circuit shown below. The battery has negligible internal resistance. X and Y are identical resistors. Z is a rheostat and the resistance of Z can vary. What will the effect be on the current in the circuit and the voltage across X as the resistance of Z is gradually increased.



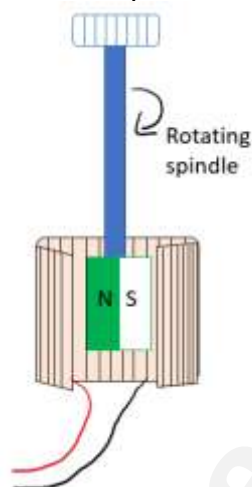
	Current in the circuit	Voltage across X
A	Increases	Remains the same
B	Increases	Decreases
C	Decrease	Remains the same
D	Decreases	Increases

Error in question: correct answer, decrease, decrease

- 1.8. Which statement about a direct current motor is incorrect?
- The speed of the motor can be increased by increasing the number of coils in the armature.
 - To determine the direction the motor turns, use Fleming's left hand rule.
 - Electrical energy is converted into mechanical energy in the motor.
 - The slip rings ensure the continuous rotation of the armature in one direction.

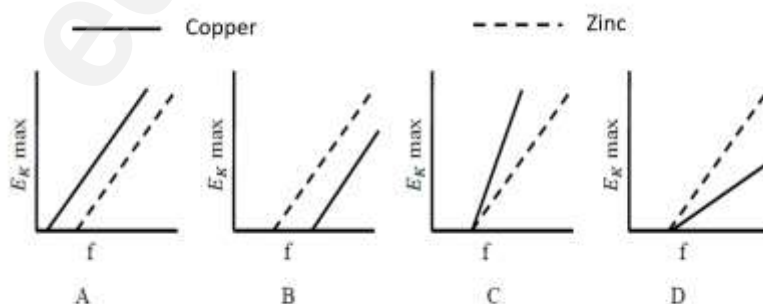
- 1.9. A dynamo is a small generator that can be placed on a bicycle and can power lights on the bicycle. As the bicycle wheel turns it rotates the spindle.

Which of the following best describes the processes that occur in the dynamo?



- A. The rotating coil experiences a changing magnetic flux. The coil induces an opposing magnetic field to counteract this changing flux. The coil does this by inducing a direct current.
- B. The rotating coil experiences a changing magnetic flux. The coil induces an opposing magnetic field to counteract this changing flux. The coil does this by inducing an alternating current.
- C. The rotating coil experiences a changing magnetic flux. The magnet induces an opposing magnetic field to counteract this changing flux. The coil does this by inducing a direct current.
- D. The rotating magnet experiences a changing magnetic flux. The coil induces an opposing magnetic field to counteract this changing flux. The coil does this by inducing an alternating current.

- 1.10. Zinc has a smaller work function than copper. Which graph correctly shows the $E_{K \text{ max}}$ vs time for the two metals?



[20]

Question 2: Zebras

2.1. Consider the cartoon shown below.

BOUND & GAGGED

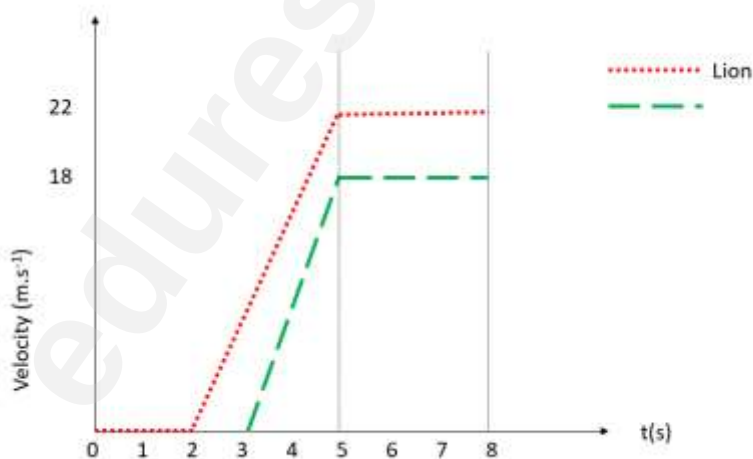


2.1.1. Name the law of motion that is illustrated in the cartoon. (1)

2.1.2. Suppose the zebra is running at 9 m.s^{-1} , then decelerates uniformly and comes to rest in 1,5 s. Calculate the magnitude of the zebra's acceleration. (3)

2.2. A zebra is at rest. At the same time, a lion which is 40 m behind the zebra is watching the zebra. The lion decides to attack and accelerates towards the zebra. When the lion reaches its maximum speed of 22 m.s^{-1} it continues running at this speed. As the zebra senses the lion it also accelerates. It reaches its maximum speed of 18 m.s^{-1} in 2 seconds.

The velocity time graph for the lion and the zebra are shown below.



2.2.1. At what time did the lion start his attack? (1)

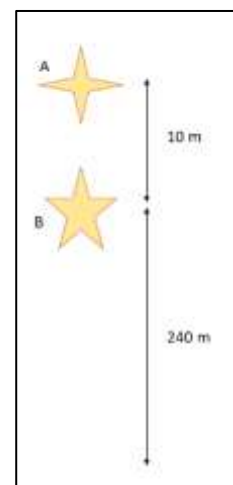
2.2.2. At what time did the zebra sense the lion? (1)

- 2.2.3. Which animal had the greater acceleration in this situation? Give a reason for your answer. (2)
- 2.2.4. Define *distance*. (2)
- 2.2.5. Calculate the distance covered by the lion in the first 8 seconds. (3)
- 2.2.6. Define *speed*. (2)
- 2.2.7. Calculate the average speed of the lion from 2 seconds to 8 seconds. (3)
- 2.2.8. Assuming that the lion and zebra can both continue at their maximum speed, at what time will the lion catch the zebra. (5)

[23]

Question 3: Fireworks

3. In a fireworks display, two fireworks are designed to go off (explode) at the **same time**. Firework A must go off at a height of 250 m above the ground (its maximum height). Firework B must go off exactly 10 m below A (this is its maximum height). They are both shot from ground level.



- 3.2. Define *acceleration*. (2)
- 3.3. State the magnitude and direction of the acceleration of firework A. (2)
- 3.4. Calculate the velocity which firework A must have when it is shot from the ground. (3)
- 3.5. Calculate the time it will take for firework A to reach its maximum height and explode. (3)
- 3.6. How long after the official has shot firework A, must he/she shoot firework B? (5)
- 3.7. On the same set of axes, sketch a graph of displacement vs time for the two fireworks. Clearly label which line represents which firework. Indicate all relevant values on the axes. (6)

[21]

Question 4: Hiking bags

4. Two rock climbers decide to lift their bags to the top of a steep rock face. They tie the hiking packs together as shown in the diagram. Bag A has a mass of 12 kg and bag B has a mass of 14 kg. The hikers have two ropes. The hikers would like to pull the bags up at a constant velocity.

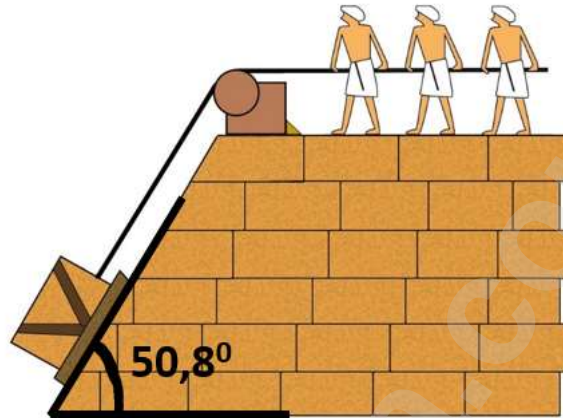


- 4.2. State *Newton's third law*. (2)
- 4.3. Identify a Newton III pair of forces acting in this situation. (2)
- 4.4. By considering just bag B, calculate the tension in rope 2 when the hikers are pulling the bags up with a constant velocity. (3)
- 4.5. Draw a free body diagram showing all the forces acting on bag A. (3)
- 4.6. Calculate the minimum force that the hikers must pull the bags up with (rope 1) in order to lift the bags at a constant velocity. (3)
- 4.7. If the hikers have two different ropes, which rope (stronger or weaker) should they use to tie the bags together with. Give a reason for your answer. (2)
- 4.8. The hikers now swap the way in which they tied the bags (i.e. if they tied the heavier bag B to the top rope and then tied the lighter bag A underneath).
State how this affects: (write increase, decrease or no effect only)
- a) The tension in rope 1. (1)
- b) The tension in rope 2. (1)

[17]

Question 5: Egyptian Pulleys

5. One possible explanation for how the Egyptians were able to build the pyramids is that they used pulleys.



Imagine a stone of mass = 2 200 kg is being lifted via a pulley up the side of a pyramid. The angle of the pyramid is $50,8^\circ$. The coefficient of kinetic friction for stone on stone is 0,1.

- 5.2. Draw a free body diagram showing all the forces acting on the stone. (4)
- 5.3. Define *normal force*. (2)
- 5.4. Calculate the normal force acting on the slope. (3)
- 5.5. Define *frictional force*. (2)
- 5.6. Calculate the kinetic friction acting on the stone. (3)
- 5.7. Calculate the minimum tension in the rope required to lift the stone at a constant velocity. (5)

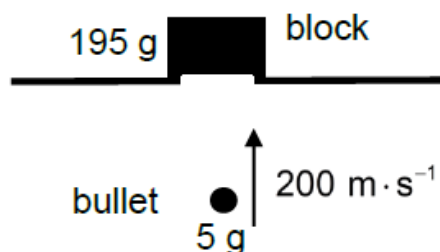
In order to build the pyramids, it has been calculated that the Egyptians would have needed to lift around one stone every three minutes. Assume that the length of the sloped surface of the pyramid that the Egyptians are pulling the stone up is 100 m.

- 5.8. Calculate the work done by the Egyptians in lifting the stone to this height. (3)
- 5.9. Calculate the power required to lift this stone to this height in three minutes. (3)
- 5.10. If the average man can produce 480 W of power when working, calculate the number of men required to lift each stone. (3)

[28]

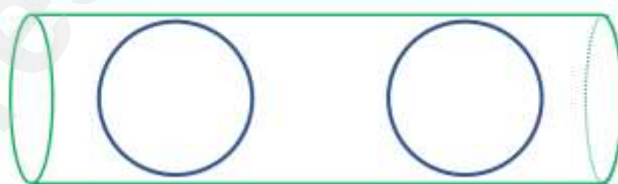
Question 6: Shooting bullet and subatomic particles

- 6.2. A lead bullet of mass 5 g is shot vertically upwards into a wooden block of mass 195 g which is at rest over a hole in a table. Ignore air resistance.



The bullet hits the block with a velocity of $200 \text{ m}\cdot\text{s}^{-1}$. The bullet embeds itself in the block.

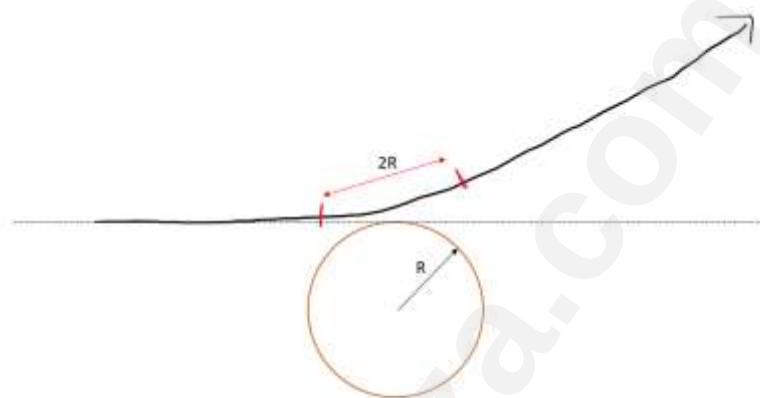
- 6.1.1. State the *law of conservation of momentum*. (2)
 - 6.1.2. Calculate the speed of the block and bullet immediately after the bullet has embedded in the block. (4)
 - 6.1.3. State the *principle of conservation of mechanical energy*. (2)
 - 6.1.4. Using energy principles (NOT equations of motion) to calculate how high the block will rise above the block's original position. (4)
- 6.2. In a particle accelerator, two protons which each have a mass of $1,67 \times 10^{-27} \text{ kg}$ are shot towards each other. Their distance of closest approach is $2 \times 10^{-10} \text{ m}$.



- 6.2.1. Draw a diagram to show the electrostatic field between the two protons. (3)
- 6.2.2. Calculate the electrostatic force of repulsion between the two protons at this distance. (3)
- 6.2.3. Calculate the gravitational force of attraction between the two protons at this distance. (3)
- 6.2.4. Hence comment on the relative strengths of these two forces calculated in 6.2.2 and 6.2.3. (2)

6.3. In a Rutherford-type experiment an alpha particle is shot at a film of gold foil. The alpha particle contains two protons and two neutrons. The alpha particle has a velocity of $1,5 \times 10^7 \text{ m.s}^{-1}$. It just passes a gold nucleus. The radius of the gold nucleus is $7 \times 10^{-15} \text{ m}$.

6.3.1. Calculate the magnitude of the electrostatic force which the gold nucleus exerts on the alpha particle. *Hint: Gold nucleus contains 79 protons.* (3)



The time for which the alpha particle experiences a force is given by $t = \frac{2R}{v}$ where R is the radius of the gold nucleus and v is the velocity of the alpha particle.

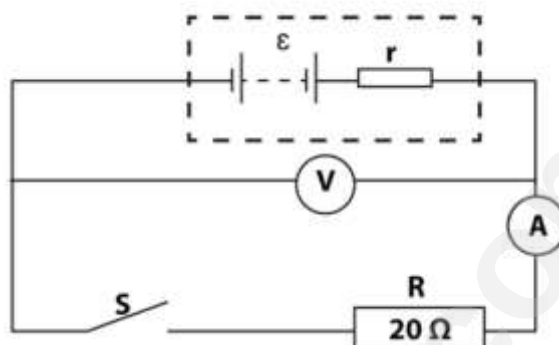
6.3.2. Use the information given to calculate the time during which the alpha particle experiences a force. (2)

6.3.3. Hence, determine the magnitude of the impulse acting on the alpha particle. (3)

[31]

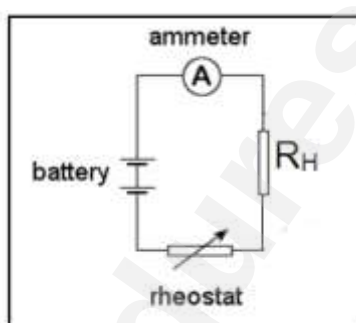
Question 7: Electricity

- 7.1. In the circuit below, a battery with internal resistance is connected to a circuit with a $20\ \Omega$ resistor, an ammeter and a switch.



When the switch is open the voltmeter reads 12 V and when it is closed it reads 10 V.

- 7.1.1. Define *emf*. (2)
- 7.1.2. Write down the emf of the battery. (1)
- 7.1.3. Calculate the internal resistance of the battery. (5)
- 7.2. A student sets up a circuit containing a heating element R_H , a rheostat (variable resistor) and an ammeter connected in series with a battery that has negligible internal resistance as shown in the diagram below.

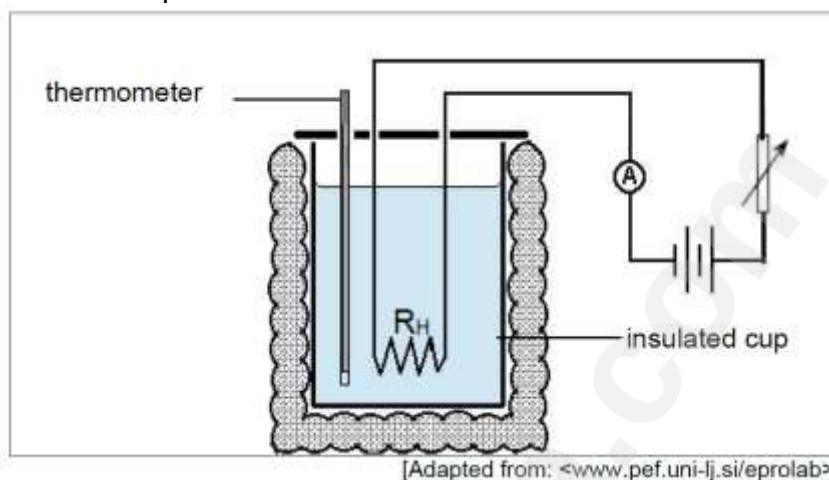


The student wishes to investigate the relationship between the current (I) in the heating element and the energy dissipated. The student follows the instructions given below.

- Place the heating element (R_H) into an insulated cup containing 100 g of water.
- Place a thermometer through a hole in the lid of the cup to measure the temperature of the water.
- Vary the current using the rheostat and allow the current to flow for two minutes.
- Measure the rise in temperature of the water when the current has been allowed to flow for two minutes.
- Repeat for each different current.

Assume that the resistance of the heating element remains constant and that all the heat dissipated in the resistor is transferred to the water.

The experimental is set up as shown below.



The student uses a formula to calculate the energy dissipated in the resistor by referring to the temperature change of the water. The results of these calculations are given in the right hand column of the table below:

Results of the experiment to investigate the relationship between the energy dissipated in a resistor and the current flowing through a resistor for two minutes.

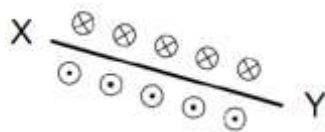
I (A)	I^2 (A ²)	Temperature change ΔT (°C)	Energy dissipated in T_H (J)
0.18	$3,42 \times 10^{-2}$	0,6	252
0,44	(a)	3,2	1344
0.61	$37,2 \times 10^{-2}$	6,0	2520
0.70	$49,0 \times 10^{-2}$	8,0	3360

- 7.2.1. Calculate the missing value in the table (1)
- 7.2.2. On the graph paper provided on the Answer sheet, plot a graph showing the relationship between the energy dissipated vs I^2 . (The X-axis scale has been provided for you.) (7)
- 7.2.3. Calculate the gradient of the graph, showing your working and clearly marking the two points you are using on your graph. (3)
- 7.2.4. Use the formula $W = I^2 R t$ and the gradient of your graph to calculate the resistance of R_H . (3)
- 7.2.5. Given that the potential difference across the power supply is 48 V and that the internal resistance can be ignored, calculate the **potential difference across the rheostat** when the current strength is 0,61 A. (4)

[26]

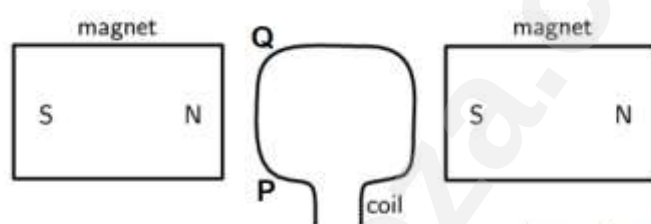
Question 8: Electrodynamics

- 8.1. The magnetic field lines created by a current in a conductor are shown in the diagram.



Is the conventional current direction from X to Y or from Y to X.? (2)

The coil and magnets illustrated in the diagram below could be used as part of a motor or a generator.



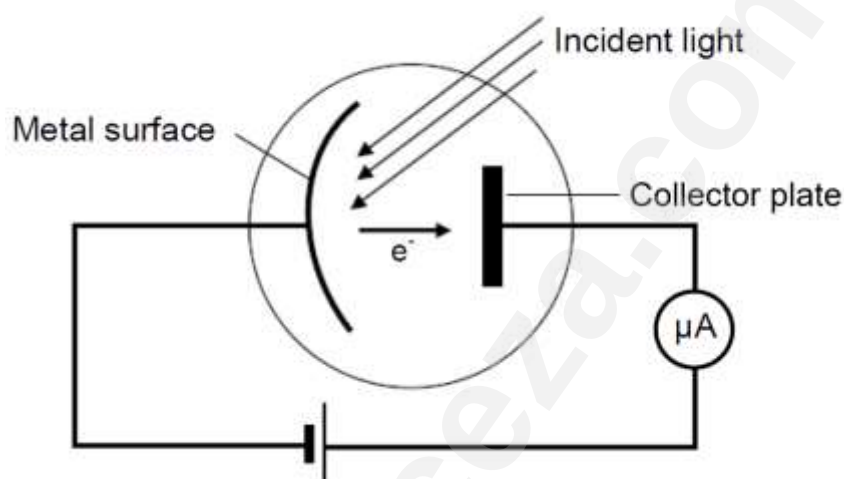
[Image from:
<<https://www.everythingmaths.co.za/science/grade-12/11-electrodynamics/11-electrodynamics-02.cnxmlplus>>]

- 8.2. Compare the motor and the generator in terms of energy conversion. (2)
- 8.3. Consider the coil in the above diagram to be part of a motor. The current direction is from P to Q in the coil.
- 8.3.1. In which direction would side PQ experience a force? (2)
- 8.3.2. State two factors and how they could be changed in order to increase the magnitude of the force exerted on PQ? (2)
- 8.3.3. A current carrying conductor placed in a magnetic field will not always experience a force. Describe a situation in which a current carrying conductor in a magnetic field will not experience a force. (2)
- 8.4. Consider the coil to be part of a generator.
- 8.4.1. Define *magnetic flux linkage*. (2)
- 8.4.2. Use Faraday's law to explain why a current is induced in the coil as it is rotated in the magnetic field. (3)
- 8.4.3. State Lenz's law. (2)
- 8.4.4. If side PQ is rotated out of the page, will the current be induced from P to Q or from Q to P? (2)

[19]

Question 9: Photons and Electrons

- 9.1. The photoelectric effect is investigated using the apparatus shown below. A beam of light is shone on a metal surface. Electrons which leave the metal surface then travel to a collector plate and through the circuit. A micro ammeter is connected to measure the current. The kinetic energy of the electrons can be measured by a method called stopping voltage. The higher the stopping voltage, the higher the kinetic energy of the electrons.



When light of 220 nm shines on a plate, a current of $2,0 \mu\text{A}$ flows through the circuit. The stopping voltage is 4 mV.

- 9.1.1. Calculate the energy of the incident radiation. (4)
- 9.1.2. Complete the table by stating how the given changes would affect the current and stopping voltage. Say only INCREASE, DECREASE or REMAINS THE SAME.

	Effect on current	Effect on stopping voltage
Decrease intensity	a.	b.
Decrease wavelength	c.	d.

(4)

- 9.1.3. Explain your answer to b and d. above. (3)

Please turn over

9.2. The energy levels for a certain atom are shown in the diagram below.



Calculate the frequency of the photon which is released when light moves from the -5,3 eV energy level to the -7,5 eV energy level.

(4)

[15]

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 $v_f = v_i + a\Delta t$	$s = \frac{v+u}{2} \Delta t$ 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 $\Delta p = mv_f - mv_i$
$p = mv$	$w = F_g = mg$	$F_f^{max} = F_N$

WORK, ENERGY AND POWER

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

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

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

ELECTRODYNAMICS

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

PHOTONS AND ELECTRONS

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

Quest:	1	2	3	4	5	6	7	8	9	Total	Percent
Mark											
Out of	20	23	21	17	28	31	26	19	15	200	100

ANSWER SHEET

Name: _____

Teacher: _____

QUESTION 1
MARK THE CORRECT ANSWER WITH A CROSS.

E.g.	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

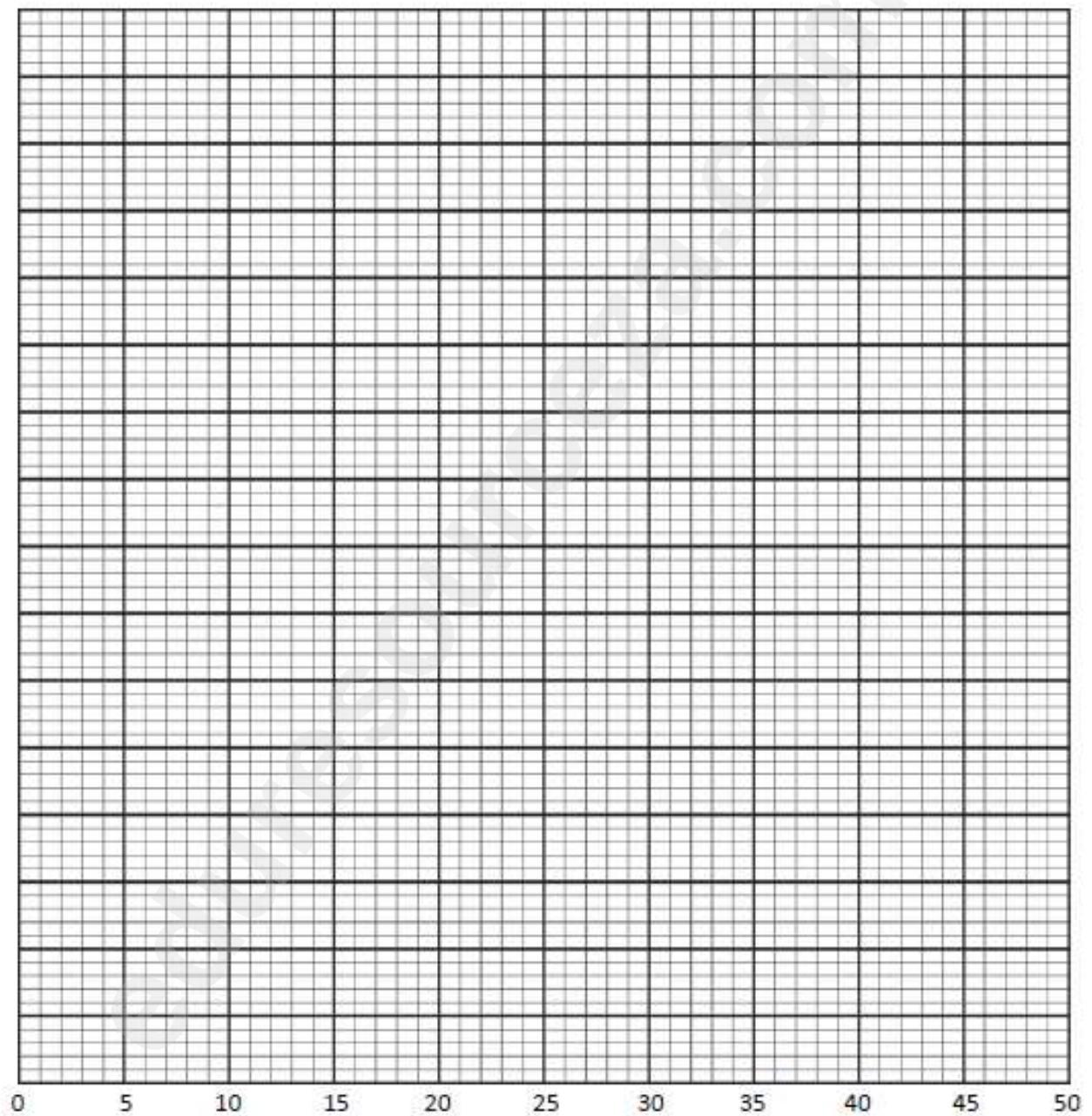
Graph on reverse side

Question 7

.....

.....

.....



Memo MCQ

1. MCQ

- | | | |
|--------|---------------|------|
| 1.1. C | 1.6. D | |
| 1.2. B | 1.7. excluded | |
| 1.3. C | 1.8. D | |
| 1.4. B | 1.9. D | |
| 1.5. C | 1.10. B | [20] |

MCQ explanations

1.1 Scalars

Mass
Time
Distance
Speed
Temperature
Energy
Pressure

Vectors

Weight
Displacement
Momentum
Impulse

- 1.2 In section RS the dots are equally spaced so the object is going at a constant speed
In section PQ the dots are equally spaced so the object is going at a constant speed
but the speed in PQ is less than the speed in RS
So the object changed speed (accelerated) in section QR
Section QR is the only section with an acceleration therefore only section with a force
- 1.3 A – True (definition)
B – True (momentum depends on velocity)
C – False (momentum is a vector)
D – True (from theory change in p = impulse and definition of impulse)
- 1.4 In C and D the field is uniform so the force is uniform
In A and B the field is non-uniform and decreases with distance from center
In A and B the force increases with distance from center
To have an increasing force you must therefore move from further (weaker force) to
closer (stronger force)
- 1.5 To know which way the charge moves we need to know which force is strongest
Force due to X = kQq/d^2
Force due to Z = $k(3Q)q/(2d)^2$
 $= \frac{3}{4} kQq/d^2$
Therefore force due to X is strongest
So the repulsion due to X is strongest
Positive charge moves towards Z

1.6 For an ohmic conductor R is constant

$$P = V^2/R$$

So P is proportional to V^2

(We cannot use the equation $P = IV$ in THIS situation as the current in THIS situation is not constant. The constant in THIS situation is the resistance)

1.7 By increasing resistance of Z

We increase the resistance of the parallel connection (note that we are increasing the resistance of Z, not adding a resistor in parallel)

This decreases the current in the circuit

The resistance of X is constant

So for less current in the circuit the voltage across X must decrease

1.8 A – True (theory)

B – True (theory)

C – True (theory)

D – False – A DC motor uses a split ring commutator to ensure rotation is constant

1.9 In the situation the magnet rotates not the coil. – A,B,C are false

The coil induces an opposing magnetic field (not the magnet) – C is false

An alternating current is induced – A and C are false

A – false

B – false

C – False

D - true

1.10 Smaller work function means

smaller threshold frequency

Smaller x intercept

Memo: Zebra

2.1.1. Newton's First Law ✓

(1)

2.1.2. $v = u + at$ ✓

$$0 = 9 + a(1,5) \quad \checkmark$$

$$a = -6 \text{ m.s}^{-2}$$

$$\text{Magnitude of acceleration} = 6 \text{ m.s}^{-2} \quad \checkmark$$

(3)

2.2.

2.2.1. 2 seconds ✓

(1)

2.2.2. 3 seconds ✓

(1)

2.2.3. The zebra ✓

The acceleration is given by the gradient of a v vs t graph

The v vs t graph for the zebra has a larger/steeper gradient ✓ (2)

2.2.4. Distance is *length of path travelled*. ✓✓ (2)

2.2.5. Distance = area under the graph ✓
 $= \frac{1}{2} (3)(22) + (3)(22)$ ✓
 $= 99 \text{ m}$ ✓ (3)

2.2.6. Rate of change of distance. ✓✓ (2)

2.2.7. Ave speed = distance_{total} / t_{total} ✓
 $= 99/6$ ✓
 $= 16,5 \text{ m.s}^{-1}$ ✓ (3)

2.2.8. For the lion to catch the zebra the displacement of the two must be equal

Displacement = Calculating area ✓

Lion = zebra ✓

$$\frac{1}{2} (3)(22) + (t-5)(22) \checkmark = 40 + \frac{1}{2} (2)(18) + (t-5)(18) \checkmark$$

$$4t = 45$$

$$t = 11,25 \text{ s} \checkmark$$

(5)

[23]

Memo: Fireworks

3.1. Rate of change of velocity. ✓✓ (2)

3.2. $9,8 \text{ m.s}^{-2}$ ✓ downward ✓ (2)

3.3. Firework A From ground to maximum height

$$v^2 = u^2 + 2as \checkmark$$

$$0 = u^2 + 2(-9,8)(250) \checkmark$$

$$u = 70 \text{ m.s}^{-1} \text{ upwards.} \checkmark \quad \text{Must include direction} \quad (3)$$

3.4. For firework A from ground to maximum height

EITHER

$$v = u + at$$

$$0 = 70 + (-9,8)t$$

$$t = 7,14 \text{ s}$$

OR

$$s = \frac{1}{2} (u+v)(t)$$

$$250 = \frac{1}{2} (70 + 0)t$$

$$t = 7,14 \text{ s}$$

OR

$$s = ut + \frac{1}{2} at^2$$

$$250 = 70t + \frac{1}{2} (-9,8)t^2$$

$$4,9 t^2 - 70t + 250 = 0$$

t

$$= \frac{-(-70) \pm \sqrt{(-70)^2 + 4(4,9)(250)}}{2(4,9)}$$

$$t = 7,14 \text{ s or } t = \dots$$

(3)

3.5. For firework B

$$v^2 = u^2 + 2as$$

$$0^2 = u^2 + 2(-9,8)(240)$$

$$u = 68,59 \text{ s}$$

$$v = u + at$$

$$0 = 68,59 + (-9,8)t$$

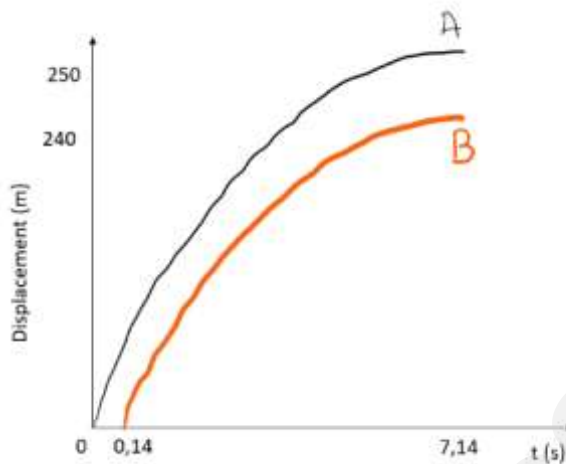
$$t = 7,00 \text{ s}$$

$$\text{Time difference} = 7,14 - 7,00$$

$$= 0,14 \text{ s}$$

(5)

3.6.



A shape correct
A starts at 0 s
A reaches a height of 250 m
B shape correct
B starts at 0,14 s
Both graphs end at 7,14 s

(6)

[21]

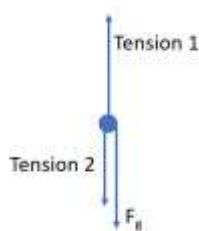
Memo: Hiking bags

4.1. When object A exerts a force on object B, then object B simultaneously exerts an equal magnitude but oppositely directed force on object A. (2)

4.2. Force of bag A on bag B and force of bag B on bag A
Or any other Newton III (such as weight) (2)

4.3. For Bag B in the Vertical direction
 $T_2 - F_{gB} = m(0)$
 $T_2 - (14)(9,8) = 0$
 $T_2 = 137,2 \text{ N}$ (3)

4.4.



(3)

4.5. For bag A in vertical direction

$$T_1 - F_g - T_2 = 0$$

$$T_1 - (12)(9,8) - 137,2 = 0$$

$$T_1 = 254,8 \text{ N}$$

(3)

4.6. They should tie the bags together with the weaker rope, as the tension in rope 2 is smaller than the tension in rope 1.

(2)

4.7.

a) No effect

(1)

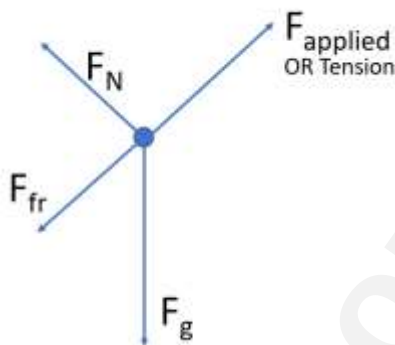
b) Decrease

(1)

[17]

Memo: Egyptian Pulleys

5.1.



(4)

5.2. The perpendicular force exerted by a surface on an object in contact with it.

(2)

5.3. In perpendicular direction

$$\begin{aligned} F_{gL} &= mg \sin \theta \checkmark \\ &= (2\,200)(9,8) \cos (50,8) \checkmark \\ &= 13\,627 \text{ N} \end{aligned}$$

$$F_N - F_{gL} = 0$$

$$F_N = 13\,627 \text{ N} \checkmark$$

(3)

5.4. frictional force as the force which opposes the motion of an object and acts parallel to the surface with which the object is in contact.

(2)

$$F_{fr} = \mu F_N \checkmark$$

$$F_{fr} = (0,1)(13\,627) \checkmark$$

$$F_{fr} = 1\,363 \text{ N} \checkmark$$

(3)

5.6. In the parallel direction

$$F_{g//} = mg \cos \theta \checkmark$$

$$F_{g//} = (2200)(9,8) \sin 50,8^\circ \checkmark$$

$$F_{g//} = 16\,708 \text{ N}$$

$$F_{\text{net}} = 0$$

$$T - F_{g//} - F_{\text{fr}} = 0 \checkmark$$

$$T - 16\,708 - 1\,363 = 0 \checkmark$$

$$T = 18\,070 \text{ N} \checkmark$$

(5)

$$\begin{aligned} 5.7. \quad W_{\text{tension}} &= F_{\text{tension}} \times s \\ &= 18\,070 \times 100 \\ &= 1\,807\,046 \text{ J} \\ &= 1,81 \text{ MJ} \end{aligned}$$

(3)

$$\begin{aligned} 5.8. \quad P &= W/t \\ P &= 1\,807\,046/180 \\ P &= 10\,039 \text{ W} \end{aligned}$$

(3)

$$\begin{aligned} 5.9. \quad N &= P_{\text{total}}/P_{\text{each}} \\ &= 10\,039 / 480 \\ &= 20,9 \end{aligned}$$

It would require 21 men lifting each stone.

(3)

[25]

Memo: Shooting bullets and subatomic particles

6.1.1. The total linear momentum in an isolated system remains constant. $\checkmark\checkmark$

(2)

$$6.1.2. \quad P_{\text{before}} = p_{\text{after}}$$

$$m_A u_A + m_B u_B = (m_A + m_B) v \checkmark$$

$$0 + (0,005)(200) \checkmark = (0,195 + 0,005)v \checkmark$$

$$v = 5 \text{ m.s}^{-1} \checkmark$$

(4)

6.1.3. In the absence of air resistance or other external forces, the mechanical energy of an object is constant. $\checkmark\checkmark$

(2)

$$6.1.4. \quad E_{\text{M before}} = E_{\text{M after}}$$

$$mgh_i + \frac{1}{2} m v_i^2 = mgh_f + \frac{1}{2} m v_f^2 \checkmark$$

$$(0,2)(9,8)0 + \frac{1}{2} (0,2)(5)^2 \checkmark = (0,2)(9,8)h + \frac{1}{2} (0,2)(0)^2 \checkmark$$

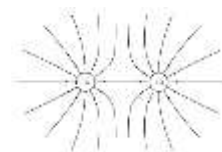
$$h = 1,28 \text{ m} \checkmark \text{ above the table}$$

(4)

6.2.1. Repulsion $\checkmark$

Direction $\checkmark$

Shape + same number of field lines $\checkmark$



(3)

$$6.2.2. \quad F = kQ_1Q_2/r^2 \checkmark$$

$$= (9 \times 10^9)(1,6 \times 10^{-19})(1,6 \times 10^{-19})/(2 \times 10^{-10})^2 \checkmark$$

$$= 5,76 \times 10^{-9} \text{ N} \checkmark \quad (3)$$

6.2.3. $F = \frac{Gm_1m_2}{r^2} \checkmark$
 $F = (6,7 \times 10^{-11})(1,67 \times 10^{-27})(1,67 \times 10^{-27}) / (2 \times 10^{-10})^2 \checkmark$
 $F = 4,67 \times 10^{-45} \text{ N} \checkmark \quad (3)$

6.3.3. The electrostatic force is much stronger than the gravitational force. $\checkmark \checkmark \quad (2)$

6.4.

6.4.1. $F = \frac{k Q_1 Q_2}{r^2} \checkmark$
 $F = \frac{(9 \times 10^9)(79 \times 1,6 \times 10^{-19})(2 \times 1,6 \times 10^{-19})}{(7 \times 10^{-15})^2} \checkmark$
 $F = \frac{(9 \times 10^9)(1,26 \times 10^{-17})(3,2 \times 10^{-19})}{(7 \times 10^{-15})^2}$
 $F = 742,92 \text{ N} \checkmark \text{repulsion} \quad (3)$

6.4.2. $t = 2(7 \times 10^{-15}) / (1,5 \times 10^7) \checkmark$
 $t = 9,33 \times 10^{-22} \text{ s.} \checkmark \quad (2)$

6.4.3. $J = F \Delta t \checkmark$
 $= (749,92)(9,33 \times 10^{-22}) \checkmark$
 $= 6,93 \times 10^{-19} \text{ N s} \checkmark \quad (3)$

[31]

Memo: Electricity

7.1. The total energy supplied by the cell per coulomb charge. $\checkmark \checkmark \quad (2)$

7.2. $12 \text{ V} \checkmark \quad (1)$

7.3. Current when switch is closed

$$I = V/R$$

$$I = 10/20 \checkmark$$

$$I = 0,5 \text{ A} \checkmark$$

$$E = V + Ir \checkmark$$

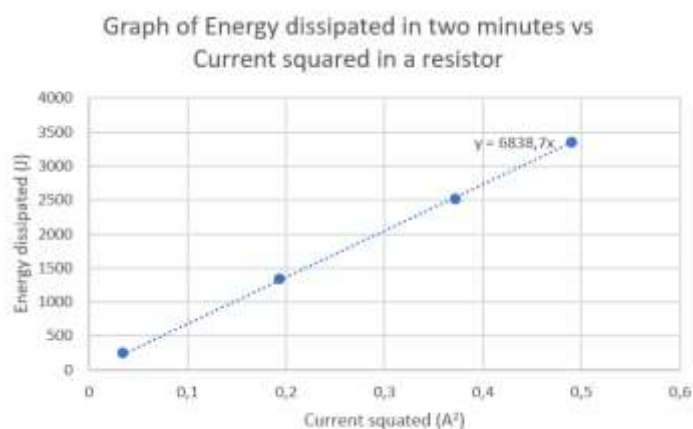
$$12 = 10 + 0,5 r \checkmark$$

$$r = 4 \Omega \checkmark \quad (5)$$

7.4. Experiment

7.4.1. $I^2 = (0,44)^2$
 $I^2 = 0,1936 \text{ A}^2 \checkmark \text{ OR } I^2 = 19,35 \times 10^{-2} \text{ A}^2 \checkmark \text{ OR } a = 19,36 \times 10^{-2} \checkmark \quad (1)$

7.4.2. Graph (7)



7.4.3. Marks two points on graph

Uses two points correctly

$$\text{Gradient} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= 6839 \text{ (6616-6956) coe if did not have } \times 10^{-2} \text{ on x axis}$$

units of gradient J.A⁻²

(3)

7.4.4. $W = I^2 R t$

gradient = Rt ✓

$$6839 = R(120) \text{ ✓ coe}$$

$$R = 56,99 \, \Omega \text{ ✓ vcoe}$$

(3)

7.4.5. $V_H = IR$

$$V_H = (0,61)(56,99) \text{ ✓ coe}$$

$$V_H = 34,76 \text{ V } \text{ ✓ coe}$$

$$V_{rhe} = V_{cell} - V_H$$

$$V_{rhe} = 48 - 34,76 \text{ ✓ coe}$$

$$V_{rhe} = 13,23 \text{ V } \text{ ✓ coe}$$

(4)

[26]

Memo: Electrodynamics

8.1. Y to X ✓✓

(2)

8.2. Motor: Electrical energy to mechanical (kinetic) energy ✓

Generator: Mechanical (kinetic) energy to electrical energy ✓

(2)

8.3.1. Into the page ✓✓

(2)

8.3.2. Increase current ✓

Increase strength of magnets ✓

Increase length of wire in field ✓

(Any 2)

(2)

8.3.3. When the conductor is parallel to the field lines. ✓✓ (2)

8.4.1. Magnetic flux linkage is the product of the number of turns on the coil and the flux through the coil. ✓✓ (2)

8.4.2. Magnetic flux changes as the coil rotates. ✓
Faraday's law states that a changing magnetic flux induces an emf ✓
An induced emf in a closed circuit means a current in the circuit. ✓ (3)

8.4.3. Lenz's law: The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux. ✓✓ (2)

8.4.4. P to Q. ✓✓ (2)
[19]

Memo: Photons and Electrons

9.1. $E = hc/\lambda$ ✓
 $E = (6,6 \times 10^{-34})(3 \times 10^8)/(220 \times 10^{-9})$ ✓
 $E = 9 \times 10^{-19} \text{ J}$ ✓ (4)

9.2. a. decreases ✓
b. no effect ✓
c. no effect ✓
d. increases ✓ (4)

9.3. The stopping voltage relates the kinetic energy of the photoelectrons
Changing intensity does not affect the energy of the electrons. ✓
Decreasing the wavelength increases the frequency ✓ of the radiation
This increases the energy of the radiation ✓
So each electron that is now ejected has a more kinetic energy ✓ (3)

9.4. $E_{\text{released}} = (-5,3) - (-7,5)$
 $E_{\text{released}} = 2,2 \text{ eV}$ ✓

 $E = 3,52 \times 10^{-19} \text{ J}$ ✓

 $f = E/h$
 $f = 3,52 \times 10^{-19} / 6,6 \times 10^{-34}$ ✓
 $f = 5,33 \times 10^{14} \text{ Hz}$ ✓ (4)
[15]