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Penryn
College

MEMO

Name:

Teacher's name:

GRADE 12

Physical Sciences Examination – Paper 1

Date: 28/08/2023

ASSESSOR: Mrs N Jones

TIME: 180 Minutes

MODERATOR: Mr J Bredenkamp

MARKS: 200 Marks

Instructions:

1. This question paper consists of 35 pages and a Data Sheet of 2 pages (i – ii). Please check that your question paper is complete.
2. Read the questions carefully.
3. Answer ALL the questions on the questions paper and hand it in at the end of the test. Remember to write your name in the space provided above.
4. Use the data and formulae whenever necessary.
5. Show your working in all calculations.
6. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
7. Answers must be expressed in decimal format, not left as proper fractions.
8. Where appropriate, express answers to TWO decimal places.
9. It is in your own interest to write legibly and to present your work neatly.
10. TWO blank pages (pages 34 & 35) are included at the end of the paper. If you run out of space for a question, use these pages. If you use this extra space, make sure that you indicate this clearly at the question to ensure that your answer is marked in full.

QUESTION 1 MULTIPLE CHOICE

Answer these questions on the multiple-choice answer sheet below. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

A	B	~~C~~	D
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Here the option C has been marked as an example.

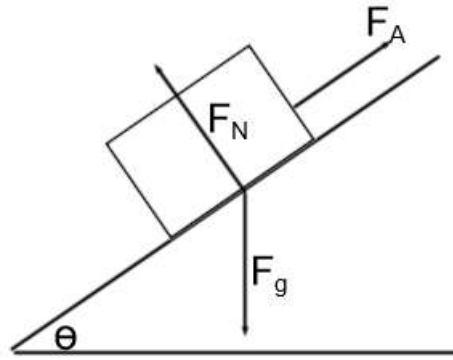
1.1	A	B	C	~~D~~
1.2	A	~~B~~	C	D
1.3	~~A~~	B	C	D
1.4	A	B	C	~~D~~
1.5	~~A~~	B	C	D
1.6	A	B	C	~~D~~
1.7	A	B	C	~~D~~
1.8	A	~~B~~	C	D
1.9	A	B	~~C~~	D
1.10	~~A~~	B	C	D

$$10 \times 2 = 20$$

1.1 Which of the following are the base units for impulse?

- A $\text{kg} \cdot \text{m} \cdot \text{s}^{-1}$
- B $\text{kg} \cdot \text{m} \cdot \text{s}^{-2}$
- C $\text{N} \cdot \text{m}$
- D $\text{N} \cdot \text{s}$

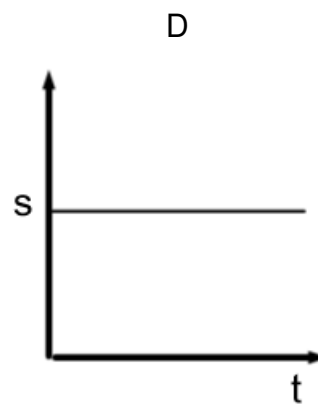
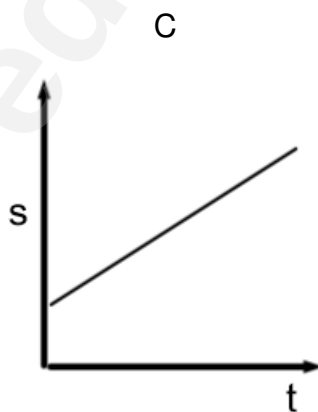
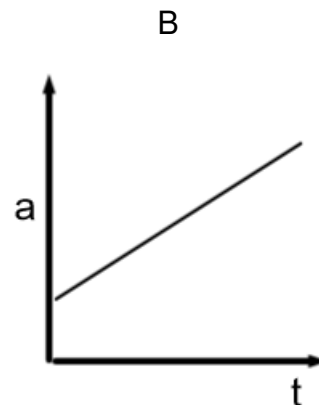
- 1.2 A force T is required to keep a body at rest on a frictionless inclined plane as in the sketch.



The magnitude of F_A is given by:

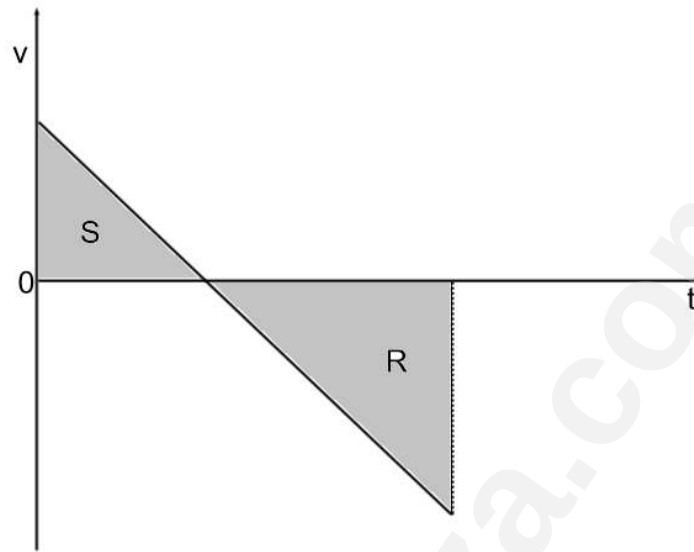
- A $F_g \tan \theta$
- B $F_g \sin \theta$
- C F_g
- D $F_g \cos \theta$

- 1.3 Which graph represents the motion of a car that is travelling along a straight road with uniformly increasing speed?



- 1.4 If a stone is thrown upwards from the top of a cliff. After reaching its maximum height it falls back past the cliff-top and into the sea.

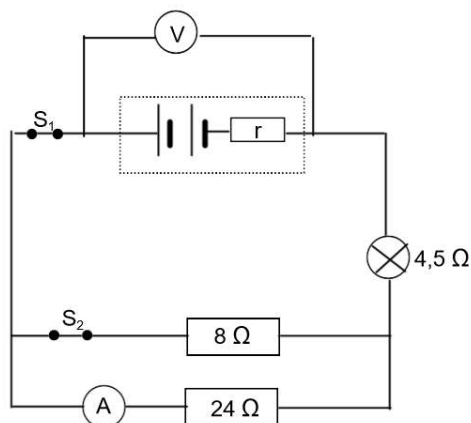
The graph below shows the velocity vs. time graph for the motion of the stone.



R and S are the magnitudes of the areas of the two triangles.
What is the height of the cliff-top above the sea?

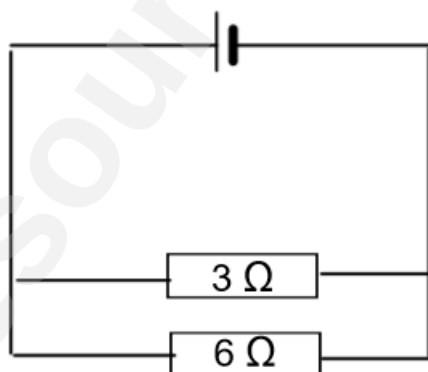
- A R
- B S
- C $R + S$
- D $R - S$

- 1.5 Consider the circuit diagram. Which of the following would describe the ammeter reading and voltmeter reading when S_2 is opened?



	Ammeter	Voltmeter
A	Decrease	Increase
B	Decrease	Decrease
C	Increase	Decrease
D	Increase	Increase

- 1.6



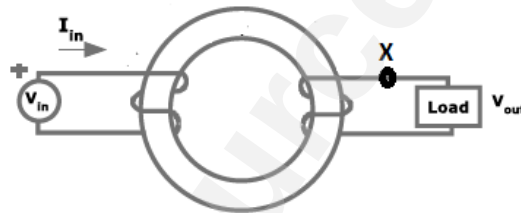
In the above circuit diagram the energy dissipation in the $3\ \Omega$ resistor, in each second, will be in the $6\ \Omega$ resistor.

- A one quarter than
- B half than
- C the same as
- D twice as much as

- 1.7 A positively charged sphere with a charge of $+8\text{ C}$ is separated from a negatively charged sphere with a charge of -4 C by a distance of r , and have a resultant attractive force, F between them. The spheres touch each other and are then moved back to their original positions. What is the magnitude of the new force on each sphere in terms of F ?

- A $4F$
 B $\frac{1}{4}F$
 C $8F$
 D $\frac{1}{8}F$

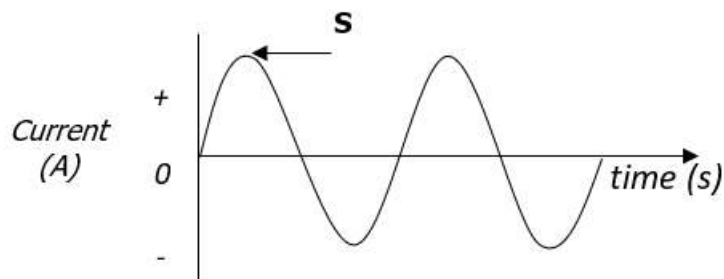
- 1.8 Michael Faraday constructed the world's first transformer in his famous "*iron ring experiment*". The apparatus used was a solid iron ring with 2 independent insulated wires coiled on opposite sides of the ring as shown below. The direction of the primary current, I_{in} , is indicated on the sketch.



Which one of the following options regarding the principle used in the functioning transformer and the direction of the output current, at X, is true?

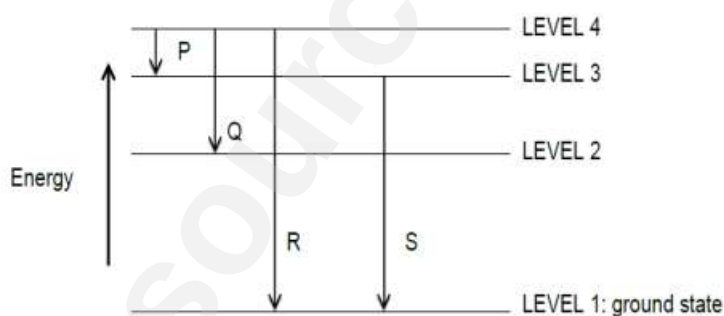
	Principle Used	Direction of current at X
A	motor effect	right
B	mutual induction	right
C	motor effect	left
D	mutual induction	left

- 1.9 The graph shows the current generated when a generator coil is rotated in a magnetic field.



The position of the rotating coil, corresponding to point S on the graph above, is:

- A Moving at 45° to the magnetic field.
 - B Moving perpendicular to the magnetic field.
 - C Moving parallel to the magnetic field.
 - D Not moving in the magnetic field.
- 1.10 The possible atomic transitions in an excited atom of an element are shown.
- Which transition will produce the spectral line with the longest wavelength?



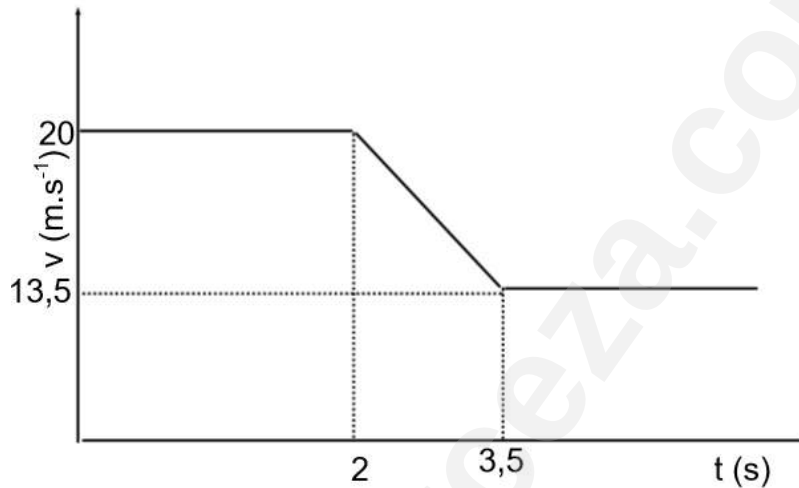
- A P
- B Q
- C R
- D S

{2 x 10} [20]

QUESTION 2

Two learners decide to go on a day trip to the Kruger National Park. They are driving along the H-1 between Crocodile Bridge and Lower Sabie. The speed limit in the Park on tar roads is $50 \text{ km} \cdot \text{h}^{-1}$. The learners are getting bored and at one point the driver looks down and sees that they are travelling at $20 \text{ m} \cdot \text{s}^{-1}$ North.

There is a traffic cop with a camera sitting up ahead and as soon as the driver notices the camera they slam on the brakes. The graph below shows the velocity vs. time graph for the car from the moment the driver spots the camera.



- 2.1 Define *acceleration*. (2)
Rate of change of velocity. ✓✓

- 2.2 Use the graph to determine the acceleration of the car whilst braking. (3)

$$\begin{aligned}
 a &= \frac{\Delta v}{\Delta t} \quad \checkmark \\
 &= \frac{13,5 - 20}{3,5 - 2} \quad \checkmark \\
 &= -4,33 \quad \therefore a = 4,33 \text{ m} \cdot \text{s}^{-2} \text{ South} \quad \checkmark \text{ (no direction -1)}
 \end{aligned}$$

- 2.3 Did the driver slow down to below the required speed limit? Show all working out. (3)

$$13,5 \times 3,6 = 48,6 \text{ km} \cdot \text{h}^{-1}$$

$\therefore$ Yes. ✓

2.4

Determine the average speed of the car during the first 3,5 s of the graph.

(5)

$$\text{Avg. speed} = \frac{\text{total dist.}}{\text{total time}} \quad \checkmark \quad \text{dist} = \text{area} \quad \checkmark \text{ may be implied}$$

$$= \frac{(20 \times 2) + \frac{1}{2}(1,5)(6,5) + (1,5 \times 13,5)}{3,5} \quad \checkmark$$

$$= 18,61 \text{ m.s}^{-1} \quad \checkmark$$

2.5

The traffic cop saw that the vehicle was speeding when it first came into range of the camera. It took the traffic cop 2,5 s after the 3,5 s indicated on the graph, to get onto his motorcycle and chase after the car. The driver didn't notice the traffic cop coming up behind them and continued at a constant velocity of $13,5 \text{ m.s}^{-1}$ North. The traffic cop was able to accelerate at $0,75 \text{ m.s}^{-2}$. How long did it take him to catch up with the car from when he started moving.

$$\text{Cop: } s = ut + \frac{1}{2}at^2 \quad \checkmark \quad \text{dist} = \text{sp.} \times t$$

$$\underline{s_{\text{car}} + 33,75} = 0 + \frac{1}{2}(0,75)t^2 \quad \checkmark \quad = 13,5 \times 2,5$$

$$= 33,75 \text{ m.} \quad \checkmark$$

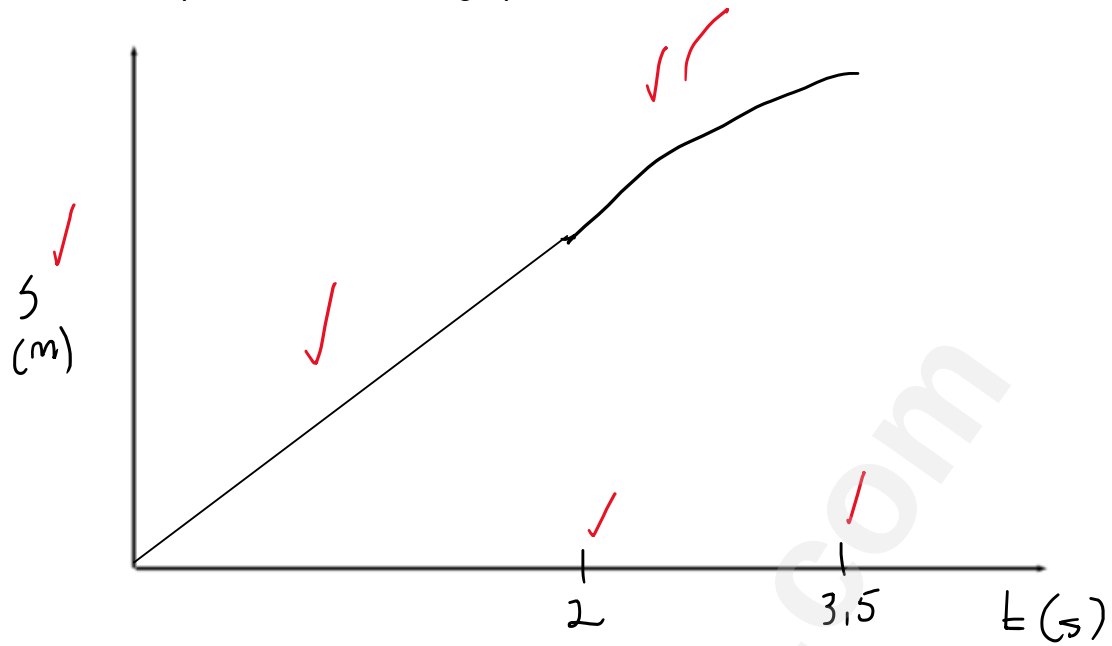
$$\text{Car: } s_{\text{car}} = 13,5t + 0 \quad \checkmark$$

$$13,5t + 33,75 = \frac{1}{2}(0,75)t^2 \quad \checkmark$$

$$t = 38,35 \text{ s.} \quad \checkmark$$

2.6 Sketch a displacement vs. time graph for the motion of the car for 0 – 3,5 s.

(5)



[25]

QUESTION 3

One of the big tuskers in the Kruger Park is fitted with a radio collar. During the drought it was observed that the elephants travelled long distances in search of water. On one particular day it was found that a particular tusker travelled a distance of 49,8 km over a period of 6 hrs 35 min 21 s.

3.1 Calculate the elephant's average speed in $\text{km}\cdot\text{h}^{-1}$.

(4)

$$\begin{aligned}\text{ave. speed} &= \frac{\text{total dist}}{\text{total time}} \checkmark \\ &= \frac{49,8 \checkmark}{6,5892 \checkmark \text{ conv.}} \\ &= 7,55 \text{ km}\cdot\text{h}^{-1} \checkmark\end{aligned}$$

A helicopter was tracking the elephant. The helicopter flew in a straight line from where the elephant started his day to where the elephant ended. The helicopter flew for 20 min at an average velocity of $120 \text{ km}\cdot\text{h}^{-1}$ North.

3.2 Distinguish between *distance* and *displacement*.

(4)

distance – length of path travelled $\checkmark\checkmark$

displacement – change in position $\checkmark\checkmark$

3.3 Determine the magnitude of the elephant's displacement at the end of the day (give your answer in km).

(2)

$$\begin{aligned}s &= ut + \frac{1}{2}at^2 \checkmark \\ &= (120)(0,33) + 0 \\ &= 39,6 \text{ km.} \checkmark\end{aligned}$$

[10]

QUESTION 4

A baboon sitting in a Marula tree picks a fruit and seeing that it is not yet ripe throws it down out of the tree. The baboon throws the Marula fruit with a velocity of $8,4 \text{ m}\cdot\text{s}^{-1}$ down. The baboon is sitting 5 m above the ground in the tree.

- 4.1 Determine the velocity of the Marula fruit as it hits the ground.

$\downarrow$ (3)

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

$$v^2 = (8,4)^2 + 2(9,8)(5) \quad \checkmark$$

$$v = 12,98 \text{ m}\cdot\text{s}^{-1} \text{ down} \quad \checkmark$$

- 4.2 Determine the time taken for the Marula fruit to hit the ground from when it was thrown.

(3)

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

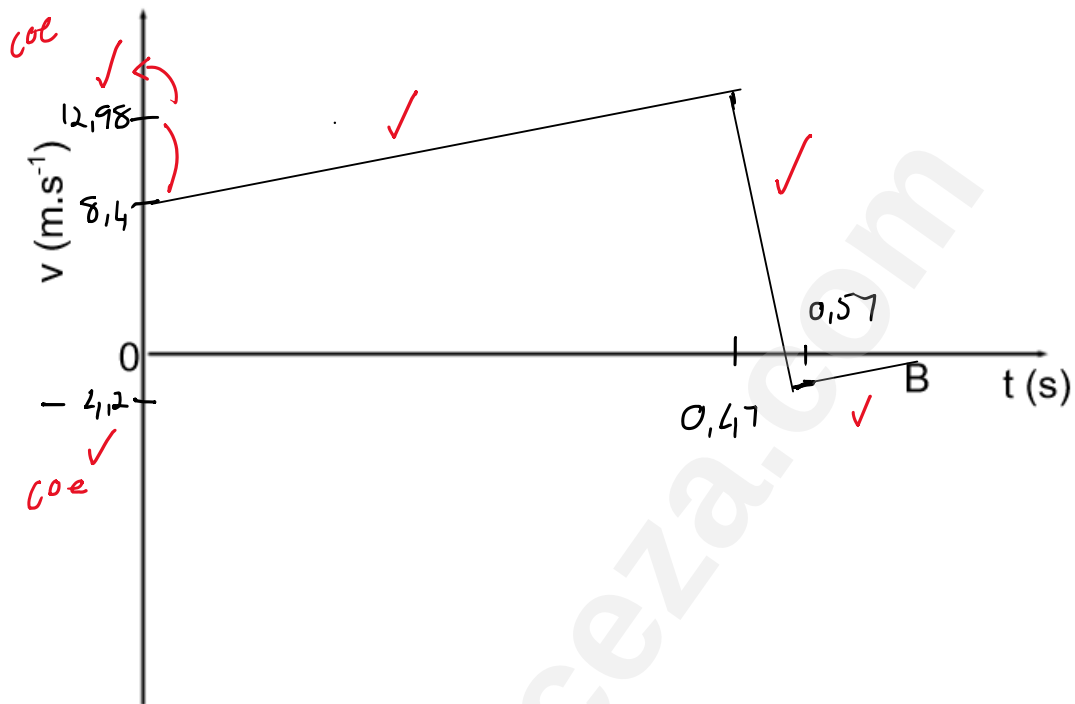
(NO COE!)

$$5 = (8,4)t + \frac{1}{2}(9,8)t^2 \quad \checkmark$$

$$t = 0,47 \text{ s.} \quad \checkmark$$

Because the Marula fruit is unripe it is hard, and so it bounces up off the ground after hitting it. The fruit bounces up off the ground with a velocity of $4,2 \text{ m}\cdot\text{s}^{-1}$ upwards. The fruit is in contact with the ground for 0,1 s. The fruit bounces to a maximum height, h . It reaches this height at a time, B .

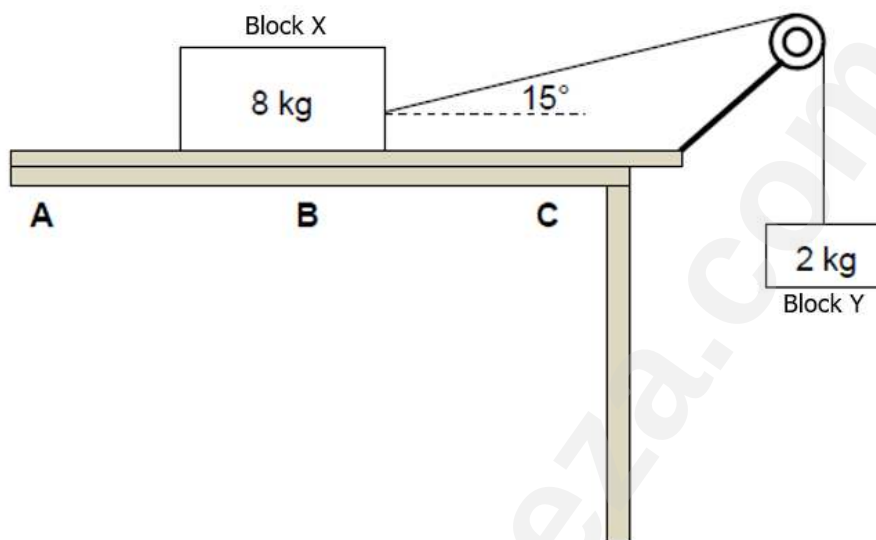
- 4.3 Sketch a velocity vs. time graph to show the motion of the Marula fruit from the time the baboon throws the fruit until it reaches its maximum height of the bounce at time B. The graph does not need to be drawn to scale, but all previously calculated values or given values need to be indicated. (Take down as positive) (5)



[11]

QUESTION 5

A block of mass 8 kg is placed on a rough horizontal surface. The 8 kg block is connected to a 2 kg block by means of a light, inextensible string, which passes over a frictionless pulley. The 8 kg block starts sliding to the right and slides from point A to point B.



- 5.1 State Newton's Third Law (2)

When object A exerts a force on object B, object B simultaneously exerts an oppositely directed force of equal magnitude on object A.

✓✓ (2 or 0)

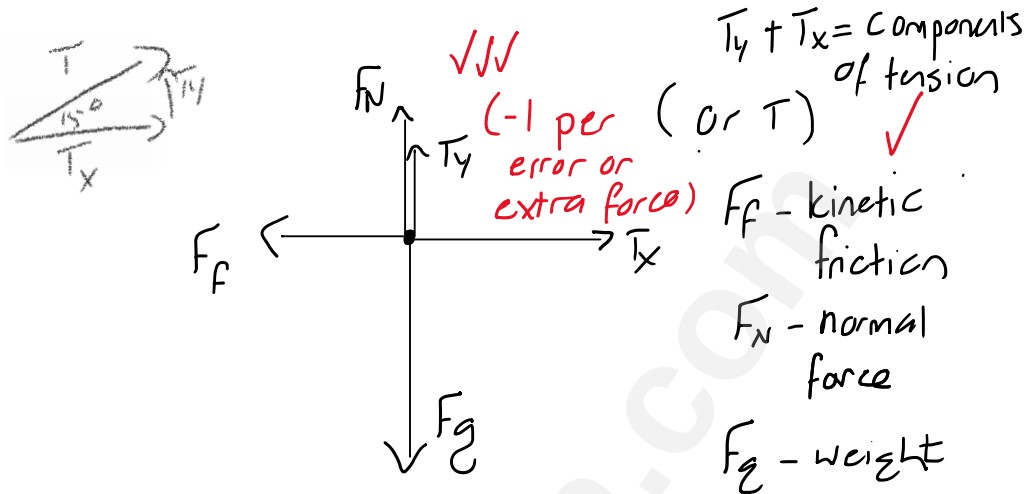
- 5.2 Identify ONE action reaction pair acting in the diagram above. (2)

Normal force on block^{up} / force on table^{down} etc.

✓ forces on opp. objects ✓ directions

- 5.3 When the block reaches point B, the angle between the string and the horizontal is 15° and the acceleration of the system is $1,32 \text{ m}\cdot\text{s}^{-2}$ right.

5.3.1 Draw a labelled free body diagram for the 8 kg block at point B. (4)



5.3.2 Determine the magnitude of the tension in the string. (3)

2 kg: $F_{net} = ma$ ✓

$$(2 \times 1,8) - T = (2)(1,32) \quad \checkmark$$

$$T = 16,96 \text{ N} \quad \checkmark$$

5.3.3 Calculate the kinetic frictional force between the 8 kg block and the horizontal surface. (4)

8 kg: $T_x - F_f = ma$ ✓

$$16,96 \cos 15^\circ - F_f = (8)(1,32) \quad \checkmark$$

$$F_f = 5,82 \text{ N} \quad \checkmark \quad \text{left}$$

- 5.4 As the 8 kg block slides from B to C, the kinetic frictional force between the 8 kg block and the horizontal surface does NOT remain constant. Explain WHY the frictional force changes between points B and C. Refer to a relevant formula in your explanation. (4)

Y component of T increases.
 $\therefore F_N$ changes/decreases.
 $F_k = \mu F_N$, μ constant.
 $\therefore F_k$ decreases/changes.

- 5.5 At point B, the 8 kg block, now referred to as block X, is loaded with other masses until it just stops moving. If the coefficient of static friction for block X is 0,25, calculate the new total mass of block X. (5)

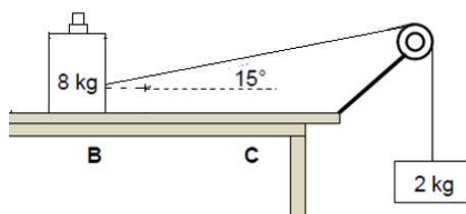
No a $\therefore T = 2 \times 9,8 = 19,6 \text{ N}$ ✓

$$F_f = T_x \\ = 19,6 \cos 15^\circ \\ = 18,93 \text{ N} \quad \checkmark$$

$$F_{fs} = \mu_s F_N \\ 18,93 = 0,25 F_N \\ F_N = 75,73 \text{ N} \quad \checkmark$$

$$T_y + F_N = F_g \\ 19,6 \sin 15^\circ + 75,73 = m(9,8) \quad \checkmark \\ m = 8,25 \text{ kg} \quad \checkmark$$

- 5.6 What would happen to the static frictional force acting on block X, the same 8 kg block loaded with additional masses, was turned onto its thinner side, as shown in the diagram below? Only write INCREASE, DECREASE or REMAINS THE SAME. (1)



Remains the same. ✓

[25]

QUESTION 6

- 6.1 A truck, delivering bread to Shingwedzi Rest Camp, with a mass of 3 500 kg, was driving from Mopani to Shingwedzi. The truck was travelling at $16,67 \text{ m}\cdot\text{s}^{-1}$ North. Just before getting to the Shingwedzi turnoff an elephant stepped into the road causing the driver to swerve into a Jackalberry Tree. The driver did not have time to break before hitting the tree. The truck came to a stop in 0,8 m.



- 6.1.1 Calculate the magnitude of the change in momentum of the truck during the accident. (3)

$$\begin{aligned}\Delta p &= mv_f - mv_i \quad \checkmark \\ &= 3500(0 - 16,67) \quad \checkmark \\ &= -58345 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} \quad \checkmark\end{aligned}$$

- 6.1.2 State the Work-Energy Theorem. (2)

Work done by a net force on an object is equal to the change in kinetic energy of the object. $\checkmark\checkmark$ (2 or 0)

- 6.1.3 Use the Work-Energy Theorem to calculate the average resultant force that brought the truck to rest. (4)

$$\begin{aligned}W_{\text{net}} &= \Delta E_k \\F_{\text{net}} \cdot s &= \Delta E_k \checkmark \\F_{\text{net}}(0,8) &= 0 - \frac{1}{2}(3500)(16,67)^2 \checkmark \\F_{\text{net}} &= -607881,97 \checkmark \\\therefore F_{\text{net}} &= 607881,97 \text{ N South} \checkmark\end{aligned}$$

- 6.1.4 Use your answers to Questions 6.1.1 to 6.1.3 to calculate how long it took for the truck to come to rest. (3)

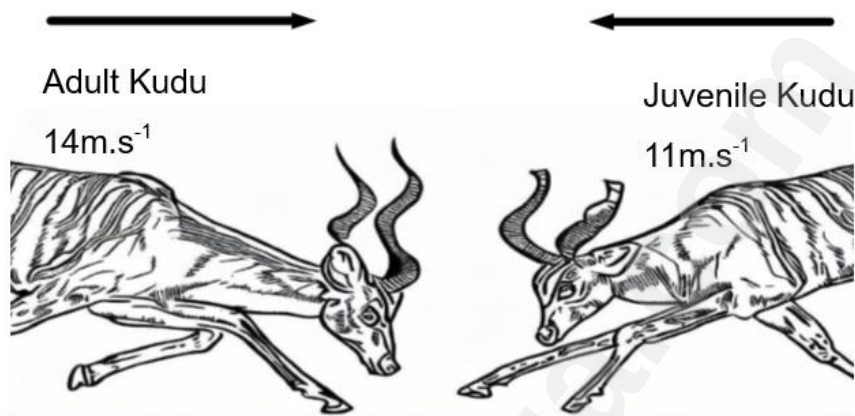
$$\begin{aligned}F_{\text{net}} \Delta t &= \Delta p \checkmark \\607881,97(\Delta t) &= 58345 \checkmark \quad \text{lose (either both + or both -)} \\\Delta t &= 0,1 \text{ s.} \checkmark\end{aligned}$$

- 6.1.5 Fortunately the driver (who was wearing his seatbelt) was not injured during the accident. Explain why the driver would have been more seriously hurt if the same truck had stopped almost instantaneously. Use a relevant formula to help with your explanation. (3)

$$\begin{aligned}F_{\text{net}} &= \frac{\Delta p}{\Delta t} \checkmark \therefore F_{\text{net}} \propto \frac{1}{\Delta t} \checkmark \\\therefore \text{Shorter time, greater force.} \checkmark\end{aligned}$$

6.2

Two bull kudus are in rutting season and are sizing each other up. One is an adult and the other is a juvenile. The kudus start to run towards each other. The adult kudu has a mass of 550 kg and runs at $14 \text{ m}\cdot\text{s}^{-1}$ East, the juvenile has a mass of 400 kg and runs at $11 \text{ m}\cdot\text{s}^{-1}$ West. They collide head on with each other. Immediately after the collision the juvenile kudu was seen to be moving at $3 \text{ m}\cdot\text{s}^{-1}$ East.



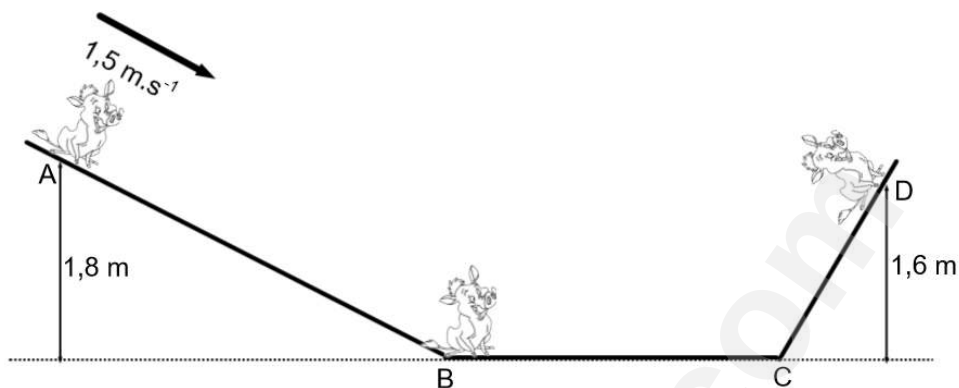
6.2.1 State the *Law of Conservation of Linear Momentum*. (2)

The total linear momentum of an isolated system remains constant /is conserved. ✓✓ (2 or 0)

6.2.2 Determine the velocity of the Adult Kudu immediately after the collision. (4)

$$\begin{aligned}\sum p_{\text{before}} &= \sum p_{\text{after}} \quad \checkmark \\ (550)(14) + (400)(-11) &= 550 v_f + (400)(3) \quad \checkmark \\ v_f &= 3,82 \text{ m}\cdot\text{s}^{-1} \text{ East} \quad \checkmark\end{aligned}$$

- 6.3 A baby warthog with a mass of 635 g is sliding down the muddy side of a waterhole. Due to the water the surface is frictionless. At point A, the piglet has a speed of $1,5 \text{ m}\cdot\text{s}^{-1}$ as shown in the diagram below. BC is also frictionless and then he slides up the other side (CD) where he does experience a frictional force.



- 6.3.1 Define *Mechanical Energy*. (2)

Sum of gravitational potential and kinetic energy at a point. $\sqrt{1(20 \text{ or } 0)}$

- 6.3.2 If point A is 1,8 m above the ground, calculate the speed of the piglet at point B. (4)

$$E_{m \text{ top}} = E_{m \text{ bottom}} \quad \checkmark$$

$$(0,635)(1,8)(1,8) + \frac{1}{2}(0,635)(1,5)^2 = 0 + \frac{1}{2}(0,635)v^2 \quad \checkmark$$

$$v = 6,13 \text{ m}\cdot\text{s}^{-1} \quad \checkmark$$

- 6.3.3 As the piglet slides up CD it experiences a frictional force of 1,2 N. At point D the piglet is 1,6 m high and comes to a stop. WITHOUT USING EQUATIONS OF MOTION, calculate the length of the inclined plane CD. (6)

$$\begin{aligned} W_{\text{net}} &= \Delta E_K \\ -W_{f_f} - W_g &= 0 - \frac{1}{2}(0,635)(6,13)^2 \\ -1,2(s) - (0,635)(9,8)(1,6) &= \frac{1}{2}(0,635)(6,13)^2 \\ s &= 1,64 \text{ m} \end{aligned}$$

Remember $W_{F_{g11}} = W_g = \Delta E_p$.

[33]

QUESTION 7

On a dark night, a group of learners are fortunate enough to be taken to the Sabie high water bridge on a night drive. They get to lie on the bridge and stare up at the stars. The sky is so clear, without light pollution, that they can clearly see the Milky Way. The guide uses a laser to point out the positions of various stars and constellations.

- 7.1 The gravitational field strength of the earth is given as $9,8 \text{ N.kg}^{-1}$. use the definition to explain what is meant by this. (2)

Every kilogram of mass on earth experiences an attractive force of $9,8 \text{ N}$.

✓

✓

- 7.2 One of the constellations is Cygnus. In Cygnus there is a planet known as Kepler-452b. The gravitational field on Kepler-452b is the same as that on Earth, $9,8 \text{ N.kg}^{-1}$. What must the mass of Kepler-452b be if its radius is $10\,384 \text{ km}$? (4)

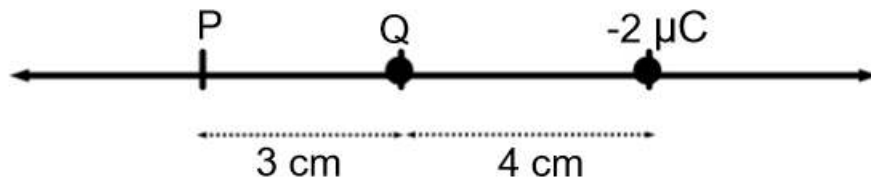
$$g = \frac{GM}{r^2} \quad \checkmark$$

$$9,8 = \frac{6,7 \times 10^{-11} \cdot m}{(10\,384\,000)^2} \quad \checkmark$$

$$m = 1,58 \times 10^{25} \text{ kg} \quad \checkmark$$

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- 7.3 Two charge particles, Q and a $-2 \mu\text{C}$ charge are placed 4 cm apart as indicated in the sketch below.



- 7.3.1 Determine the electric field strength at point P due to the $-2 \mu\text{C}$ charge only. (4)

$$\begin{aligned}
 E &= \frac{kQ}{r^2} \quad \checkmark \\
 &= \frac{9 \times 10^9 \cdot 2 \times 10^{-6}}{(0,07)^2} \quad \checkmark \\
 &= 3\,673\,169,39 \text{ N}\cdot\text{C}^{-1} \text{ right} \quad \checkmark \quad \checkmark \\
 \text{or } 3,67 \times 10^6 \text{ N}\cdot\text{C}^{-1} \text{ right}
 \end{aligned}$$

- 7.3.2 What charge must Q possess in order for the resultant electric field strength at P to be zero? Give the magnitude and sign of charge Q. (4)

$$\begin{aligned}
 3,67 \times 10^6 &= \frac{9 \times 10^9 Q}{(0,03)^2} \quad \checkmark \text{ method} \quad \checkmark \text{ subst} \quad \checkmark \text{ coe} \\
 Q &= (+) 3,67 \times 10^{-7} \text{ C} \quad \checkmark
 \end{aligned}$$

[14]

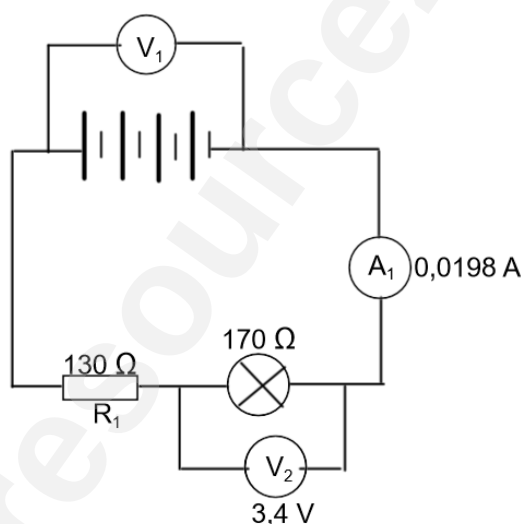
QUESTION 8

The ranger at Lower Sabie decides he wants to build an alarm circuit for the gate to alert the night guard if an animal approaches the gate. He decides that the alarm will need both a light and a buzzer. He starts researching various colour light bulbs and buzzers. He finds out that many animals can't see red light, but that humans can. So he decides to go with a red light bulb.

The bulb he chooses has the following information on the box:

- Resistance = $170\ \Omega$
- Must be connected in series with a $130\ \Omega$ resistor to limit the current passing through.
- Recommended voltage supply = 4 x AA cells each with an emf of 1,5 V.

Before getting the buzzer he decides to test the light bulb. He sets up the sample circuit as shown below:



When the sample circuit is connected the reading on Ammeter 1 is 0,0198 A.

8.1 Refer to the information in the diagram and calculate the reading on Voltmeter 1. (3)

$$\begin{aligned} R_T &= 300\ \Omega & R &= \frac{V}{I} \checkmark \\ 300 &= \frac{V}{0,0198} \checkmark \\ V &= 5,94\ \text{V} \checkmark \end{aligned}$$

- 8.2 Determine the internal resistance of EACH cell. Give your answer correct to 3 decimal places. (4)

$$E = V_{\text{ext}} + V_{\text{lost}} \quad V_{\text{lost}} = Ir$$

$$6 = 5,94 + 0,0198r$$

$$r = 3,03 \Omega$$

$$E_{\text{each}}: \frac{3,03}{4} = 0,757 \Omega$$

- 8.3 Calculate how much energy is dissipated by the red lightbulb when it shines for 10 s. (4)

$$W = VIt \quad \text{or} \quad W = I^2 R t$$

$$= (3,4)(0,0198)(10) \quad = (0,0198)^2 (170)(10)$$

$$= 0,675 \quad = 0,675$$

$$\text{or} \quad W = \frac{V^2}{R} \cdot t = \frac{(3,4)^2}{170} \cdot 10 = 0,685$$

Once the ranger is satisfied with the intensity of the red lightbulb he goes looking for a buzzer (in case the guard doesn't see the light, he'll hear the buzzer).

The buzzer has the following information supplied with it:

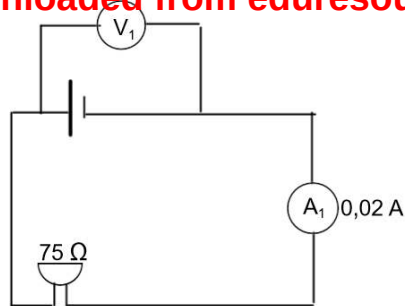
- Symbol:



Operation:

- Resistance = 75Ω
- Wide tolerance for voltage and current supply
- Use with AA cells with an emf of 1,5 V each.

The ranger sets up a sample circuit as shown below with one cell. He then adds cells one at a time until he gets to four cells. He investigates how the reading on the ammeter changes as he puts more cells into the circuit.



- 8.4 Give the full name for the following two variables: (3)

Independent: *potential difference* ✓ (voltage = 1 mark)
 or no. of cells.

Dependent: *current* ✓

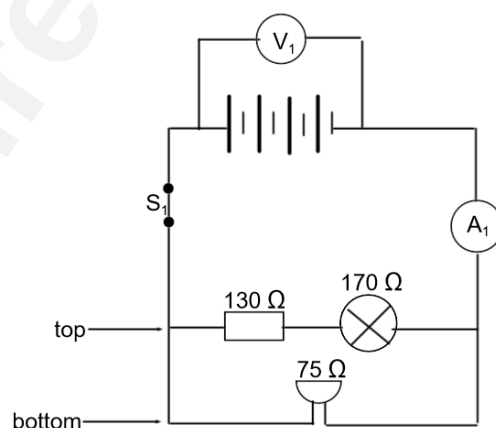
- 8.5 What is the name of the type of relationship you would expect to find between the variables? (1)

Directly proportional ✓

- 8.6 Give one other variable, other than resistance of the buzzer or apparatus, that needs to remain constant in order for this to be a fair investigation. (1)

Temperature ✓

The ranger is finally happy with his components and sets up the circuit as shown below. He uses 4 new AA cells, EACH with an emf of 1,5 V and an internal resistance of 0,15 Ω. The resistor and light bulb are connected in series in parallel with the buzzer.



Refer to the sketch above and answer the following questions.

- 8.7 Determine the reading on the ammeter. Give your answer correct to 3 decimal places. (6)

$$\frac{1}{R_p} = \frac{1}{300} + \frac{1}{75} = \frac{1}{60}$$

$$R = 60 \Omega$$

$$\mathcal{E} = I(R + r)$$

$$6 = I(60 + 0,6)$$

$$I = 0,099 \text{ A}$$

- 8.8 Calculate the ratio of the current in the top branch to the current in the bottom branch of the circuit. Give your answer in the form: $I_{\text{top}} : I_{\text{bottom}}$. (2)

$$75 : 300$$

$$\hookrightarrow 1 : 4 \quad \checkmark \checkmark$$

- 8.9 Unfortunately all the ranger's testing did not prevent the buzzer from overheating and it stops working. How will the reading on the voltmeter be affected when the buzzer stops working? Answer with INCREASES, DECREASES or REMAINS THE SAME. (4)

Use a suitable formula and explain your answer fully.

Increase. $\checkmark$

$$R \uparrow \therefore I \downarrow \quad \checkmark$$

$$\mathcal{E} = V_{\text{ext}} + Ir \quad \checkmark$$

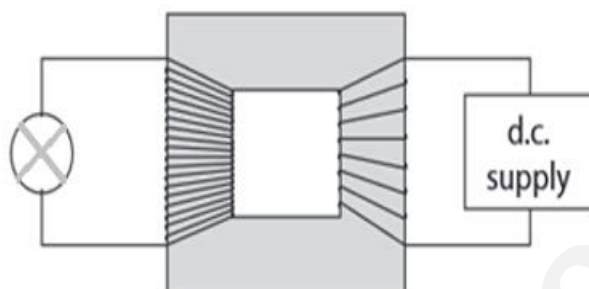
$$\mathcal{E} \neq r \text{ constant. } \quad \checkmark$$

$$\therefore V_{\text{ext}} \uparrow$$

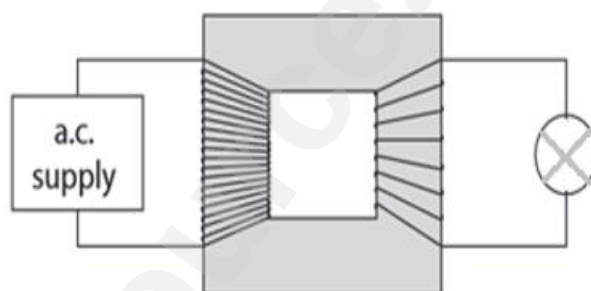
[28]

QUESTION 9

- 9.1 The same Lower Sabie ranger needs to connect some outside lights. First he connects a lamp and a power supply to a transformer as shown in Diagram 1. Unfortunately the lamp does not glow. (1)

**Diagram 1**

He goes off and does some research, comes back and not connects the same lamp to the other side of the same transformer and he uses a different power supply, as shown in Diagram 2. The lamp now glows.

**Diagram 2**

State why the lamp glows when connected as shown in Diagram 2, but does not glow when connected as shown in Diagram 1.

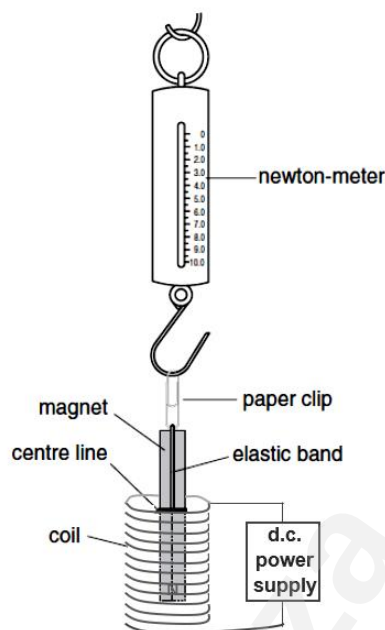
Power supply. ✓

- 9.2 A step-down transformer has 30 turns on one coil and 500 turns on the other. (3)
One end of the transformer is connected to a power supply and the other end to an appliance which requires 12 V to run optimally.

Determine the voltage of the power supply.

$$\frac{N_s}{N_p} = \frac{V_s}{V_p} \quad \checkmark$$
$$\frac{30}{500} = \frac{12}{V_p} \quad \checkmark \therefore V_p = 200V \quad \checkmark$$

- 9.3 A student carries out an investigation to find out how the force acting on a bar magnet suspended in a current carrying coil is related to the magnitude of the current in the coil. The setup of the experiment is shown below:



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

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

- 9.3.1 Consider the north pole of the magnet to be the side inside the coil. (3)
When viewed from ABOVE, must the current flow CLOCKWISE or ANTICLOCKWISE to ensure that the reading on the newton-meter will increase? Explain your answer briefly.

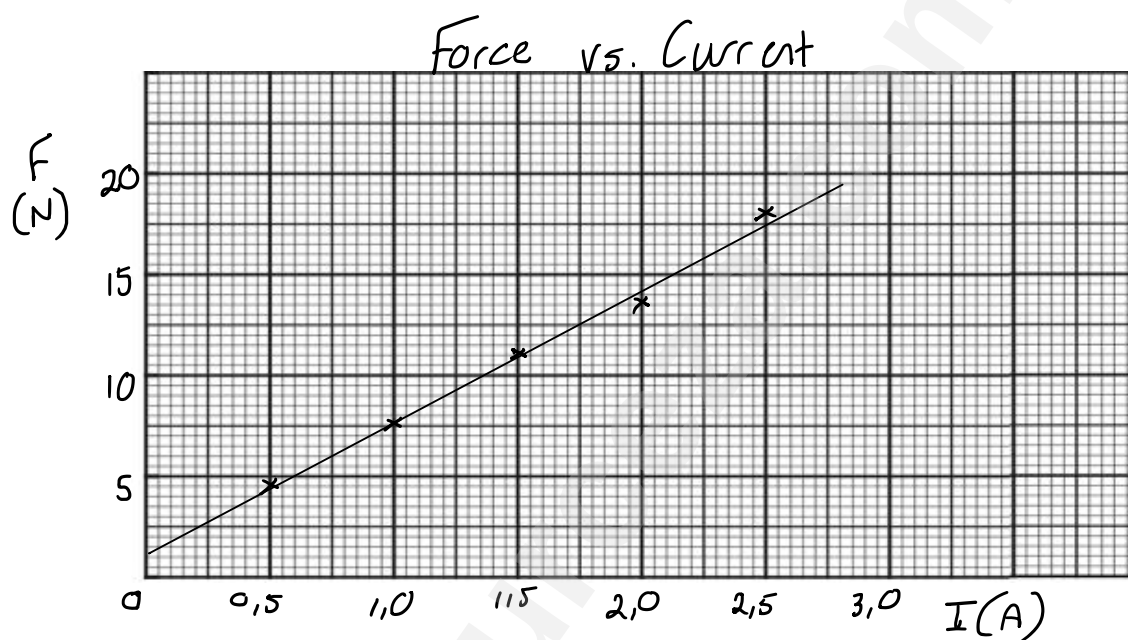
Anticlockwise ✓
Bottom of coil must be South to attract magnet down. ✓

The following results were obtained from the investigation.

Current (A)	Force (N)
0,5	4,65
1,0	7,59
1,5	11,17
2,0	13,96
2,5	17,39

9.3.2 Plot of graph of the data obtained.

(6)



9.3.3 One of the students suggest that there is a directly proportional relationship between the variables. Does your graph support this?

(2)

No ✓

Justify your answer.

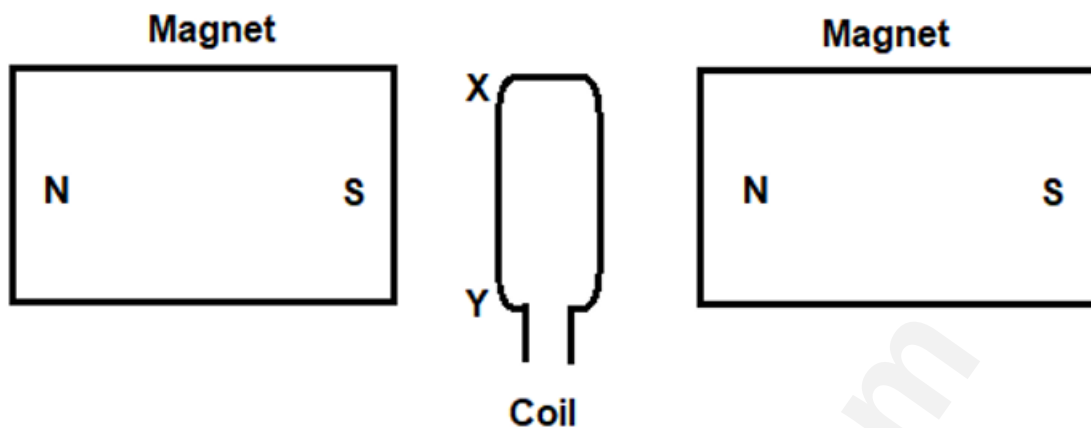
Does not go through origin. ✓

9.3.4 What does the y-intercept represent in this experiment?

(1)

Weight of magnet. ✓

- 9.4 The coil and magnets illustrated in the diagram below are part of a motor.



The current direction in the coil is from X to Y.

- 9.4.1 In which direction would side XY experience a force? (1)

Into page. ✓

- 9.4.2 How would you change TWO factors in order to increase the magnitude of the force exerted on side XY? (2)

Stronger current

Longer wire

Stronger magnet

✓✓ (any 2)

- 9.4.3 Compare a motor and generator in terms of energy conversion. (2)

Motor: electrical → Kinetic ✓

Generator: kinetic → electrical ✓

[21]

QUESTION 10

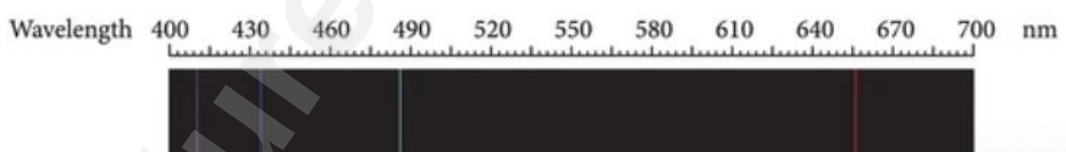
- 10.1 Whilst lying under the stars in the campsite the learners experience a most unusual phenomenon. The sun emits a “solar storm” – an unusually large burst of electromagnetic radiation. This causes an effect the same as the Aurora Borealis (Northern Lights) to be witnessed by the learners. The effect is the result of various gases in the magnetosphere being excited by the electromagnetic radiation from the sun, as the electrons drop down to more stable levels they emit energy in the form of emission spectra. This light is observed as a “light storm” in the sky. It is truly one of the most spectacular natural phenomena in nature.



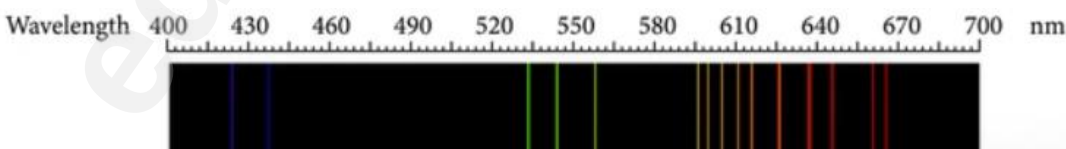
(Source: <https://www.newscientist.com/article/mg24432590-500-see-the-northern-lights-or-aurora-borealis-follow-this-easy-guide/>)

Three of the most common gases in our atmosphere are Hydrogen, Nitrogen and Oxygen. The emission spectra of these three elements are given below:

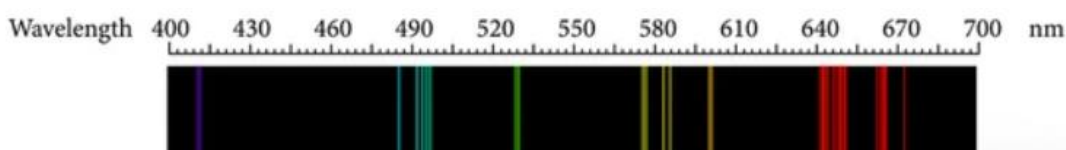
Hydrogen:



Oxygen:



Nitrogen:



The lights are initially green and then gradually change to a bright red.

- 10.1.1 Which two gases were excited to cause the phenomenon that the learners observed? (2)

O_2 ✓ N_2 ✓

- 10.1.2 The brightest red in the sky is given off by an emission at 645 nm. (4)
Determine the energy of this emission.

$$E = \frac{hc}{\lambda} \quad \checkmark$$

$$E = \frac{6,6 \times 10^{-34} \cdot 3 \times 10^8}{645 \times 10^{-9}} \quad \checkmark \text{ conv.}$$

$$= 3,07 \times 10^{-19} \text{ J} \quad \checkmark$$

- 10.2 Ultraviolet light of frequency $9,1 \times 10^{14}$ Hz is shone onto a metal surface. The work function of the metal is 2,19 eV.

- 10.2.1 Define work function. (2)

Minimum amount of energy needed to emit an electron from the surface of a metal. ✓✓

- 10.2.2 Calculate the maximum velocity of the ejected electrons. (5)

$$E = W_0 + E_{k \max} \quad \checkmark$$

$$6,6 \times 10^{-34} \cdot 9,1 \times 10^{14} = (2,19 \times 1,6 \times 10^{-19}) + \frac{1}{2} (9,1 \times 10^{-31}) v^2 \quad \checkmark \text{ conv.} \quad \checkmark \text{ subst.}$$

$$v = 741\,545,76 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

away from metal. ✓

[13]

GRAND TOTAL: {200 marks}

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