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GRADE 12
Physical Science: Paper 1 (Physics)
July 2019

Time: 3 hours
Examiner: K van Schoor

Marks: 200
Moderator: S Govender

READ THESE INSTRUCTIONS:

1. This paper consists of 16 pages (including the front page). Ensure that your paper is complete.
2. A data sheet, answer sheet and an answer booklet are provided.
3. Answer question one on the inside of your answer booklet and use the graph paper at the back of your answer booklet for question 4.1.3.
4. Start each question on a new page.
5. Take note of mark allocation and read the question thoroughly.
6. You must show all working for calculations and give appropriate units for numerical answers.
7. Where appropriate write all final numerical answers to a maximum of **2 decimal places**.
8. A non-programmable calculator may be used.
9. Use a pencil when drawing diagrams and graphs.

Name/Exam number:	Teacher:
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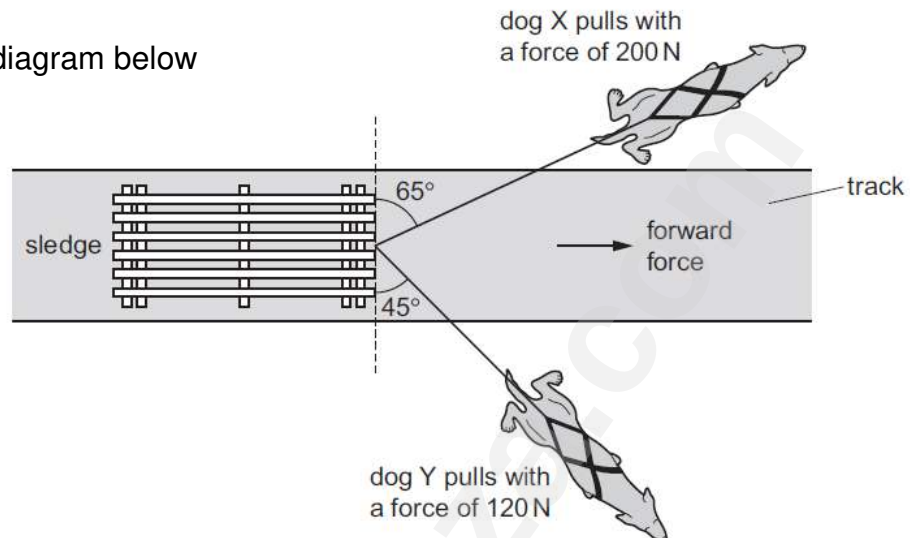
Acknowledgements: CIE 2018, IEBT 2016, Southdown's College 2019, S Crossman

Question 1: Multiple Choice Questions

[20]

Answer these questions on the front inside flap of your answer booklet.

1.1. See the diagram below

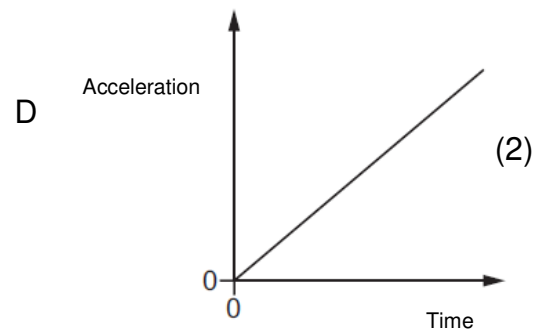
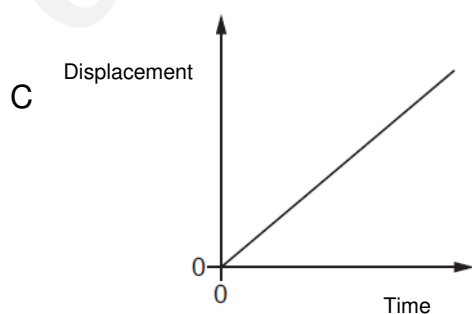
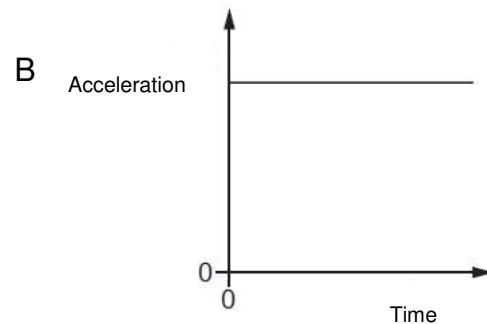
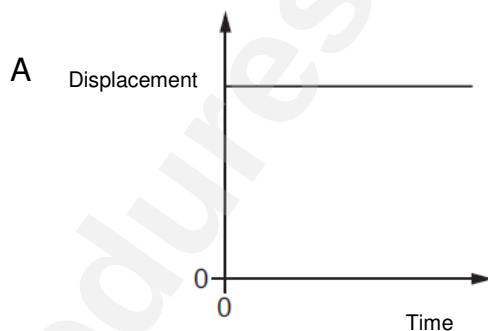


The angle between the two dogs can change. Which of the following forces could not be a resultant force of the two dogs on the sledge?

- A 320 N
- B 80 N
- C 400 N
- D 170 N

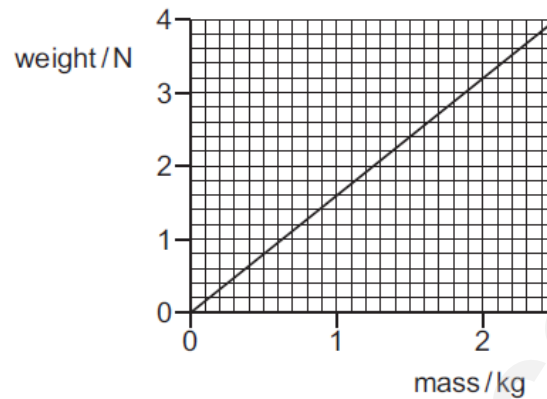
(2)

1.2. A car is moving along a straight level road with a constant velocity. Which of the graphs below shows the motion of the car the most accurately?



(2)

- 1.3. The graph below shows the variation with mass of the weight of objects on planet L.



What is the value of the acceleration of free fall on the planet in m.s^{-2} ?

- A 5,00
B 1,60
C 3,20
D 9,80 (2)

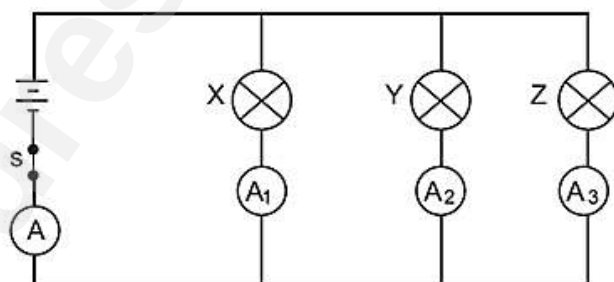
- 1.4. An elastic collision occurs between two bodies X and Y. The mass of body X is m and the mass of body Y is $4m$. Body X travels at v to the right before the collision and with a speed $\frac{3v}{5}$ to the left after the collision. Body Y is stationary before the collision.



What is the kinetic energy of body Y after the collision?

- A $\frac{16}{50} mv^2$ B $\frac{34}{50} mv^2$ C $\frac{8}{10} mv^2$ D $\frac{1}{5} mv^2$

- 1.5. A person stands on a scale in an elevator (a lift). He notices that the scale reading is lower than his usual weight. Which of the following could possibly describe the motion of the elevator (the lift)?
- A It is moving down at a constant speed
 B It is moving down and slowing down
 C It is moving up and slowing down
 D It is moving up and speeding up. (2)
- 1.6. Safety rails installed along some roads can collapse (bend and crumple) when a car runs onto them. Why is this done?
- A So that the car can come to rest faster
 B To increase the momentum and decrease the crash force
 C To increase the change in velocity of the car
 D To increase the contact time and decrease the crash force (2)
- 1.7. Planet K exerts a force of F on ♥Star man. In terms of F , what would the gravitational force be on ♥Star man exerted by Planet D that is 4 times more massive than planet K and 6 times closer to ♥Star man?
- A $\frac{2}{3} F$ B $\frac{1}{9} F$
 C $24 F$ D $144 F$
- 1.8. Three light bulbs, **X**, **Y** and **Z**, with resistances **R**, **2R** and **4R** respectively, are connected in a circuit as shown in the circuit diagram below. The battery has negligible internal resistance. The reading on ammeter **A** is 3,5 A.



When lightbulb Y burns out, what would the reading on A₃ be?

- A 1,75 A
 B 0,50 A
 C 2,00 A
 D 0,70 A

- 1.9. The kettle in the Science Lab is rated 2 500 W. During winter it is used for a total of 130 minutes per day. The cost of electricity is R1,90 per kWh. Which of the expressions below can be used to calculate the cost in rands, per day, of using the kettle?

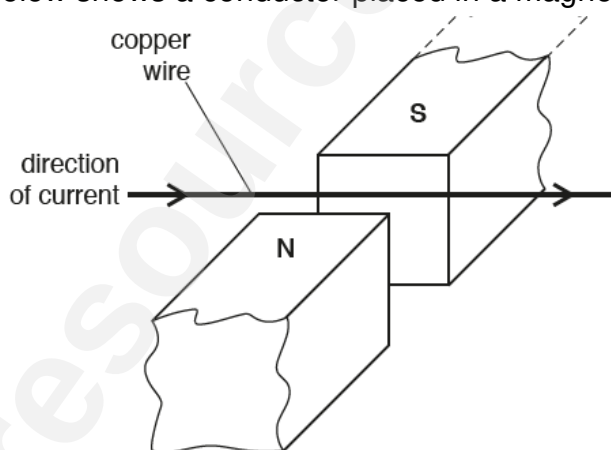
A
$$\frac{2,5 \times 130 \times 1,9}{1000}$$

B
$$\frac{2,5 \times 130 \times 190}{1000}$$

C
$$\frac{2500 \times 130 \times 1,9}{1000 \times 60}$$

D
$$\frac{2500 \times 130 \times 1,9}{60}$$

- 1.10. The diagram below shows a conductor placed in a magnetic field.



In which direction will the wire experience a force when the current is moving to the right in the conductor as shown above?

- | | |
|-------------|-------------|
| A Upwards | B Downwards |
| C Towards S | D Towards N |

Question 2: Kinematics**[31]**

2.1. The 2019 Comrades Marathon took place on 9th June with an “UP” run from Durban to Pietermaritzburg. The race distance is approximately 87 km. Gerda Steyn won the Woman’s Race in a time of 5 hours 58 minutes and 33 seconds.

2.1.1. Calculate Gerda’s average speed in meters per second. (4)

A helicopter flew along a straight path from the start of the race in Durban to land at the finish at Scottsville Racecourse in Pietermaritzburg. It travelled for 32 minutes at an average speed of 126 km.h⁻¹.

2.1.2. Distinguish between *distance* and *displacement*. (3)

2.1.3. What is the speed of the helicopter in m.s⁻¹? (1)

2.1.4. Calculate the magnitude of Gerda’s displacement when she reaches the finish. (2)

2.2. A spectator throws a mascot up into the air from a balcony of an apartment building.

The sketch graph below shows the motion of the mascot from the time it leaves her hand to the moment it falls on the ground.

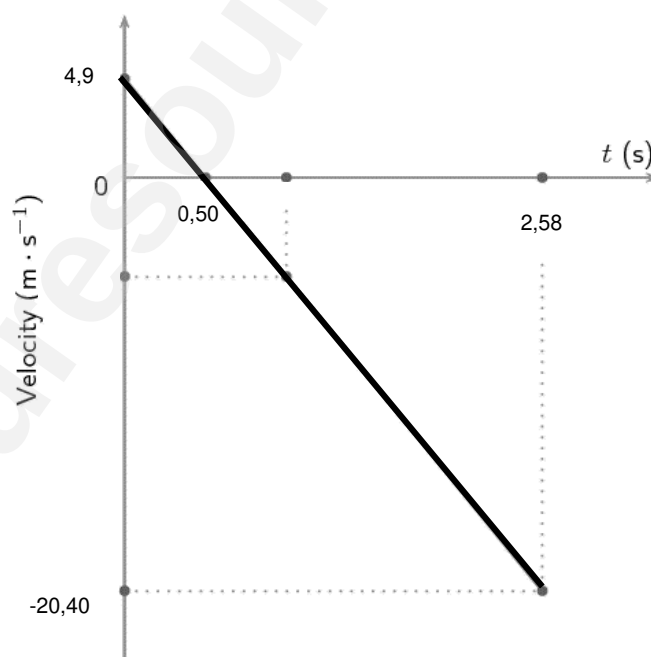


Diagram: Siyavula

2.2.1. During which time intervals is the mascot

- a) Speeding up?
- b) Slowing down? (2)

2.2.2. Use the graph to determine the height of the balcony from the ground. (4)

2.2.3. In your answer book, draw sketch graphs for the motion of the mascot of the following:

- a) Displacement vs time using the ground as a reference. (4)
Only already calculated values have to be added into the graph.
- b) Acceleration vs time. Include the magnitude of the acceleration. (3)

2.3. Two boys getting bored on the side decide to have a friendly bicycle race. John accelerates from rest with a constant acceleration of $0,4 \text{ m.s}^{-2}$. Paul gives John a head start of 5 s, and then accelerates from rest with a constant acceleration of $1,0 \text{ m.s}^{-2}$.

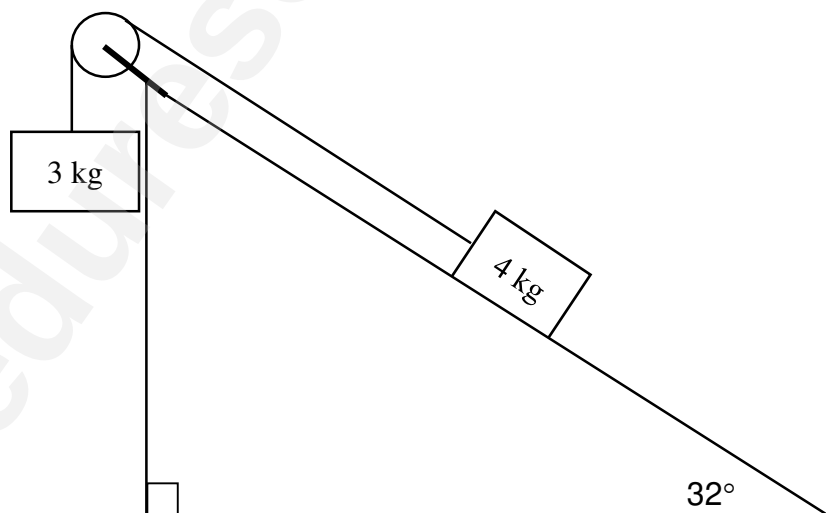
2.3.1. What distance does John cover before Paul starts to cycle? (3)

2.3.2. Calculate how long it takes for Paul to catch John from the time John started cycling. (5)

Question 3: Newton's Laws

[29]

The diagram below represents a frictionless pulley with an inextensible string of negligible mass connecting 2 blocks. The 4 kg block is on a rough surface inclined at 32° as shown. The 3 kg block accelerates downwards at a rate of $0,25 \text{ m.s}^{-2}$.



3.1. Draw a labelled free-body diagram showing all the forces acting on the 4 kg block. (4)

3.2. State Newton's second law of motion. (2)

- 3.3. Determine the magnitude of the tension in the string. (3)
- 3.4. Calculate the frictional force acting between the block and the incline plane. (5)
- 3.5. Define *normal force*. (2)
- 3.6. Determine the coefficient of kinetic friction for the plane and the 4 kg block. (4)

The coefficient of static friction is 0,23.

- 3.7. What must the tension force in the string be to just keep the 4 kg block at rest? (3)
- 3.8. Determine the minimum mass that must be added to the 4 kg block to just keep the system at rest. (6)

Question 4: Momentum, Work and Energy [40]

- 4.1. Thomas Röhler won the 2016 men's javelin throw competition at the Olympics in Rio de Janeiro by throwing a distance of 90,3 m



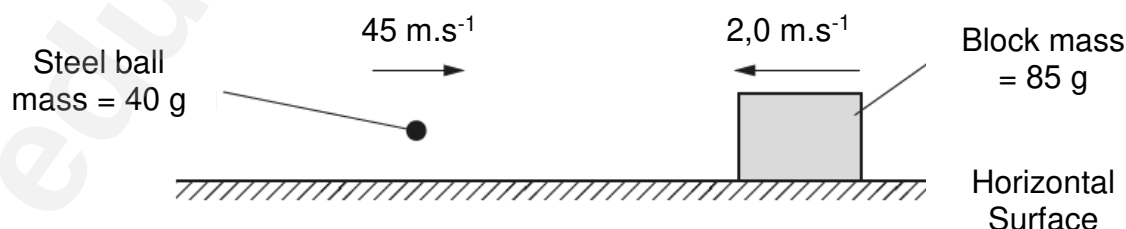
Wall street journal

To determine the different factors influencing the distance that the javelin will travel Thomas's managers decide to investigate the effect of the time of contact during the throw on the velocity that the javelin leaves his hand. Thomas was standing still during this investigation to make it a fair test.

The data in the table below was gathered by the sports scientists.

Time of contact (s)	Velocity of javelin (m.s^{-1})
0,3	6,6
0,6	16,5
0,7	19,0
0,8	21,8
1,0	27,2
1,2	31,0

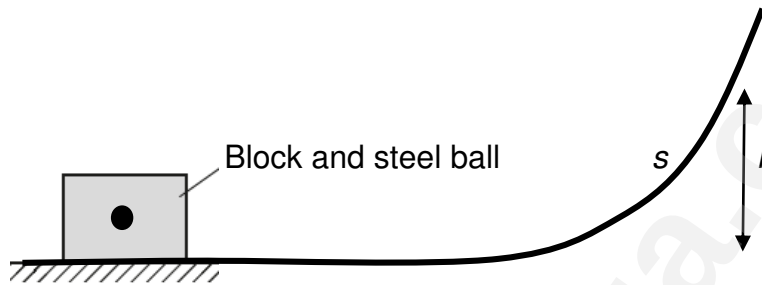
- 4.1.1. Write a hypothesis for this investigation. (2)
- 4.1.2. Define *impulse*. (2)
- 4.1.3. On the graph paper provided at the back of your answer booklet, plot a graph of the velocity that the javelin leaves the hand vs the time of contact during the throw. (6)
- 4.1.4. Determine the gradient of your graph. Clearly indicate on your graph the values used to determine the gradient. (4)
- 4.1.5. Write an expression for the final velocity that the javelin leaves his hand in terms of force, mass and the contact time for the change to take place. (2)
- 4.1.6. The mass of the javelin used was 850 g. Use your answers in 4.1.4 and 4.1.5. and your knowledge about straight line graphs, to determine the average force that was applied to the javelin during this investigation. (3)
- 4.2. A wooden block moves along a horizontal frictionless surface as shown below. The block has a mass of 85 g and moves to the left with a velocity of $2,0 \text{ m.s}^{-1}$. A steel ball of mass 40 g is fired to the right with a velocity of 45 m.s^{-1} .



The ball collides with the block and becomes embedded in it. After the collision the block and the steel ball both have a velocity v .

- 4.2.1. Determine the velocity, v , of the block and the steel ball after the collision. (4)
- 4.2.2. Explain how you would determine whether the collision is elastic or not. (2)
- 4.2.3. Use Newton's third law to explain the relationship between the rate of change of momentum of the ball and the rate of change of momentum of the block during the collision. (3)

After the collision the block slides up a curved surface as shown below.



- 4.2.4. State the law of conservation of mechanical energy. (2)
- 4.2.5. Determine the maximum vertical height (h) that the block and the ball will reach while moving up the curved plane. (4)
- 4.2.6. State the work-energy theorem. (2)
- 4.2.7. The block moved a distance (s) of 0,32 m along the curved path. Determine the net force acting on the block while moving along the path. (4)

Question 5: Fields and Vectors**[28]**

- 5.1. Two identical metal spheres are hanging 0,8 m apart on insulated threads as shown below. Sphere D has a charge of -9 nC and sphere J a charge of +15 nC as indicated on the diagram.



- 5.1.1. Sketch the electric field lines around the two charged spheres. (3)

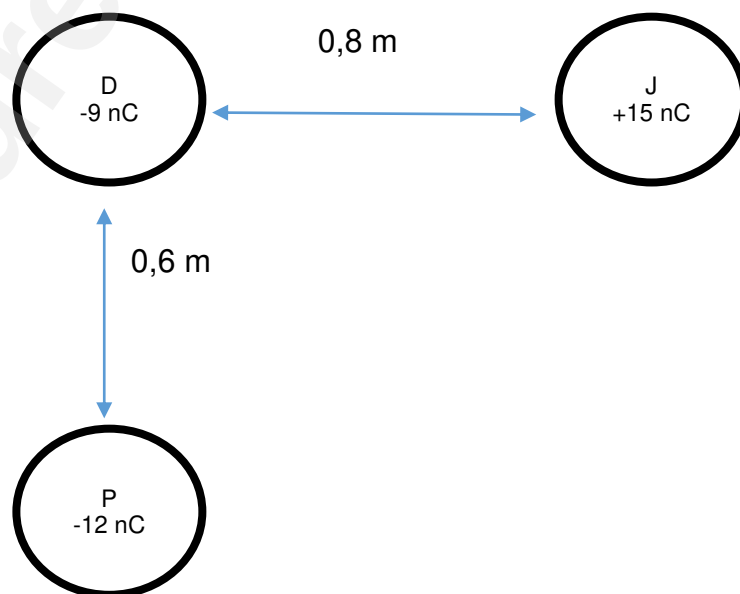
The two spheres are allowed to touch each other and separated again.

- 5.1.2. State the direction of electron transfer between the spheres. Only state D to J or J to D. (2)

- 5.1.3. Calculate the new charge on each sphere. (2)

- 5.1.4. Calculate the number of electrons transferred while the spheres were touching. (3)

- 5.2. Another charged sphere P (-12 nC) is placed below the original spheres, directly below sphere D as shown below.



5.2.1. State *Coulombs law*. (2)

5.2.2. Draw a free body diagram showing all the **electrostatic** forces acting on sphere D. (2)

5.2.3. Determine the magnitude and direction of the net force acting on sphere D due to spheres J and P. (6)

5.3. Mercury is the smallest inner planet in the Solar System.



This planet has a radius of 2 439,7 km and a mass of $3,285 \times 10^{23}$ kg.
A space rover of 2 500 kg roams the surface of this planet.

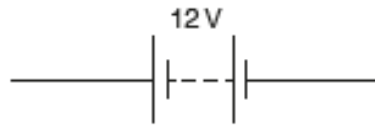
5.3.1. Define *weight*. (2)

5.3.2. Determine gravitational field strength of Mercury. (4)

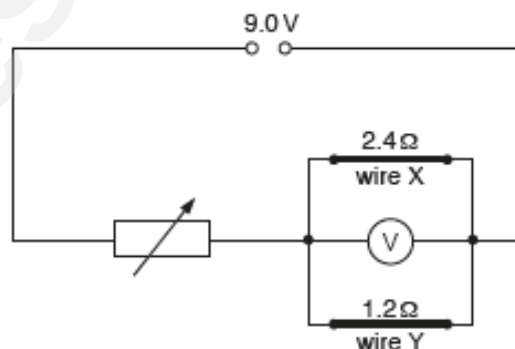
5.3.3. What would the mass of the space rover be on Mercury? (2)

Question 6: Current Electricity**[32]**

- 6.1. The figure below shows the symbol for a 12 V battery with negligible internal resistance.



- 6.1.1. Two light bulbs are connected in parallel with the battery. In your answer booklet, redraw the battery and using the correct symbols, complete the circuit diagram. (1)
- 6.1.2. Define *current*. (2)
- 6.1.3. One of the light bulbs has a resistance of $6\ \Omega$. For this light bulb, calculate:
- the current. (3)
 - the power of the other lamp is $36\ \text{W}$. Calculate the total energy delivered to this light bulb in 20 hours. (3)
- 6.2. An electric heater containing two heating wires X and Y is connected to a power supply with an emf of $9,0\ \text{V}$ and negligible internal resistance as shown in the diagram below.



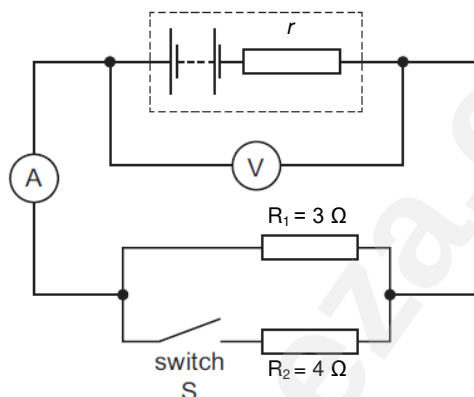
Wire X has a resistance of $2,4\ \Omega$ and wire Y has a resistance of $1,2\ \Omega$. A voltmeter is connected in parallel with the wires and a variable resistor is used to adjust the power dissipated in wires X and Y.

The variable resistor is adjusted so that the voltmeter reads $6,0\ \text{V}$.

- 6.2.1. Calculate the resistance of the variable resistor. (4)

6.2.2. Explain why the $1,2\ \Omega$ resistor will have a slower rate of energy conversion to heat energy than the $2,4\ \Omega$ resistor. Use appropriate equations to support your explanation. (4)

6.3. A battery, with significant internal resistance, r , is connected to an arrangement of two resistors and a switch as shown below. The connecting leads, ammeter and switch have negligible internal resistance but the voltmeter has a very high resistance. R_1 has a resistance of $3\ \Omega$ and R_2 has a resistance of $4\ \Omega$. Initially switch S is open.



6.3.1. Define *emf*. (2)

6.3.2. Determine the combined resistance of the two resistors when the switch is closed. (3)

In the circuit, the ammeter reads $2,2\ \text{A}$ when the switch S is open and $2,6\ \text{A}$ with the switch is closed.

6.3.3. Consider the open and closed circuits and calculate:

- the internal resistance of the battery
 - the emf of the battery
- (6)

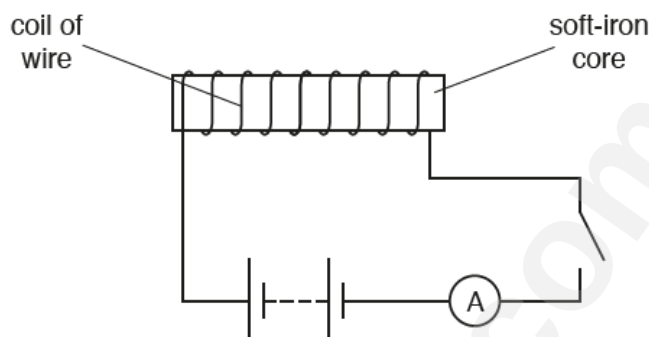
6.3.4. How is the voltmeter reading affected when the switch is closed? Only write increase, decrease or remain the same. (1)

6.3.5. Explain your answer in 6.3.4. by making reference to an appropriate equation. (3)

Question 7: Electrodynamics**[20]**

A coil of insulated wire is wound around an iron core.

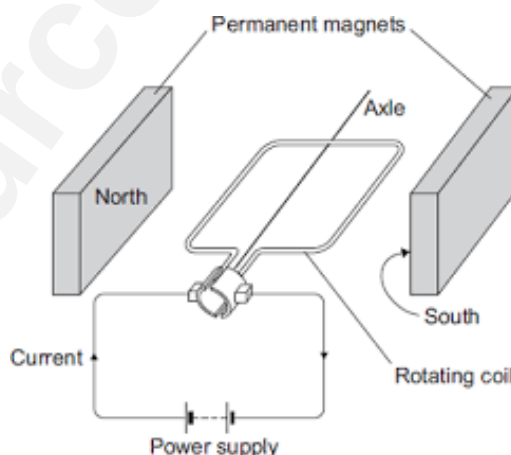
The coil is connected in series with a battery, a switch and an ammeter as shown.



7.1.1. In your answer book, draw a sketch of the electromagnet created by indicating the North and South poles of the electromagnet. (1)

7.1.2. State 2 ways to increase the strength of this electromagnet. (2)

7.2. The diagram below was found in the science class.
Kaylin decides to use it to construct a generator or a motor with the apparatus available in the class.



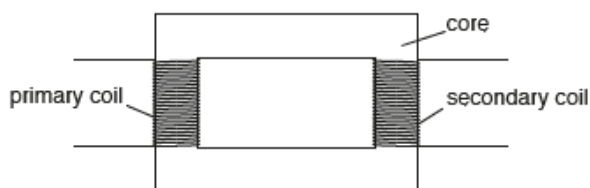
7.2.1. Does the diagram represent a motor or a generator? (1)

7.2.2. Explain your decision in 7.2.1 by referring to the energy conversion taking place. (2)

7.2.3. When the current flows in the circuit as shown, will the armature turn clockwise or anticlockwise? (1)

7.2.4. Explain how the armature remains turning in the direction stated in 7.2.3 using a direct current supply. (3)

- 7.3. A transformer consists of two coils of wire wound on a metal core as indicated below.



- 7.3.1. The primary coil of the transformer is connected to the output voltage of a generator which supplies an alternating current. Use *Faraday's Law of electromagnetic Induction* to explain why there is a voltage recorded between the two terminals of the secondary coil. (3)
- 7.3.2. There are 650 turns on the primary coil and 910 on the secondary coil of the transformer. This transformer is 90 % efficient and a peak current of 15 A is supplied to the primary coil. Calculate the current in the secondary coil. (5)
- 7.3.3. Step up transformers are used to increase the voltage when electrical energy is transmitted in cables along long distances. Explain why energy losses in the cables are lower when the voltage is high. (2)