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GRADE 12 EXAMINATION
JULY 2020

**PHYSICAL SCIENCE: PAPER I
PHYSICS**

Time: 3 Hours

Total: 200

Examiner: Ms. I Botha

Moderators: Mrs. F Paterson

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 14 pages and an answer sheet. **Please hand in the answer sheet with your answer booklet.**
2. Please check that your question paper is complete.
3. ALL the questions in this paper must be answered.
4. Question 1 consists of 10 multiple-choice questions. There is only one correct answer to each question. These questions are answered on the inside front cover of your Answer Book. The letter that corresponds with your choice of the correct answer must be marked with a cross as shown in the example below:

A	B	C	D
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Here the answer C has been marked.

5. **START EACH QUESTION ON A NEW PAGE.**
6. Read the questions carefully.
7. Use the data and formulae whenever necessary.
8. Express ALL answers correct to TWO decimal places, unless stated otherwise in the question.
9. An approved calculator (non-programmable, non-graphical) may be used.
10. Show all the necessary steps in calculations.
11. It is in your own interest to write legibly and to set your work out neatly.
12. You may NOT use Tippex.
13. You may not borrow ANYTHING during the examination.

Question 1 [20]

1.1. Which one of the following CANNOT be the magnitude of the resultant of two forces of magnitude 28N and 20N respectively?

- A. 10N B. 15N C. 40N D. 50N (2)

1.2. A body falls freely from rest. It falls a distance x in time t . What distance does it fall in double the time?

- A. $\frac{1}{2}x$ B. $2x$ C. $4x$ D. $9x$ (2)

1.3. A lady of weight 650N is standing on a Newton scale in a lift. While the lift is moving the reading on the scale is 680N. This implies that the lift is moving with a constant

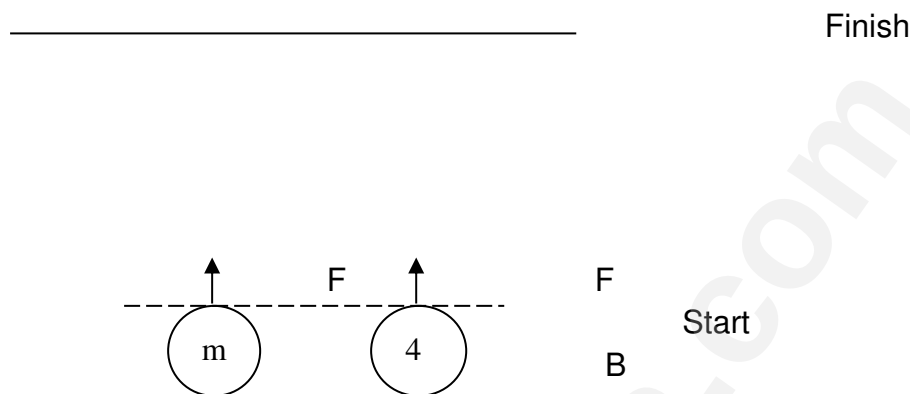
- A. velocity, upward.
B. velocity, downward.
C. acceleration, upward.
D. acceleration, downward. (2)

1.4. A ball of mass 100g collides **inelastically** with a wall at +20 m/s. What is the velocity at which the ball rebounds?

- A. $v < -20\text{m/s}$ C. $v > -20\text{m/s}$
B. $v = -20\text{m/s}$ D. $v < +20\text{m/s}$ (2)

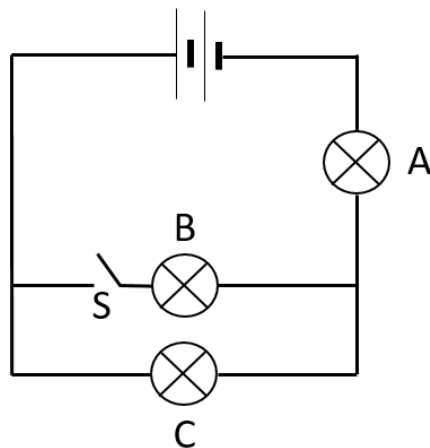
Questions 1.5 and 1.6 refer to the following information:

The diagram below shows two metal disks on a frictionless track. Disk B has four times the mass of disk A. Starting from rest, the disks are pushed all the way along the track by two equal forces, F .



- 1.5. Which disk will reach the finish line first?
- A.
 - B.
 - They will reach the finish line simultaneously.
 - There is not enough information to answer the question. (2)
- 1.6. Which disk will have the greater momentum upon reaching the finish line?
- A.
 - B.
 - They will have the same momentum.
 - There is not enough information to answer the question. (2)
- 1.7. Two objects carrying charges of 5 nC and 10 nC, respectively, are placed a certain distance apart. If the 5 nC charge experiences an electrostatic force of magnitude F , the 10 nC charge will experience an electrostatic force of magnitude
- $\frac{1}{2} F$
 - F
 - $2F$
 - $4F$ (2)

- 1.8. Three identical light bulbs are connected in a circuit as shown in the diagram below:

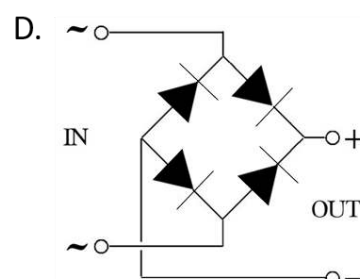
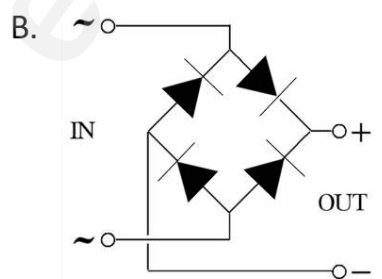
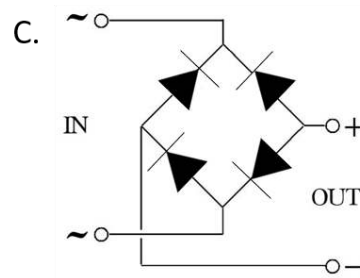
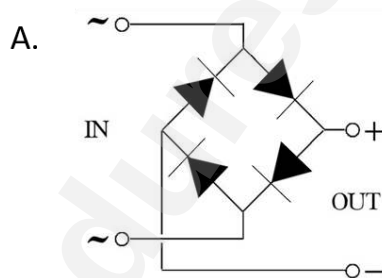


How do the current in bulbs A and C change when switch S is closed?

	Bulb A	Bulb C
A.	Increases	Increases
B.	Decreases	Decreases
C.	Increases	Decreases
D.	Decreases	Increases

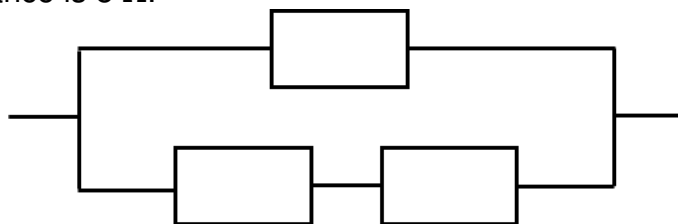
(2)

- 1.9. Which one of the connections of diodes below is the correct configuration of a rectifier?



(2)

- 1.10. The diagram shows an arrangement of three equal resistors. Its equivalent (total) resistance is $8\ \Omega$.



The value, in Ω , of each resistor is:

- A. 4 B. 8 C. 12 D. 18 (2)

Question 2 [104]

An agent (mass 65 kg) is doing the physical assessment for her special forces training.

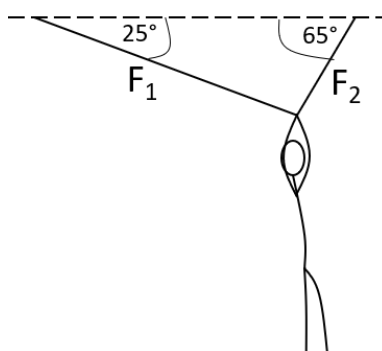
- 2.1. During the first part of the assessment she has to complete a 21 km course in a maximum of four hours. She completes the first 5 km part of the course in 45 minutes. She completes the second 10 km part of the course at an average speed of 4 km/h.

- 2.1.1. Calculate her average speed (in km/h) for the first part of the course. (3)

- 2.1.2. Calculate how long (in hours) it took her to complete the second part of the course. (2)

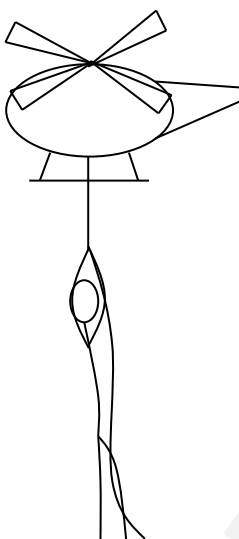
- 2.1.3. Calculate what her average speed (in km/h) should be for the third and last part of the course if she is to finish in time? (3)

- 2.2. **The diagram below represents the agent (mass 65 kg), stationary at one point while crossing a ravine using a rope.**



- Calculate the forces, F_1 and F_2 , as indicated in the diagram. (6)

- 2.3. During a rescue simulation, the agent is hoisted upward at a constant acceleration of $0,5 \text{ m/s}^2$ by a helicopter, as indicated in the diagram below: (Ignore any forces of friction when answering the questions below.)



- 2.3.1. Draw a labelled free-body diagram showing all forces acting on the agent. (3)
- 2.3.2. Calculate the **net** force acting on the agent. (4)
- 2.3.3. **Name and state** the law used to calculate 2.3.2. above. (5)
- 2.3.4. Calculate the tension in the cable while the agent is being hoisted up. (4)
- 2.4. During a high speed chase along a straight, horizontal road, the agent is racing at 180 km/h when she notices an obstacle 200 m ahead of her in the road. The agent has a lower than average reaction time of $0,4 \text{ seconds}$, which means that she slams on the brakes $0,4 \text{ seconds}$ after she noticed the obstacle.
- 2.4.1. Convert 180 km/h into m/s . (2)
- 2.4.2. What distance does the agent cover before she hits the brakes? (3)
- 2.4.3. If the maximum deceleration of the car once the brakes are applied is 8 m/s^2 , determine through calculation whether the agent manages to stop before hitting the obstacle. (6)
- 2.4.4. Calculate the maximum coefficient of kinetic friction between the tyres of car and the road while the brakes are applied. (4)
- 2.4.5. The car is equipped with ABS brakes, which prevents skidding. Explain why this improves the braking performance of cars. (3)

2.4.6. Calculate how long it takes for the car to come to rest after the brakes are applied. (4)

2.5. **While fleeing pursuers the agent jumps off a 4m high roof onto a canvas canopy. The canopy tears and the agent lands on the ground at a velocity of 6 m/s.**

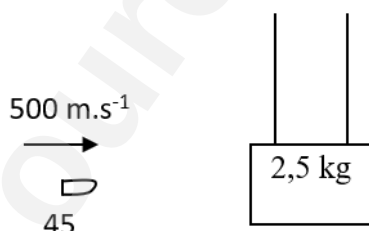
2.5.1. Calculate her gravitational potential energy on the roof. (3)

2.5.2. Use **energy principles** to calculate the energy required to tear the canvas. (4)

2.5.3. The agent bends her knees when she lands. Explain how bending her knees decreases the risk of injury. (4)

2.5.4. It takes 0,3s from the time that the agent's feet touch the ground until she stops moving. Use **momentum** to calculate the average net force acting on her after her feet touch the ground. (5)

2.6. **The agent fires her pistol at a stationary target consisting of a wooden block of mass 2,5 kg that can swing freely from ropes, as in the diagram below: (Frictional forces are negligible.)**



The bullet of mass 45g enters the block at a velocity of 500 m/s and gets stuck in the block.

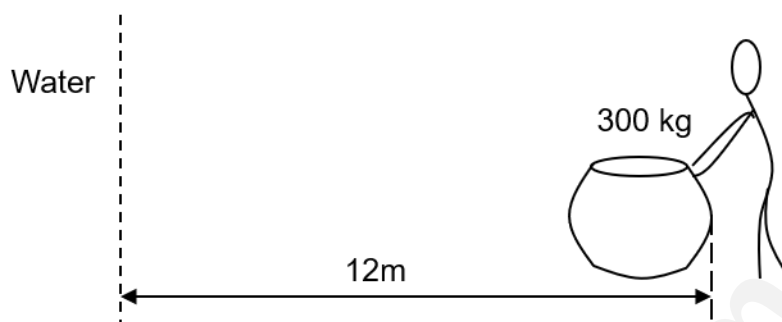
2.6.1. Name and state the conservation law that may be used to calculate the speed of the block with the bullet embedded in it. (4)

2.6.2. Use the law mentioned in 2.6.1 above to calculate the speed of the block with the bullet in it directly after the bullet hit the block. (5)

2.6.3. Name the conservation law that may be used to calculate the maximum height reached by the block once the bullet is embedded in it. (2)

2.6.4. Calculate the maximum height reached by the block with the bullet embedded in it. (4)

2.7. **The agent has to push a 300 kg barrel containing a bomb, set to explode in 5 seconds, 12m across a rough, horizontal surface into the water. While the agent pushes against the barrel at an angle of 40° to the horizontal, the coefficient of maximum static friction is 0,38.**



- 2.7.1. Calculate the force of friction between the surface and the barrel just before it starts to move. (5)
- 2.7.2. Calculate the minimum force that the agent has to exert (at a 40° angle to the horizontal) in order **to start the barrel moving**. (3)
- 2.7.3. The force of kinetic friction is 90% of the static friction. Calculate the force of kinetic friction. (2)
- 2.7.4. The agent continues to push with the same constant force calculated in 2.7.2. while the barrel moves. Use the **work-energy theorem** to calculate the horizontal velocity of the barrel when it reaches the water. (6)
- 2.7.5. Determine by calculation if the agent manages to push the barrel into the water before the bomb explodes. (5)

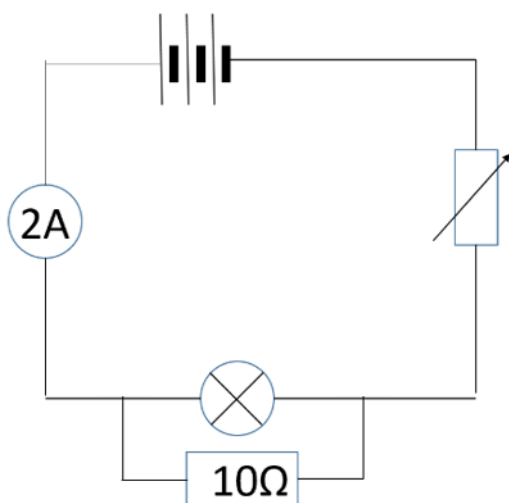
Question 3 [8]

The radius of a hydrogen atom is 53 pm. This means that the average distance between the nucleus (containing one proton) and the electron in a hydrogen atom is 53pm.

- 3.1. Draw the electric field between a proton and an electron. (3)
- 3.2. Calculate the average electrostatic force between the electron and the nucleus in a hydrogen atom. (5)

Question 4 [33]

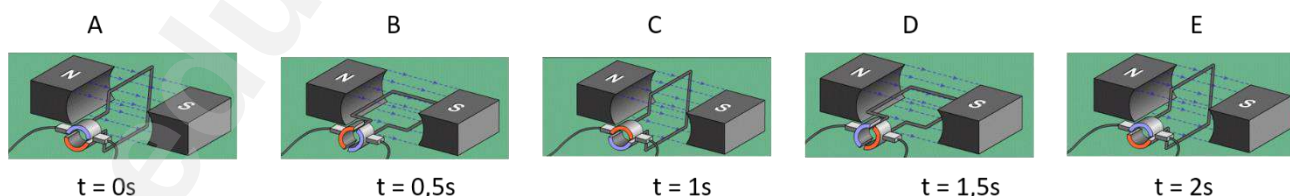
In the circuit diagram given below, each cell has an Emf of 3V and internal resistance of $0,2\ \Omega$ and the resistance of the bulb is $2\ \Omega$:



- 4.1. What does an Emf of 3V mean? (3)
- 4.2. Calculate the Emf of the battery? (1)
- 4.3. Calculate the equivalent resistance of the components connected in parallel. (4)
- 4.4. What is the function of a rheostat in a circuit? (1)
- 4.4. Calculate the resistance of the rheostat. (5)
- 4.5. Calculate the current passing through the 10Ω resistor. (5)
- 4.6. Calculate the power dissipated in the bulb. (4)
- 4.7. Calculate the cost (in cent) of using the bulb for 8 hours in a town where the price of electricity is R1,70 per unit. (4)
- 4.8. The 10Ω resistor is removed from the circuit. Use an equation to explain the effect on the brightness of the bulb. (6)

Question 5 [18]

The series of diagrams below shows a single loop of the coil of a DC generator. The coil rotates once every 2 seconds.



- 5.1. Define magnetic flux linkage. (2)
- 5.2. What does DC mean? (1)
- 5.3. What change should be made to the generator above to change it into an AC generator? (1)
- 5.4. What energy conversion takes place in a generator? (2)
- 5.6. Draw a sketch graph of the **flux linkage versus time** for the diagrams above. (4)

- 5.7. What physical quantity can be obtained from the gradient of the graph in 5.6 above? (1)
- 5.8. State Faraday's Law of Electromagnetic Induction. (3)
- 5.9. Use an equation to explain why doubling the speed at which the coil turns doubles the Emf induced. (2)
- 5.10. State two other changes that can be made to the generator that would increase the Emf that is induced. (2)

Question 6 [17]

The line spectra of elements are unique and can be used to identify elements.

- 6.1. Explain how the lines in line spectra form. (3)

A specific line in the spectrum of an element has a wavelength of 457 nm.

- 6.2. Calculate the frequency of the light. (3)

Sodium metal, which has a work function of 2.46 eV, is irradiated with light from a 457 nm source.

- 6.3. Define **work function** of a metal. (2)

- 6.4. Convert the work function of sodium into Joules. (2)

- 6.5. Calculate the maximum kinetic energy (in J) of the photoelectrons released from the surface of the sodium metal. Give your answer in Joules. (4)

The intensity of this strontium lamp is now increased.

- 6.6.1. What effect does this change have on the photoelectrons that are released? (1)

- 6.6.2. Explain your answer to 6.6.1. above. (2)

Total: 200

END OF PAPER