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Stanford Lake College

PHYSICAL SCIENCES
GRADE 12
PRELIMINARY EXAMS
PAPER 1
28 AUGUSTUS 2023

Examiner: Mrs G. van Staden
Moderator: Mr S. Mpangeva & Mrs A. White
Time: 3 hours
Total Marks: 200

NAME: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 29 pages and a Data Sheet. Please check that your question paper is complete.
2. Read the questions carefully.
3. Answer ALL the questions on the question paper and hand it in at the end of the examination. Remember to write your examination number 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. THREE blank pages (pages 30 to 32) are included at the end of the paper. If you run out of space for a question, use these pages. Clearly indicate the question number of your answer should you use this extra space.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	TOTAL
Mark	20	18	19	14	12	21	30	28	20	18	200
Moderated mark											
Total											



QUESTION 1

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.

Here, option C has been marked as an example

A	B	☒	D
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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

1.1 Two forces acts on an object as shown below:



Choose the correct option for the resultant of the two forces from the table below:

	Magnitude (N)	Direction
A	13	67,4° South of West
B	17	22,6° South of West
C	13	67,4° West of South
D	13	22,6° West of South

(2)

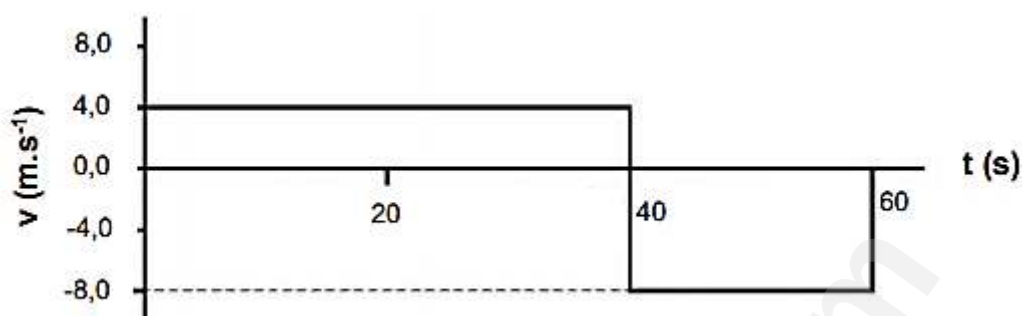
1.2 Two parallel forces, X and Y, have a resultant of 6 N. If the magnitude of X is 14 N then the magnitude of Y could be:

- A. 6 N
- B. 8 N
- C. 16 N
- D. 22 N

(2)



- 1.3 A bicycle travels along a straight horizontal road. The velocity vs time graph for its motion is shown below.

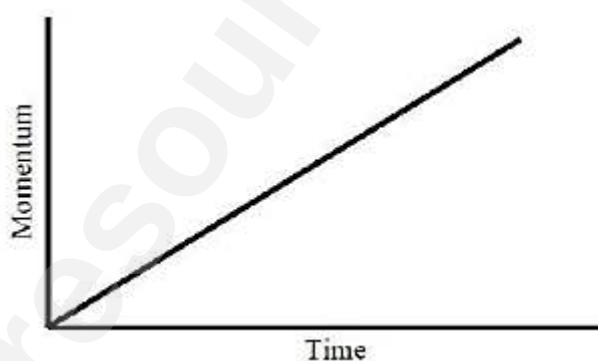


What is the distance travelled and the magnitude of the average velocity of the bicycle after 60 s?

	Distance (m)	Average velocity (m.s^{-1})
A	320,0	8,1
B	0,0	5,3
C	320,0	0,0
D	320,0	5,3

(2)

- 1.4 A graph of the momentum of a car against time is shown below.



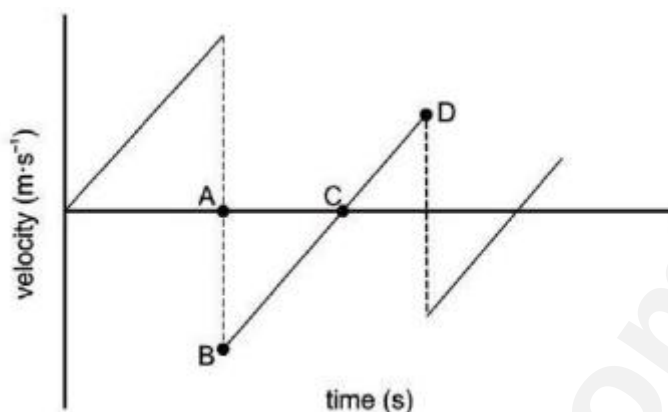
What does the gradient of the graph represent?

- A. The acceleration of the car.
- B. The resultant force acting on the car.
- C. The change in kinetic energy of the car.
- D. The rate of change of velocity of the car.

(2)



- 1.5 A ball is dropped vertically from rest above a hard, horizontal surface. The motion for the bouncing ball is represented on the velocity vs time graph shown below. Air resistance is negligible.



At which point labelled on the graph does the ball reach its maximum height after the first bounce?

- A. A
- B. B
- C. C
- D. D

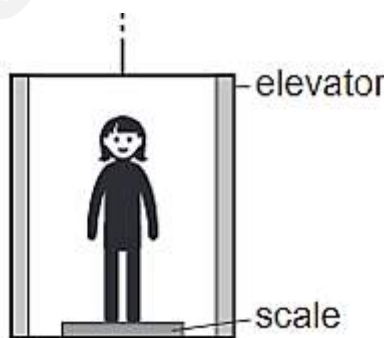
(2)

- 1.6 The table shows data from a high-jump competition. Which athlete jumps the highest?

	Weight of athlete (N)	Increase in gravitational energy (J)
A	600	1320
B	700	1610
C	800	1760
D	900	1800

(2)

- 1.7 A person with a weight of 600 N stands on a scale in an elevator.



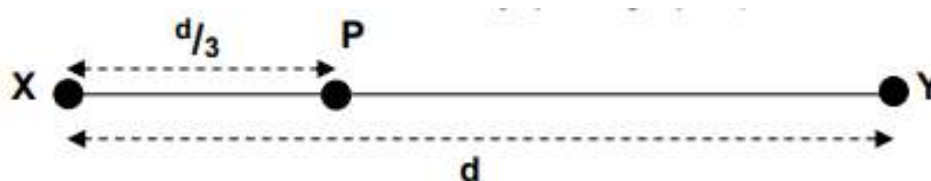
What is the acceleration of the elevator when the scale reads 900 N?

- A. $5 \text{ m}\cdot\text{s}^{-2}$ downwards
- B. $1,5 \text{ m}\cdot\text{s}^{-2}$ downwards
- C. $1,5 \text{ m}\cdot\text{s}^{-2}$ upwards
- D. $5 \text{ m}\cdot\text{s}^{-2}$ upwards

(2)



- 1.8 Two point charges (X and Y) are placed a distance d apart from each other. The net/resultant electric field intensity (strength) at point P is zero. Point P is $d/3$ from X.



Which of the following statements concerning X and Y is correct?

	Charge on X	Charge on Y	
A	Positive	Positive	Charge on X < charge on Y
B	Positive	Negative	Charge on X < charge on Y
C	Positive	Positive	Charge on X > charge on Y
D	Positive	Negative	Charge on X > charge on Y

(2)

- 1.9 An electric pump lifts 500 kg of water per hour to a height of 4 m. The power output rating of the pump can be calculated by:

A $\frac{500 \times 9,8 \times 4}{1}$

B $\frac{500 \times 9,8 \times 4}{60}$

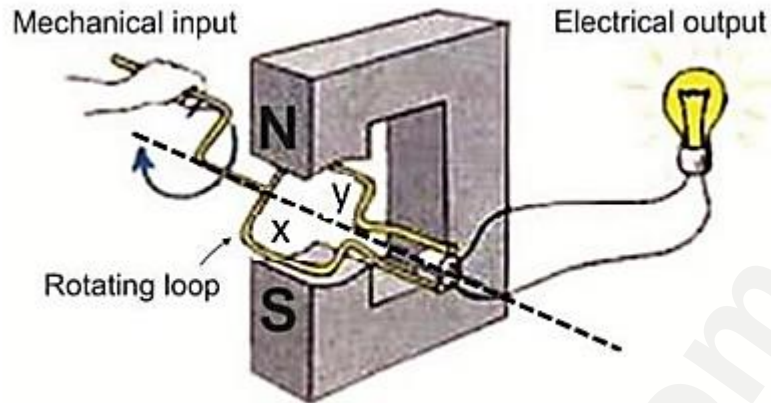
C $\frac{500 \times 9,8}{60 \times 4}$

D $\frac{500 \times 9,8 \times 4}{3600}$

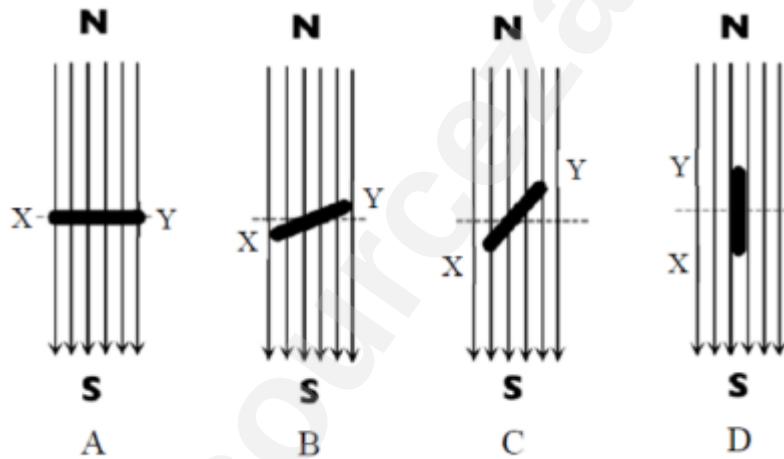
(2)



1.10 In a generator, a loop of wire is rotated in a magnetic field to cause the light to glow.



The solid dark line in the following diagrams illustrates the orientation of the plane XY of the loop. For which of the diagrams below will the magnetic flux be maximum?



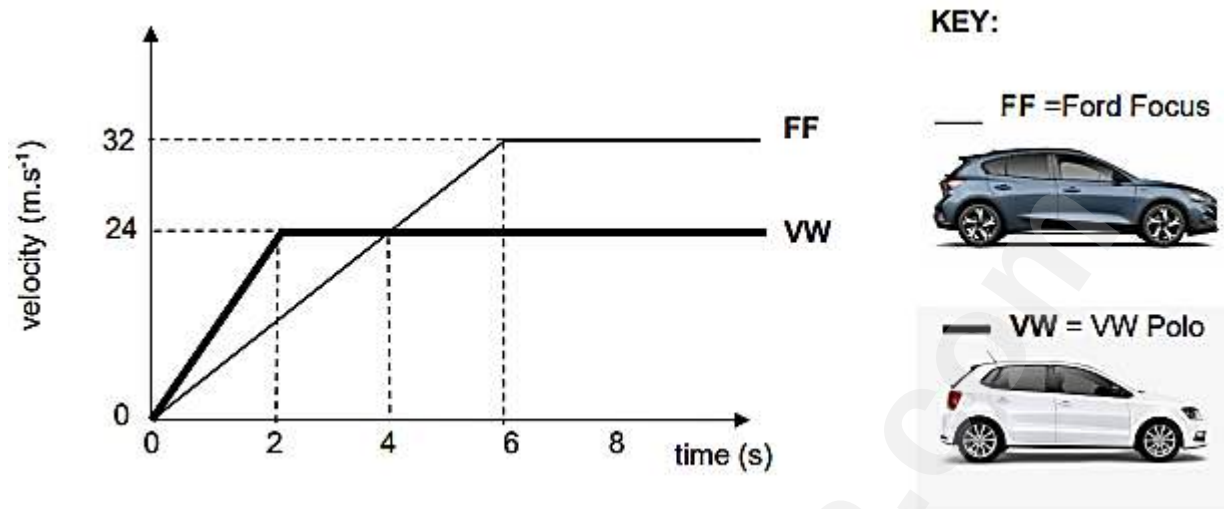
(2)

[20]



QUESTION 2

A VW Polo and a Ford Focus travel due east from the same starting position on a straight road. The velocity of each car is shown against time in the graph below.



2.1 Define velocity. (2)

2.2 Calculate the magnitude of the acceleration of the Ford Focus (FF) during the first 6 s. (3)

2.3 Calculate the distance travelled by the VW Polo (VW) in the first 6 s (3)

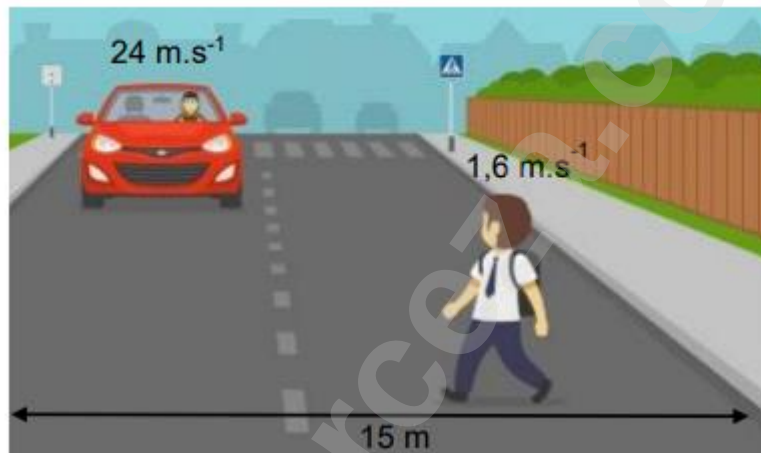


2.4 At what time (from the start) will the Ford Focus (FF) draw level with the VW Polo (VW)?

(5)

2.5 A pedestrian wants to cross the road in front of an approaching car.

(5)



The road is 15 m wide and the pedestrian walks across the road at a constant speed of $1,6 \text{ m.s}^{-1}$. The car is travelling at a constant speed of 24 m.s^{-1} . To avoid being hit by the car, the pedestrian must start crossing the road timeously. What is the minimum distance in front of the car that the pedestrian must start crossing the road, in order to cross safely to the other side?

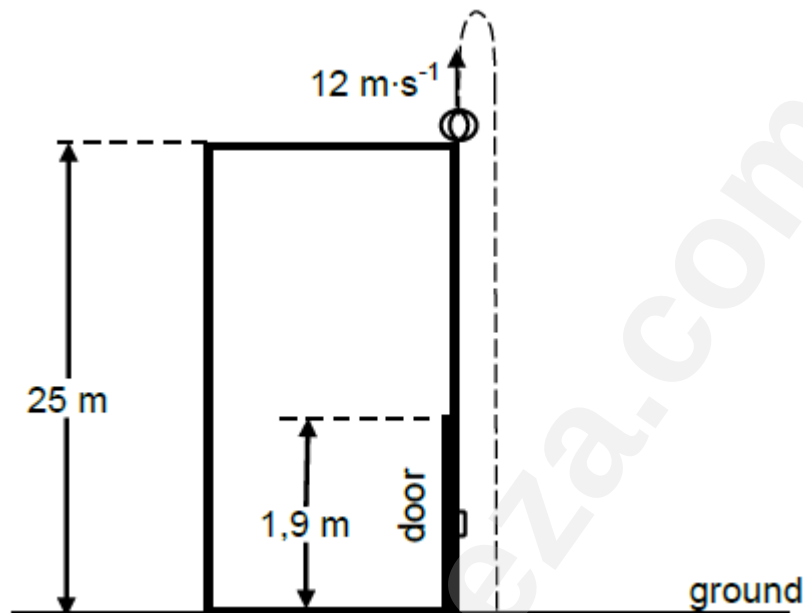
[18]



QUESTION 3

A ball is thrown vertically upwards from the top of a building of height 25 m with a velocity of $\text{m}\cdot\text{s}^{-1}$. On its way down, the ball passes a door which has a height of 1,9 m and then strikes the ground, as shown in the diagram below.

Ignore the effects of air friction.



- 3.1 Explain what is meant by the term projectile. (2)

- 3.2 Calculate the:

- 3.2.1 Time taken for the ball to reach its maximum height. (3)



3.2.2 Velocity with which the ball strikes the ground.

(4)

3.2.3 Time it took the ball to move from the top of the door to the ground.

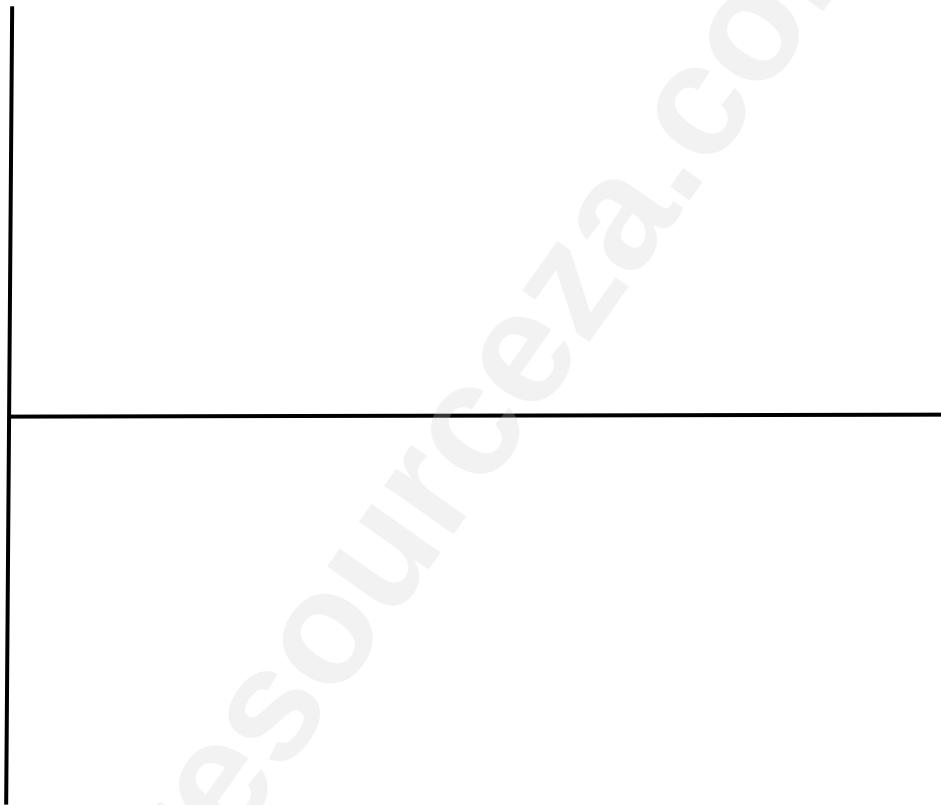
(5)



- 3.3 Draw a velocity versus time graph for the motion of the ball from the moment that the ball is thrown upwards until it strikes the ground. Use the ground as zero reference. (5)

Clearly indicate the following on your graph:

- The velocity with which the ball was thrown upwards
- Time taken by the ball to reach its maximum height
- The velocity with which the ball strikes the ground

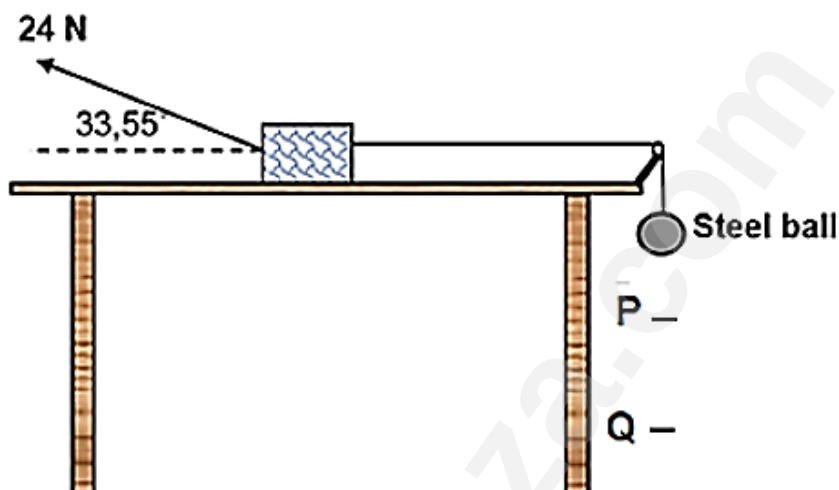


[19]



QUESTION 4

A wooden block, placed on a frictionless table, is connected to a steel ball by means of a light, inextensible string that passes over a frictionless pulley. A force of 24 N is applied to the wooden block at an angle of $33,55^\circ$ to the horizontal to the left as shown in the diagram below. The wooden block moves at a **CONSTANT VELOCITY** to the right. The steel ball moves past point P with a velocity of $0,25 \text{ m}\cdot\text{s}^{-1}$.



- 4.1. Name the Newton's Third Law pair (action-reaction) forces acting between the block and the table. (2)

- 4.2 Define the term weight. (2)

- 4.3 Calculate the mass of the steel ball. (4)



- 4.4 It takes the wooden block 1,2 s to move from point **P** to point **Q**. (3)
Calculate the distance between points **P** and **Q**.

- 4.5 At the instant that the steel ball moves past point **Q**, the string breaks. (3)
How long does the steel ball take to reach the ground which is 0,55 m below point **Q**?

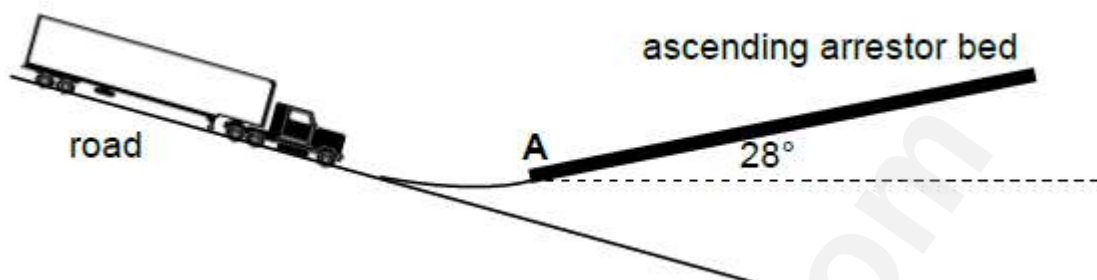
[14]



QUESTION 5

Arrestor beds are used to help moving trucks to come to a stop when their brakes fail.

The driver of a 30 000 kg truck driving down a steep road drives onto an ASCENDING arrestor bed inclined at 28° to the horizontal, as shown in the diagram below.



5.1 State the work-energy theorem in words.

(2)

The truck with failed brakes passes point A at the beginning of the arrestor bed at a speed of $33 \text{ m}\cdot\text{s}^{-1}$. The average frictional force on the truck is 31 000 N while the truck moves up the arrestor bed.

Ignore the rotational effects of the wheels.

5.2 Give a reason why the net work done on the truck, while moving on the arrestor bed, is negative.

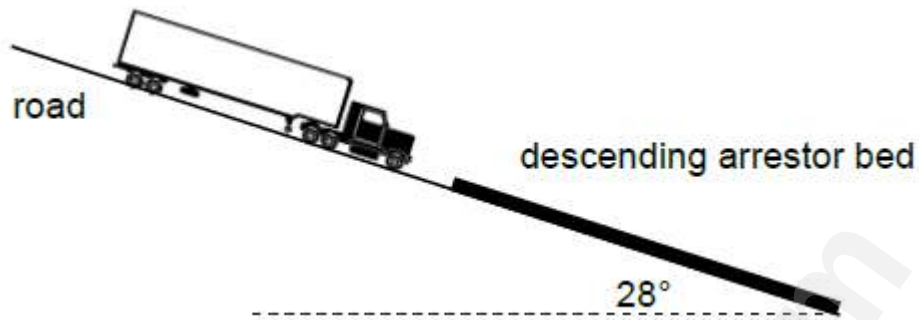
(2)

5.3 Use ENERGY PRINCIPLES to calculate the minimum length of the arrestor bed needed to bring the truck to a stop.

(5)



The diagram below shows the same truck entering a DESCENDING arrestor bed inclined at 28° to the horizontal. The initial speed of the truck and the average frictional force on the truck are $33 \text{ m}\cdot\text{s}^{-1}$ and $31\,000 \text{ N}$ respectively



- 5.4 Which arrestor bed, ASCENDING or DESCENDING, will be able to stop the truck in a shorter distance?

Explain the answer in terms of the forces acting on the truck.

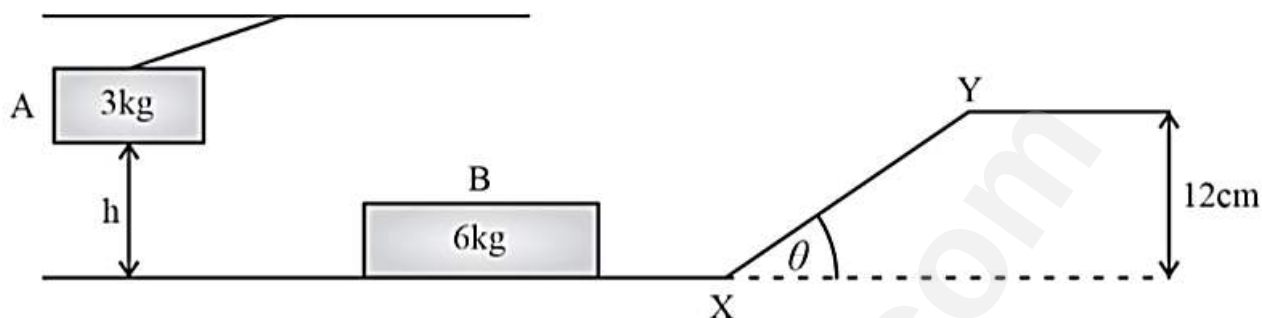
(3)

[12]



QUESTION 6

Block A with a mass of 3 kg is released from height h and collides with block B with a mass of 6 kg at the bottom of its swing. Immediately after the collision block A moves at $0,5 \text{ m} \cdot \text{s}^{-1}$ to the left and block B moves at $2,25 \text{ m} \cdot \text{s}^{-1}$ to the right.



6.1 State the law of conservation of linear momentum. (2)

6.2 Calculate the speed of block A before the collision at the bottom of its swing. (4)

6.3 Determine the height, h , that block A was released from. (4)



- 6.4 If the collision lasts 0,01 s, calculate the magnitude of the force exerted by the 3 kg block on the 6 kg block during the collision. (3)

After the collision, block B moves up a rough incline XY. A constant frictional force of 20,5 N acts on the block and causes it to come to rest at point Y.

- 6.5 Determine the angle of the incline. (8)

[21]



QUESTION 7

- 7.1 A 20 g balloon is filled with helium and allowed to float around a room. The balloon holds a static charge of -10 nC . As the balloon passes over a charged plastic chair, it comes to a stop and hovers $0,2 \text{ m}$ above the chair.



- 7.1.1 State Coulomb's Law. (2)

- 7.1.2 Does the chair have a positive or negative charge? (1)

- 7.1.3 Draw the free-body diagram of the forces acting on the suspended balloon. (2)



7.1.4 Calculate the magnitude of the charge on the chair.

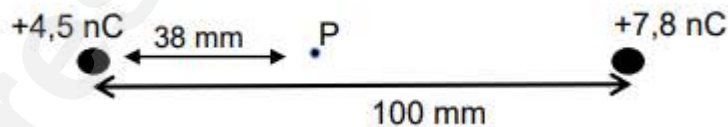
(5)

7.2 Two small conducting spheres which carry charges of $+4,5 \text{ nC}$ and $+7,8 \text{ nC}$ are placed a distance of 100 mm apart as shown in the diagram below.

7.2.1 Describe what is meant by an electric field.

(2)

7.1.2 Along the straight line joining the two small spheres, there is a point P as indicated on the diagram. This point is 38 mm from the $+4,5 \text{ nC}$ charge.



a) Determine the resultant electric field strength at P.

(4)



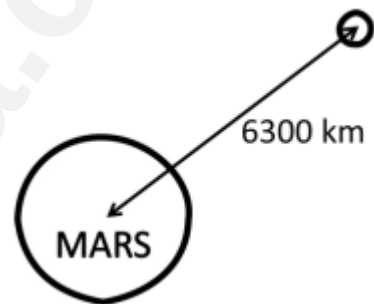
- b) An proton is placed at P. Determine the magnitude of the net force that the proton will experience due to the electric fields.

(3)

- 7.3 An astronaut visiting Mars in the year 2072 is orbiting the planet in his spacecraft.

The orbiting spacecraft (including the astronaut) has a mass of 4 250 kg and Mars has a mass of $6,4 \times 10^{23}$ kg.

While in orbit, the spacecraft is a distance of 6 300 km from the centre of Mars.



- 7.3.1 Calculate the gravitational force between the spacecraft and Mars.

(4)



After landing, the astronaut measures the acceleration due to gravity on the surface of Mars to be $3,7 \text{ m}\cdot\text{s}^{-2}$.

7.3.2 Use the value for g measured on the surface to calculate the radius of Mars. (3)

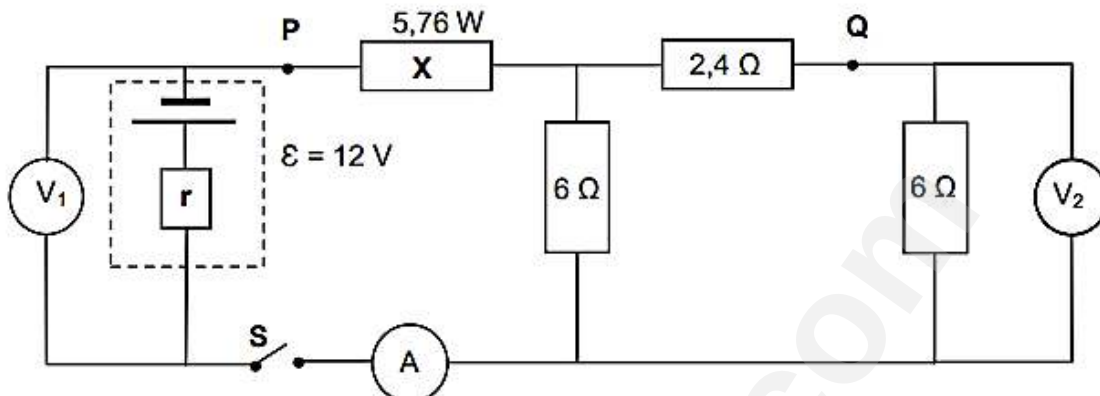
7.3.3 If Mercury has half the mass of Mars and a radius one third the radius of Mars, what is the value of g on the surface of Mercury? (3)

[29]



QUESTION 8

- 8.1 The battery in the circuit shown below has an emf of 12 V and an unknown internal resistance r . The resistance of the connecting wires and the ammeter is negligible.



Switch S is OPEN.

- 8.1.1 Write down the reading on:

a) Voltmeter V_1 (1)

b) Voltmeter V_2 (1)

Switch S is now CLOSED. The reading on the ammeter is 1,2 A and the power dissipated in resistor X is 5,76 W.

8.1.2 Define the term power. (2)

Calculate the:

8.1.3 Resistance of resistor X. (3)



8.1.4 Total EXTERNAL resistance of the circuit

(3)

8.1.5 Reading on voltmeter V_2

(5)

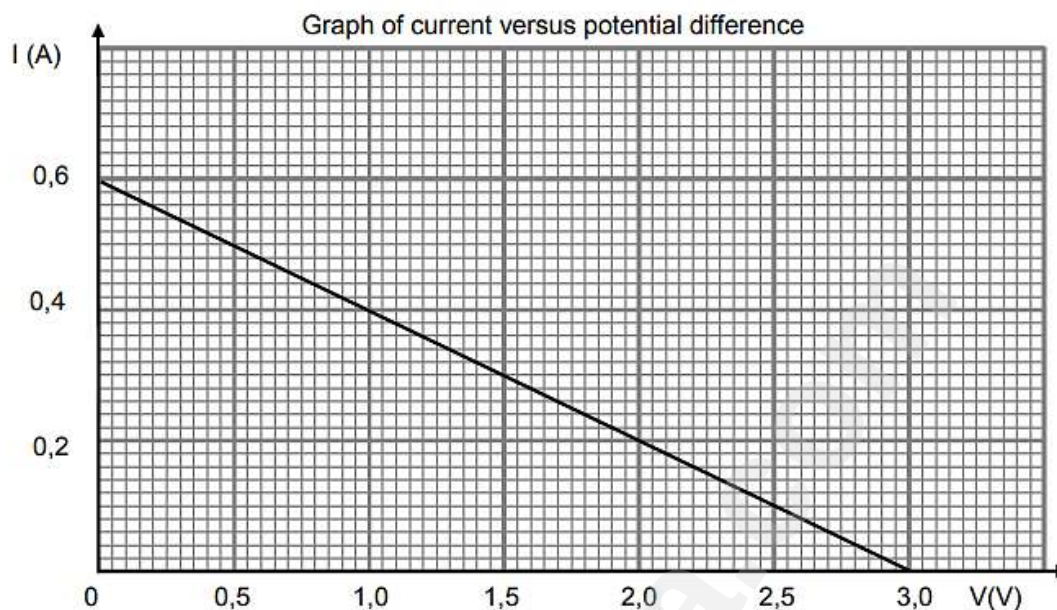
A length of wire of negligible resistance is used to connect point P to point Q in the circuit.

8.1.6 How will the reading on voltmeter V_1 be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

(4)



- 8.2 The graph below is obtained from an experiment to calculate the internal resistance of a battery.



- 8.2.1 Define the term Emf. (2)

- 8.2.2 Calculate V_{internal} resistance if the current in the circuit is equal to 0,2 A . (2)

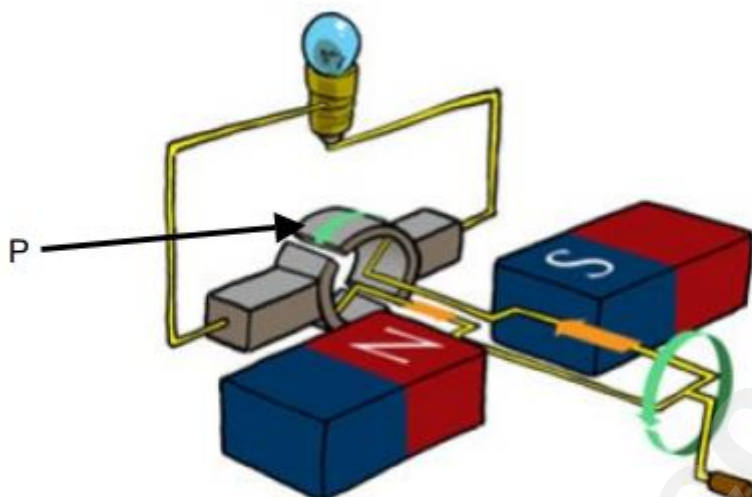
- 8.2.3 Use the graph to calculate the internal resistance of the battery. (5)

[28]



QUESTION 9

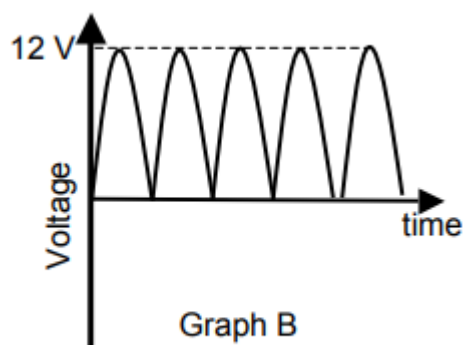
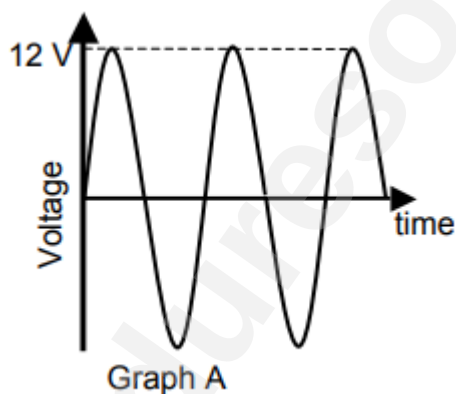
The diagram below represents an electrical device and P is a split ring commutator.



9.1 Give the name of the device. (2)

9.2 Write down the energy conversion that takes place in this device (2)

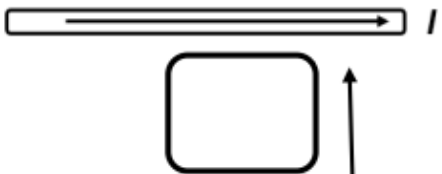
9.3 The split ring commutator is replaced by slip rings. Which ONE of the following voltage-time graphs (Graph A or Graph B) corresponds with the above change? (2)



9.4 The Emf is decreasing to 6 V. Suggest two changes that will result this outcome. (2)



- 9.5 The table below shows 4 different scenarios in which identical loops of wire are close to a straight, current carrying conductor. The current is moving to the right.

A <i>The loop is moving upwards towards the current carrying conductor</i> 	B <i>The loop is moving towards the right</i> 
C <i>The loop is not moving</i> 	D <i>The loop is moving downwards away from the current carrying conductor</i> 

9.5.1 State Lenz's Law.

(2)

9.5.2 In which of the scenario/s above will a current be induced? State the letter/s only.

(2)

9.5.3 In which scenario will the current move in a clockwise direction.

(2)

9.5.4 Use Faraday's Law to explain why you stated that a current was induced or not induced, in loop scenario B.

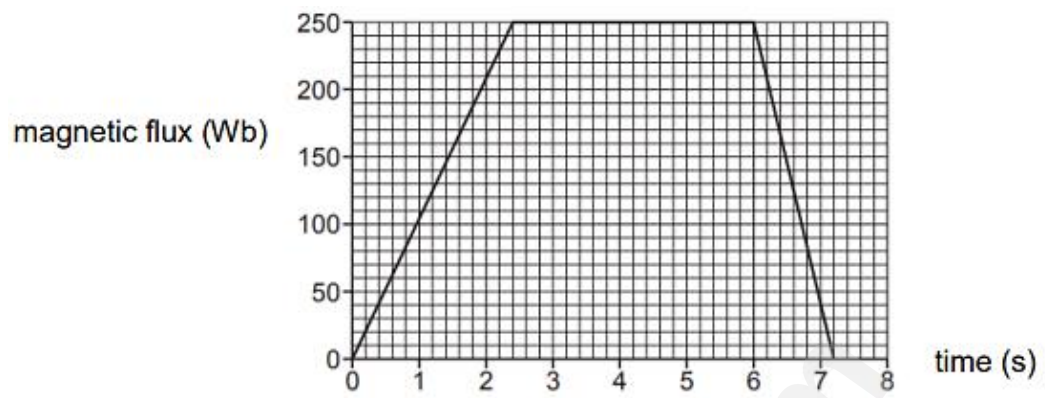
(2)



9.5.5

The variation with time t of the magnetic flux in a coil is shown below.

(4)



Sketch a graph showing the variation with time of the emf induced in the coil.
No exact values are needed.

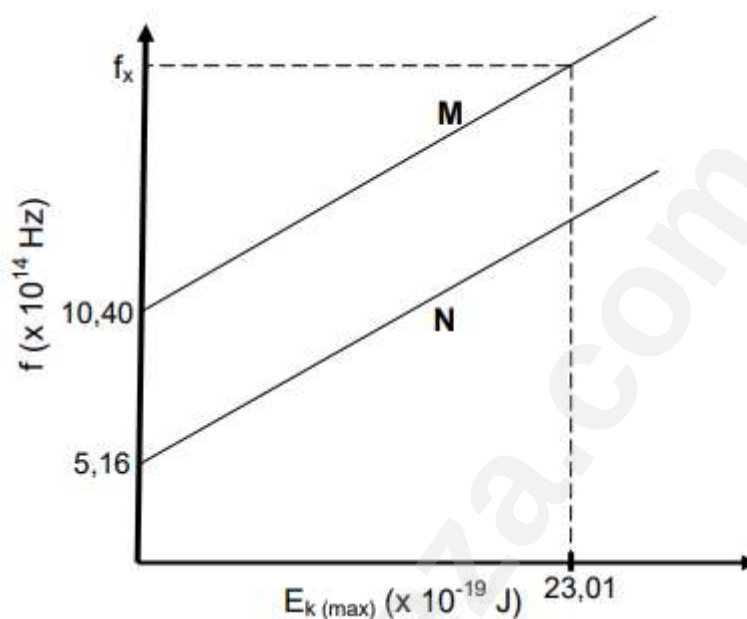


[20]



QUESTION 10

- 10.1 The relationship between frequency (f) and maximum kinetic energy ($E_k(\text{max})$) of photoelectrons emitted from two cathodes, M and N, of different photoelectric cells is investigated. The graphs below have been obtained from the results.



- 10.1.1 Define threshold frequency. (2)

- 10.1.2 How does the maximum kinetic energy of photoelectrons emitted from cathode N compare to the maximum kinetic energy of those emitted from cathode M when light of a frequency greater than $10,40 \times 10^{14}$ Hz is shone on each of the cathodes? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (2)

- 10.1.3 Calculate the maximum wavelength of the light that will be needed to emit photo-electrones from cathode N. (3)



10.1.4 Calculate the value of frequency f_x indicated on the graph. (5)

10.1.5 The experiment is now repeated for cathode M using light of frequency f_x , but of higher intensity. How will EACH of the following be affected?

i The y-intercept of the graph (2)

ii The number of photoelectrons emitted per unit time. (2)

iii The maximum kinetic energy of the emitted photoelectrons. (2)

[18]

Total: 200 marks



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