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TRINITYHOUSE HIGH SCHOOL
PHYSICAL SCIENCES GRADE 12 PRELIM EXAMINATION
PAPER 1 - PHYSICS

MARKS: 200

TIME: 3 HOURS

EXAMINERS: MRS MILLETT-CLAY; MRS SHEPPARD

MODERATED: MRS GOVENDER

NAME: _____ KEY: _____

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of 13 pages, a Data Sheet and an Answer Sheet.
2. Please make sure that your question paper is complete.
3. Write your name on all 3 sheets.
4. Read the questions carefully.
5. ALL of the questions in this paper must be answered.
6. Question 1 consists of 10 multiple-choice questions. There is only one correct answer to each question. The questions must be answered on the grid provided on the answer sheet. 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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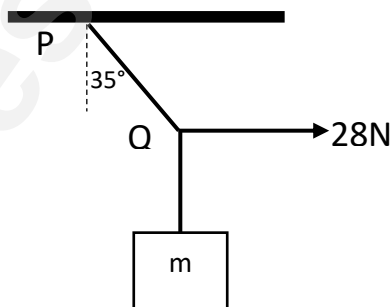
7. START EACH QUESTION ON A NEW PAGE.
8. Please ensure that you number your answers as the questions are numbered.
9. Use data and formulae whenever necessary.
10. You may use approved, non-programmable and non-graphical calculators, unless otherwise stated.
11. Show the necessary steps in calculations.
12. Where appropriate take your final answer to 2 decimal places.
13. It is in your own interest to write legibly and to set out your work neatly.

QUESTION 1 – MULTIPLE CHOICE

Select the answer that you consider to be the most correct and make a cross (X) over the symbol representing your choice (A, B, C or D) next to the question number in the **grid below**:

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

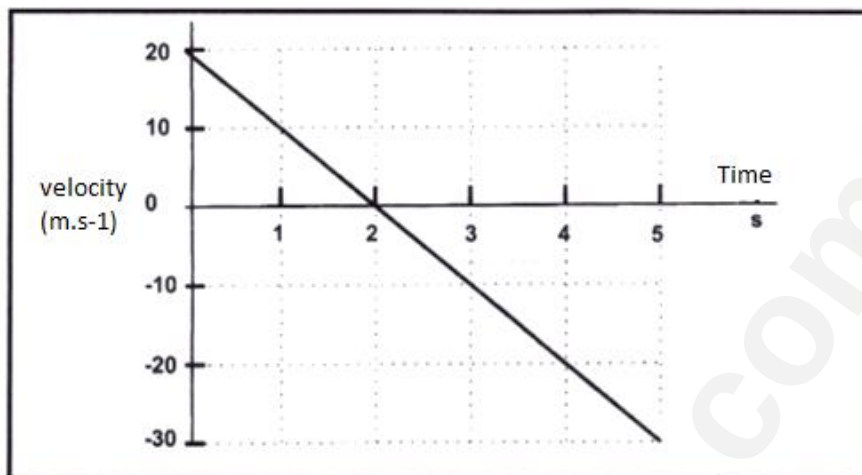
- 1.1 A box is suspended from a string as shown below. PQ makes an angle of 35° with the vertical.



The mass of the box is...

- A 40,0 kg
- B 41,1 kg
- C 19,6 kg
- D 4,1 kg

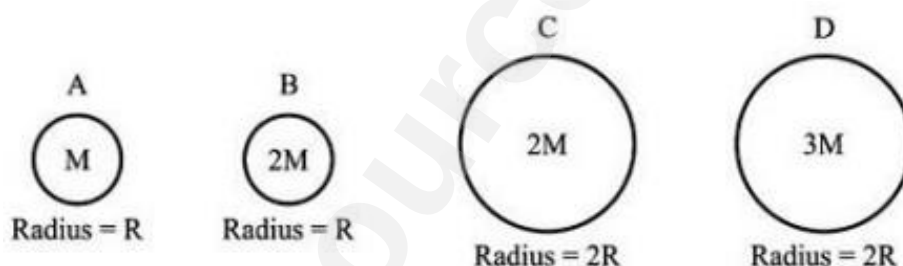
- 1.2 A ball is thrown vertically upwards from the top of a building and the graph below shows the change in the ball's velocity against time for the first 5 seconds.



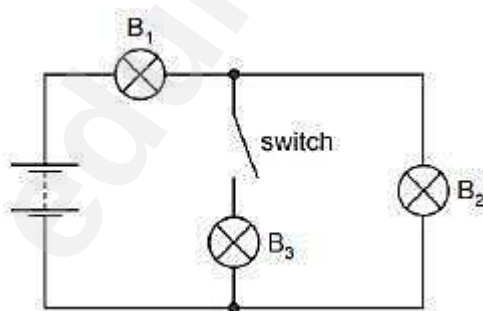
At the end of the motion of 5 s (as illustrated by the graph) the ball is:

- A back at the point of projection.
 - B 20 m from the point of projection and is moving upwards.
 - C 22,5 m from the point of projection and it is moving downwards.
 - D 45 m from the point of projection and is moving downwards.
- 1.3 Two trolleys, **A** with mass 2 kg, and **B** with mass 4 kg are connected by an elastic band and are standing on a frictionless horizontal surface. The trolleys are moved apart with the elastic stretching and then released so that they collide and stick together. In which direction will the joined trolleys move after the collision?
- A Move in the direction of **A** (the 2 kg trolley)
 - B Move in the direction of **B** (the 4 kg trolley)
 - C Move in the direction of **B** but with increased velocity
 - D Remain stationary

- 1.4 A net force F is applied to two stationary objects **P** and **Q**. The mass of **P** is triple that of **Q**. The rate of change of momentum of **P** is Y . What will the rate of change of momentum of **Q** be?
- A 0,5 Y
 B Y
 C $3Y$
 D 0,33 Y
- 1.5 A cyclist pedals at a constant velocity of 15 m.s^{-1} on a straight level road for 50 s. He applies a force of 85 N to the pedals which is transmitted to the wheels. What is the power exerted by him?
- A 25.5 W
 B 750 W
 C 1 275 W
 D 1 700 W
- 1.6 Which of the planets depicted will have the greatest free-fall acceleration on the surface of the planet?



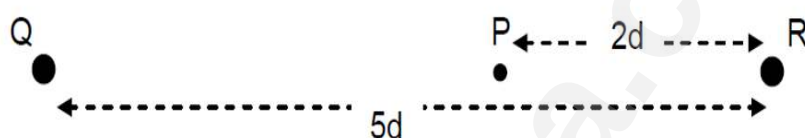
- 1.7 B₁, B₂ and B₃ are three identical lamps. They are connected to a battery with zero internal resistance, as shown.



Initially the switch is closed. The switch is then opened and lamp B₃ goes out. What happens to the brightness of lamps B₁ and B₂ when the switch is opened?

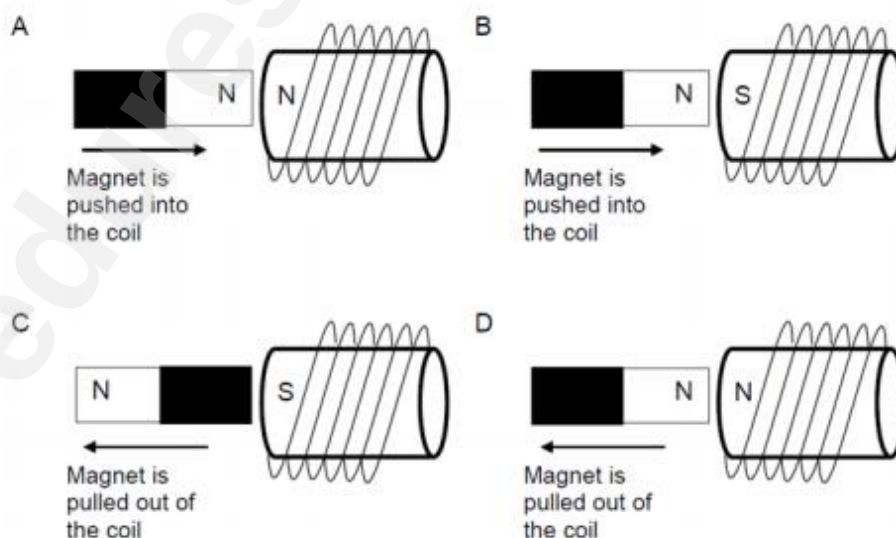
	Brightness of lamp B ₁	Brightness of lamp B ₂
A	decreases	decreases
B	increases	decreases
C	decreases	increases
D	increases	increases

- 1.8 A negative charge Q is placed at a distance of $5d$ from another charge R.
 If the net electric field at point P, at a distance of $2d$ from R, is ZERO, which ONE of the following combinations concerning the ratio of the charges Q and R and the charge on R, is CORRECT?

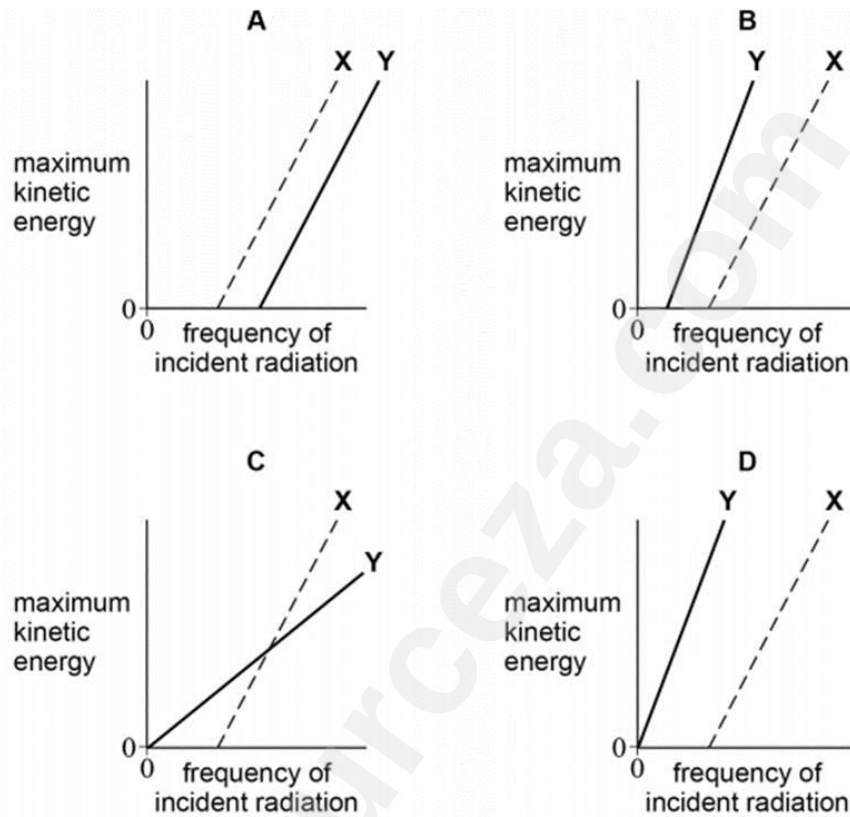


	Ratio of charges Q:R	Charge on R
A.	4:9	Positive
B.	3:2	Negative
C.	5:2	Positive
D.	9:4	Negative

- 1.9 In which ONE of the sketches below is the induced polarity of the coil CORRECTLY indicated?



- 1.10 Line X on the graphs below shows how the maximum kinetic energy of emitted photoelectrons varies with the frequency of the incident radiation for a particular metal. Which graph shows the results for a metal Y that has a higher work function than X?

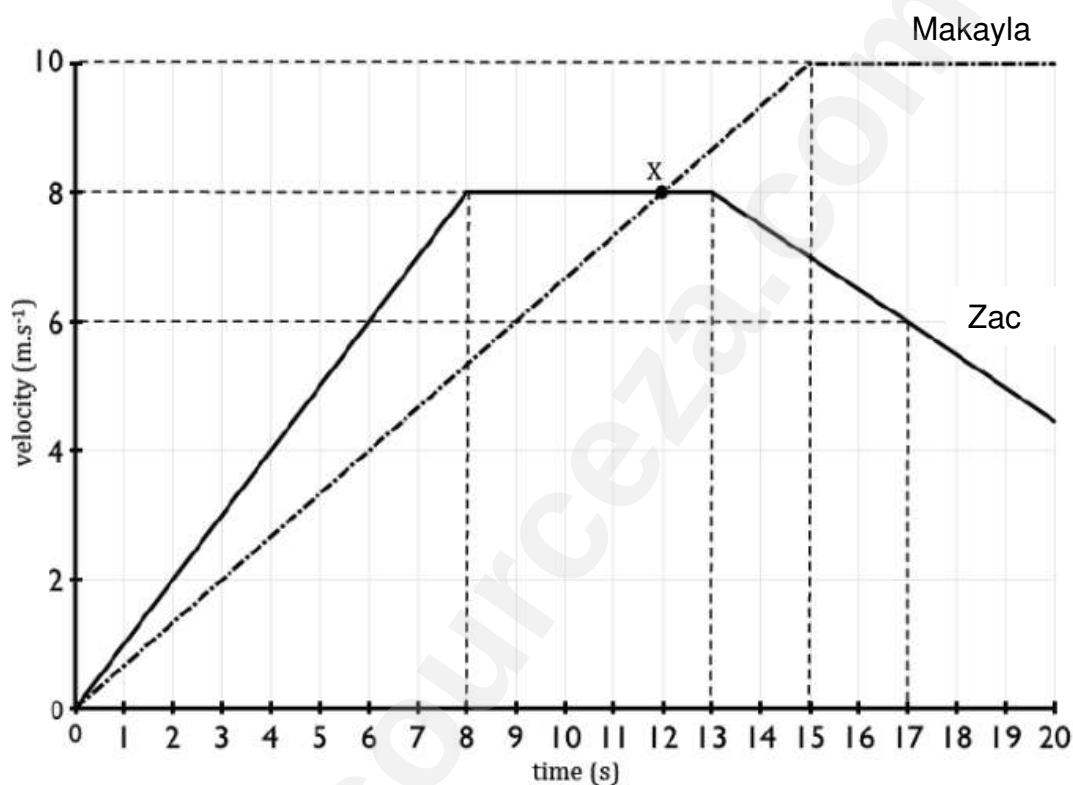


[20]

QUESTION 2 - MOTION IN 1D

- 2.1 Two athletes, Zac and Makayla challenge each other to a race over 100 m. The velocity / time graphs for both Makayla and Zac running the race are shown on the axes below.

(NOTE : the graphs reflect the runners going beyond the finishing line)



- 2.1 2.1.1 Define acceleration. (2)

- 2.1.2 Use the graph to find the magnitude of Zac's acceleration during the first 8 s of the race. (3)

- 2.1.3 Use the graph to determine how far Zac ran in 17 s. (4)

- 2.1.4 The two graphs intersect at point X. What can you conclude about the athletes at that point? (2)

- 2.1.5 Determine how long Mikayla takes to complete the 100 m race. (4)

- 2.1.6 Sketch the displacement/time graph for Zac's motion over the full 20 s represented on the above graph. You need **ONLY** show values on the time axis. (5)

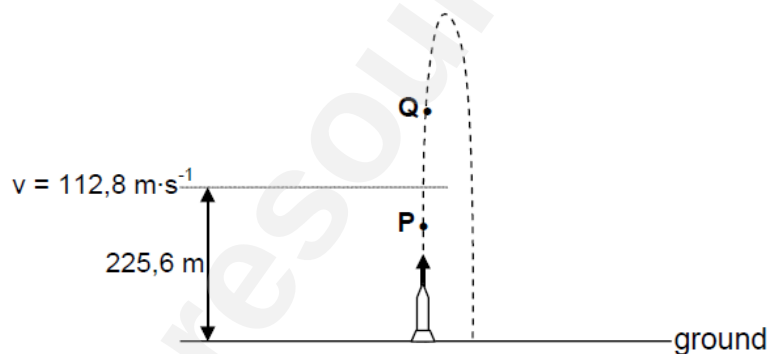
- 2.2 Rachael completes a 2 km race with a go-kart. She starts her kart from rest and accelerates at $2,1 \text{ m.s}^{-2}$ until reaching its top speed (6)

of $68,4 \text{ km}\cdot\text{h}^{-1}$. Rachael maintains this speed to complete the race. How long does it take her to complete the 2 km race?

- 2.3 A rocket is launched vertically upwards from the ground with a constant acceleration. After 4 s, when the rocket is at a height of 225,6 m, all the rocket fuel is used up.

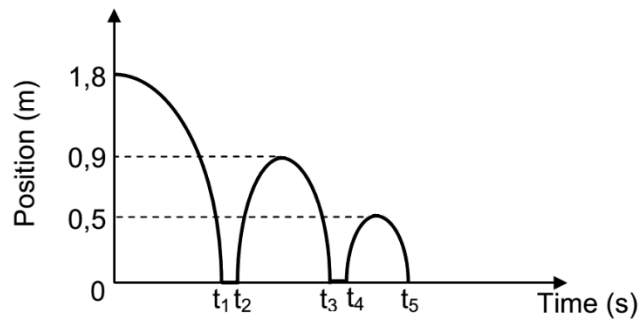
At this instant, the velocity of the rocket is $112,8 \text{ m}\cdot\text{s}^{-1}$ upwards.

The diagram below shows the path followed by the rocket.(ignore all effects of friction)



Use equations of motion to determine the total time that the rocket is in the air. (5)

- 2.4 A ball of mass 0,5 kg is projected vertically downwards towards the ground from a height of 1,8 m at a velocity of 2 m.s^{-1} . The position-time graph for the motion of the ball is shown below



- 2.4.1 Calculate the magnitude of the time t_1 indicated on the graph. (5)

- 2.4.2 Find the velocity with which the ball rebounds from the ground during the first bounce. (4)

2.5 A hot air balloon is ascending at a steady speed of 8 m.s^{-1} . A passenger's cell phone accidentally falls over the edge of the basket of the hot air balloon when the bottom of the basket is 200 m above the ground.

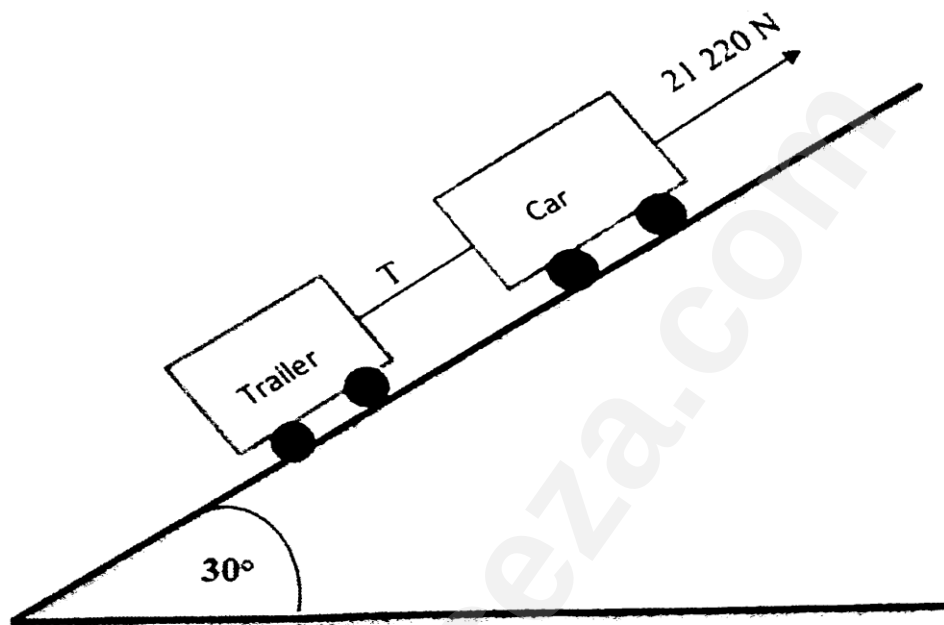
2.5.1 Calculate the maximum height reached by the cell phone above its point of release. (4)

2.5.2 Calculate the position of the basket of the balloon relative to the cell phone when the phone reached its highest point. Assume that the balloon continued to ascend at a constant speed of 8 m.s^{-1} from the time the phone was released. (4)

[48]

QUESTION 3 - NEWTON'S LAWS

- 3.1 A car of mass 1 650 kg, pulls a loaded trailer of mass 750 kg up a 30° incline as shown in the sketch below. There is a frictional force of 3 800 N acting on the car and a frictional force of 1 680 N acting on the trailer. The car's engine provides a driving force of 21 220 N.



- 3.1.1 State Newton's second Law of motion (2)

- 3.1.2 Draw a **fully labelled** free body diagram to represent all the forces acting on the car. (5)

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[illegible]

3.2 A lift carrying people in it, has a combined mass of 475 kg. It is going upwards with a uniform acceleration of $2,5 \text{ m.s}^{-2}$

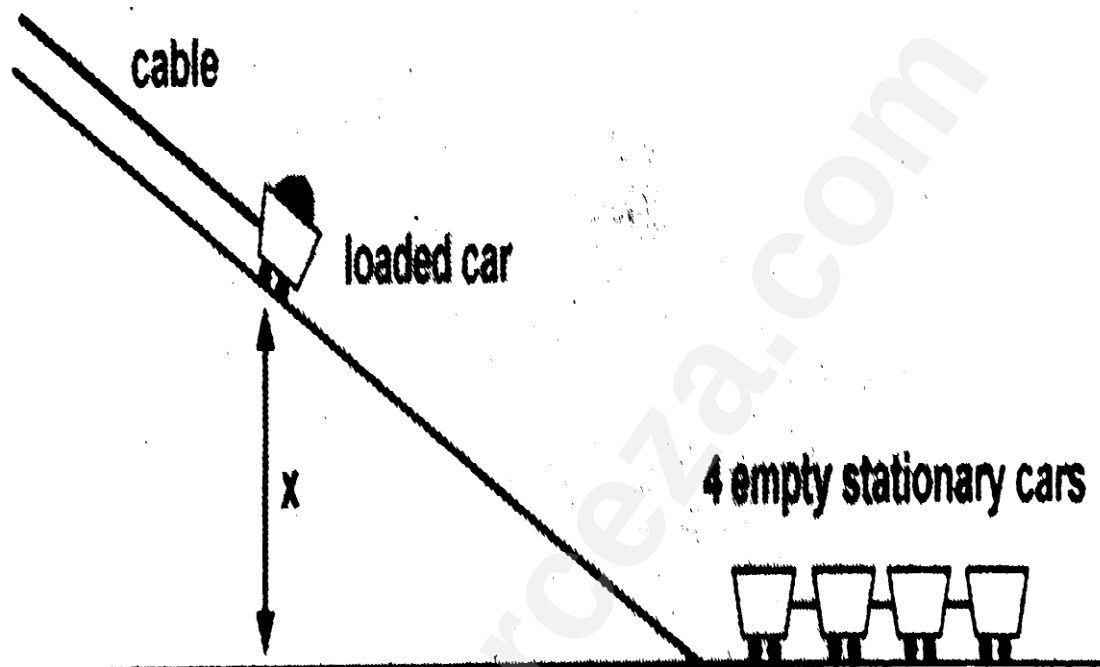
3.2.1 Will the cable holding the lift snap or not, if the tension in the cable is 5 800 N? (prove your answer with a calculation) (4)

3.2.2 Name **two** Third Law force pairs in the above situation of the passengers (people) standing in the lift before it moves upwards. (2)

[28]

QUESTION 4 - MOMENTUM AND IMPULSE

A rubble-carrying car, in a coal mine, has a total mass of 7 000 kg. It is held at rest on an incline by a cable, before being hauled up to the surface. The cable snaps and the car hurtles back down the frictionless incline. At the bottom of the incline the car collides with a row of four stationary, empty cars, each with a mass of 1 500 kg. The five cars couple together and move off at a speed of 4 m.s^{-1} .



- 4.1 Name the conservation Law which can be used to determine the speed of the loaded car just before impact. (1)

- 4.2 Calculate the speed of the loaded car just before impact. (3)

- 4.3 Is this collision between the loaded car and the empty cars elastic or inelastic? Justify your answer by means of a calculation (3)

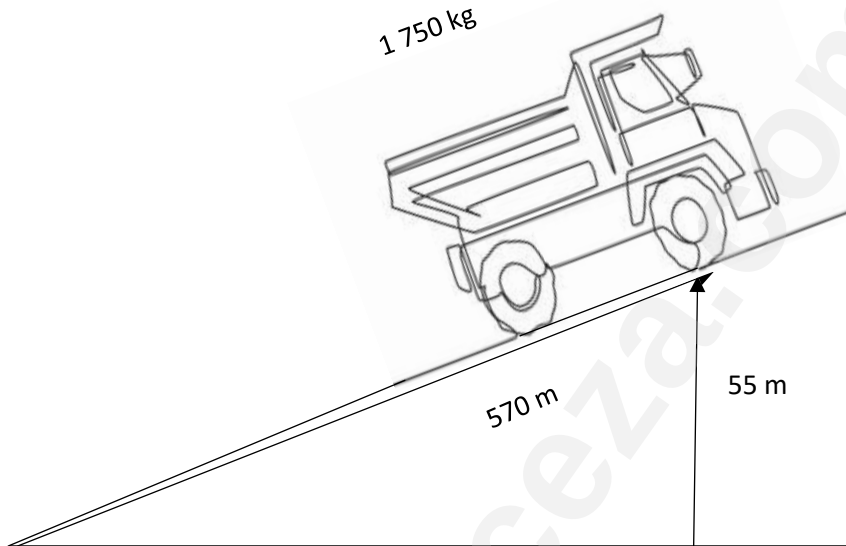
- 4.4 Calculate the height at **X**. (3)

- 4.5 Calculate the magnitude of the force with which the loaded car hits the stationary empty cars, if the contact time during the collision was 0,02 s. (3)

[13]

QUESTION 5 – WORK, ENERGY AND POWER

A loaded mini truck with a total mass of 1 750 kg travels up a rough sloping road. The truck maintains a constant speed of $72 \text{ km}\cdot\text{h}^{-1}$. During the climb the truck travels a distance of 570 m and when it reaches the highest point on the road, the truck has risen a vertical height of 55 m from the start of the slope.



- 5.1 If the work done to overcome the friction is $5,84 \times 10^6 \text{ J}$, calculate the average power of the truck's engine. (5)

- 5.2 What is the resultant force on the truck half-way up the climb? Explain your answer. (2)

- 5.3 The truck dumps its load at the top of the climb and the empty truck now has a mass of 1100 kg. On its return journey, the truck accelerates from $72 \text{ km}\cdot\text{h}^{-1}$ to $90 \text{ km}\cdot\text{h}^{-1}$ downhill while the average frictional force on the truck is $6,44 \times 10^3 \text{ N}$. Calculate how much work the engine does while the truck is accelerating. (4)

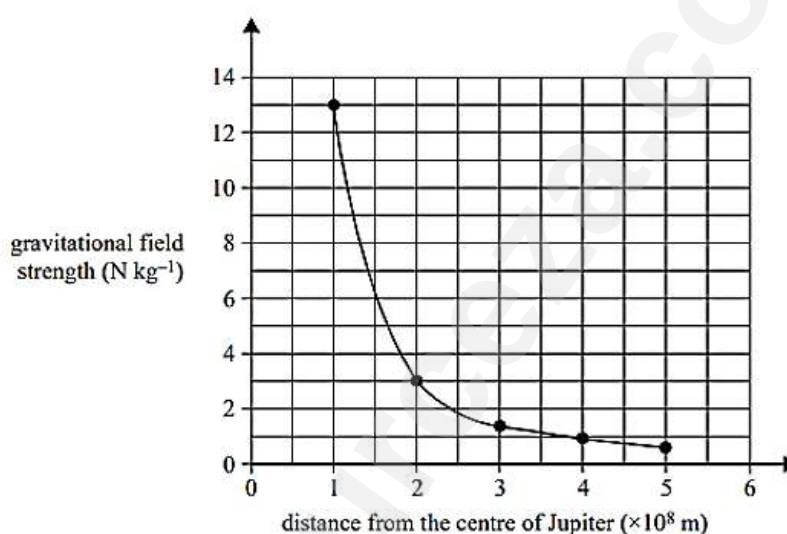
[11]

QUESTION 6 – FIELDS

- 6.1 The spacecraft *Juno* has been put into orbit around Jupiter. The table below contains information about the planet Jupiter and the spacecraft *Juno*.

Mass of Jupiter	$1,9 \times 10^{27} \text{ kg}$
Radius of Jupiter	$7 \times 10^7 \text{ m}$
Mass of spacecraft <i>Juno</i>	1 500 kg

The graph shows gravitational field strength (N.kg^{-1}) as a function of distance from the centre of Jupiter.

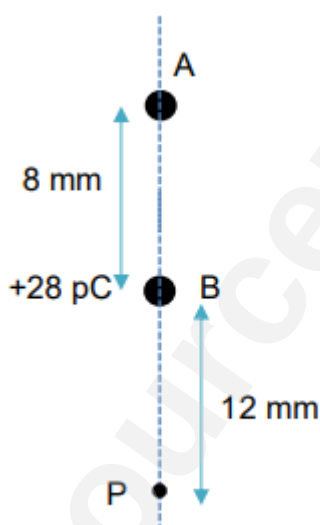


- 6.1.1 Define *Gravitational Field*. (2)

- 6.1.2 Calculate the gravitational force acting on *Juno* by Jupiter when *Juno* is at a distance of $2 \times 10^8 \text{ m}$ from the centre of Jupiter. (3)

- 6.1.3 Use the ratio method to determine by what factor the gravitational force acting on the spacecraft *Juno* changes as it moves from a distance of 2×10^8 m to a distance of 1×10^8 m from the centre of Jupiter. (2)

- 6.2 Two isolated charged metal spheres, **A** and **B** are arranged as shown in the diagram below:



- Sphere **B** has a charge of +28 pC.
- A point **P** is located 12 mm below the charged sphere **B**.
- The net electric field at point **P** is 805 N.C^{-1} downwards.

- 6.2.1 Calculate the charge on sphere **A**. (4)

6.2.2 State *Coulomb's Law*.

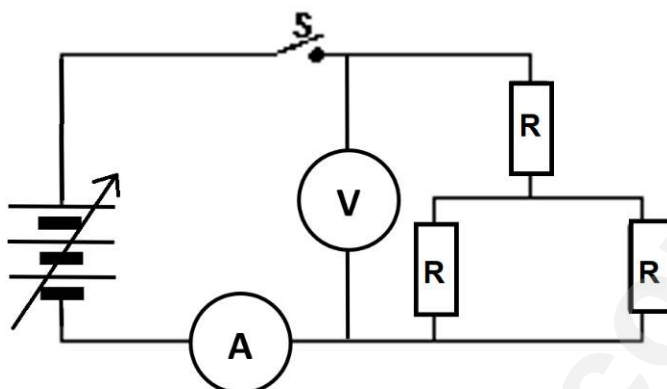
(2)

6.2.3 Calculate the magnitude of the force experienced by point **P** as a result of charge **A** and **B**. (3)

[16]

QUESTION 7 – CIRCUITS

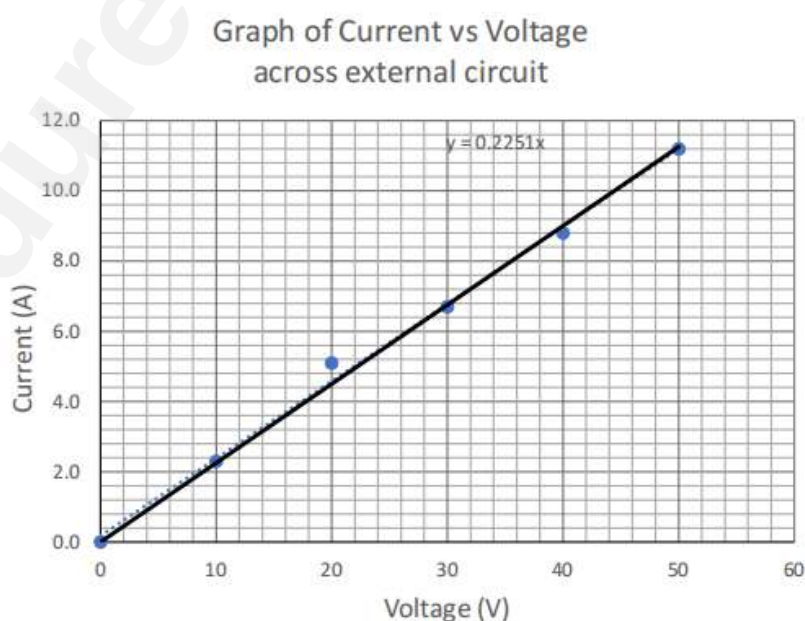
- 7.1 Study the circuit diagram shown below. The three resistors in the circuit are identical.



The ammeter, connecting wires and battery have negligible resistance.

- 7.1.1 State *Ohm's law*. (2)

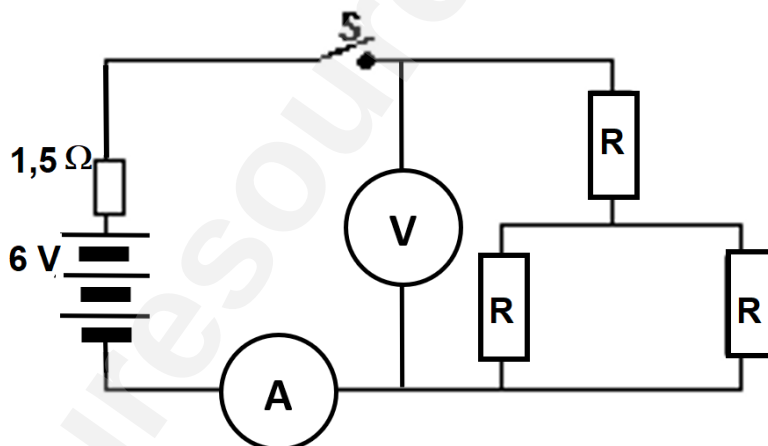
- 7.1.2 A variable DC voltage supply is connected across the combination of three resistors. As the voltage is varied, readings of voltage and current are recorded. The graph of current against voltage for this combination of resistors is shown below.



a) Does the combination of resistors behave as an *ohmic conductor*? Explain briefly. (3)

b) Use the graph to determine the effective resistance of the resistors. (3)

7.1.3 A 6 V battery with internal resistance of $1,5\ \Omega$ is connected across the same circuit as shown below.



a) Determine the resistance **R** of each of these resistors if the total effective external resistance remains the same as calculated in 7.1.2 b). (4)

- b) Determine the reading on the ammeter when switch **S** is closed. (3)

- 7.2 Two resistors of $2,0\ \Omega$ and $3,0\ \Omega$ are connected to a battery which has significant internal resistance.

When the two resistors are connected in series, the current is $0,97\ \text{A}$.
When the two resistors are connected in parallel, the current is $2,5\ \text{A}$.

- 7.2.1 Define the *emf of a battery*. (2)

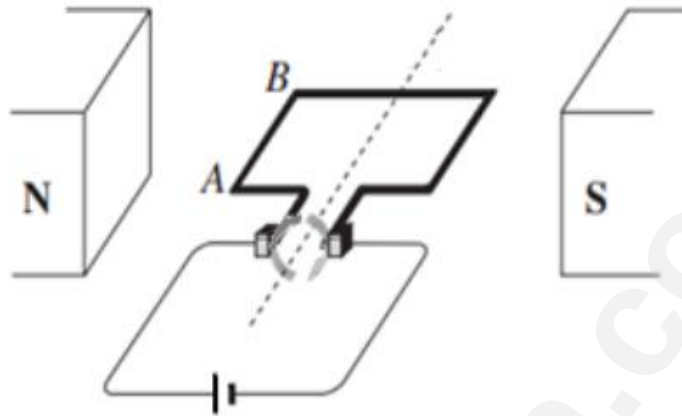
- 7.2.2 Determine the emf and the internal resistance of the battery. (7)

- 7.2.3 Determine the power dissipated in the $2,0\ \Omega$ resistor when it is connected in parallel. (4)

[28]

QUESTION 8 – ELECTRODYNAMICS

- 8.1 The diagram shows a DC motor with a constant current passing through the coil.

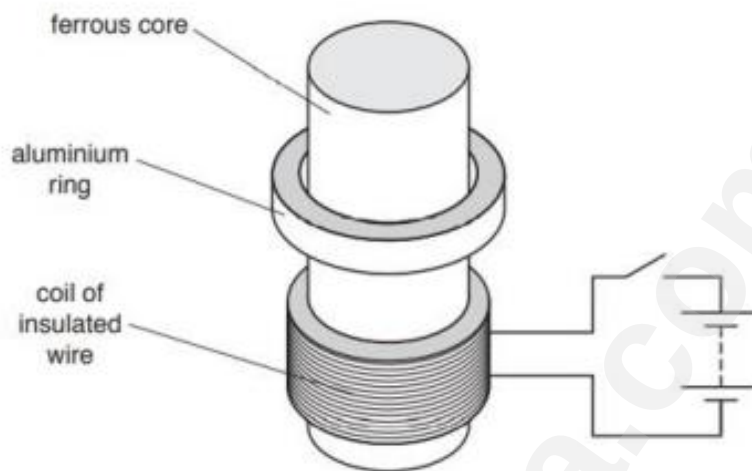


- 8.1.1 Explain why the coil of the motor rotates when current passes through it. (2)

- 8.1.2 In which direction does the coil of this DC motor rotate? Answer **CLOCKWISE** or **ANTI-CLOCKWISE**. (1)

- 8.1.3 Suggest one different way to increase the speed of rotation of the coil. (1)

- 8.2 A coil of insulated copper wire is wound on to a ferrous (iron) core and connected to a battery and a switch. Refer to the diagram below.



An aluminium ring is placed on the core. The ring can move freely up and down along the length of the core.
The switch is initially open

- 8.2.1 State Lenz's law. (2)

- 8.2.2 Use principles of Physics to explain why the aluminium ring jumps upwards when the switch is closed. (4)

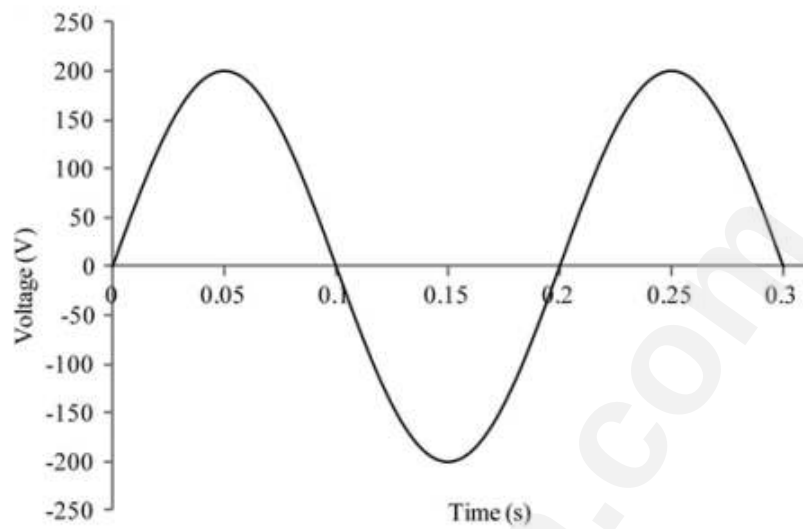
- 8.2.3 If the polarity of the battery is reversed, will the ring still jump upwards? Explain briefly. (4)

- 8.3 An ideal transformer has 12 000 turns in the secondary. A maximum AC voltage as shown in 8.3.3 on the graph below, is generated in the secondary coil, and an AC voltage of 5 V is applied to the primary coil. The current in the primary is 16 A.

- 8.3.1 Calculate the number of turns in the primary coil. (3)

- 8.3.2 Calculate the current in the secondary coil. (3)

- 8.3.3 A graph of voltage against time for the secondary coil is shown below. (2)

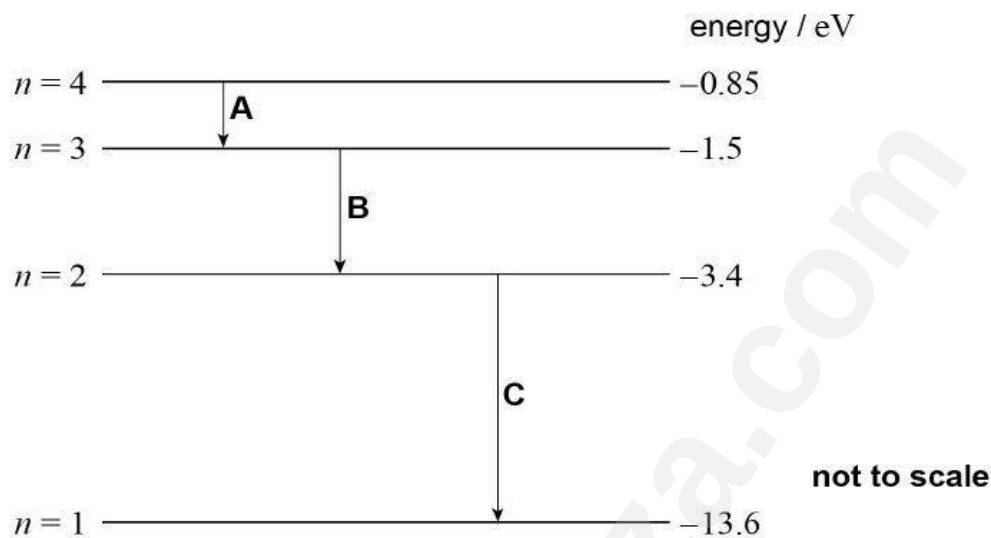


On this graph, show how the corresponding **graph of magnetic flux through the iron core against time** would be drawn.

[22]

QUESTION 9 – PHOTOELECTRIC EFFECT AND EMISSION SPECTRUM

The diagram below shows some of the energy levels for a hydrogen atom



An excited hydrogen atom can emit photons of certain discrete frequencies. Three possible transitions are shown in the diagram.

The transitions shown in the diagram result in photons being emitted in the **ultraviolet**, **visible** and **infrared** regions of the electromagnetic spectrum.

- 9.1 To which region of the spectrum do the emitted photons of A and C belong? (2)

- 9.2 Calculate the frequency of the photon emitted when the electron transition is from the $n=3$ level to the ground state. (4)

- 9.3 Why are the energy levels stated as negative values? (2)

- 9.4 The surface of a sample of caesium is exposed to photons emitted in each of the three transitions shown above. (3)

The threshold frequency for caesium is $5,1 \times 10^{14}$ Hz.

Determine whether any of these transitions would produce photons that would cause electrons to be emitted from the surface of caesium.

- 9.5 Photons each with energy 12,1 eV are incident on the surface of the caesium sample. Calculate the maximum speed of electrons emitted from caesium. (3)

[14]