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**ST. MARY'S DSG, KLOOF
PHYSICAL SCIENCES
TRIALS PAPER 1: PHYSICS**

**GRADE 12
August 2020**

**TIME: 3 hours + 10 mins reading
MARKS: 200**

Examiners and Moderators: Mrs K. Bolton, Mrs G. Main and Mrs T. Kirsten

Read the Following Instructions Carefully:

1. This paper consists of:
 - A question paper of 17 pages
 - A separate yellow answer sheet
 - A green data sheet
 - An answer booklet
2. Read the questions carefully. Answer **ALL** questions.
3. Write your NAME (not your examination number) on your question paper, so you can get your own paper back after Trials.
4. Number your answers exactly as the questions are numbered. **Answer each new question on a new page in your answer booklet.**
5. Please hand in the yellow answer sheet inside your answer booklet.
6. Write legibly and present your work neatly.
7. All working should be shown and units **MUST** be given with answers. Work to two significant figures. **Make sure your calculator is in the correct mode.**
8. Consult the data sheet where necessary.

ACKNOWLEDGEMENTS:

- Cambridge International Examinations Cambridge International Advanced Subsidiary and Advanced Level October/November 2018 (C)
- Cambridge International Examinations Cambridge Pre-U Certificate May/June 2017
- IB Physics Standard level Paper 1 Friday 17 May 2019
- Cambridge International AS & A Level February/March 2020.
- Cambridge international Examinations Cambridge International Advanced Subsidiary and Advanced Level October/November 2017)
- DBE Grade 10 November 2018 Paper 1
- Cambridge International Examinations Cambridge International Advanced Subsidiary and Advanced Level May/June 2018
- Cambridge International Examinations Cambridge Pre-U Certificate May/June 2018 9792
- DBE Grade 11 March 2020 Common Test Paper 1
- Leaving Cert Physics Higher Level 2006
- Redhill Trials Paper 1 2018
- St. Anne's Trials Paper 1 2019
- St. Mary's Waverley Trials Paper 1 2019
- Beaulieu College Trials Paper 1 2018 and 2019
- St. John's College Prelims Paper 1 2019

QUESTION 1 MULTIPLE CHOICE

Answer these questions on the multiple-choice **Answer Sheet** provided. Make a cross (X) in the box corresponding to the letter which you consider to be the most correct.

1.1 Which group of quantities contains only vectors?

- A acceleration, displacement, speed
- B acceleration, work, electric field strength
- C displacement, force, velocity
- D power, electric field strength, force

1.2 A mass is placed on a frictionless slope inclined at 30° to the horizontal. The mass is then released. What is its acceleration down the slope?

- A $4,9 \text{ m.s}^{-2}$
- B $5,7 \text{ m.s}^{-2}$
- C $8,5 \text{ m.s}^{-2}$
- D $9,8 \text{ m.s}^{-2}$

1.3 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 up and slowing down
- B It is moving up and speeding up.
- C It is moving down and slowing down
- D It is moving down at a constant speed

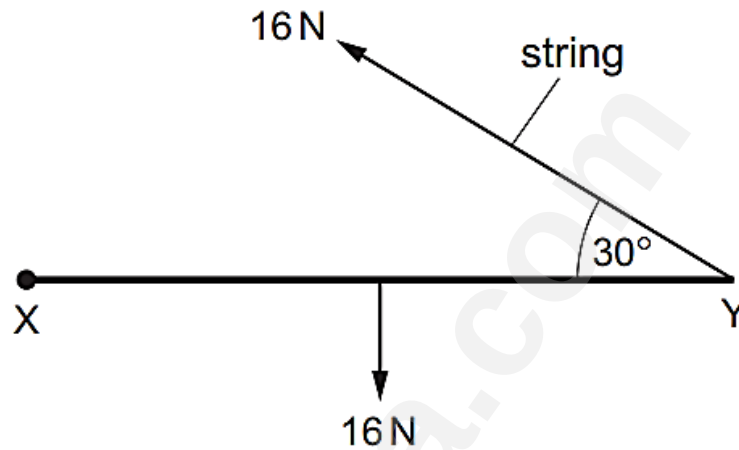
1.4 Three identical balls (**A**, **B** and **C**) are launched from the same height above the ground.

- Ball **A** is thrown up with an initial velocity of 13 m.s^{-1} .
- Ball **B** is thrown down with an initial velocity of 13 m.s^{-1} .
- Ball **C** is dropped from rest.

Which one of the following statements concerning the magnitude of the final velocity of the balls is TRUE?

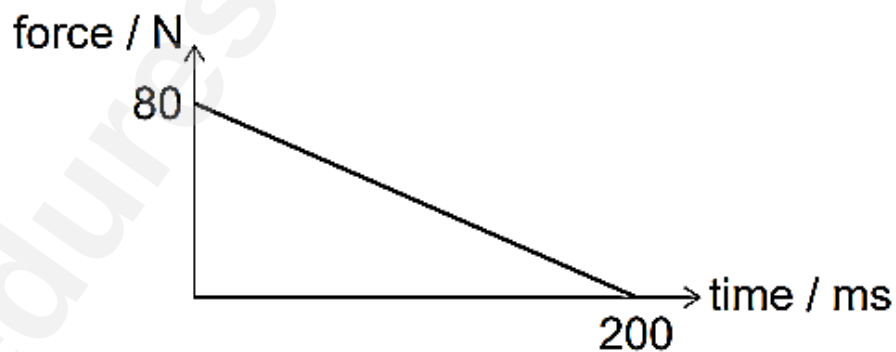
- A Ball **A** has the lowest final velocity.
- B Ball **B** has the greatest final velocity.
- C Ball **A** and Ball **B** have the same final velocity.
- D All three balls have the same final velocity.

- 1.5 A rod XY of weight 16 N is hinged at X and supported by a string at Y. The string is at an angle of 30° . The tension in the string is 16 N. What is the horizontal component of the force acting at X?



- A 16 N
- B 14 N
- C 9 N
- D 8 N

- 1.6 The graph shows the variation with time of the resultant net force acting on an object. The object has a mass of 1 kg and is initially at rest.



What is the velocity of the object at a time of 200 ms?

- A 16 km.s^{-1}
- B 8 km.s^{-1}
- C 16 m.s^{-1}
- D 8 m.s^{-1}

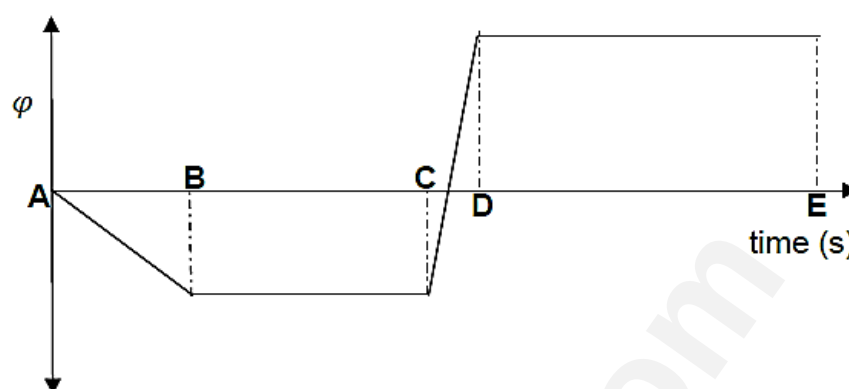
- 1.7 Two small charged objects, a distance d apart, exert an attractive force F on each other. The charge on each object is doubled and the distance increased to $2d$. The force of attraction would be:

- A F
 B $2F$
 C $\frac{F}{2}$
 D $\frac{F}{4}$

- 1.8 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?

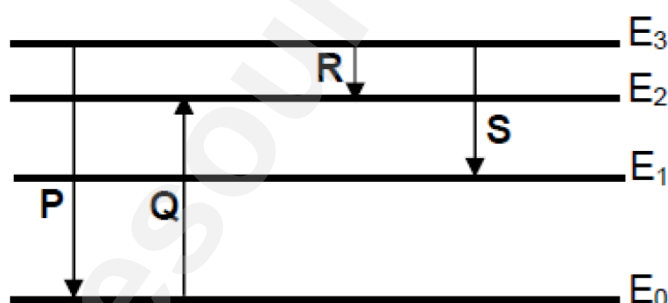
- A $\frac{2,5 \times 130 \times 1,9}{1000}$
 B $\frac{2,5 \times 130 \times 190}{1000}$
 C $\frac{2500 \times 130 \times 1,9}{1000 \times 60}$
 D $\frac{2500 \times 130 \times 1,9}{60}$

- 1.9 The magnetic flux (ϕ) through a loop of wire changes as shown in the sketch graph below. During which time interval will the induced emf be **positive and non-zero**?



- A A–B
- B B–C
- C C–D
- D D–E

- 1.10 The diagram below shows the electron transitions P, Q, R and S between different energy levels in an atom.



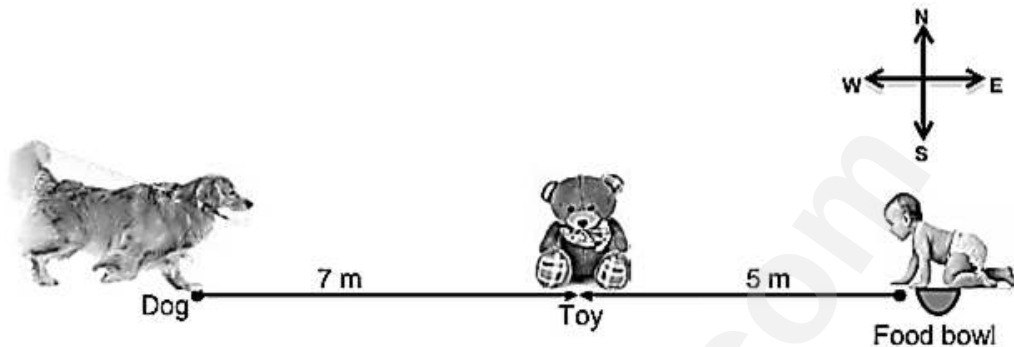
Which ONE of the transitions will result in an emission of a radiation with the longest wavelength?

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

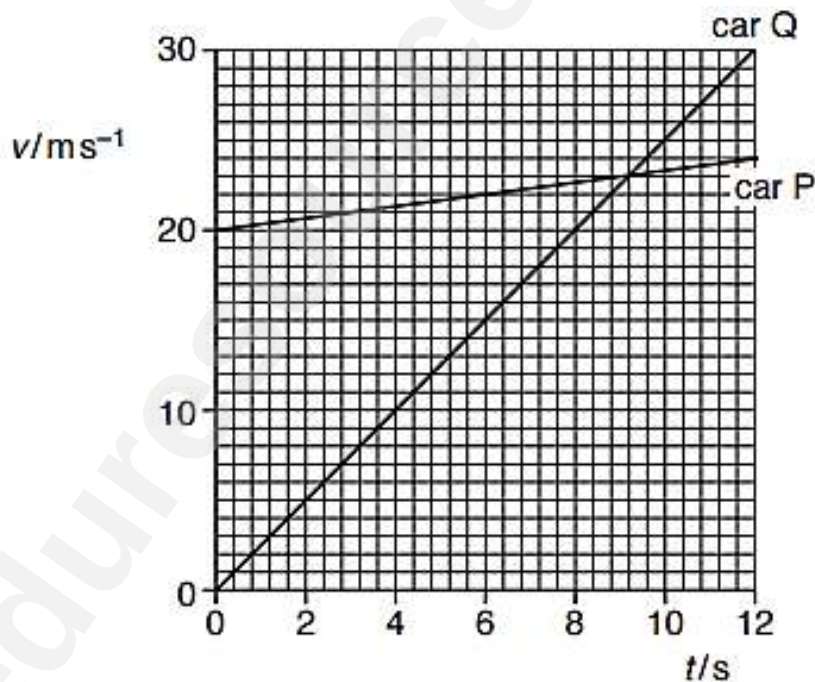
10 x 2 = [20]

QUESTION 2 KINEMATICS

- 2.1 A baby leaves a bowl of food on the floor and crawls westwards to fetch a toy placed 5 m away. At the same time a dog walks eastwards towards the baby. It takes the baby 30 s to reach the toy. The dog walks past the toy to eat the baby's food in the bowl.



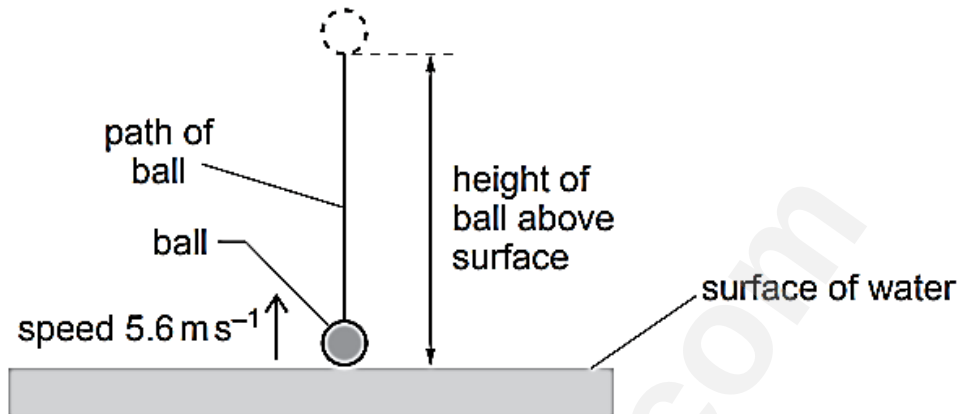
- 2.1.1 Define the term *displacement*. (2)
- 2.1.2 Determine the position of the dog relative to the baby before they both moved. (2)
- 2.1.3 Calculate the average velocity of the baby. (3)
- 2.2 The variation with time t of the velocity v of two cars P and Q is shown in the graph below



The cars travel in the same direction (SOUTH) along a straight road. Car P passes car Q at time $t = 0$. The speed limit for cars on the road is $100 \text{ km}\cdot\text{h}^{-1}$.

- 2.2.1 State and explain whether car Q exceeds the speed limit. (2)
- 2.2.2 Calculate the acceleration of car P. (3)
- 2.2.3 Determine the distance between the two cars at time $t = 12 \text{ s}$. (4)
- 2.2.4 From time $t = 12 \text{ s}$, the velocity of each car remains constant at its value at $t = 12 \text{ s}$. Determine the time t at which car Q passes car P. (4)

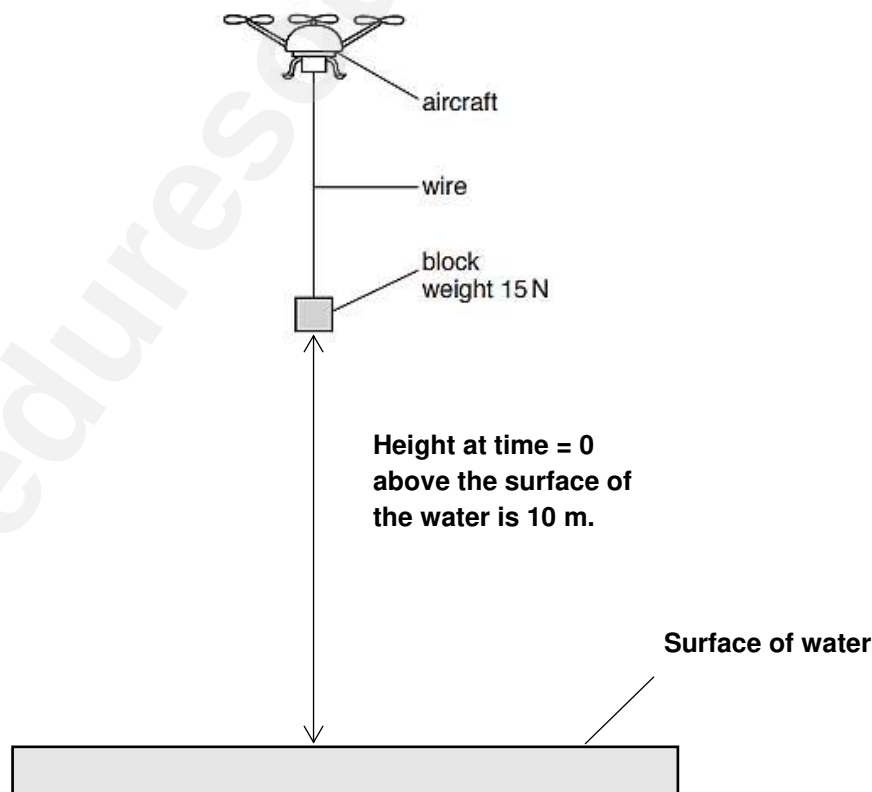
- 2.3 A dolphin strikes the bottom of a floating ball so that the ball rises vertically upwards from the surface of the water, as illustrated in the figure below.



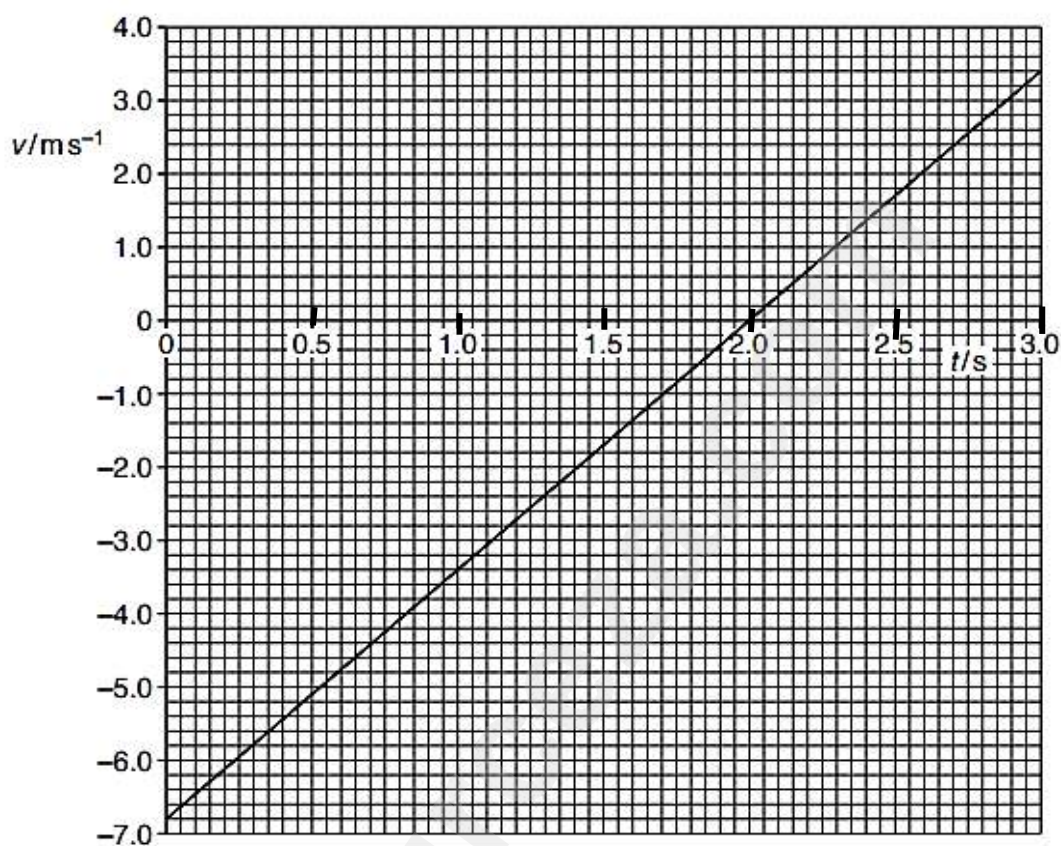
The ball leaves the water surface with speed $5,6 \text{ m.s}^{-1}$. Assume that air resistance is negligible.

- 2.3.1 Calculate the maximum height reached by the ball above the surface of the water. (3)

Flying above the floating ball and water surface is a remotely controlled aircraft. A block of weight 15 N hangs by a wire from the remotely controlled aircraft at a height of 10 m above the surface of the water, as shown in the figure below.



The aircraft is used to move the block only in a vertical direction. The force on the block due to air resistance is negligible. The variation with time t of the vertical velocity v of the block is shown in the graph below. The velocity is taken to be positive in the upward direction.



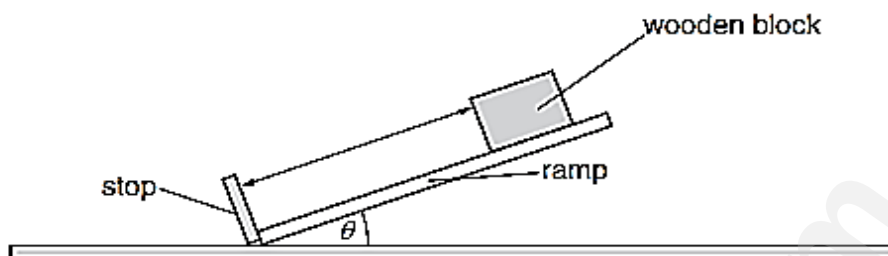
- 2.3.2 Define the term *velocity*. (2)
- 2.3.3 What is the initial velocity of the block? (2)
- 2.3.4 Determine the displacement for the block from time $t = 0$ to $t = 3$ s. (3)
- 2.3.5 Sketch a displacement vs time graph for the block from time $t = 0$ to $t = 3$ s. Include relevant time and displacement values. (3)
- 2.3.6 Calculate the magnitude of the acceleration of the block at time $t = 2$ s. (2)
- 2.3.7 Use your answer in Q 2.3.6 to calculate the magnitude of the tension T in the wire at time $t = 2$ s. (3)
- 2.3.8 At $t = 3$ s the cable wire snaps. Calculate the speed with which the block hits the water. (3)
- 2.3.9 State whether the following statement is true or false. Use an appropriate law to support your answer. (You do not have to state the law – only provide the name of the law)

“When the block hits the water, the water surface experiences a greater force than the block because the water is stationary, and the block is moving fast.” (3)

[44]

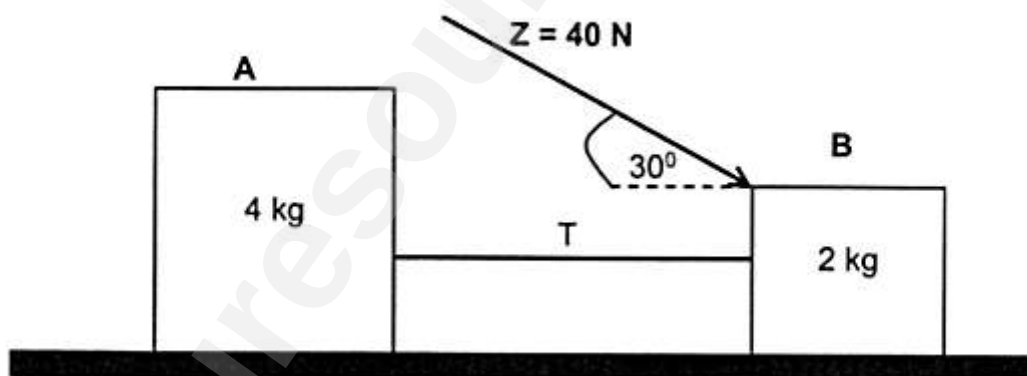
QUESTION 3 NEWTON'S LAWS

- 3.1 The figure shows a wooden block of mass m at rest on a ramp which is inclined at an angle θ to the horizontal.



The ramp is rotated very slowly so that the angle θ increases to $35,5^\circ$ with the block stationary. The ramp stops moving and remains at $35,5^\circ$ to the horizontal. With θ equal to $35,5^\circ$, the block is just on the point of sliding down the ramp but it remains stationary on the ramp.

- 3.1.1 State *Newton's first law of motion*. (2)
- 3.1.2 Draw a labelled free body diagram for the forces on the block. (4)
- 3.1.3 Determine the coefficient of static friction μ_s between the block and the ramp. (3)
- 3.2 Two blocks A and B are connected by a string of negligible mass. The mass of A is 4 kg and the mass of B is 2 kg.



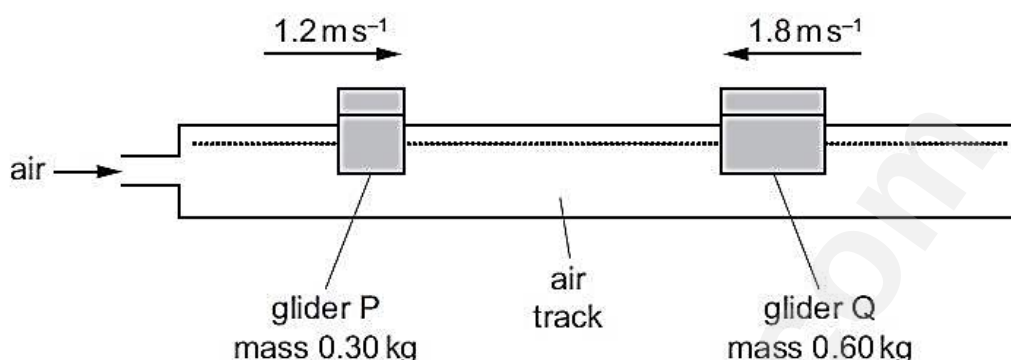
Block B is pushed by a force Z of magnitude 40 N acting at an angle of 30° to the horizontal. The coefficient of kinetic friction between block B and the horizontal surface is 0,25. Block A experiences a frictional force of 9,8 N during its motion. The system accelerates to the right.

- 3.2.1 Draw a free body diagram to show all the forces acting on the 2 kg block. (6)
- 3.2.2 Calculate the magnitude of the kinetic frictional force experienced by block B. (4)
- 3.2.3 Calculate the magnitude of the tension T in the string by applying Newton's second law of motion separately to each of the blocks. (5)

[24]

QUESTION 4 MOMENTUM

Two gliders are travelling towards each other on a horizontal air track. Glider P has mass $0,3 \text{ kg}$ and is moving with a constant speed of $1,2 \text{ m.s}^{-1}$. Glider Q has mass $0,6 \text{ kg}$ and is moving with a constant speed of $1,8 \text{ m.s}^{-1}$.



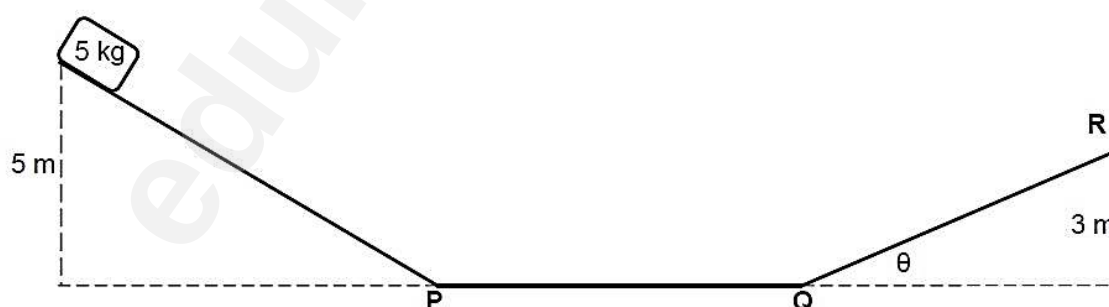
After the collision, glider P moves left with a speed of $2,8 \text{ m.s}^{-1}$.

- 4.1 State the *law of conservation of linear momentum*. (2)
- 4.2 Calculate the magnitude of the velocity of glider Q after the collision. (3)
- 4.3 Determine, with calculations, if this was an elastic or inelastic collision. (4)
- 4.4 If the gliders remain in contact with each other for $0,005 \text{ s}$, calculate the magnitude of the force exerted by glider P on glider Q during the collision. (3)

[12]

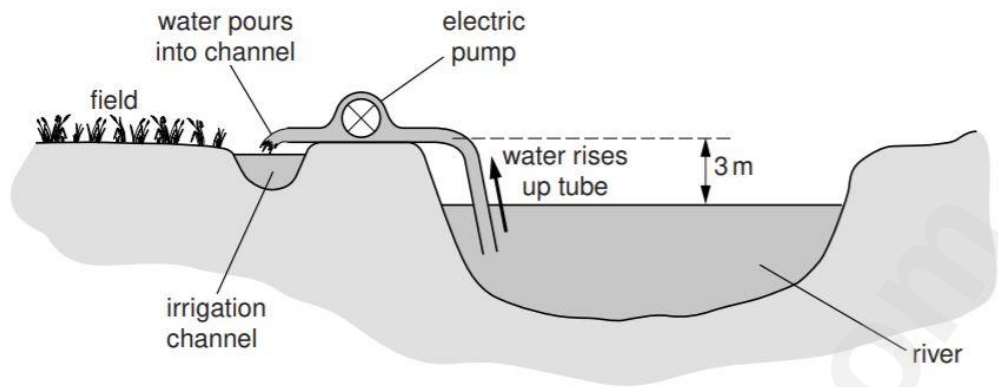
QUESTION 5 ENERGY AND POWER

- 5.1 A 5 kg block is released from rest from a height of 5 m and slides down a frictionless incline to point **P** as shown in the diagram below. It then moves along a frictionless horizontal portion **PQ** and finally moves up a second rough inclined plane. It comes to a stop at point **R** which is 3 m above the horizontal. The frictional force between the surface and the block from **Q** to **R** is 18 N .



- 5.1.1 Using energy principles only, calculate the speed of the block at point **P**. (3)
- 5.1.2 Explain why the kinetic energy at point **Q** is the same as that at point **P**. (2)
- 5.1.3 Calculate the length of the slope **QR**. (4)
- 5.1.4 Calculate the angle (θ) of the slope **QR**. (2)

- 5.2 A farmer uses an 8 W electric pump to raise water from a river in order to fill the irrigation channels that keep the soil in his fields moist.



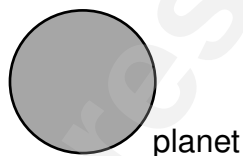
Every minute, the pump raises 12 litres of water, at a constant rate, through a vertical height of 3 m.

- 5.2.1 Calculate the power output of the motor. (4)
 5.2.2 Calculate the percentage efficiency of the motor. (2)
[17]

QUESTION 6 FIELDS

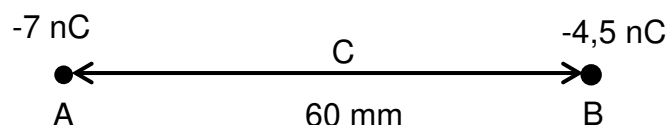
- 6.1 A planet has a radius of $3,1 \times 10^6$ m. At a point P a distance $2,4 \times 10^7$ m above the surface of the planet the gravitational field strength is $2,2 \text{ N.kg}^{-1}$.

• point P



- 6.1.1 Define a *gravitational field*. (2)
 6.1.2 An asteroid of mass $6,2 \times 10^{12}$ kg, passes the planet. Calculate the magnitude of the gravitational force experienced by the asteroid when it is at point P. (3)
 6.1.3 Calculate the mass of the planet. (4)

6.2 Two point charges A and B are placed 60 mm apart as shown in the diagram below.



6.2.1 Draw the field pattern around and between charges A and B. (3)

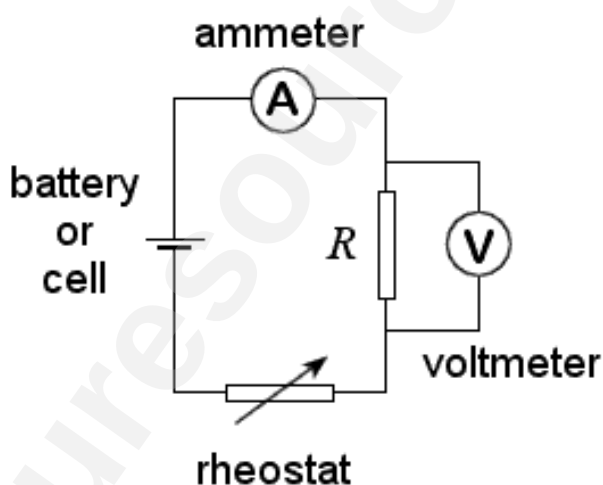
6.2.2 Determine the resultant electric field strength at point C midway between A and B. (6)

6.2.3 Do you think the resultant electric field strength will be zero on the left or right of position C? (Just write LEFT or RIGHT) (2)

[20]

QUESTION 7 ELECTRIC CIRCUITS

7.1 The following circuit was set up by a student to investigate Ohm's Law. She varied the current in the circuit by using a rheostat, then for each current reading she read off the corresponding potential difference across the resistor, R , being investigated.



The following readings were obtained:

Current (I)	Potential difference (V)
0,1	0,4
0,3	1,1
0,5	1,7
0,7	2,4

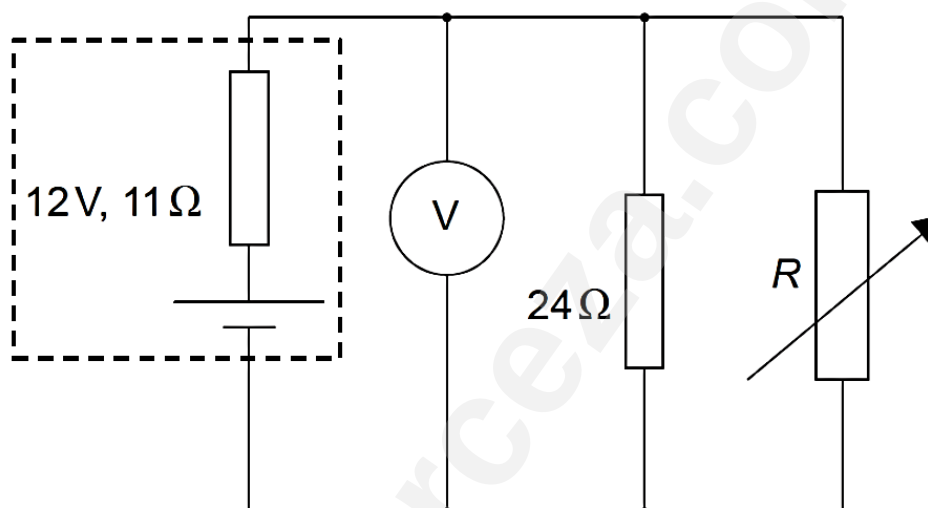
7.1.1 State *Ohm's Law*. (2)

7.1.2 On the axes provided on your answer sheet, plot a graph of Potential difference vs Current. (5)

7.1.3 Calculate the resistance of resistor R . Indicate values used from the graph. (3)

- 7.1.4 The student then repeated the experiment using a light bulb instead of resistor R .
Using a different coloured pen (not red), or a dashed line, indicate on your graph how the shape of the line would change with a light bulb. (2)
- 7.1.5 How long would it take 75 C of charge to flow through resistor R when the current strength is 0,5 A? (3)

- 7.2 An electric circuit consists of a cell connected to a $24\ \Omega$ resistor in parallel with a variable resistor of resistance R . The cell has an emf of 12 V and an internal resistance of $11\ \Omega$.



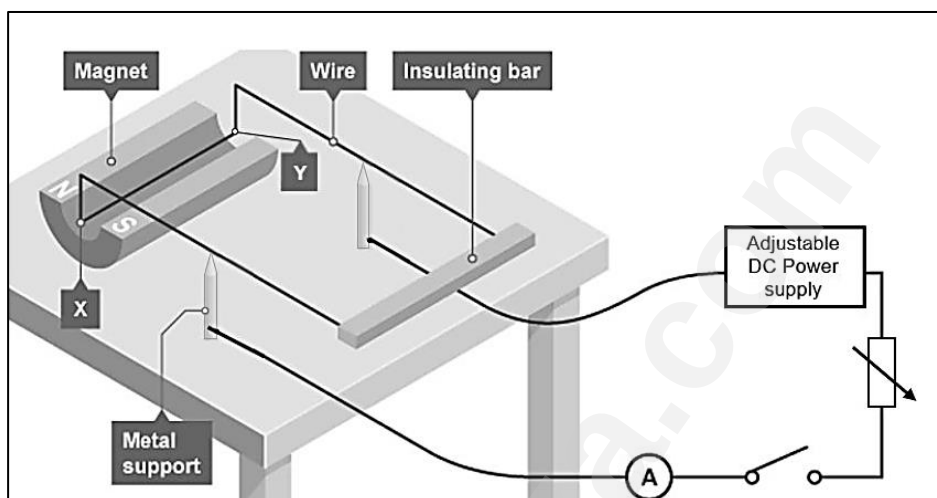
A cell delivers maximum power to an external circuit when the *resistance of the external circuit equals the internal resistance of the power supply*.

- 7.2.1 Calculate the current which is delivered to the external circuit at maximum power. (3)
- 7.2.2 Determine the value of R for this circuit at which maximum power is delivered to the external circuit. (3)
- 7.2.3 What is the reading on the voltmeter for the value of R calculated in Q 7.2.2? (2)
- 7.2.4 Calculate the total power delivered by the cell when the maximum power is being delivered to the external circuit. (3)

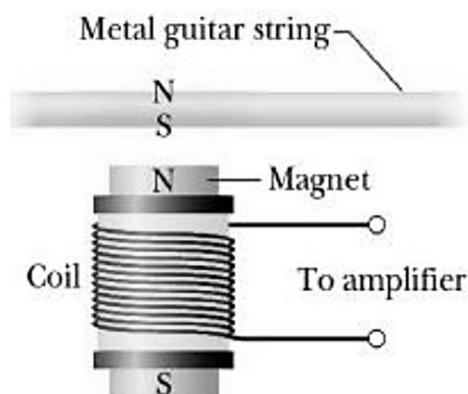
[26]

QUESTION 8 ELECTRODYNAMICS

- 8.1 The picture below shows a piece of apparatus called a current balance. A length of conducting wire (XY) runs through a magnetic field set up inside a permanent magnet. All wires and metal supports conduct electricity. The insulating bar does not conduct electricity.

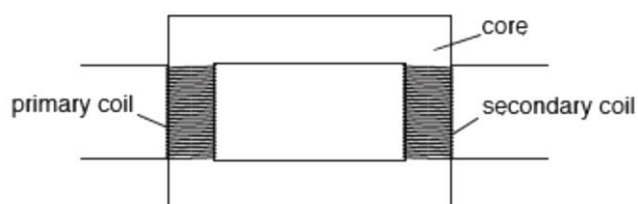


- 8.1.1 On the answer sheet provided, the view from above the magnet is shown with wire, XY running between the poles. On the diagram, sketch lines to show the direction of the magnetic field due to the permanent magnet. (2)
- 8.1.2 When the switch is closed, the part of the wire labelled XY experiences a force and moves downwards. Is the current direction from X to Y or Y to X? (1)
- 8.2 In an electric guitar, small bar magnets are placed under the steel strings, as shown in the diagram below. Each magnet is placed inside a coil and it magnetises the steel guitar string immediately above it. When the string vibrates the magnetic flux cutting the coil changes, and an emf is induced causing a varying current to flow in the coil. The signal is amplified and sent to a set of speakers.



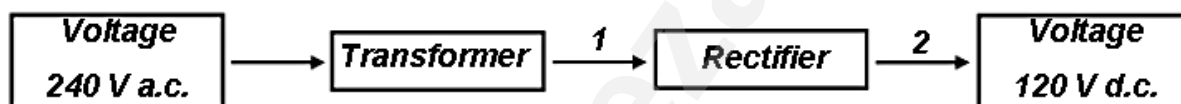
- 8.2.1 Define *magnetic flux linkage*. (2)
- 8.2.2 Using an appropriate equation, explain how a louder sound could be produced from the electric guitar **when a string is plucked**. No actual values are required. Use bullet points in your answer. (4)

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

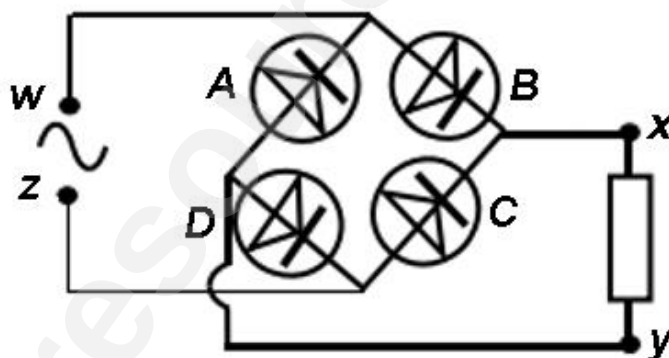


The primary coil of the transformer is connected to the output voltage of a generator which supplies an alternating current. Use *Faraday's law of electromagnetic induction* to explain why there is a voltage recorded between the two terminals of the secondary coil. (3)

- 8.4 A household appliance can also be connected via a transformer and rectifier to a 240 V a.c. source as shown in the simplified flow chart in the diagram below.



The rectifier consists of a combination of diodes connected as shown in the diagram below.



- 8.4.1 What is a *diode*? (2)
 8.4.2 What is the function of the rectifier? (2)
 8.4.3 For the cycle when **W** is positive, which diodes (**A**, **B**, **C**, **D**) will conventional current flow through? (2)
 8.4.4 For the cycle when **W** is positive, in what direction will conventional current flow through the load (**x** to **y** or **y** to **x**)? (1)

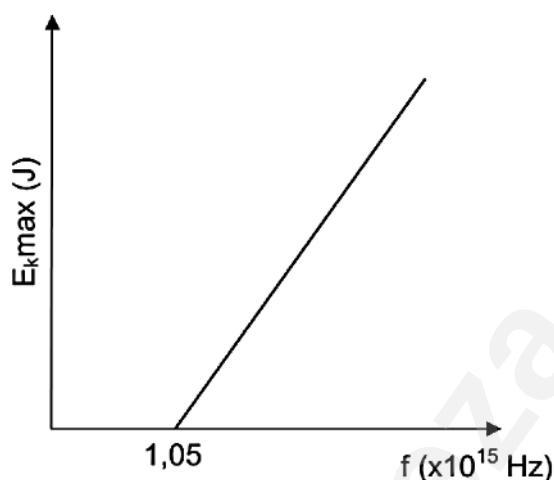
Ignoring actual values of emf and time, draw sketch graphs to represent the change in emf with time...

- 8.4.5 immediately before the current passes through the rectifier (position **1** on the flow chart). (2)
 8.4.6 immediately after the current passes through the rectifier (position **2** on the flow chart). (2)

QUESTION 9 PHOTONS AND ELECTRONS

Khanya measures the maximum kinetic energy of photoelectrons emitted from the surface of metal X, using different frequencies of the incident radiation. She uses her data to plot the graph shown below.

Graph showing the relationship between the maximum kinetic energy of photoelectrons and the frequency of incident radiation for metal X.



The following table shows the work function of a variety of metals:

Metal	Work Function (J)
Sodium	$3,82 \times 10^{-19}$
Zinc	$6,97 \times 10^{-19}$
Copper	$7,52 \times 10^{-19}$
Platinum	$1,02 \times 10^{-18}$
Calcium	$4,78 \times 10^{-19}$

- 9.1 Define *work function*. (2)
- 9.2 Use information from the graph and the table above to determine the identity of metal X. (4)
- 9.3 When blue light, with a wavelength of 475 nm is shone onto a certain metal surface, the maximum speed of emitted electrons is $2,77 \times 10^5 \text{ m}\cdot\text{s}^{-1}$. Determine which metal from the table above is being used. (6)
- 9.4 What would happen to i) the number of electrons ejected per second and
ii) the maximum kinetic energy of the electrons
if *violet light* of the same intensity as the blue light, was shone onto the metal named in Q9.3 (state only *increase*, *decrease*, or *no change*). (2)

[14]