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TOTAL MARKS

INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
NOVEMBER 2024

PHYSICAL SCIENCES: PAPER I

EXAMINATION NUMBER

Time: 3 hours 200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 32 pages and a Data Sheet of 2 pages (i–ii). Please check that your question paper is complete.
2. **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 on the question paper.**
3. Read the questions carefully.
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. Two blank pages (pages 31 and 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.

FOR MARKER'S USE ONLY

Question	1	2	3	4	5	6	7	8	9	10	Total
Marks	20	30	26	10	18	14	16	27	15	24	200
Marked											
Moderated											

QUESTION 1

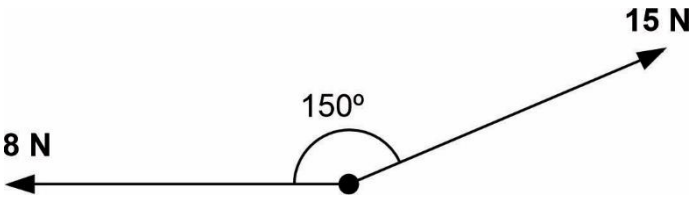
Answer these questions on the multiple-choice answer grid below. Make a clear cross (X) in the box corresponding to the letter that you consider to be correct. Every question has only one correct answer.

A	B	C	D

Here the option C has been marked as an example.

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 force of 8 N and a force of 15 N act on an object. The angle between the forces is 150º.



The **resultant vector** acting on the object can be resolved into two components. Which row in the table shows the possible magnitude of the two components?

	COMPONENT 1 (N)	**COMPONENT 2 (N)**
A	8 – 15 cos 60º	15 sin 60º
B	15 cos 30º – 8	15 sin 30º
C	15 cos 60º	15 sin 60º
D	15 sin 30º	15 cos 30º

1.2 A hot air balloon rises vertically upwards at a constant velocity of 3 $m.s^{-1}$. When it is at 100 m above the ground, a ball is dropped vertically down. Ignore wind resistance and calculate the time it will take the ball to hit the ground.

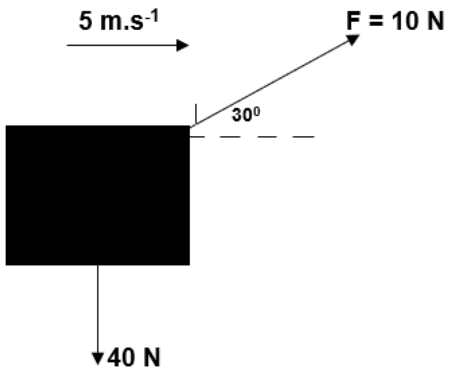
A 4,20 s

B 4,22 s

C 4,31 s

D 4,83 s

1.3 An object with a weight of 40 N is pulled along a horizontal road at a constant velocity of 5 $m.s^{-1}$. The force applied is 10 N acting at an angle of 30º to the horizontal, as shown below.



The power used to move this object is:

A 43,3 W

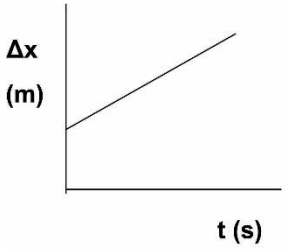
B 25,0 W

C 50,0 W

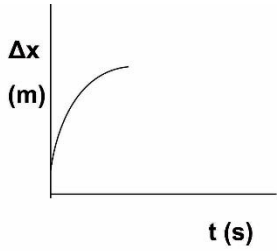
D 175,0 W

1.4 An object is moving in a straight line with a constant acceleration. Which graph is the correct representation of the motion?

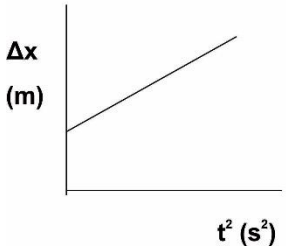
A



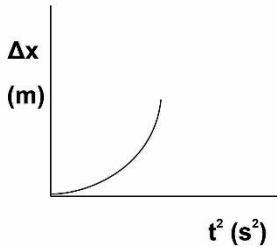
B



C



D



1.5 Which row in the table is correct for an elastic collision?

	Energy conserved	**Momentum**
A	Mechanical energy	Conserved
B	Kinetic energy	Conserved
C	Gravitational potential energy	Not conserved
D	Elastic potential energy	Conserved

1.6 When catching a cricket ball travelling at a high speed, the fielder moves his hands in the direction of motion of the ball. The reason for this can be BEST explained by the following:

A The time to change the momentum is shorter, making the force on his hands less.
B The momentum remains the same and thus the force is less on his hands as the time of contact is increased while stopping the ball.
C The force acting on his hands is smaller because the time and change in momentum is increased.
D For the force acting on his hands to be smaller, he must decrease the time of contact with the ball to bring about the same change in momentum.

1.7 Work done is measured in joules. Which ONE of the following units also represent work being done on an object by a force?

A N.s

B $kg.m.s^{-1}$

C $kg.m^2.s^{-1}$

D $kg.m^2.s^{-2}$

1.8 The earth has a mass **M** and a radius **R**. The force of attraction of the earth on a rocket with a mass **m**, just starting to leave the surface of the earth, is **F**. What would the new force **F/** be in relation to **F**, if the rocket is a distance double that of the radius of the earth above the surface? At this time the rocket would have lost 10% of its mass due to the usage of fuel.

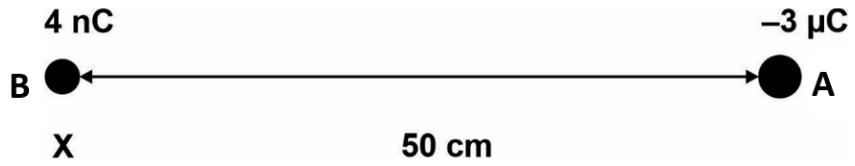
A $F^{/} = \frac{GmM}{10R^2}$

B $F^{/} = \frac{G9mM}{40R^2}$

C $F^{/} = \frac{G10mM}{4R^2}$

D $F^{/} = \frac{G\,mM}{40R^2}$

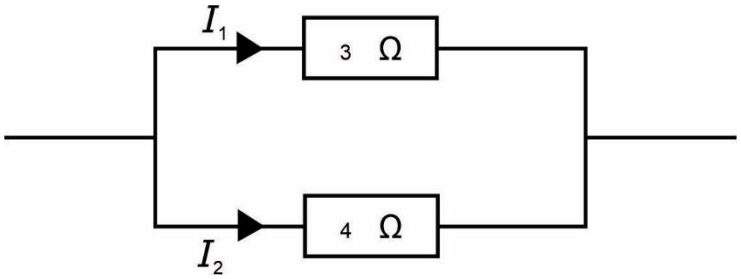
1.9 A metal ball A, with a charge of –3 μC, is lying on a horizontal wooden table. At a point **X**, 50 cm away as shown in the sketch, the electric field strength due to this charge is **E**. Another metal ball B with a charge of 4 nC is put at this point **X**.



Which row in the table gives the correct electric field, **E**, at **X** and the force that metal ball B will experience?

	Electric field ($N.C^{-1}$)	**Force (N)**
A	$1{,}08 \times 10^5$ right	$4{,}32 \times 10^{-4}$ right
B	$1{,}08 \times 10^5$ left	$4{,}32 \times 10^{-4}$ right
C	$1{,}08 \times 10^5$ left	$4{,}32 \times 10^{-4}$ left
D	$1{,}08 \times 10^5$ right	$4{,}32 \times 10^{-4}$ left

1.10 A 3 Ω and a 4 Ω resistor are connected in parallel as shown in the sketch.



The ratio between the currents I_1 and I_2 will be:

A $I_1 = \frac{3}{4} I_2$

B $I_1 = \frac{4}{3} I_2$

C $I_1 = \frac{7}{12} I_2$

D $I_1 = \frac{4}{12} I_2$

[20]

QUESTION 2

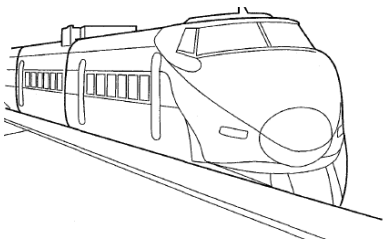
2.1 Define *speed* in words.

_____

_____

(2)

2.2 A train leaves station A and reaches his next stop, station B, in 8 minutes. It accelerates uniformly at 1,5 $m.s^{-2}$ for the first 10 seconds and then continues at a constant speed before it starts to brake. The train needs 15 s to come to a stop at station B.



2.2.1 Calculate the constant speed of the train.

(3)

2.2.2 Calculate the distance it covered while moving at the constant speed.

(3)

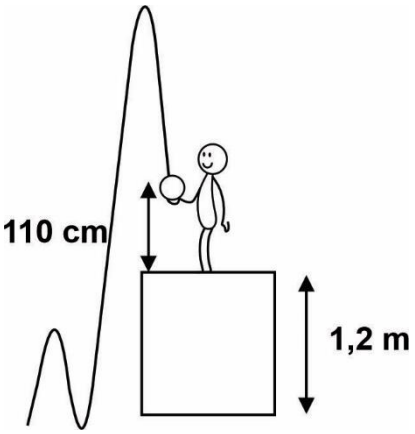
2.2.3 Calculate the acceleration of the train while it is braking to stop.

(3)

2.2.4 How far, in kilometers, are the two stations from each other?

(6)

2.3 A person standing on a 1,2 m tall crate throws a ball vertically upwards. When it leaves the person's hand, it is 110 cm above the crate. The ball reaches a maximum height of 3,4 m above the ground when it starts moving downward.



2.3.1 Calculate the speed with which the ball was thrown up into the air.

(3)

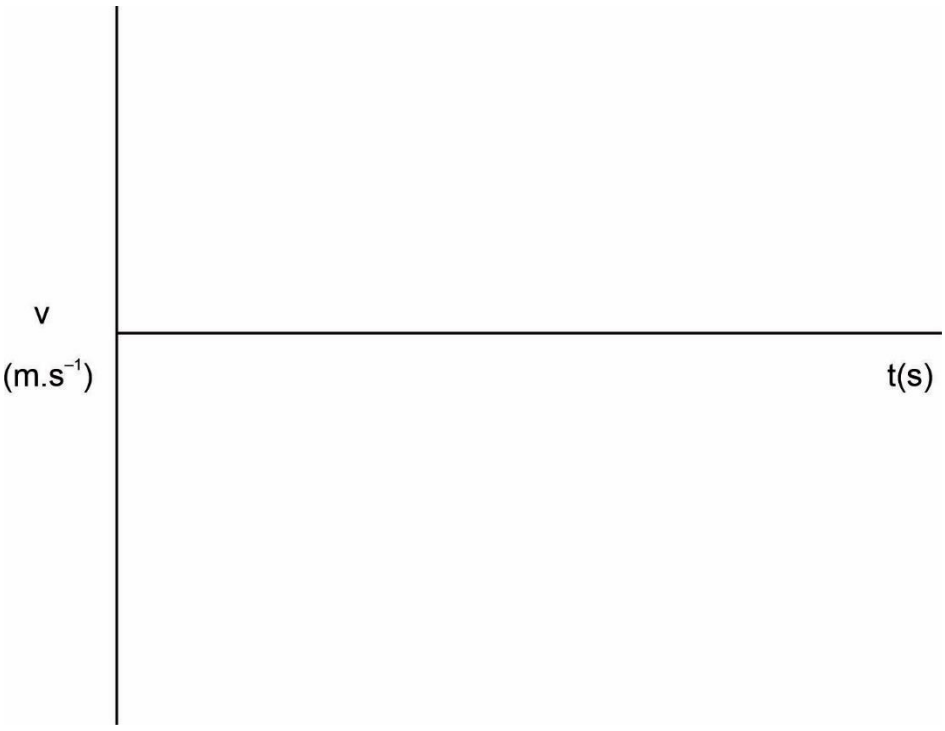
2.3.2 Calculate the speed with which the ball hits the ground.

(3)

2.3.3 Calculate the total time the ball spends in the air.

(3)

2.3.4 Draw a velocity-time graph of the movement of the ball from the moment it was thrown upwards until it has bounced twice. Take up as positive. No specific values need to be shown on the axes.



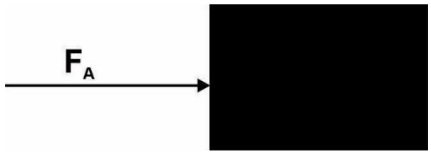
(4)
[30]

QUESTION 3

3.1 Define a *frictional force* due to a surface in words.

(2)

3.2 A force is applied horizontally to a box full of books to try and move it. The mass of the box and the books is 50 kg. The applied force is increased but the box is still not moving.



3.2.1 Is the following statement correct? Explain your answer.

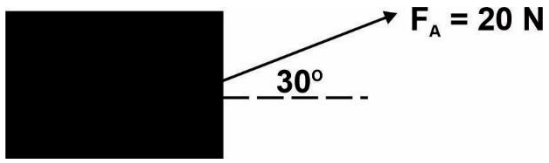
'The box is not moving because the static frictional force is bigger than the applied force.'

(2)

3.2.2 If the coefficient of static friction, μ_s, is 0,03 for this surface, calculate the maximum static friction acting on the box.

(2)

3.2.3 The applied force is now changed so that the box is no longer pushed, but pulled with a force of 20 N at an angle of 30º to the horizontal.



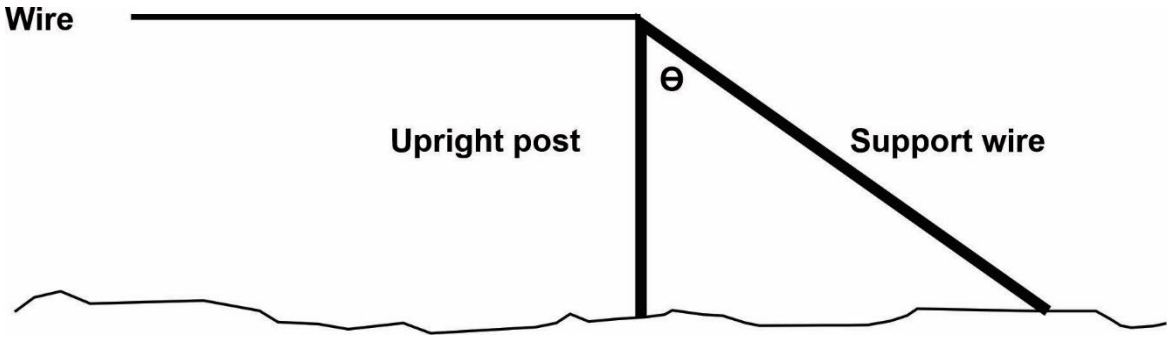
(a) Will the normal force acting on the box still be the same? Explain your answer.

(2)

(b) If the box accelerates at 0,2 $m.s^{-2}$, calculate the kinetic coefficient of friction. Round your answer to 3 decimal places.

(8)

3.3 A farmer is busy tensioning a boundary wire. When the wire is pulled tight enough, it will carry a tension of 4 536 N and remain horizontal. The upright post exerts an upwards force of 1 500 N.



Calculate:

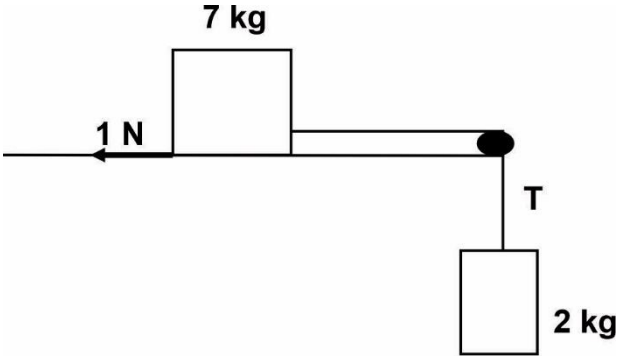
3.3.1 The angle, Θ, at which the support wire must be stretched so that it keeps everything in equilibrium.

(2)

3.3.2 The magnitude of the tension in the support wire.

(2)

3.4 A box with mass 7 kg is at rest on a rough surface of a table. It is then connected to a 2 kg block, which is hanging vertically, with a light, inextensible string that runs over a frictionless pulley. When the 7 kg block is released, it experiences a kinetic frictional force of 1 N to the left.



3.4.1 Calculate the magnitude of the acceleration of the system.

(4)

3.4.2 Calculate the magnitude of the tension T in the string.

(2)
[26]

QUESTION 4

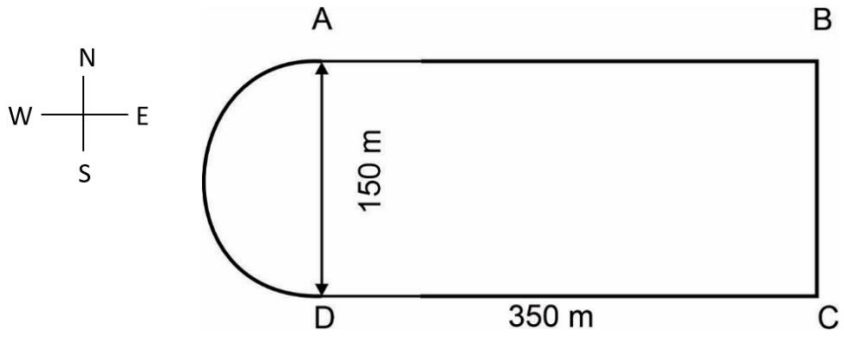
4.1 Define *distance* in words.

_____

_____

(2)

4.2 Peter runs from point A around the half circle to point D and then from point D in a straight line to point C.



The diameter of the circle is 150 m and the length of CD is 350 m. If he covers this distance in 1,5 minutes, calculate his:

4.2.1 average speed

(4)

4.2.2 average velocity

(4)
[10]

QUESTION 5

Two cars are moving towards each other as shown below. After they collide, they stay connected to each other.

Car A: mass 1 000 kg
v = 63 km.h^{-1}

Car B: mass 1 300 kg
v = 90 km.h^{-1}

Two cars connected after collision

5.1 Determine the speed of the two cars before they collide, in m.s^{-1}.

(2)

5.2 Calculate the velocity of the two cars connected after they had collided.

(4)

5.3 Calculate the magnitude of the driving force on the car B **before** the collision if the power used was 33 kW.

(3)

5.4 Define *impulse*.

(2)

5.5 The drivers of both cars have the same mass. Both drivers are wearing seatbelts which stretch slightly to bring the drivers to rest during the collision, relative to the car, in the same time. Neither car has air bags.

Which driver is likely to experience the greater force during the collision? Explain your answer with reference to a formula.

(4)

5.6 The fact that an airbag allows you to move a small distance forward before it stops you, decreases the injuries your body will experience. Explain why this statement is true.

(3)
[18]

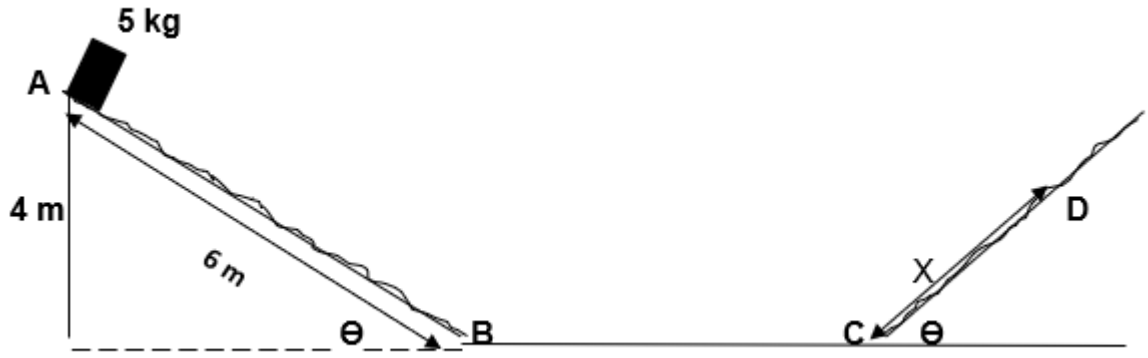
QUESTION 6

A crate slides down a rough decline that makes an angle Θ to the horizontal. The crate starts from rest at point A and ends 4 m lower than the starting point at point B. It then slides along this frictionless surface to point C and then up a rough incline to a point D where it stops before it slides back down. Both inclines are at the same angle Θ to the horizontal.

The mass of the crate is 5 kg.

The length of surface AB is 6 m.

The kinetic frictional force acting parallel to the surface from point A to point B is 14,5 N.



6.1 State the *principle of conservation of mechanical energy*.

_____

_____

(2)

6.2 Calculate the magnitude of the velocity with which the crate will reach point B making use of energy principles.

(4)

6.3 State the *work-energy principle*.

(2)

6.4 What would the speed of the crate be when it reaches point C? Explain your answer.

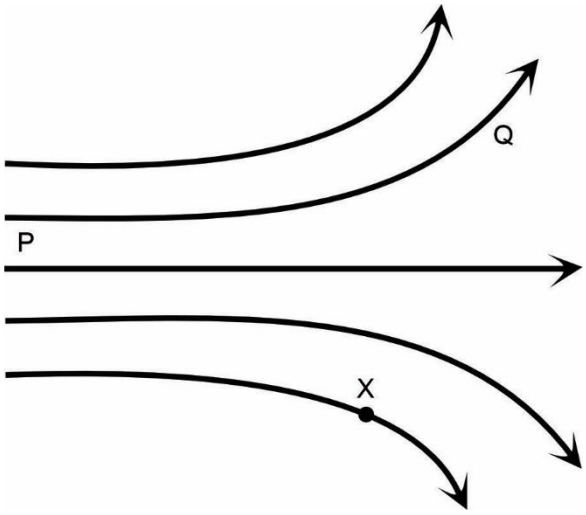
(2)

6.5 If the frictional force acting on surface from point C to D is 18,4 N, calculate the distance X that it will move up the incline.

(4)
[14]

QUESTION 7

7.1 An electric field is shown below.



7.1.1 Compare the strength of the electric field at P and Q by referring to the sketch.

_____

_____

(2)

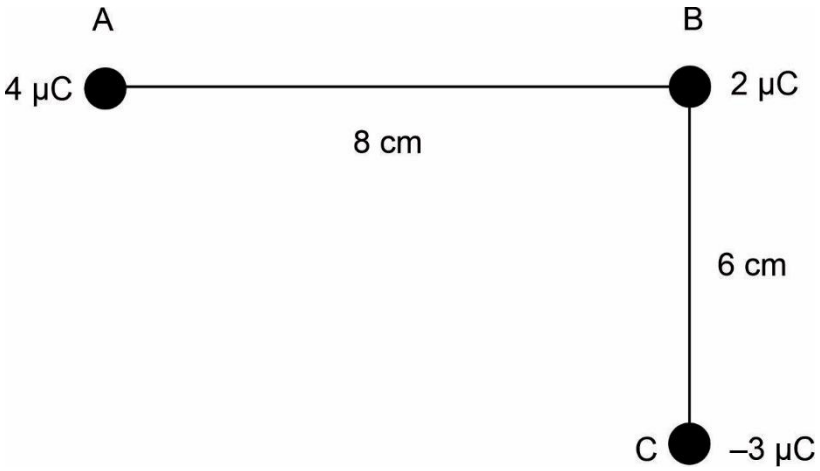
7.1.2 Use an arrow to draw the direction of the movement of an electron, on the sketch above, if the electron was put in position X. Explain your answer.

_____

_____

(2)

7.2 Two spheres with charges of 4 μC and 2 μC, are placed on a horizontal line at positions A and B. B is placed 8 cm due east of A. Another sphere with a charge of –3 μC, is then placed 6 cm due south of B on a vertical line at C.



7.2.1 State *Coulomb's law* in words.

(2)

7.2.2 Calculate the number of excess electrons on the sphere at C.

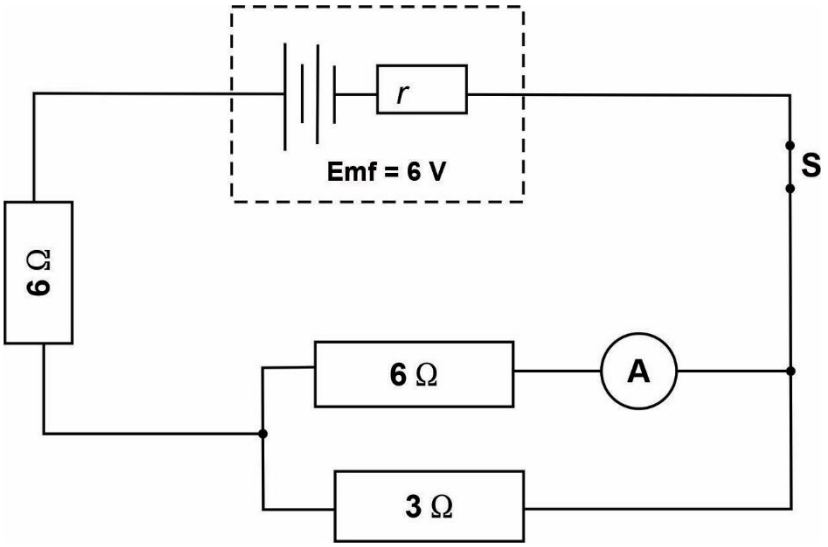
(2)

7.2.3 Calculate the resultant electrostatic force acting on the 2 μC charge, at position B.

(8)
[16]

QUESTION 8

8.1 In the circuit below the battery has an emf of 6 V and an internal resistance, r. The reading on the ammeter is 0,2 A.



8.1.1 Calculate the current in the 3 Ω resistor. Show all calculations.

(3)

8.1.2 Calculate the effective resistance of the parallel combination.

(2)

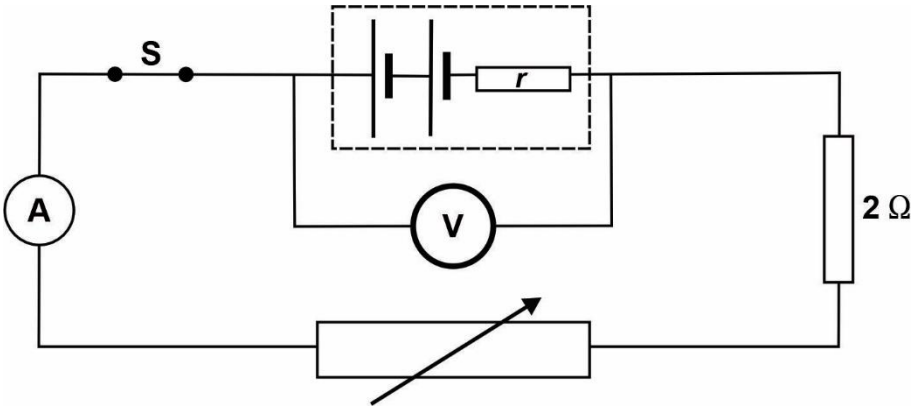
8.1.3 Calculate the internal resistance of the battery.

(4)

8.1.4 The 3 Ω resistor is removed from the circuit. Explain the influence of this on the internal potential difference of the battery.

(4)

8.2 Gomo and Amy decided to conduct experiments with electricity. For the first experiment they set up the circuit as shown:



8.2.1 Why would they use a rheostat in the circuit?

(1)

8.2.2 Give a research question for this experiment.

(2)

8.2.3 The results for the experiment are given in the table below:

Current (A)	Potential difference (V)
0,0	15,0
0,6	13,5
1,2	12,0
2,0	10,0
2,6	8,5
3,2	7,0

Give the relationship between current and potential difference in words.

_____

_____

(2)

8.2.4 What is the emf value for the battery they have used?

_____

(1)

8.2.5 Gomo and Amy then decided to conduct an experiment to find the relationship between the current through the 2 Ω resistor and the potential difference over the 2 Ω resistor.

By using the **formula** for Ohm's Law explain the relationship in words.

_____

_____

_____

_____

_____

_____

(3)

8.2.6 Calculate the amount of energy used by the 2 Ω resistor if a current of 0,5 A flows through it in 5 minutes.

(3)

8.2.7 Give the definition of *potential difference* in words.

_____

_____

(2)
[27]

QUESTION 9

Learners in the class want to do an experiment to see if the photoelectric effect is true. A red light with a wavelength of 650 nm is shone onto a piece of metal. The metal has a work function of 3,68 eV.

9.1 Calculate the energy carried by a photon of the red light.

(3)

9.2 Use the data in the table below and decide which type of metal was used in this experiment. Show your calculations.

Type of metal	**Work function ($x10^{-19}$ J)**
Magnesium	5,89
Copper	7,52
Cobalt	8,00

(2)

9.3 Will electrons be emitted from the metals when the red light shines on it? Explain your answer.

(2)

9.4 There is also an ultraviolet light and an infra-red (IR) light available to test the photo-electric effect with. The learners decided to use the ultraviolet light. Explain why they would rather use the UV-light and not the IR-light.

(3)

9.5 Name the instrument that can be used by the learners to determine whether electrons are emitted by the metal.

(1)

9.6 The ultraviolet light is intensified and then used to shine on the piece of metal again. **Explain** how this will influence:

9.6.1 the kinetic energy of the electrons if they are emitted.

(2)

9.6.2 the number of electrons released per unit time if it is emitted.

(2)
[15]

QUESTION 10

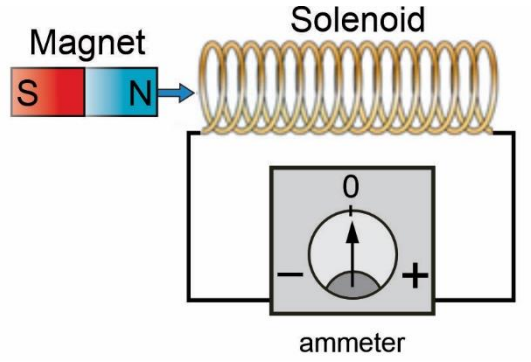
10.1 Give *Lenz's Law* in words.

_____

_____

(2)

10.2 A magnet is moved horizontally towards a coil as shown in the sketch below.



10.2.1 What will you observe on the ammeter? Only mention one of the following:

NEEDLE MOVES TOWARDS POSITIVE or NEEDLE MOVES TOWARDS NEGATIVE.

_____

(1)

10.2.2 Explain your answer to Question 10.2.1 by underlining the correct word or phrase.

The change in magnetic flux into the coil is **increasing/decreasing** and thus an induced magnetic field in the coil will cause a **north pole/south pole** where the flux enters as this will have a magnetic field direction **towards the magnet/away from the magnet**.

(3)

10.3 Complete the table:

	Magnetic flux density	**Magnetic flux**
Symbol		
Unit		
Scalar/vector		

(6)

10.4 Electricity is supplied to homes by high voltage wires that transmit it. However, homes need lower potential difference at the wall plugs. Transformers are used for this change.

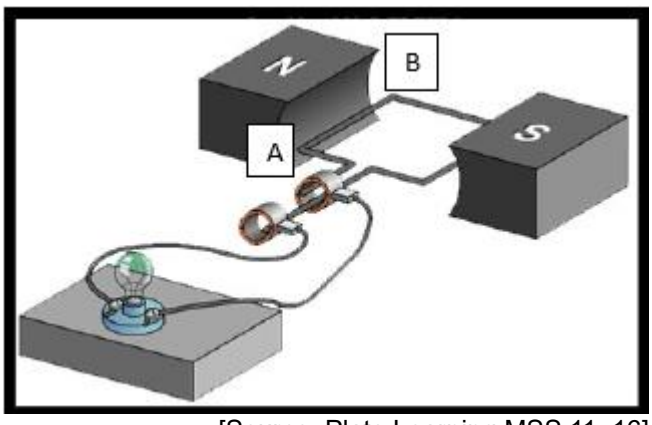
10.4.1 Why is it necessary for a transformer to work with alternating current?

(3)

10.4.2 If the primary input in a transformer is at 4 400 V and it consists of 800 turns in the coil, how many turns should there be in the secondary coil if the potential difference must be brought down to 220 V?

(2)

10.5 Consider the diagram below and answer the questions that follow.



[Source: Plato Learning MSS 11–16]

10.5.1 Is this a diagram of a generator or an electric motor? Explain your answer by referring to the equipment in the diagram.

(2)

10.5.2 If the coil **starts** to turn clockwise, will the current flow from A to B, or from B to A?

(1)

10.5.3 **Explain** what you will observe when looking at the light bulb when:

(a) the coil keeps turning clockwise.

(2)

(b) the coil is turned faster.

(2)

[24]

Total: 200 marks

ADDITIONAL SPACE (ALL QUESTIONS)

REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.

