Please paste the barcoded label here

TOTAL MARKS

INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
MAY 2023

PHYSICAL SCIENCES: PAPER I

EXAMINATION NUMBER

Time: 3 hours 200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 28 pages and a Data Sheet of 2 pages (i–ii). 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 when 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 26 to 28) are included at the end of the exam paper. If you run out of space for an answer, use these pages. Clearly indicate the 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	**Total**
Marks	20	23	21	28	27	17	28	21	15	**200**
Marked										
Moderated										

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

Answer these questions on the 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

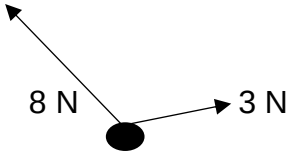
Here the option C has been marked as an example.

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 stone is thrown vertically upwards. During the time that the stone moves upwards until it hits the ground, the magnitude of the acceleration will …

A decrease while it moves upwards.
B remain constant.
C increase while it moves downwards.
D be zero at the maximum height.

1.2 Two forces, one of 8 N and one of 3 N, act on the same object as shown in the diagram below. The angle between the forces can be varied/changed.



Which of the following forces would **NOT** be able to bring these two forces into equilibrium, no matter what the angles between the forces?

A 11 N
B 5 N
C 13 N
D 9 N

1.3 Which one of the following will remain constant under **all** circumstances when balanced forces act on an object?

A Internal energy
B Kinetic energy
C Potential energy
D Mechanical energy

1.4 The diameter of planet Q is 13 times that of the earth, while its mass is 431 times that of the earth. Which one of the following will be the acceleration (in $m \cdot s^{-2}$) on the surface of planet Q?

A $\frac{431 \times 9{,}8 \times 4}{13^2}$

B $\frac{431 \times 9{,}8}{13}$

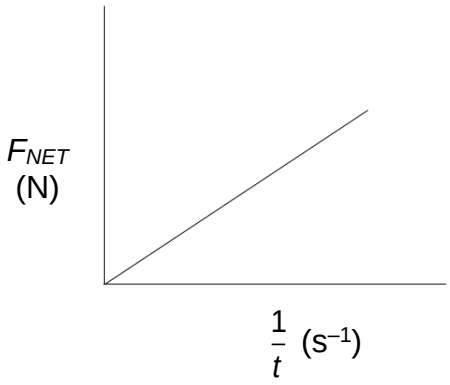
C $\frac{13^2}{431 \times 9{,}8 \times 4}$

D $\frac{13^2 \times 4}{431 \times 9{,}8}$

1.5 A car, moving at constant velocity with kinetic energy E_k, undergoes a displacement x in time t. If the car's kinetic energy changes to a value of $2E_k$, then at the same time, at a new constant velocity, it will undergo a displacement of …

A $4x$
B $2x$
C $\sqrt{2}\,x$
D $\frac{1}{\sqrt{2}}x$

1.6 A nett force F acts on a mass m and the following graph of F_{NET} against $\frac{1}{t}$ is drawn.

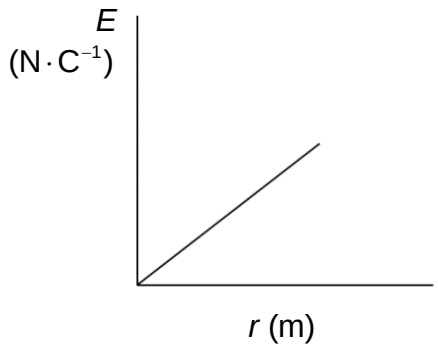


The gradient of this graph gives the ... of the mass.

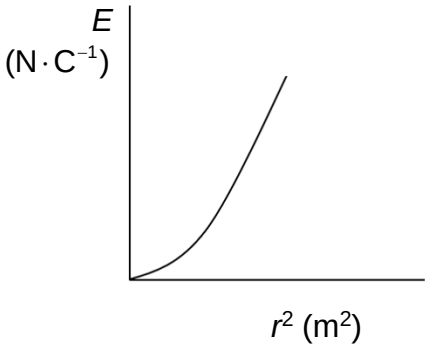
A displacement
B change in momentum
C constant speed
D acceleration

1.7 Which one of the following graphs gives the correct relationship between the electric-field strength (E) due to a charge Q and the distance r away from the charge?

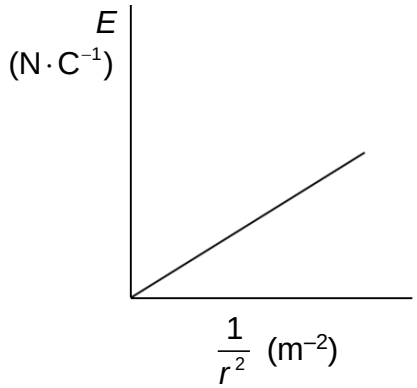
A



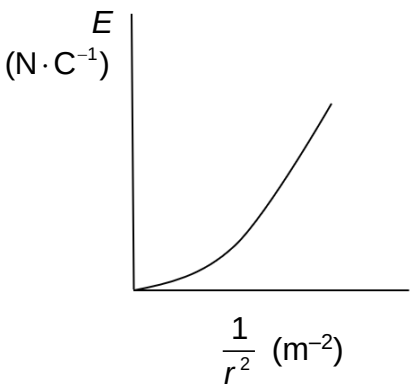
B



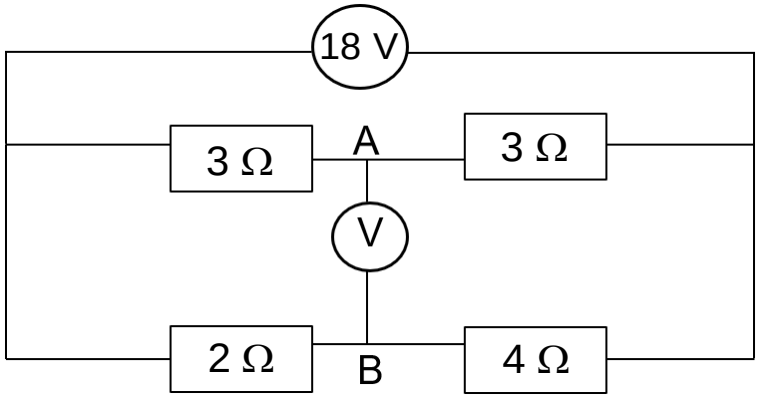
C



D



1.8 Four resistors are connected as part of a larger circuit as shown in the diagram below.



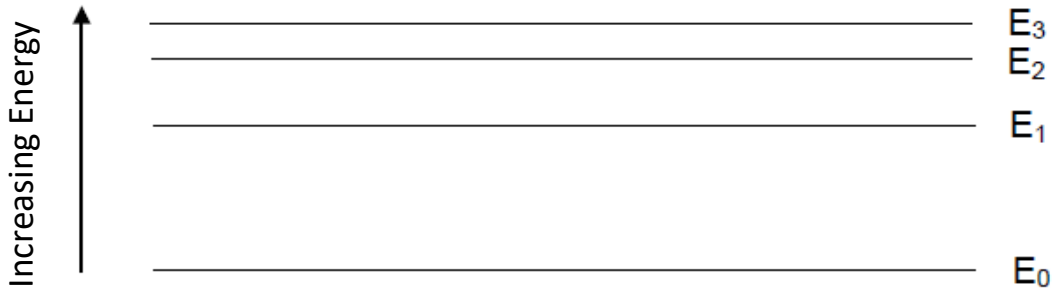
What will the reading on the voltmeter be between points **A** and **B**?

A 3 V
B 4 V
C 6 V
D 0 V

1.9 In an AC-generator the current is delivered to the external circuit by the ...

A split rings (commutator).
B battery.
C coil.
D slip rings.

1.10 The diagram below shows four energy levels in an atom. When an excited electron falls back from a higher energy level to a lower energy level it will cause the release of a photon.



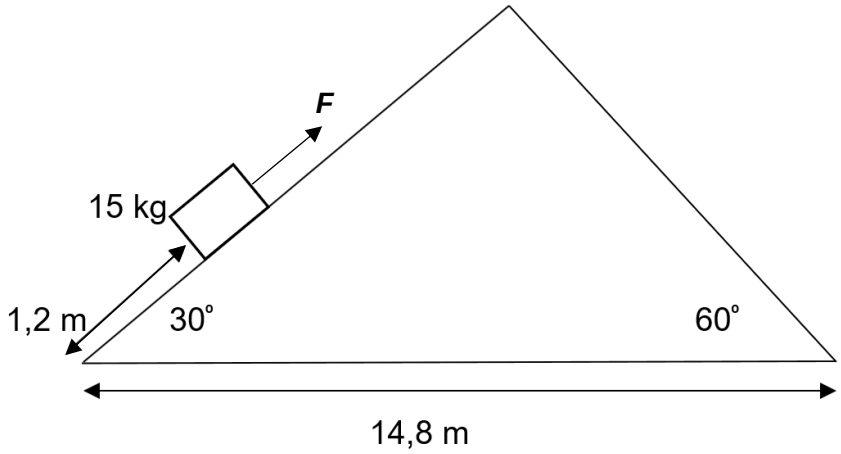
Which one of the following transitions will lead to the release of a photon with the shortest wavelength?

A Level $\mathbf{E_1}$ to $\mathbf{E_0}$
B Level $\mathbf{E_3}$ to $\mathbf{E_2}$
C Level $\mathbf{E_3}$ to $\mathbf{E_0}$
D Level $\mathbf{E_2}$ to $\mathbf{E_1}$

[20]

QUESTION 2 KINEMATICS

A crate with a mass of 15 kg is pushed up a frictionless slope at a constant speed. The slope is at a 30° angle to the horizontal. The force applied to the crate acts parallel to the slope.



2.1 Calculate the magnitude of the applied force.

(3)

2.2 Calculate the distance it should still move up to reach the top of the slope if it is already 1,2 m up the slope.

(3)

2.3 Define *acceleration*.

(2)

When the crate reaches the highest point, it is released from rest to move down the rough slope making an angle of 60° with the horizontal. It reaches the bottom in 4 seconds.

2.4 Calculate the acceleration of the crate down the slope.

(4)

2.5 What will the velocity of the crate be at the bottom of the slope?

(3)

2.6 Calculate the resultant force acting on the crate while it moves down the slope.

(2)

2.7 State Newton's second law of motion in words.

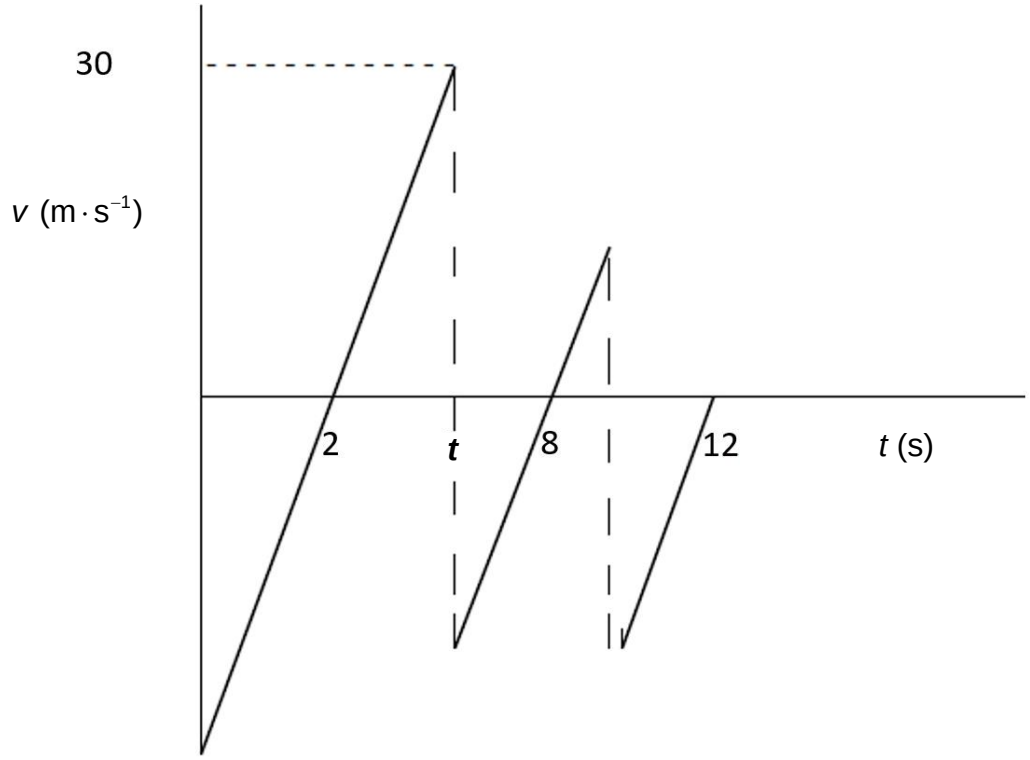
(2)

2.8 Calculate the magnitude of the frictional force acting on the crate whilst it moves down the slope.

(4)
[23]

QUESTION 3 KINEMATICS

3.1 A ball is thrown vertically upwards. It reaches the ground and bounces a few times. (The graph is not drawn to scale.)



3.1.1 According to the given graph, which sign convention, positive or negative, was chosen for the downwards motion?

(2)

3.1.2 How long did it take the ball to reach the maximum height after it was thrown?

(2)

3.1.3 Without a calculation, state the acceleration of the ball.

(2)

3.1.4 Calculate the time ***t*** as shown on the graph.

(4)

3.1.5 How many times did the ball bounce as shown in this graph?

(2)

3.1.6 Calculate the distance that the ball covered from the maximum height until it hit the ground the first time.

(3)

3.2 A golf ball rolls from rest down a slope with a constant acceleration. It rolls 1,1 m during the 2nd second and 2,2 m during the 3rd second. How far (in m) did it roll during the 1st second?

(6)
[21]

QUESTION 4 NEWTON

4.1 Two containers, **P** and **Q**, each with a mass of 12 kg are separately pushed over a cement floor at a constant speed. To overcome the friction, a force of 40 N acts on **P** and a force of 60 N on **Q**.

4.1.1 Give a possible reason why the frictional forces for the two containers differ from each other.

(2)

The two containers are now placed against each other and pushed together over the cement floor.

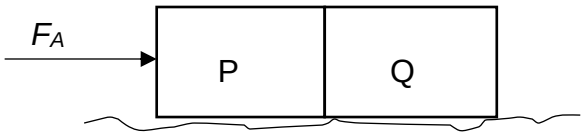
4.1.2 How big should the applied force on the two containers be to move them at a constant speed?

(2)

4.1.3 State Newton's third law of motion in words.

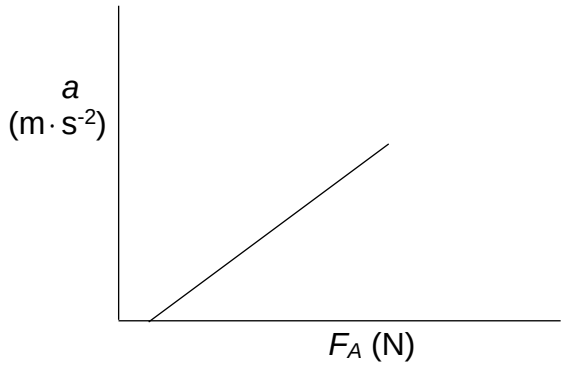
(2)

4.1.4 Calculate the force that **P** will exert on **Q** when they are pushed together with an acceleration of 0,2 $m \cdot s^{-2}$. The applied force acts on **P**.



(4)

4.2 A mass *M* undergoes different accelerations every time a different magnitude applied force F_A acts on it. A sketch graph of the results is shown below.



4.2.1 Give two variables that must be kept constant during the experiment.

(2)

4.2.2 Why is it necessary to keep certain variables constant to ensure that it is a fair experiment?

(2)

4.2.3 Give the independent variable for this experiment.

(2)

4.2.4 Explain why the straight line does not pass through the zero point **and** why it passes through the *x*-axis.

(4)

4.2.5 By making use of the equation of a straight line, $y = mx + c$, explain what the gradient of the graph in Question 4.2 would represent if it passed through the origin.

(3)

4.3 A traffic officer looked at the damage done to a truck and a car that were in a collision. He then said the following:

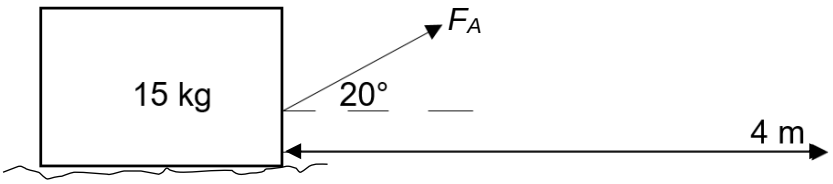
'The car has so much more damage than the truck because it experienced a bigger force during the collision due to the bigger mass of the truck.'

Is his statement correct? Explain your answer by making use of Newton's laws of motion as well as explaining the influence of a bigger mass.

(5)
[28]

QUESTION 5 MOMENTUM, WORK, ENERGY & POWER

5.1 An object with a mass of 15 kg is pulled horizontally over a distance of 4 m on a rough surface. The applied force makes an angle of 20° with the horizontal, as shown in the sketch. The coefficient of kinetic friction is 0,3.



5.1.1 Draw a labelled free-body diagram that shows ALL the forces acting on the block while it is being pulled.

(4)

5.1.2 State the *work-energy theorem* in words.

(2)

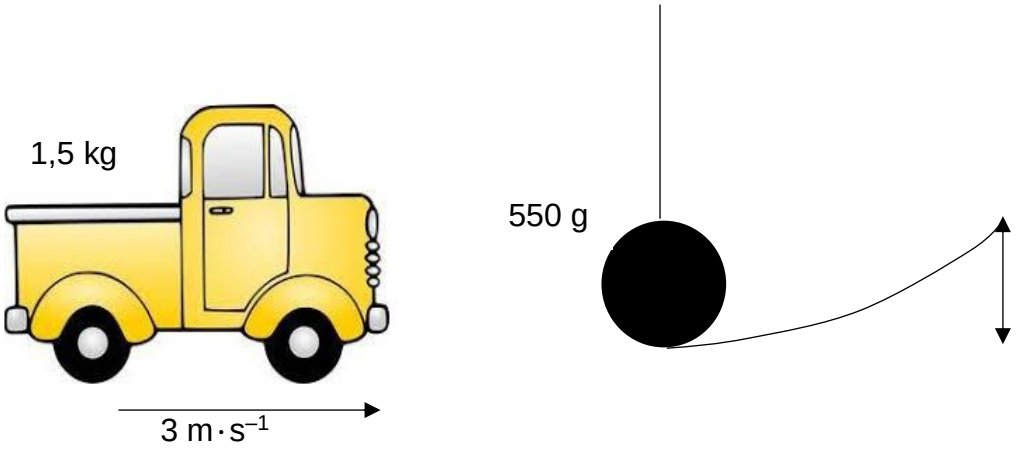
5.1.3 Show that the work done by the kinetic friction force (W_f) on the block, can be written as $W_f = (-17{,}64 + 0{,}041\ \boldsymbol{F_A})$ J.

(5)

5.1.4 Find the magnitude of the applied force F_A if the total amount of work done on the object is zero.

(4)

5.2 A toy-truck, mass 1,5 kg, moves at 3 m·s^{-1} on a smooth horizontal surface. It collides with a ball, mass 550 g, that hangs on an inelastic string. The ball swings upwards while the truck still moves forward at 2 m·s^{-1}. Ignore the effects of air resistance.



5.2.1 State the *law of conservation of momentum* in words.

(2)

5.2.2 Calculate the speed at which the ball moves away once the truck has collided with it.

(4)

5.2.3 The contact time of the collision is 0,02 s. Calculate the force that the truck exerts on the ball.

(3)

5.2.4 Calculate how high the ball will swing upwards.

(3)
[27]

QUESTION 6 FIELDS

6.1 Calculate the electric field strength at 2,5 cm away from a point charge of +6 mC.

(4)

6.2 Two identical small balls hang on strings close to each other. The one ball is neutral, but the other ball is negatively charged.

6.2.1 Explain how it is possible for the two balls to attract each other.

(3)

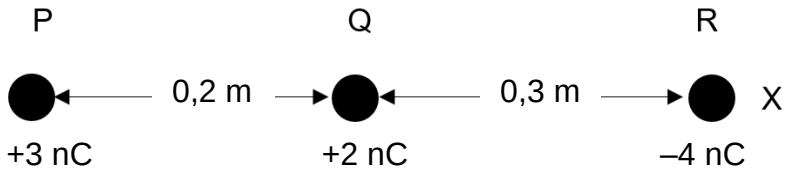
6.2.2 When the two balls touch each other, they immediately move apart again. Explain why this happens.

(2)

6.2.3 If the neutral ball now has a charge of –2 μC, how many electrons did it gain to have this charge?

(2)

6.3 Three charges **P**, **Q** and **R** lie in a straight line as shown in the sketch below.



6.3.1 Calculate the resultant force **Q** will experience due to the influence of **P** and **R**.

(5)

6.3.2 What is the direction of the resultant electric field strength at **X**?

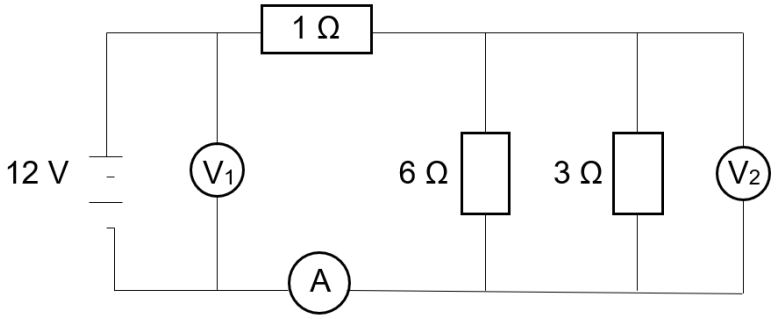
(1)
[17]

QUESTION 7 ELECTRIC CIRCUITS

7.1 State *Ohm's law* in words.

(2)

7.2 A circuit is set up as shown in the diagram below. The battery has an emf of 12 V and has significant internal resistance.



The reading on the ammeter **A** is 3 A.

Calculate the following:

7.2.1 The internal resistance of the battery.

(6)

7.2.2 The reading on voltmeter $\mathbf{V_1}$.

(2)

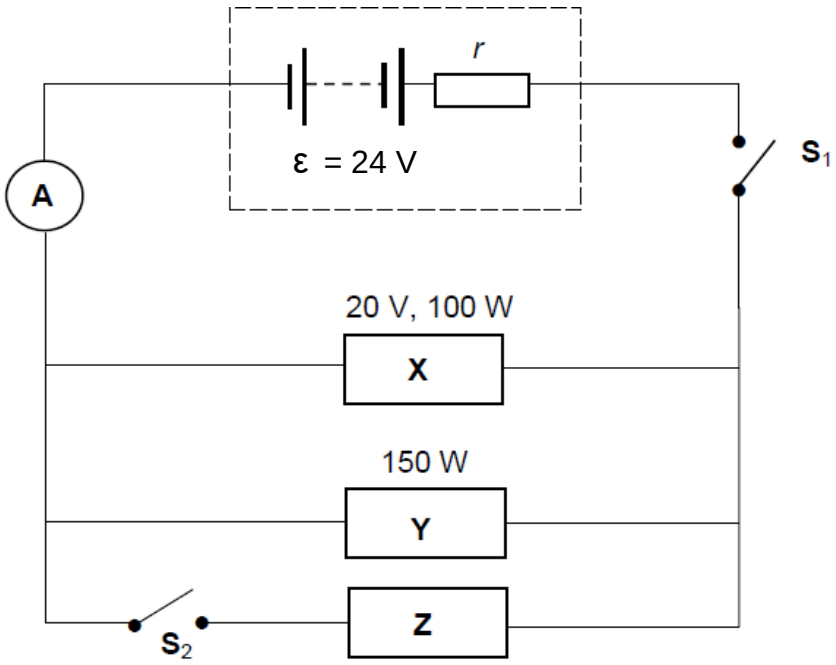
7.2.3 The reading on voltmeter V_2.

(2)

7.2.4 The energy conversion in the 3 Ω resistor in 2 minutes.

(3)

7.3 Three electrical devices, **X**, **Y** and **Z**, are connected to a 24 V battery with internal resistance *r* as shown in the circuit diagram below. The power rating of the devices **X** and **Y** are indicated in the diagram.



With switch S_1 closed and S_2 open, the devices function as rated.

7.3.1 Define *current*.

(2)

7.3.2 What does it mean if a bulb is marked 20 V?

(2)

7.3.3 Calculate the current flowing in **Y**.

(3)

7.3.4 Identify device **Z** that, when placed in the position shown, can still enable **X** and **Y** to operate as rated. Assume that the resistances of all the devices remain unchanged and explain how you arrived at the answer.

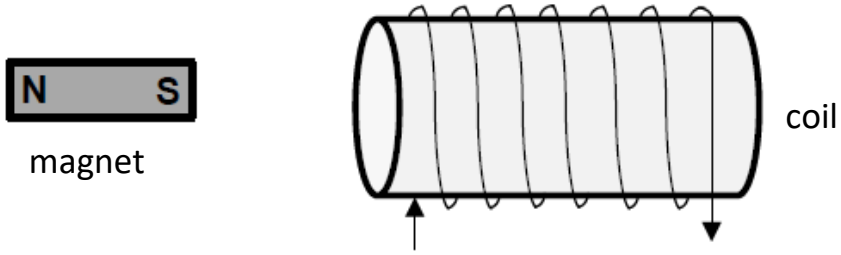
(3)

7.3.5 If a switch is opened in the branch containing device **X**, explain what would happen to the internal voltage of the battery and the internal resistance.

(3)
[28]

QUESTION 8 ELECTRODYNAMICS

8.1 A magnet is pushed through a coil that is connected to a digital galvanometer and then pulled back out again.



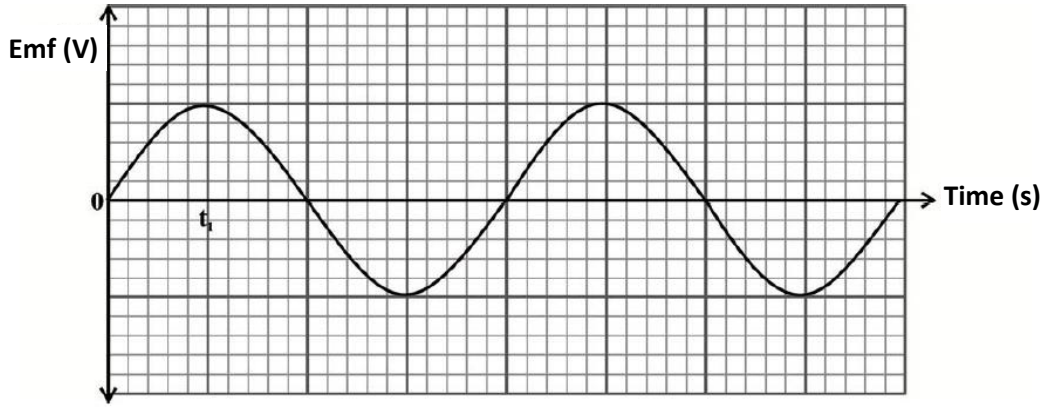
8.1.1 State *Lenz's law* in words.

(2)

8.1.2 Explain with the aid of Faraday's law of electromagnetic induction why an emf is induced.

(3)

The following graph is seen when the galvanometer is connected to a computer that draws a graph of the induced emf against time. The amplitudes above and beneath the time axis are identical.



8.1.3 Which pole will form on the coil when the magnet moves out on the other side before it is pulled back?

(1)

8.1.4 If the magnet should be dropped vertically through the coil and a graph should be drawn of the emf against time; **explain** why the graph's amplitude beneath the time-axis would be bigger than the amplitude above the time-axis.

(3)

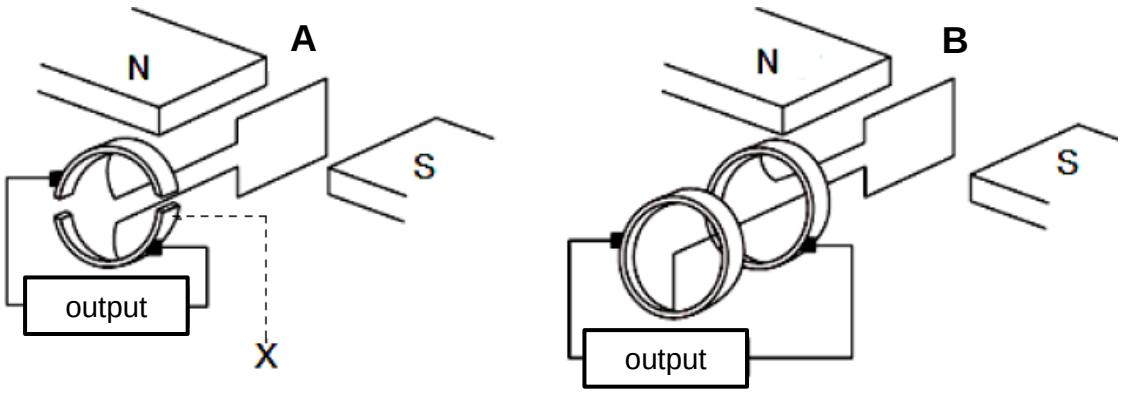
8.2 Two current-carrying conductors are placed parallel and close to each other as shown in the sketch.

X ●

Explain, with the aid of a sketch of the magnetic fields around the conductors, why they will attract or repel each other.

(4)

8.3 Study the following two sketches, **A** and **B** of a DC motor and an AC generator, and answer the questions that follow.



8.3.1 Give the energy conversion that happens in **A**.

(1)

8.3.2 Name the part that is marked with an **X**.

(1)

8.3.3 Fully explain what the function is of the part that is marked with **X**.

(4)

8.3.4 Draw a sketch graph of current in the external circuit against time as it will form in the setup in sketch **B**.

(2)
[21]

QUESTION 9 PHOTONS AND ELECTRONS

9.1 Light with a wavelength of $3,4 \times 10^{-6}$ cm falls onto a metal. How much energy is transferred to the metal?

(3)

9.2 9.2.1 Define *threshold frequency*.

(2)

9.2.2 Calculate the threshold frequency needed for light to be able to release an electron from a metal with a work function of $3,5 \times 10^{-19}$ J.

(3)

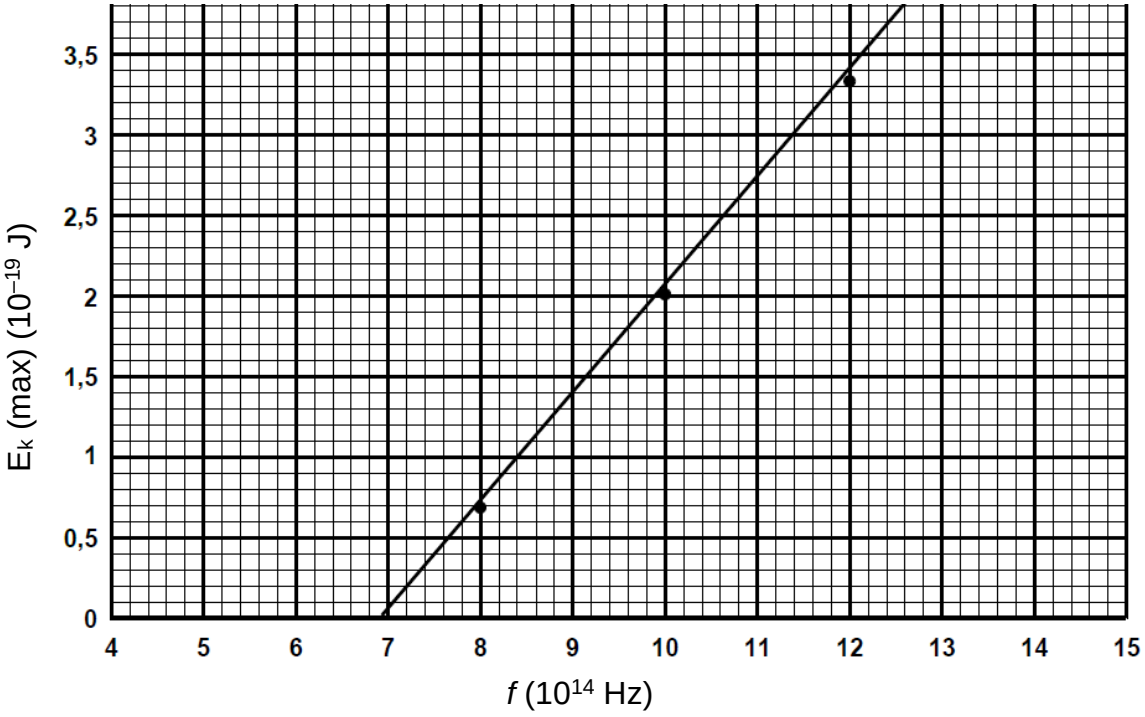
9.3 9.3.1 Explain how a line spectrum forms and how it can be used to identify an element.

(3)

9.3.2 If the energy released is 3,4 eV, calculate the corresponding energy in joule.

(1)

9.4 By making use of the graph below, prove that the value of Planck's constant, h, is $6{,}6 \times 10^{-34}$ J·s.



(3)
[15]

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.

