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Waldorf School

Grade 12 Physical Science

Physics Preliminary Examination 2023

28 August 2023

200 Marks

3 hours

Full Name:

INSTRUCTIONS:

1. This paper consists of 28 pages.
2. Write in dark blue or black pen.
3. Answer all questions in the spaces provided on the question paper.
4. You should show all your working on the question paper.
5. Where appropriate, express answers to TWO decimal places.
6. The number of marks is given in brackets () at the end of each question.
7. TWO blank pages (pages 27 to 28) 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 Examiner's Use <i>Mr. K. Bennett</i>		For Moderators's Use <i>Mr. K. Hall</i>	
Question	Mark	Question	Mark
1	/20	1	/20
2	/14	2	/14
3	/30	3	/30
4	/13	4	/13
5	/7	5	/7
6	/18	6	/18
7	/21	7	/21
8	/18	8	/18
9	/28	9	/28
10	/18	10	/18
11	/13	11	/13
Total	/200	Total	/200
Initial		Initial	

Question 1 [20 Marks]

MULTIPLE CHOICE

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.

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 Which of the following options contains both a **scalar** AND a **vector**?

- A Power and Work
- B Mass and Mechanical Energy
- C Weight and Electric Field
- D Electromotive Force and Impulse

(2)

1.2 An object initially at rest travels a distance d in a time t at a constant acceleration.

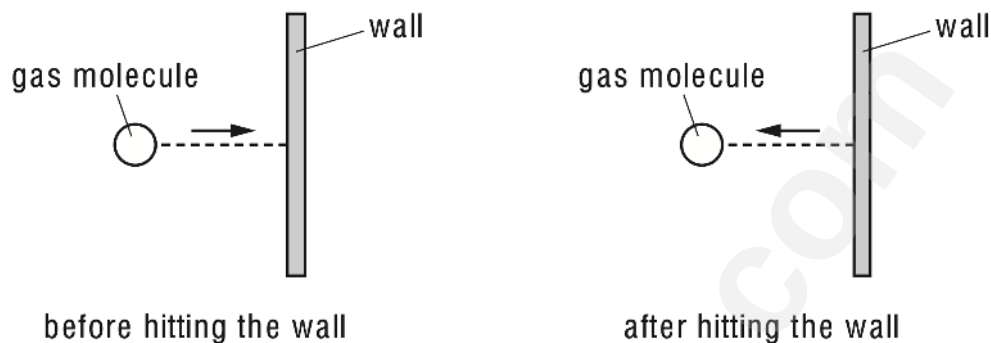
What is the time taken for the object to travel $16d$ from rest at the same acceleration?

- A $2t$
- B $4t$
- C $8t$
- D $16t$

(2)

- 1.3** A gas molecule strikes the wall of a container. The molecule rebounds with the same speed.

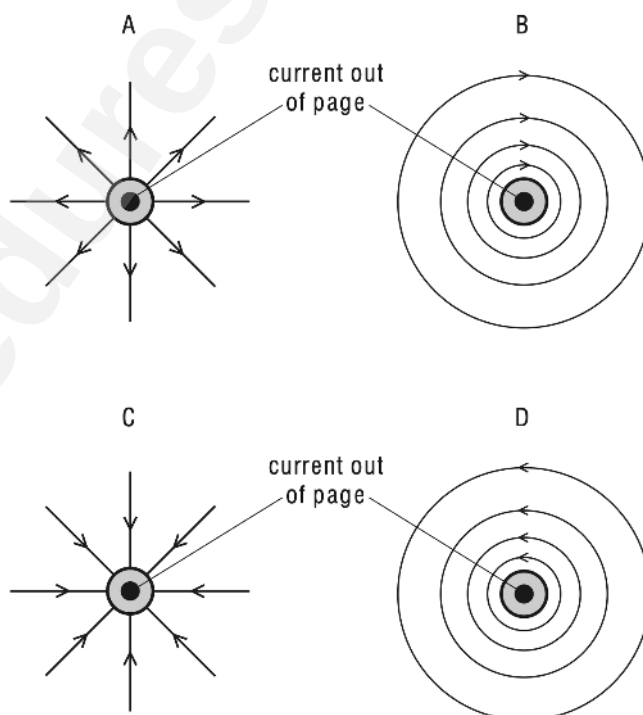
What happens to the kinetic energy and what happens to the momentum of the molecule?



	Kinetic Energy	Momentum
A	changes	changes
B	changes	stays the same
C	stays the same	changes
D	stays the same	stays the same

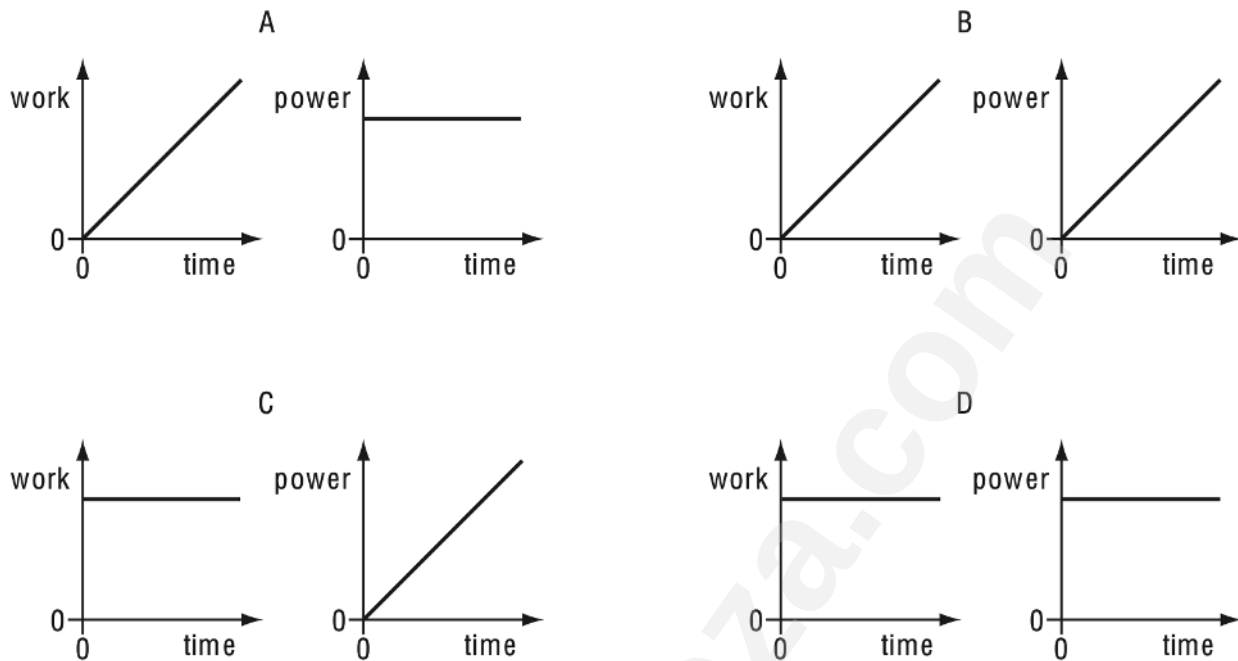
(2)

- 1.4** Which diagram shows the magnetic field pattern around a wire that is carrying a current perpendicular to the page?



(2)

- 1.5** A car moves along a level road at constant speed. Work is done by the engine and power is developed by the engine.



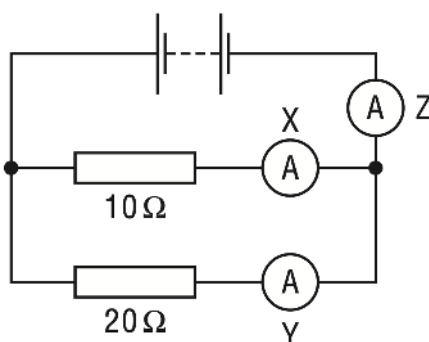
(2)

- 1.6** An astronaut has mass m and weight W on earth. What is the astronaut's mass and weight on a planet which has twice the mass and twice the radius of earth?

	Mass	Weight
A	m	W
B	m	$\frac{W}{2}$
C	$2m$	$2W$
D	$\frac{m}{2}$	$\frac{W}{2}$

(2)

1.7 The circuit shown contains three ammeters X, Y and Z.

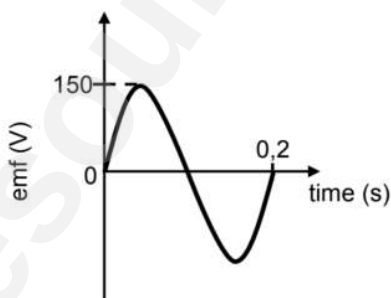


Which ammeter has the smallest reading?

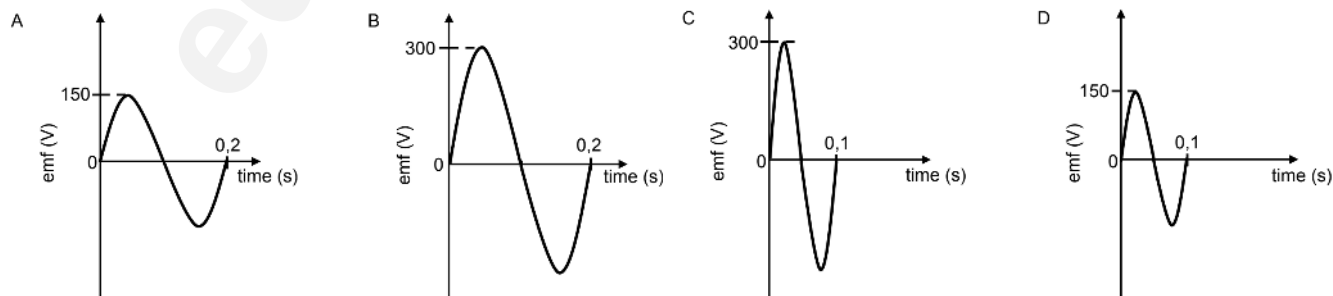
- A X
- B Y
- C Z
- D They all have the same reading

(2)

1.8 An AC generator consists of a coil which is rotated in a magnetic field. The emf-time graph for one complete rotation of the coil is shown below.



If the speed of rotation of the coil is now DOUBLED, which ONE of the following graphs is CORRECT for one complete rotation of the coil?



(2)

1.9 Regions of unbalanced charge are produced inside a cloud as shown.



For the region X, which diagram correctly represents the direction of the electric field and the initial direction in which electrons would move?

	A	B	C	D
electric field				
direction of movement of electrons				

(2)

1.10 Monochromatic radiation from a source of light (**source A**) is shone on to a metallic surface and electrons are emitted from the surface.

When a second source (**source B**) is used no electrons are emitted from the metallic surface.

Which property of the radiation from **source A** must be GREATER than that from **source B**?

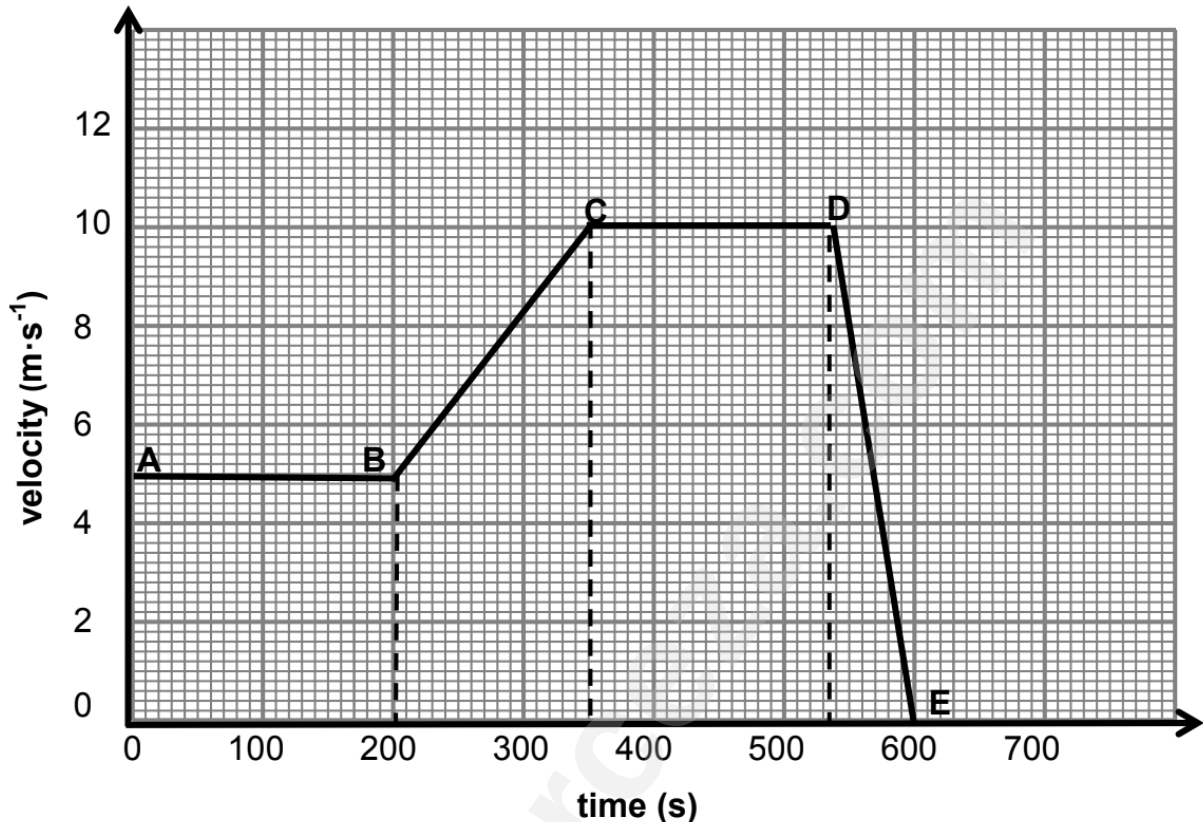
- A intensity
- B frequency
- C speed
- D wavelength

(2)

Question 2 [14 Marks]

ONE-DIMENSIONAL MOTION

The velocity-time graph below represents the motion of a girl riding her bicycle in a northerly direction. The girl and her bicycle have a combined mass of 45 kg.



2.1 Define *velocity*.

.....
 (2)

2.2 Write down the girl's initial velocity: (2)

2.3 What is the resultant force acting on the girl between C and D? (2)

2.4 Use the information on the graph to describe the motion of the girl:

2.4.1 From B to C: (2)

2.4.2 From C to D: (2)

2.5 Use the graph to calculate the acceleration of the girl between D and E.

Acceleration:

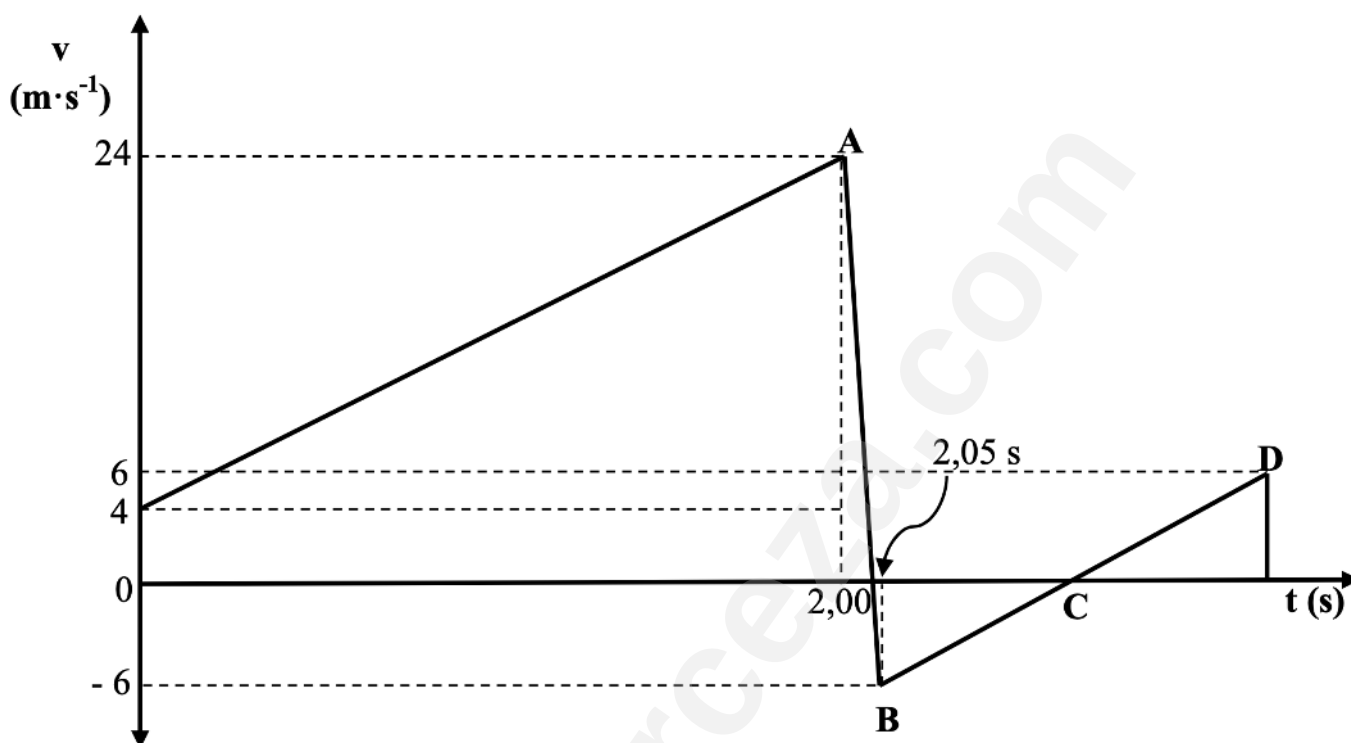
(4)

[14]

Question 3 [30 Marks]

FALLING BODIES

A child throws a golf ball vertically downwards from a 1st floor balcony.
The velocity versus time graph below represents the motion of the stone.
Air resistance can be ignored.



- 3.1 From the graph, was upwards or downwards taken as the positive direction?
Circle the correct option.

UPWARDS / DOWNWARDS

(1)

- 3.2 The upward sloping lines on the graph are parallel with each other. Why?

.....
.....
..... (2)

- 3.3 At what speed was the golf ball thrown? (1)

- 3.4 At which point did the golf ball hit the ground for the first time?

Choose from A, B, C or D:

(2)

- 3.5 Where on the graph did the golf ball reach its maximum height after bouncing?

Choose from A, B, C or D:

(2)

- 3.6 Use the graph, and not equations of motion, to determine the height of the balcony above the ground.

Height of balcony:

(4)

- 3.7 If the golf ball has a mass of 150 g, what force does the ground exert on the golf ball between A and B?

Force of ground on golf ball:

(5)

- 3.8 What is the momentum of the golf ball at point C? (2)

- 3.9 Calculate the total time it took for the golf ball to reach point C.

Time:

(3)

- 3.10 Sketch a displacement-time sketch graph to represent the change in position of the golf ball for the same time period given in the velocity-time graph. No values need to be shown, but the positions A, B, C and D must be clearly marked. **Take the ground as your frame of reference.**



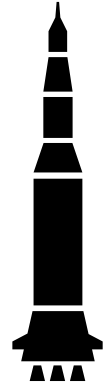
(5)

- 3.11 Draw an acceleration-time graph for the same period given in the velocity-time graph. Positions A and B must be clearly show. **Mark any significant values on the graph.**



(3)

[30]

Question 4 [13 Marks]**ROCKET SCIENCE**

A model rocket is fired vertically upwards from rest at ground level.

The rocket accelerates upwards at 25 m.s^{-2} for 15 s and then runs out of fuel.

Air resistance is negligible. Take the ground as the reference point.

4.1 Calculate the rocket's maximum height above the ground.

Maximum height: (5)

4.2 Calculate the time the rocket is in the air from launch to crashing on the ground.

Time: (4)

4.3 Define *displacement*.

..... (2)

4.4 What is the rocket's displacement when it reaches its maximum velocity?

Displacement: (2)

[13]

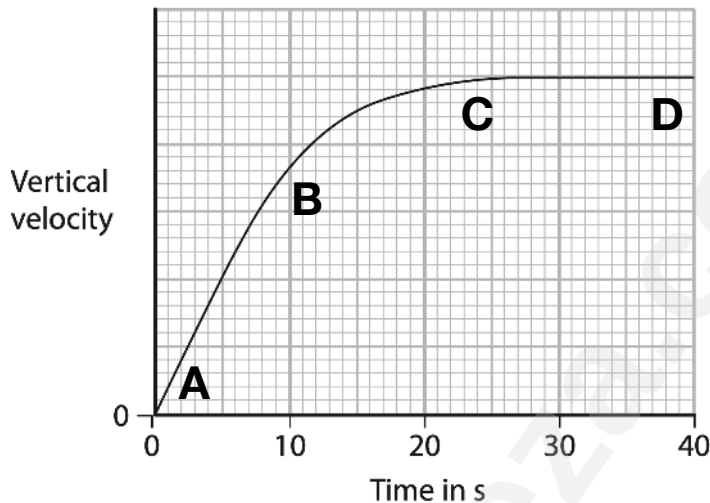
Question 5 [7 Marks]

SYKDIVING

A skydiver jumps from an aircraft.

The graph shows the vertical velocity of the skydiver during the first 40 s of the fall.

His parachute is not open during this time.

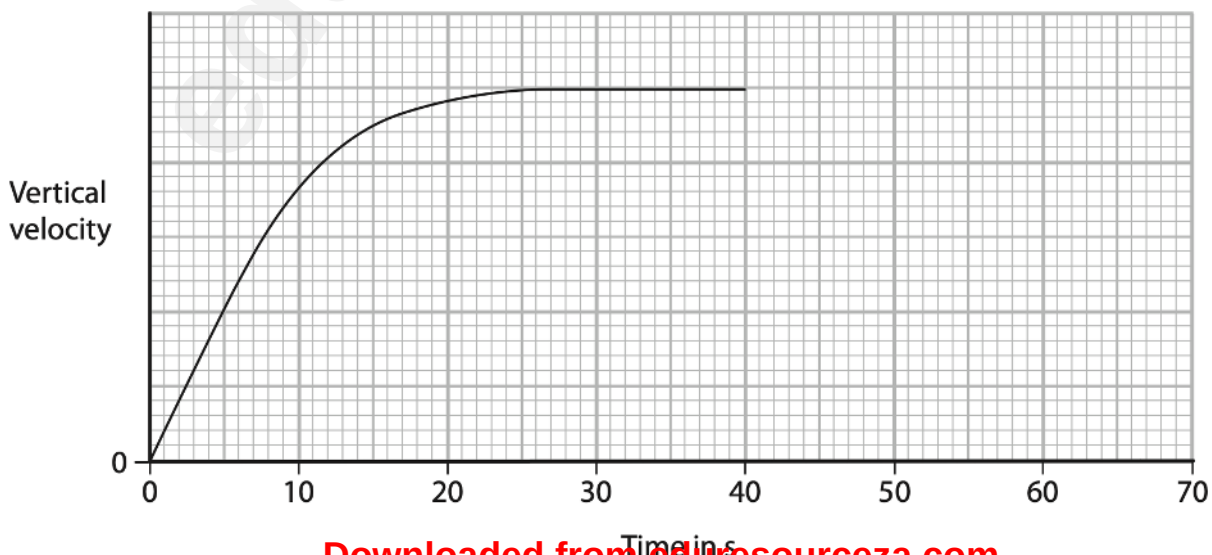


5.1 Draw THREE free-body diagrams for the skydiver for times AB, BC and CD.

5.2 During which portion of the skydiver's journey is mechanical energy conserved? (3)

Choose from AB, BC or CD: (2)

5.3 The skydiver opens his parachute after 40 s. Continue the line on the graph to show how the skydiver's vertical velocity changes and reaches terminal velocity.

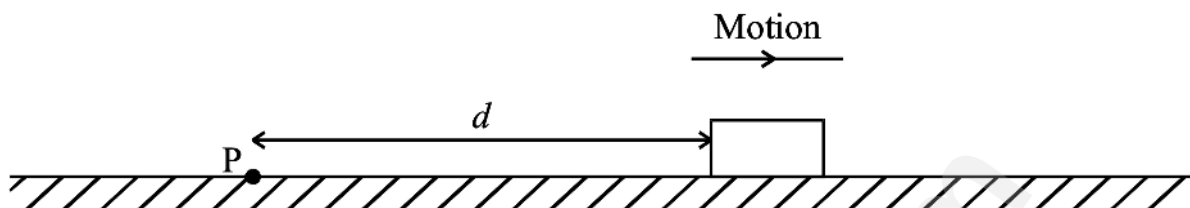


(2)
[7]

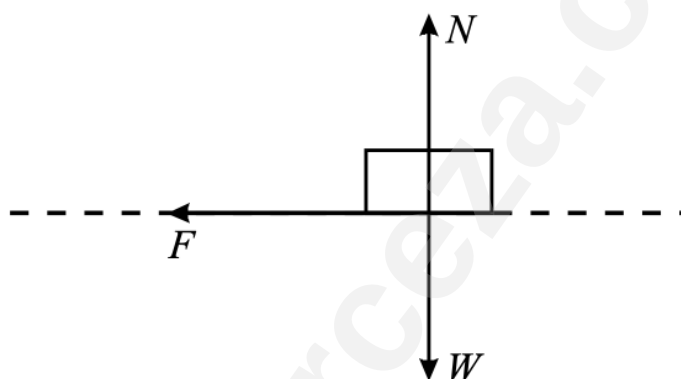
Question 6 [18 Marks]

SLIDING BLOCKS

A block is projected from a point P across a rough, horizontal surface.



The block slows down under the influence of a constant frictional force F and eventually comes to rest. Below is a free-body force diagram for the block whilst it is moving.



6.1 Define *work*.

.....
 (2)

6.2 State, with a reason, the amount of work done by each of the forces W and N as the block moves across the surface.

.....
 (2)

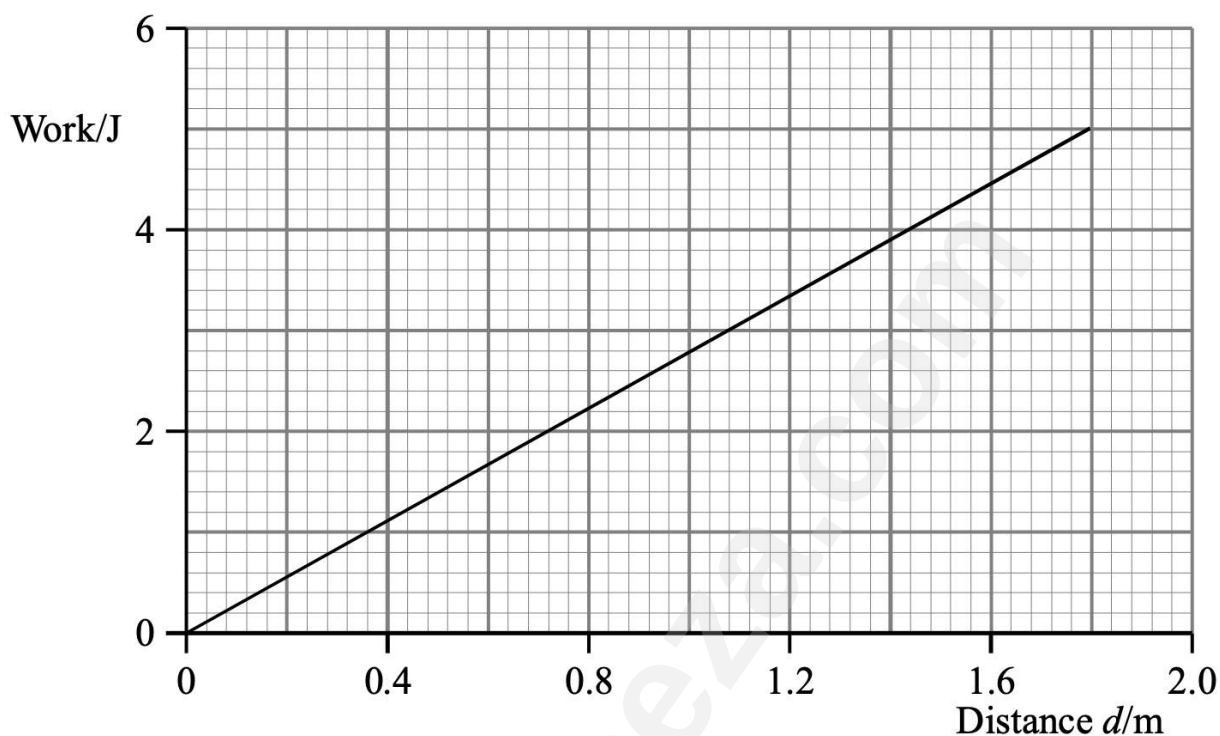
6.3 Does the frictional force F act to INCREASE or DECREASE the kinetic energy of the sliding block?

..... (1)

6.4 Hence, does the frictional force F do POSITIVE or NEGATIVE work on the sliding block?

..... (1)

The graph shows how the total work done varies with the distance d which the block has travelled from the projection point P.



6.5 Use the graph to determine the magnitude of force F .

Force F :

(3)

6.6 The block comes to rest 1.80 m from P.
Draw a line on the graph above to show how the kinetic energy of the block varied during the motion.

(2)

6.7 The mass of the block was 820 g.
Use the work-energy theorem to calculate the speed with which it was projected from P.

Speed:

(3)

6.8 Suppose that, instead of a constant friction force, the block had been brought to rest by a drag force (air resistance) which depends on speed.

6.8.1 On the axes below sketch a graph to show qualitatively how you would expect the total work done against air resistance to vary with the distance d .



6.8.2 Explain the shape of your graph.

.....

.....

.....

..... (2)

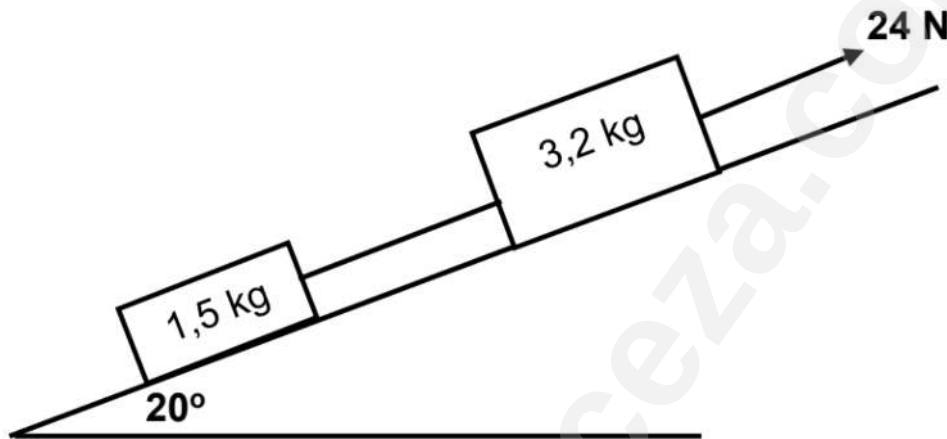
[18]

Question 7 [21 Marks]**INCLINED PLANES**

Two blocks of masses 1,5 kg and 3,2 kg are connected by a light inextensible string.

A 24 N force is applied on a system of blocks by a motor to move them up an inclined surface which is 20° to the horizontal at a **CONSTANT VELOCITY** as shown on the diagram below.

The 1,5 kg box experiences a constant frictional force of 2 N as it moves up the incline.



7.1 State Newton's Second Law of Motion in words.

.....

.....

.....

..... (2)

7.2 What is the resultant force acting on the 3.2 kg block?

..... (2)

7.3 Draw a labelled free-body diagram of all forces acting on the 1,5 kg block.

(4)

7.4 Show that tension in the string connecting the blocks is approximately 7.0 N.

(5)

7.5 Calculate the coefficient of kinetic frictional force between the 3,2 kg block and the surface.

Coefficient of kinetic friction:

(5)

7.6 Calculate the average power developed by the motor in pulling the system of blocks 11 m in 4,9 seconds.

Power:

(3)

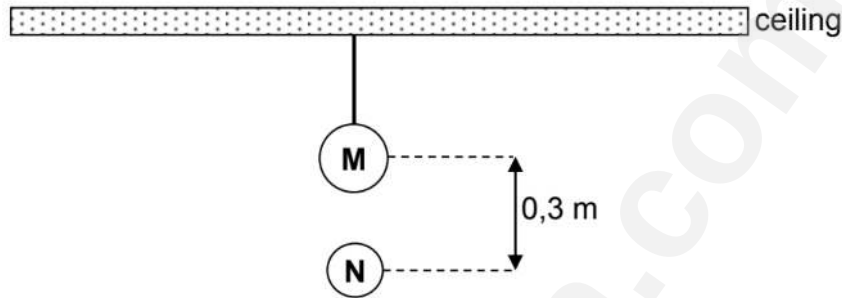
[21]

Question 8 [18 Marks]**ELECTRIC FIELDS**

A charged sphere **M** is suspended from a ceiling by a light, inextensible, insulated string.

Another charged sphere **N**, of mass $2,04 \times 10^{-3} \text{ kg}$ and carrying a charge of $+8,6 \times 10^{-8} \text{ C}$, hangs STATIONARY vertically below sphere **M**.

The centres of the spheres are 0,3 m apart, as shown in the diagram below.



8.1 State Coulomb's law in words.

.....

.....

..... (2)

8.2 State whether the charge on sphere M is POSITIVE or NEGATIVE.

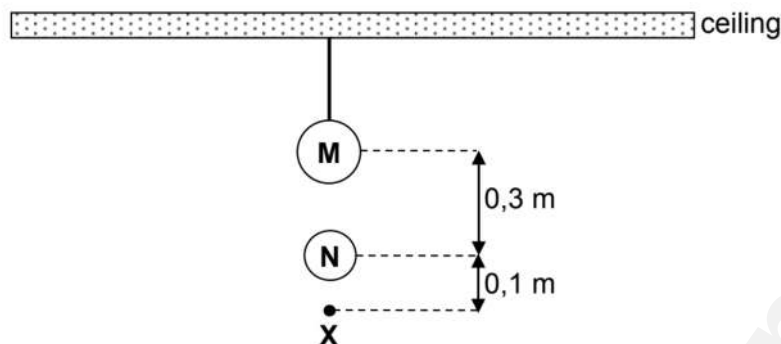
..... (2)

8.3 Calculate the magnitude of the charge on sphere **M**.

Charge on **M**:

(5)

Point **X** is 0,1 m vertically below the centre of sphere N, as shown below.



8.4 Calculate the net electric field at point **X**.

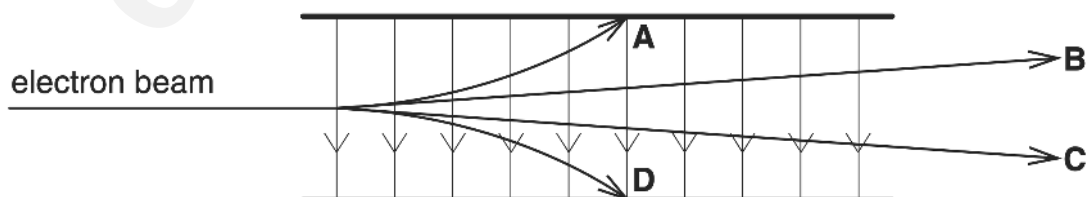
Net electric field: (5)

8.5 An electron is fired through a uniform electric field.

8.5.1 Draw the electric field pattern surrounding an electron.

(2)

8.5.2 Which path shows a possible movement of an electron in the electric field shown below?



Choose from A, B, C or D:

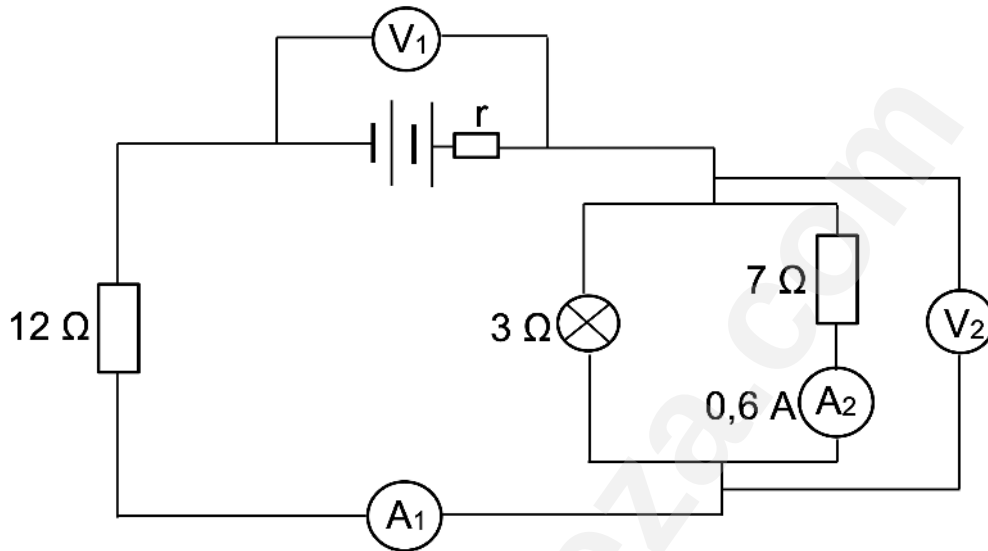
(2)

[18]

Question 9 [28 Marks]

ELECTRIC CIRCUITS

In the circuit represented below, the battery has an emf of 30 V and an unknown internal resistance. Ammeter A_2 reads 0,6 A. The ammeters have zero resistance and the voltmeters have infinite resistance.



9.1 State *Ohm's Law*.

.....

 (2)

9.2 Calculate the reading on V_2 .

V_2 :
 (3)

9.3 What is the effective resistance of the bulb and resistor connected in parallel?

Effective resistance:
 (2)

9.4 Define *current*.

.....
..... (2)

9.5 Calculate the current reading on ammeter A_1 .

A_1 :
(4)

9.6 Calculate the power dissipated by the $12\ \Omega$ resistor.

Power:
(3)

9.7 Determine the internal resistance of the battery.

Internal resistance:
(4)

9.8 Calculate the amount of energy emitted by the $3\ \Omega$ bulb in 3 minutes.

Energy:

(4)

9.9 If the voltmeter V_2 is replaced by a conducting wire, what would happen to the reading on V_1 ?

..... (1)

9.10 Explain your answer to Question 9.9. Use an appropriate equation to aid you in your explanation.

.....
.....
.....
.....
..... (3)

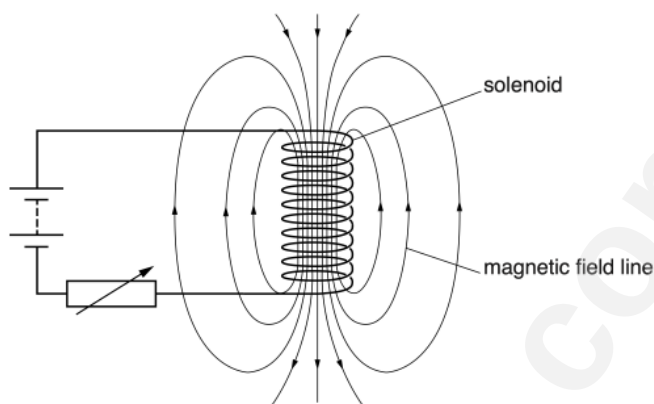
[28]

Question 10 [18 Marks]

ELECTROMAGNETIC EFFECTS

A circuit contains a battery, a variable resistor and a solenoid.

The figure below shows the magnetic field pattern produced by the current in the solenoid.



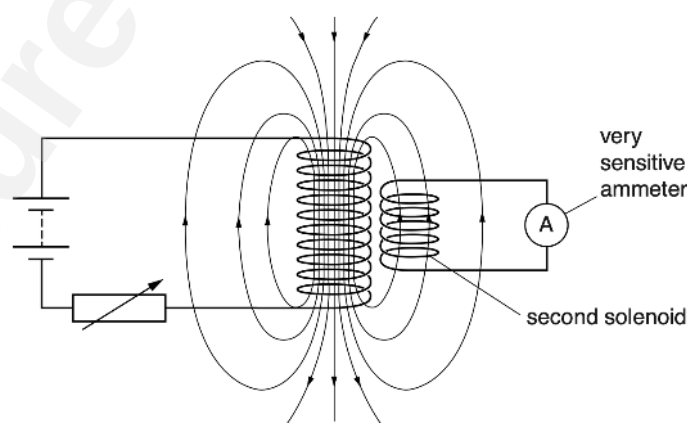
10.1 State how the magnetic field pattern indicates regions where the magnetic field is stronger.

.....
 (2)

10.2 State what happens to the magnetic field when the current in the circuit is reversed.

.....
 (2)

A second solenoid is placed next to the first solenoid. The diagram below shows the second solenoid connected to a very sensitive ammeter.



10.3 State Faraday's law of electromagnetic induction.

.....
 (2)

The variable resistor is adjusted so that its resistance changes **quickly**.

10.4 State and explain what is seen to happen in the circuit of the second solenoid.

.....

.....

.....

..... (3)

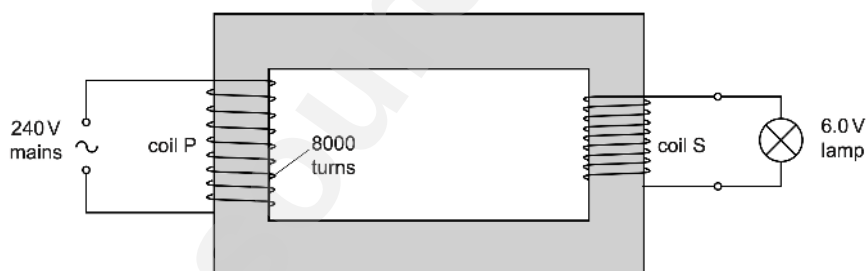
10.5 The variable resistor is then adjusted much more **slowly** than in 10.3. State and explain the difference in what is seen to happen in the circuit of the 2nd solenoid.

.....

.....

..... (2)

The figure below shows two separate solenoids wound around an iron core. The primary coil P is connected to an a.c. supply. A 6.0 V lamp is connected across the secondary coil S.



10.6 Name the specific device shown in the figure: (2)

10.7 The e.m.f. of the a.c. supply is 240 V. The primary coil has 8000 turns. Calculate the number of turns on the secondary coil.

Turns:

(3)

10.8 A 240 d.c. supply is used instead of the 240 a.c. supply. Tick **one** box to indicate what happens to the lamp.

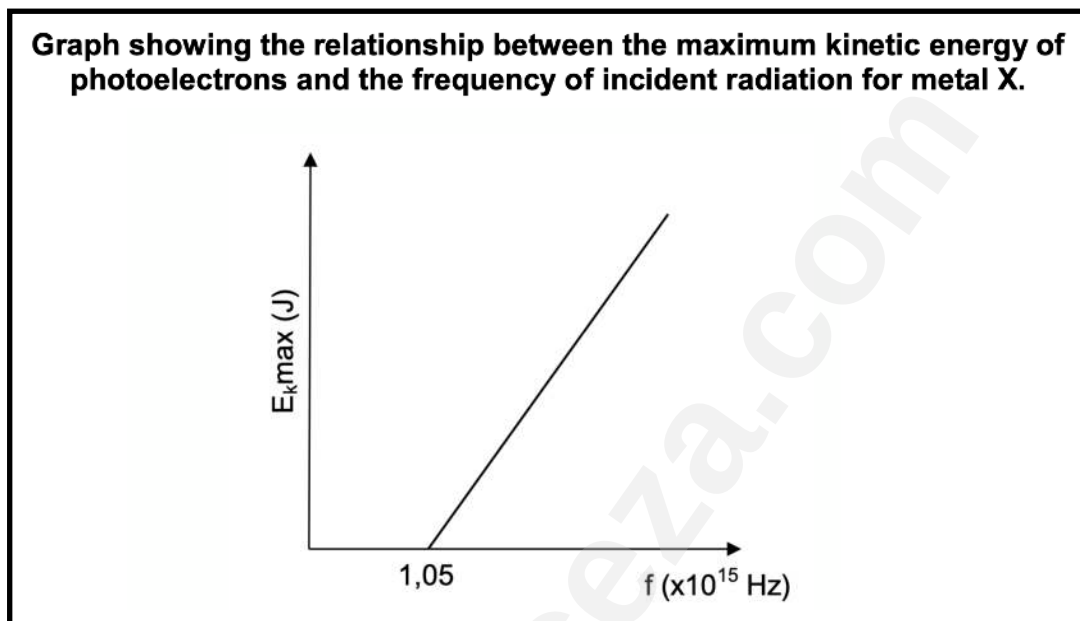
☐	glows more brightly	☐	glows less brightly
☐	glows with the same brightness	☐	does not glow

(2)
[18]

Question 11 [13 Marks]

QUANTUM PHYSICS

A Physics student measures the maximum kinetic energy of photoelectrons emitted from the surface of metal X, using different frequencies of the incident radiation. The student uses his data to plot the graph shown below.



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	$4,78 \times 10^{-19}$

11.1 Define *work function*.

.....

 (2)

11.2 What is represented by the gradient of the graph above?

..... (2)

11.3 Use the information from the graph and table to determine the identity of metal **X**.

Metal **X**:

(4)

11.4 The wavelength of blue light is given as 475 nm. When this blue light is shone onto a certain metal surface, the maximum velocity 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.

Metal:

(5)

[13]

.....
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.

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