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NAME: _____

TEACHER: KB / KC

St Andrew's College & Diocesan School for Girls

ST ANDREW'S COLLEGE

THE DIOCESAN SCHOOL
FOR GIRLS**GRADE 12****PHYSICAL SCIENCES: PAPER 1 (PHYSICS)**

Date: Friday 12 July 2024

Time: 08h00

Examiner: K Bryan

Moderator: K Cobbing

Duration: 3 hours

200 marks

READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

1. Write your name on the front cover of your question paper.
2. Please check that your paper is complete:
 - This question paper has 28 printed pages, including this cover sheet.
 - There should be a loose, double-sided **data sheet** provided as an insert in this question paper.
3. Read the questions carefully.
4. Present your work neatly and legibly.
5. Answer ALL the questions in the spaces provided.
6. You may answer the questions in any order.
7. All working out must be shown and units must be given with answers.
8. Where appropriate, express answers to TWO decimal places.
9. 3 blank pages (pages 15, 26, and 28) are included in 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.
10. A spare piece of graph paper is included on page 27, should you need it.

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	TOTAL
20	20	24	36	23	23	37	17	200

QUESTION 1 MULTIPLE CHOICE

On the ANSWER GRID, mark the letter that corresponds to your answer with a cross (X).

10 x (2) marks

e.g.

X	B	C	D
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 Here the correct answer is A.

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

YOU ARE ENCOURAGED TO USE THE SPACE BETWEEN THE MULTIPLE CHOICE QUESTIONS TO SOLVE THESE QUESTIONS, BUT MUST INDICATE YOUR CHOSEN ANSWER FOR EACH QUESTION IN THE GRID ABOVE.

1.1 Which one of the following expressions results in a scalar quantity?

- A. mv
- B. mgh
- C. ma
- D. $F_{\text{NET}}\Delta t$

- 1.2 A stone X is thrown vertically upwards with speed v from the top of a building. At the same time, a second stone Y is thrown vertically downwards with the same speed v . Air resistance is negligible.

Which one of the following statements is true about the speeds at which the stones hit the ground?

- A. the speed of stone X is greater than the speed of stone Y
- B. the speed of stone Y is greater than the speed of stone X
- C. the speed of stone X is equal to the speed of stone Y
- D. The speed of stone X can only be compared to the speed of stone Y when the height of the building is known

NSC NOV '20

- 1.3 Consider the following statements regarding their accuracy in relation to statements of Newton's laws of motion:

- I The inertia of an object is proportional to the mass of the object.
- II The acceleration of an object is directly proportional to the net force acting on it.
- III The action-reaction pairs of forces always act simultaneously.

Which of the above statements are correct?

- A. I and II
- B. I and III
- C. II and III
- D. I, II and III

G11 leBT '22

1.4 The driver of a sportscar is test driving it over a 500 km course. The car's average speed for the course is 200 km/h. The car travels at 100 km/h for the first 150 km. What is the average velocity for the remainder of the course?

- A. 200 km/h
- B. 250 km/h
- C. 300 km/h
- D. 350 km/h

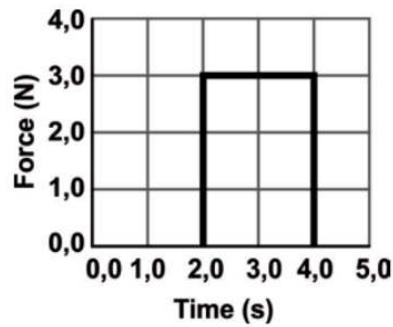
G11 leBT '23

1.5 Power is a useful quantity to know in both electrical and mechanical systems. Which quantity is equivalent to 1 W?

- A. 1 J.s
- B. 1 V.A
- C. 1 J.m
- D. 1 V.C

NSC '21

- 1.6 A 3 kg mass moving in a straight line with an initial velocity of 4 m/s forwards is acted on by a net force as shown in the graph above. What is the speed (in m/s) of the mass at 5 s?



- A. 4
- B. 5
- C. 6
- D. 10

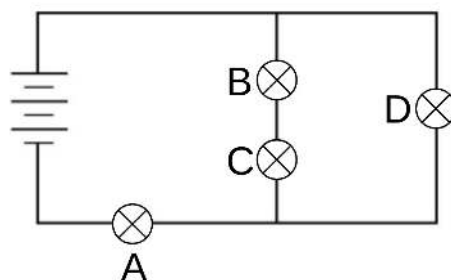
G11 leBT '19

- 1.7 Spaceship A has a weight of W when it is on Earth. What is its weight when it is two Earth's radii above the surface of the Earth?

- A. $\frac{1}{2} W$
- B. $\frac{1}{4} W$
- C. $\frac{1}{3} W$
- D. $\frac{1}{9} W$

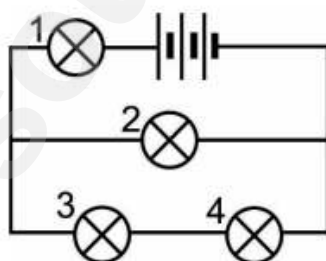
G11 leBT '20

- 1.8 In the circuit diagram below, all of the bulbs are identical. Which bulb will be the brightest?



NSC '2017

- 1.9 All the bulbs shown in the circuit diagram below have identical resistances. The battery has negligible internal resistance. Each of the bulbs has resistance of $2\ \Omega$. A current of 3 A passes through bulb 1.



Consider the validity of the four statements, shown below, regarding the power P of the light bulbs:

- A. $P_3 = P_4 > P_2 > P_1$
- B. $P_1 > P_2 > P_3 = P_4$
- C. $P_2 + P_3 + P_4 = P_1$
- D. $P_1 = \frac{9}{4} P_2$

G11 leBT '21

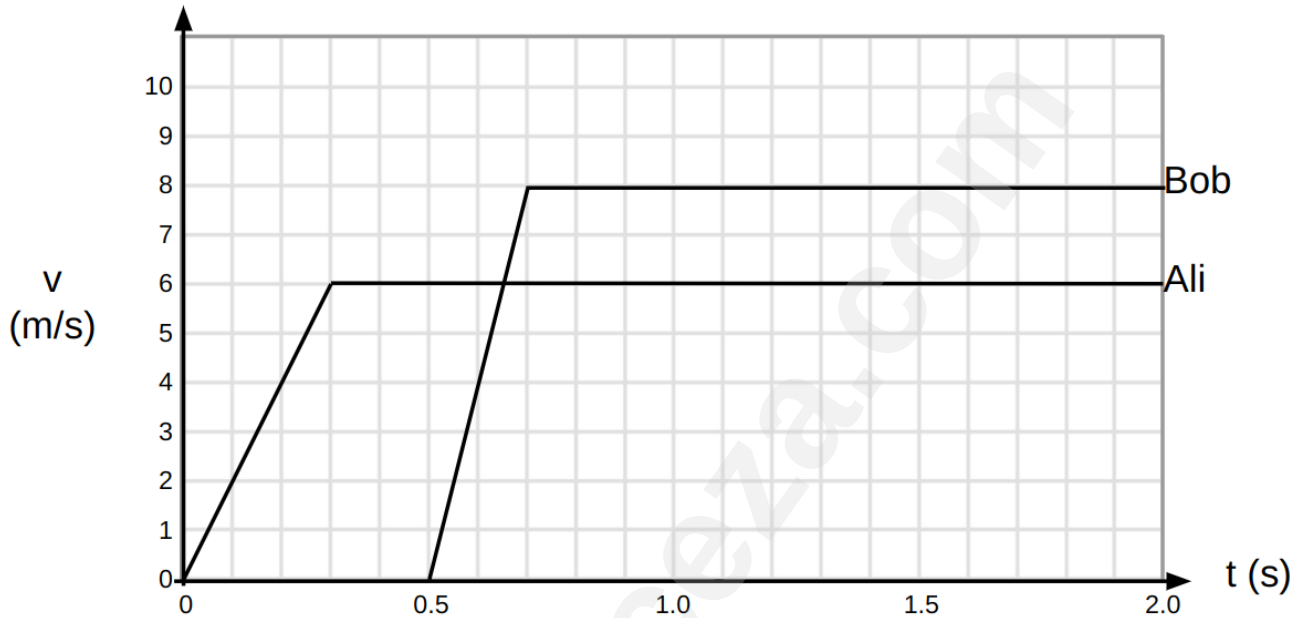
- 1.10 The role of a step-up transformer in an electrical power station is to ...
- A. reduce heat in the transmission lines by increasing the voltage.
 - B. reduce heat in the transmission lines by increasing the current.
 - C. increase heat in the transmission lines by increasing the voltage.
 - D. increase heat in the transmission lines by increasing the current.

NSC SUPP MAR '19

[20]

QUESTION 2 HOCKEY PLAYERS (KINEMATICS)

Two hockey players, Ali and Bob, are standing next to each other on the field. Ali receives the ball at time $t = 0$ and starts running in a straight line due West, towards the goal. Bob starts running in the same direction 0,5 seconds later. The velocity of each player is plotted on the graph below.



2.1 Define *acceleration*. (2)

2.2 Which player accelerates for longer? (1)

2.3 Determine Bob's acceleration. (4)

2.4 What is the distance between Ali and Bob at 0,7 seconds? (5)

- 2.5 On the axis below, plot a graph of acceleration vs time for **each** player. Label the lines 'Ali' and 'Bob', respectively. Include values for both axes. (4)



At time $t = 0,7$ s, Ali is 10 m away from the line where she can shoot for the goal.

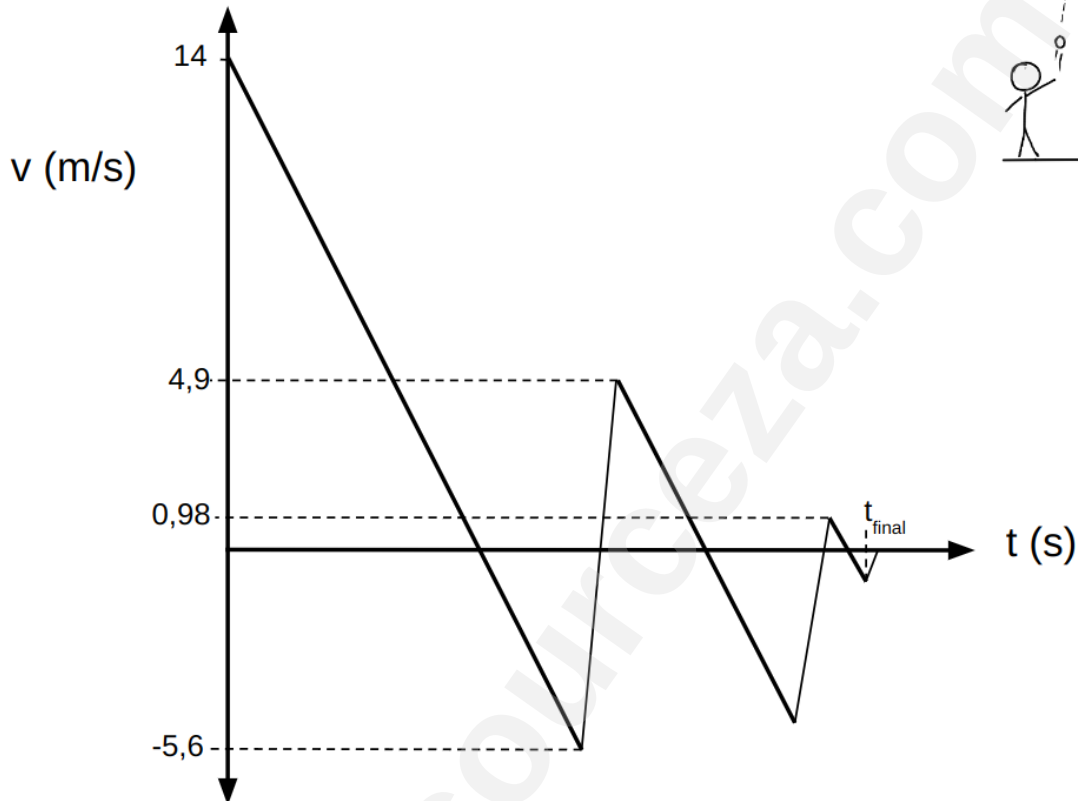
- 2.6 Will Bob catch up to Ali before she reaches the line? (4)

QUESTION 3 TOSS UP (VERTICAL MOTION & NLII)

A person throws a ball vertically upwards. The ball hits a roof on its way down, and it bounces twice before coming to a stop.

For each bounce, the ball is in contact with the roof for 0,2 s.

The velocity of the ball from the moment it is thrown is shown below.

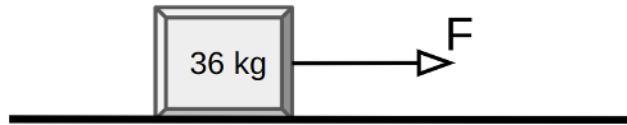


- 3.1 What is the acceleration of the ball at its maximum height? (2)
- 3.2 Define *displacement*. (2)
- 3.3 Determine the distance from the person's hand to the roof. (4)

- 3.4 From the moment it was thrown, how long did it take the ball to first hit the roof? (3)
- 3.5 Determine the time t_{final} indicated on graph. (5)
- 3.6 State *Newton's Second Law*. (2)
- 3.7 Determine the magnitude of the acceleration of the ball during its first contact with the roof. (3)
- 3.8 If the mass of the ball is 200 g, what is the magnitude of the net force acting on the ball when it is first in contact with the roof? (3)

QUESTION 4 SLIDING AROUND (NL, WORK, AND POWER)

- 4.1 A box of mass 36 kg is pulled along a surface with an applied force of 146 N to the right.

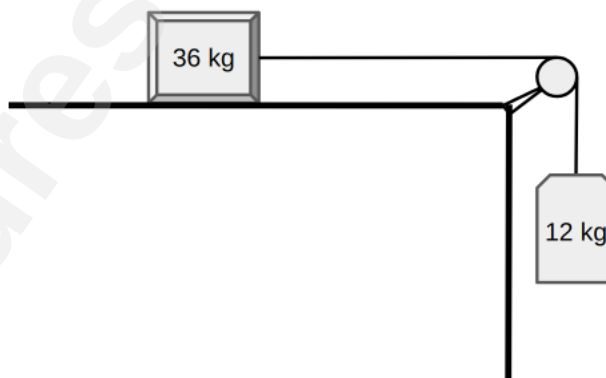


The coefficient of friction between the surface and the box is 0,1.

- 4.1.1 Determine the magnitude of the frictional force acting on the box. (3)

- 4.1.2 Calculate the acceleration of the box. (4)

- 4.2 The applied force is removed and the box is now attached to a weight of mass 12 kg via a rope. The masses are arranged so the rope lies over a frictionless pulley as shown below.

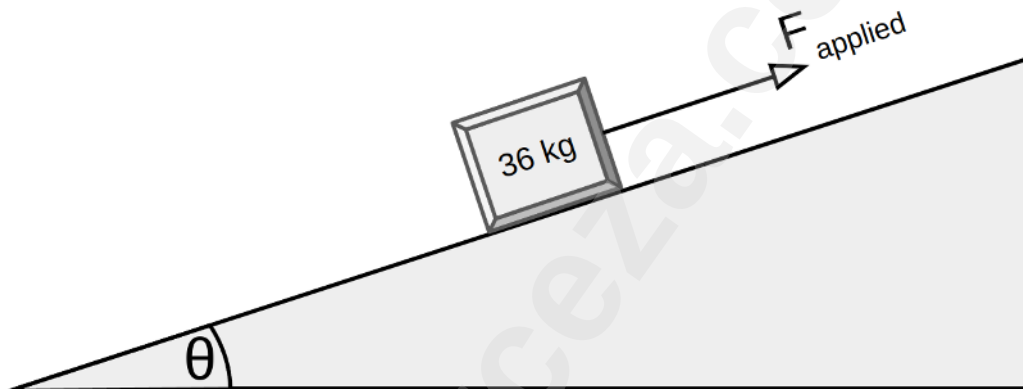


The coefficient of friction between the box and the surface remains the same.

- 4.2.1 Calculate the magnitude of the acceleration of the system. (4)

4.2.2 Hence, determine the tension in the rope.

- 4.3 The same 36 kg box is later attached to a winch. The winch pulls the box up an incline using an applied force, as shown below. The box starts at rest before sliding a distance of 1,2 m up the incline in 6 seconds.



The angle of the incline is $\theta = 30^\circ$ and the coefficient of friction between the box and the surface of the incline is 0,15.

- 4.3.1 Draw a free body diagram of all the forces acting on the box while the box is sliding up the incline. (4)

4.3.2 Define *friction*.

(2)

4.3.3 Calculate the magnitude of the frictional force acting on the box.

(4)

4.3.4 State the *work-energy theorem*.

(2)

4.3.5 What was the speed of the box after 6 seconds?

(3)

4.3.6 Hence, determine the magnitude of the net force acting on the box.

(3)

4.3.7 Calculate the amount of energy expended by the winch during the 6 seconds.

(5)

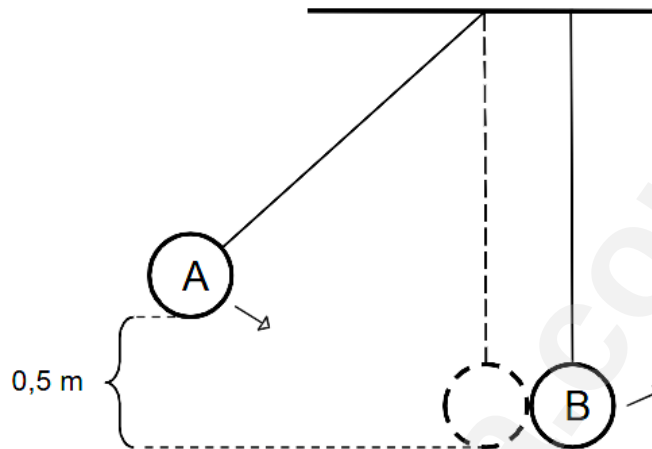
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REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED

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QUESTION 5 MOMENTUM, ENERGY

A simple Newton's pendulum is made of two metal spheres, each suspended by a string. They are initially hanging at rest next to one another. Sphere A is then lifted up to a height of 0,5 m above its resting position, as shown below.



Sphere A has a mass of 0,2 kg while sphere B has a mass of 0,3 kg.

- 5.1 Calculate ball A's gravitational potential energy when it is held at this height, relative to its rest position. (3)

Ball A is now released. It swings and hits ball B. Ball A comes to rest as it hits Ball B.

- 5.2 Calculate ball A's speed just before it hits ball B. (3)

- 5.3 State the *law of conservation of linear momentum*. (2)

- 5.4 Calculate the speed of Ball B directly after the collision. (4)
- 5.5 As ball B swings up, 0,25 J of thermal energy is lost due to friction with the string. Calculate the maximum height reached by ball B after the collision. (4)
- 5.6 Which ball experiences a greater force during the collision of ball A and ball B? Explain your answer with reference to a law of physics. (3)
- 5.7 By use of a calculation, show whether the collision between ball A and ball B is elastic or inelastic. (4)

QUESTION 6 FIELDS

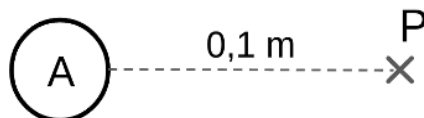
6.1 The Earth has a mass of 6×10^{24} kg, while the Sun has a mass of 2×10^{30} kg.

6.1.1 State *Newton's Law of Universal Gravitation*. (2)

6.1.2 If the Sun has a radius of 700 000 km, calculate the gravitational field strength on its surface? (4)

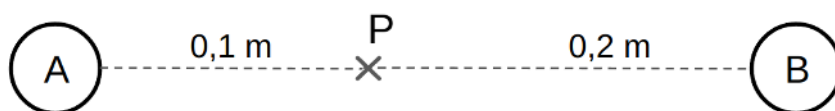
6.1.3 Calculate the gravitational force due to the Sun that an astronaut with a mass of 75 kg would experience if they were in orbit at a distance of 300 000 km above the Sun's surface. (4)

6.2 Sphere A carries a positive charge $60 \mu\text{C}$. Point P is 0,1 m away from sphere A.



6.2.1 Determine the magnitude and direction of the electric field at point P. (4)

A negative charge with a magnitude of $120\ \mu\text{C}$ is now placed at a distance of $0,2\ \text{m}$ to the right of point P, as shown.

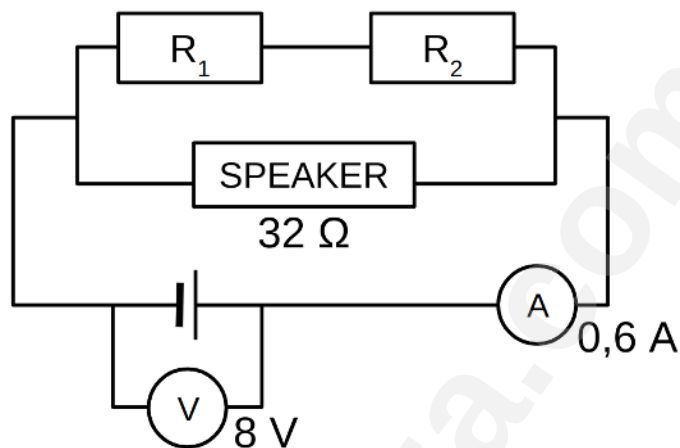


6.2.2 Determine the new electric field at point P. (5)

6.2.3 Calculate the force experienced by an electron placed at point P. (4)

QUESTION 7 CIRCUITS

- 7.1 Two resistors, R_1 and R_2 , are connected in parallel to a speaker with a resistance of $32\ \Omega$. The parallel combination is connected in series with an ammeter and a battery with negligible internal resistance.



A voltmeter connected across the battery reads 8 V. The ammeter reads 0,6 A.

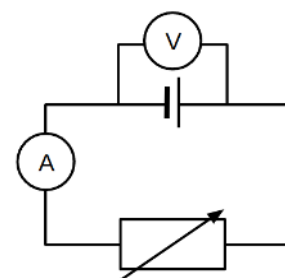
- 7.1.1 State *Ohm's Law*. (2)

- 7.1.2 Calculate the total resistance of the circuit (3)

- 7.1.3 Determine the current through the speaker. (3)

- 7.1.4 If resistor R_1 has three times the resistance of resistor R_2 , determine the value of each resistor. (4)
- 7.2 The battery is now replaced for one with the same emf and a significant internal resistance.
- 7.2.1 Define *power*. (2)
- 7.2.2 When the new battery with internal resistance is connected to the same circuit, does the rate of energy dissipated by the speaker increase, decrease, or stay the same? Justify your answer. (4)
- 7.3 The cost of electricity is R3,48 per kilowatt-hour. Calculate how much it costs to run a 750 W washing machine for three hours. (4)

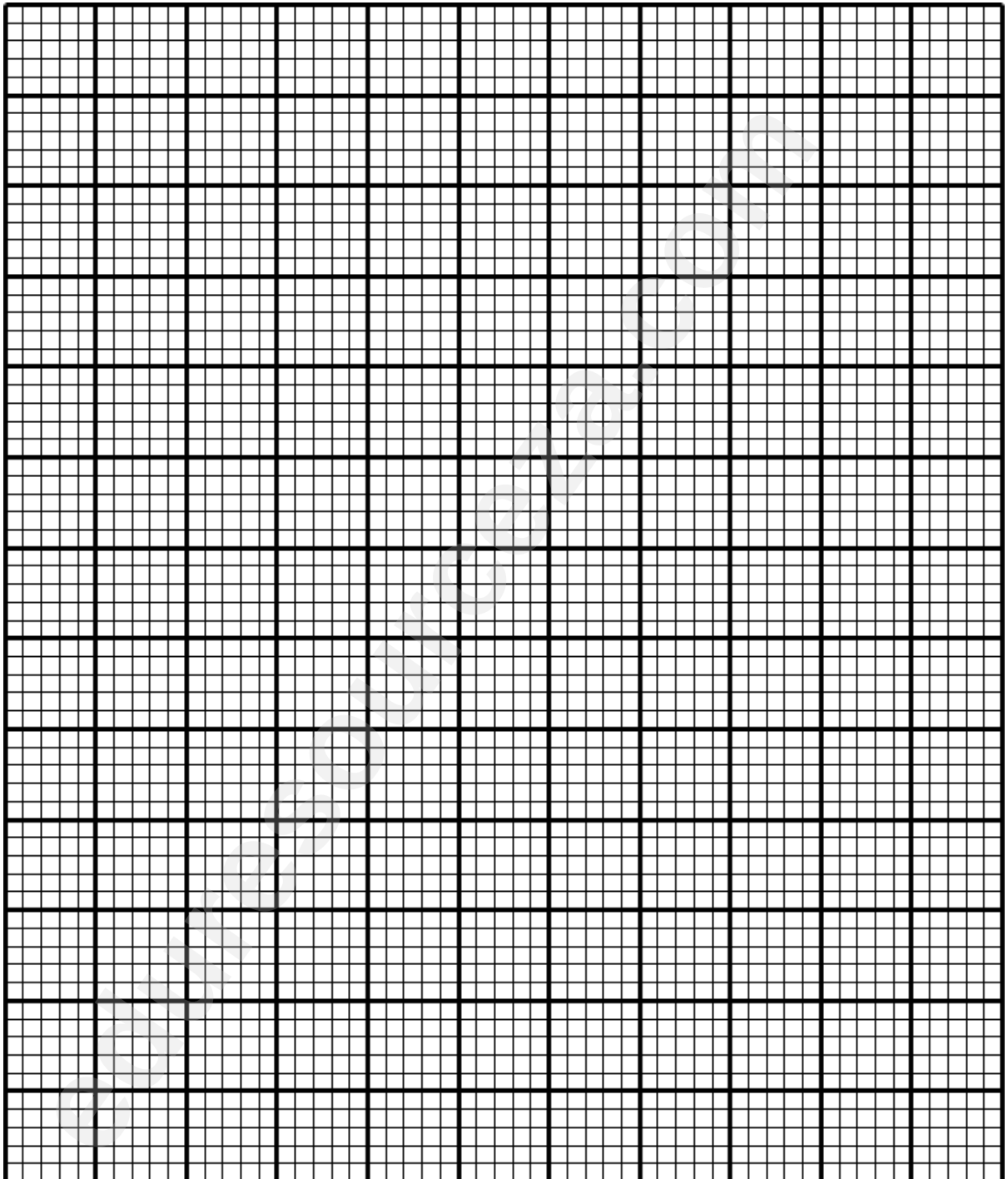
- 7.4 A battery of unknown emf and internal resistance is connected in series with an ammeter and a variable resistor, as shown. A voltmeter is connected across the battery.



The current is changed by varying the resistor value, and measured using the ammeter. For each setting of the current, the voltmeter reading is recorded. The values are given in the table below.

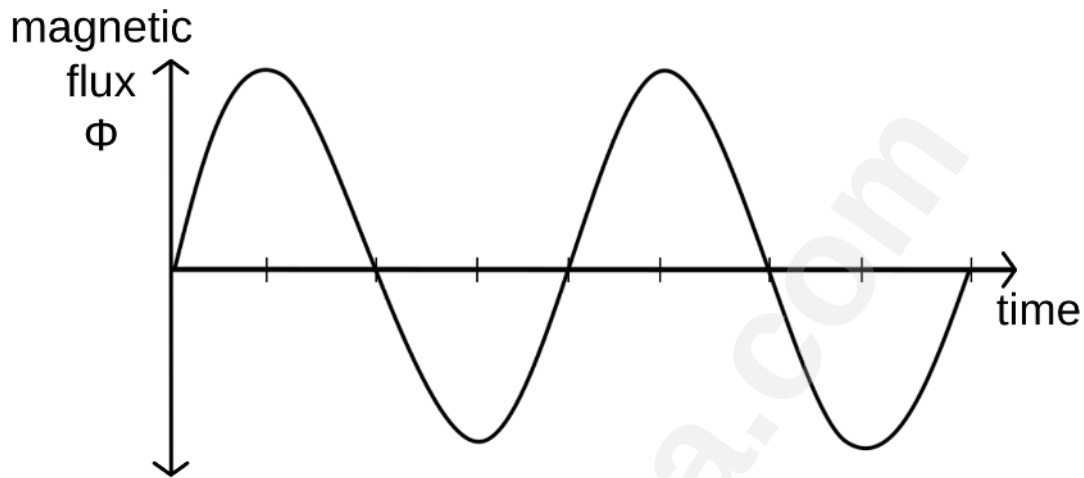
Ammeter reading (A)	Voltmeter reading (V)
0.5	4.8
1.0	4.5
2.5	3.7
4.0	3.0
6.0	2.0
7.2	1.3

- 7.4.1 Plot a graph of the data on the graph paper given on the opposite page. (6)
- 7.4.2 Calculate the gradient of your graph. Show the points used. (4)
- 7.4.3 By rearranging the equation $emf = V_{TERM} + Ir$ into the form $y = mx + c$, determine the internal resistance of the battery. (3)
- 7.4.4. Determine the emf of the battery and briefly explain where it is represented on your graph. (2)



QUESTION 8 ELECTRODYNAMICS

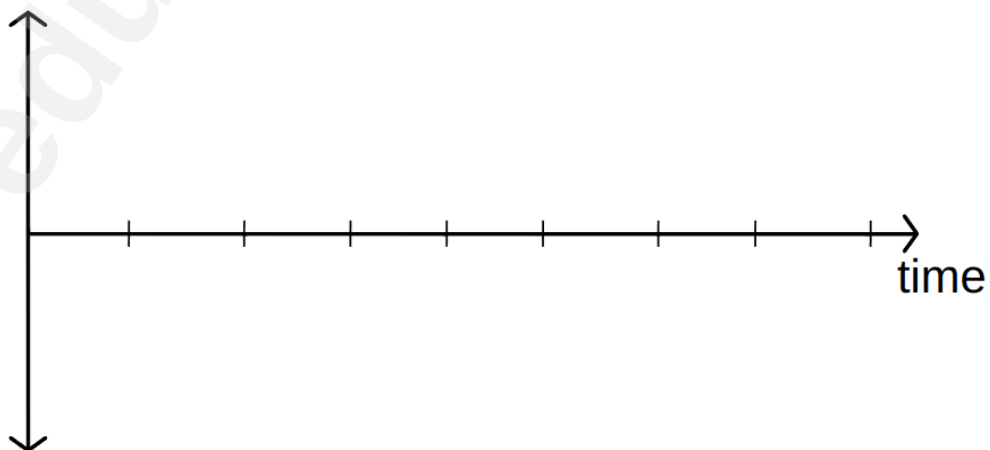
- 8.1 A generator produces an alternating current as a coil is rotated inside a magnetic field. The change in magnetic flux through the coil is plotted on Graph 1 below.

Graph 1

An emf is induced in the coil.

- 8.1.1 State *Faraday's Law of electromagnetic induction*. (2)

- 8.1.2 On Graph 2 below, sketch a line showing the change in the emf induced in the coil with time. (3)

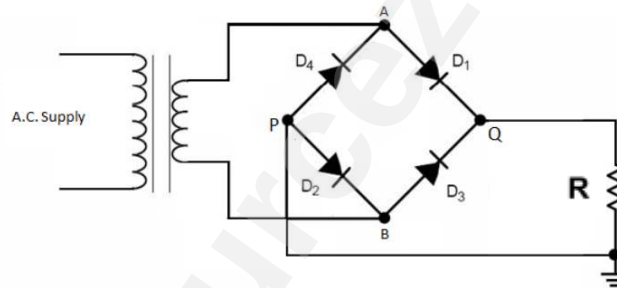
Graph 2

8.2 The generator is connected to a transformer so that the primary input voltage is 200 V. There are 400 turns on the primary coil and 1200 turns on the secondary coil.

8.2.1 Calculate the secondary output voltage. (3)

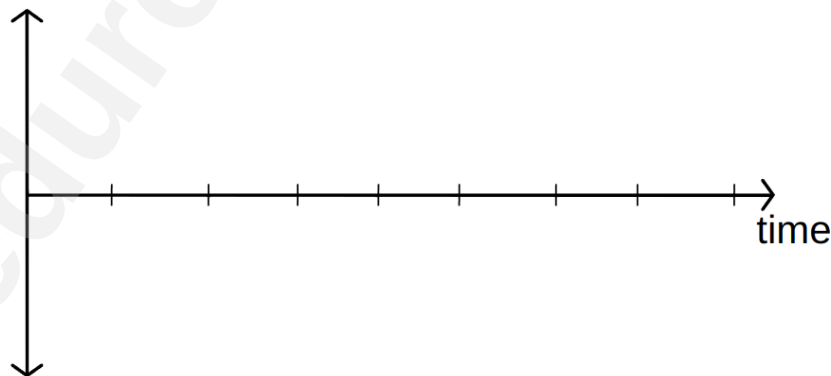
8.2.2 Explain why a direct current (DC) cannot be used in a transformer. (2)

8.3 The output from the generator is connected to the following circuit:



8.3.1 State the function of a diode. (2)

8.3.2 Sketch a graph of the voltage versus time for the resistor R in the circuit above. (3)



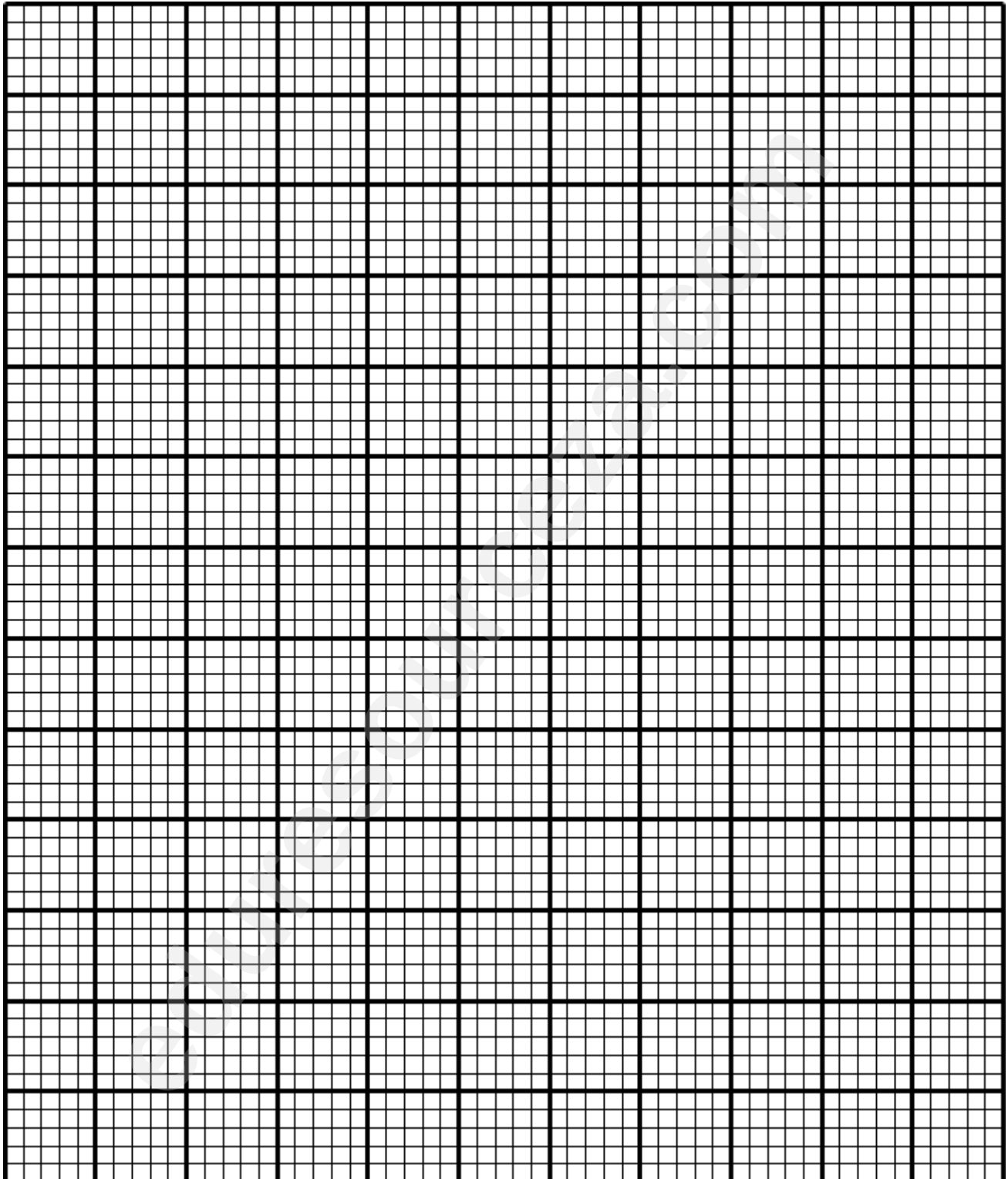
8.3.3 What component could be added to the circuit so that the voltage across the resistor was smoother? (2)

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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Spare graph paper



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