Surname	Centre Number	Candidate Number
First name(s)		2

GCE A LEVEL

Preview Paper

1420U40-1

MONDAY, 9 JUNE 2025 – MORNING

PHYSICS – A2 unit 4
Fields and Options

2 hours

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**		
	2.		
	3.		
	4.		
	5.		
	6.		
Section B	**Option**		
	Total	**100**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a **Data Booklet**.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

This paper is in 2 sections, **A** and **B**.

Section **A**: 80 marks. Answer **all** questions. You are advised to spend about 1 hour 35 minutes on this section.

Section **B**: 20 marks. Options. Answer **one option only**. You are advised to spend about 25 minutes on this section.

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **3**.

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SECTION A

Answer **all** questions.

1. (d) (i) Define electric potential

[2]

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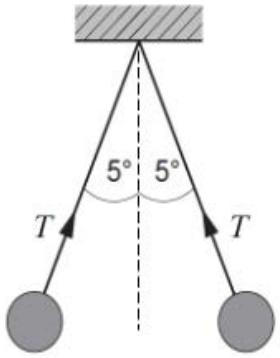
Two identical insulated spheres are suspended by light threads and store an equal amount of charge.



(ii) Calculate the electric potential at a point which is 7.0cm from the center of one sphere and 18.0cm from the center of the other sphere. Assume that both spheres can be considered as 125nC point charges.

[3]

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2. (a) The gravitational field strength at a point near a star is 230N kg^{-1}. Explain the meaning of this statement.

[2]

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(f) Solomon incorrectly states that this red shift, combined with the Hubble constant, H_0, means that this star is approximately 60 x 10^{18} m from the solar system. Explain how Solomon has arrived at his conclusion **and** why the conclusion is incorrect.

[4]

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3. State Kepler's three laws of planetary motion. Explain their significance for planets in circular and elliptical orbits. [6 QER]

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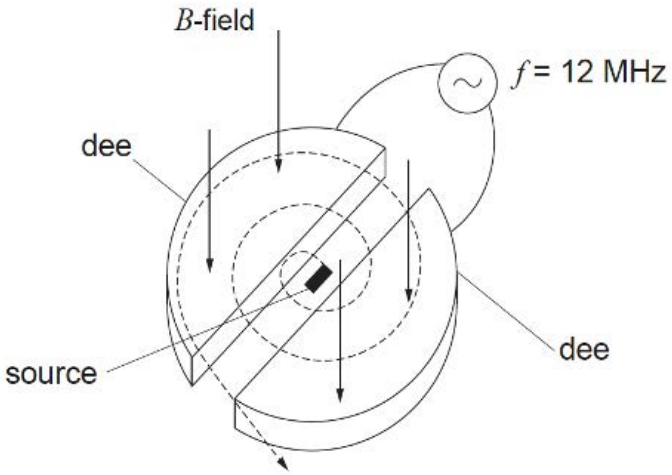
4. A cyclotron consists of two dees in a strong magnetic field. Protons are accelerated between the dees by a varying pd of frequency 12 MHz.



(a) (i) Explain why a valid equation for the motion of the proton while inside a dee is:

$$m\omega^2 r = Bq\omega r$$

where m is the mass of the proton, ω is the angular velocity of the proton, r is the radius of motion of the proton, q is the proton charge and B is the magnetic flux density. [3]

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(c) When the proton motion reaches a radius of 0.45m it exits the cyclotron.

(i) Show that this happens when the proton has a kinetic energy of approximately 1pJ.

[2]

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(ii) The proton is accelerated twice per cycle. Determine whether the proton spends more than a millisecond in the cyclotron if it is accelerated from rest.

[2]

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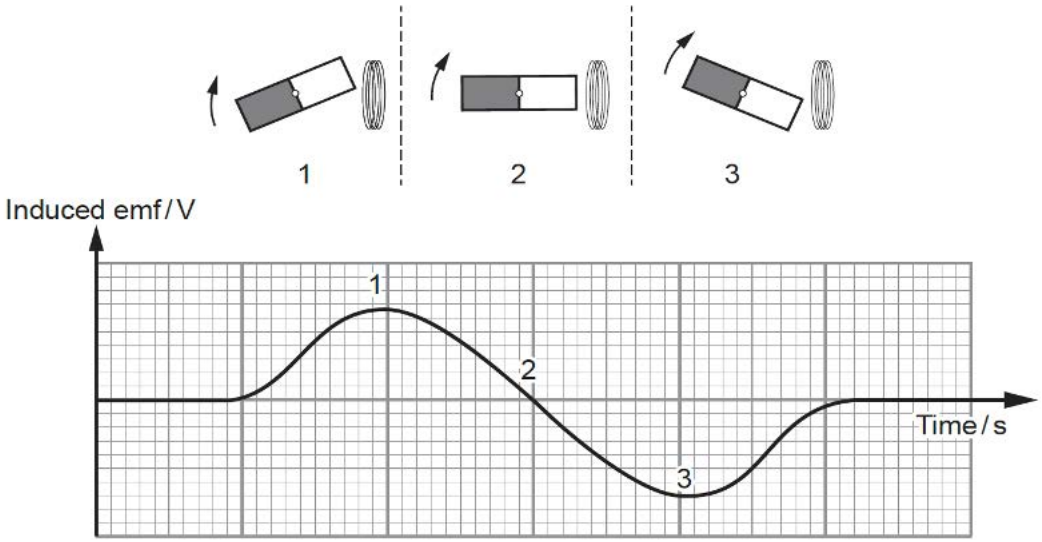
5. A rotating magnet and a stationary coil are used as a generator to produce an emf.



(a) By considering the motion of the magnet between positions 1 and 3, explain why the induced emf in the coil varies as shown in the graph. [4]

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Turn over.

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1 (d) (i) Work done per unit charge accept WD on unit charge (1)
Bringing charge from infinity to that point (1)

1 (d) (ii) Use of $V = \frac{kq}{r}$ (1)
Adding potentials correctly as scalars (1)
Correct answer = 22 300 V (1) **unit mark** C F^{-1} or J C^{-1}

2 (a) {Force **OR** (gravitational) pull **OR** 230 N) at that point (accept "there") (1)
per unit mass (1) Accept per kilogram(me) or on 1 kg NOT just kg^{-1}

Alternative:
Acceleration at that point (1)
Inertial mass = gravitational mass **OR** equivalence principle **OR** any mass (1)

2 (f) Statement {Solomon / he used} $v = H_0 D$ **OR** using the equation (1)
Giving $D = 60 \times 10^{18}$ [m] **OR** $2.2 \times 10^{-18} \times 60 \times 10^{18} = 132$ (1)
NOTE: 0.3 pm gives 6.2×10^{19} m (award 1st 2 marks)
Wrong because not cosmic expansion **OR** galaxy redshifts **OR** anything to do with galactic motion **OR** recessional velocity is constant (1)
NOTE: "should have used recessional speed" not enough - it just means moving away
Due to a planet **OR** orbit **OR** rotational velocity **OR** should have taken mean speed / shift **OR** the velocity is not constant **OR** anything suggesting orbital motion (1)

Alternative for last 2 marks:
Has used radial rather than recessional velocity **OR** reverse (1)
Star also has tangential velocity **OR** reverse (1)

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3 QER

Indicative content:

K1
- Planets orbit in ellipses
- With Sun at a focus
- Only 1 focus for a circle / at centre

K2
- Equal areas swept in equal time
- For line between Sun and planet
- Constant speed for a circle

K3
- $T^2 \propto r^3$
- Period and semi-major axis named (as the variables)
- r is the radius for a circular orbit

OR

K3
- $T^2 \propto r^3$
- Period and radius named (as the variables)
- Radius replace by semi-major axis for ellipse

5-6 marks
All 3 laws well covered expect 2 points for each law as a minimum.
There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.

3-4 marks
All 3 laws poorly covered OR 2 covered well and 1 poor OR 2 covered well and 1 not covered.
There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.

1-2 marks
1 OR 2 laws poorly covered OR 1 law well covered
There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with little structure.

0 marks
No attempt made or no response worthy of credit.

4 (a)

Centripetal force / circular motion identified ACCEPT force towards middle (1)
$Bq\omega r$ is the force on a (moving) charge carrier in a B-field **OR** the LHR force **OR** is Bqv ACCEPT Lorentz force (1)
Magnetic force provides / causes the centripetal force **OR** Bqv is the resultant force (1)

4 (c)

(i)	Use of $v = \omega r$ (1) (gives 3.4×10^7 m s^{-1}) OR equivalent (1) Use of $\frac{1}{2}mv^2$ (gives 9.6×10^{-13} J) (1) no ecf on m_e ALLOW marks for working backwards using 1 pJ
(ii)	Divide energy by answer to (b) **AND** dividing by 2 (gives 2500 cycles) (1) **ecf** on (b) Correct answer = 0.21 m[s] and comment **ecf** on mass (1) NOTE: 0.4 ms and 0.8 ms score 1 mark i.e. slips for full marks -1

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5 (a) [Induced] emf is rate of change of flux [linkage] / Faraday's law mentioned (1)
Flux [linkage] is increasing in 1 **OR** rate of change of flux is positive (1)
Flux [linkage] is maximum in 2 [hence emf = 0] **OR** momentarily no change in flux [linkage] (1)
Conditions in 3 opposite to 1 stated **OR** flux linkage is decreasing **OR** rate of change of flux is negative **OR** moving away **OR** due to Lenz (1)

Alternative:
[Induced] emf is rate of cutting of flux / Faraday's law mentioned (1)
Flux cut [more] on top side of loop at position 1 (1)
Flux cut in and out of loop [equally] at 2 [hence emf = 0] **OR** cut same at top and bottom (1)
Conditions in 3 opposite to 1 stated **OR** bottom side does more cutting **OR** moving away **OR** due to Lenz (1)

Other notes on this paper:

- Explain why the age of the Universe is approximately $1/H_0$
- Q4b You need to know how to convert eV to J (2 mark)
- Application of particle accelerator include neon signs, oscilloscopes, magnetrons, X-ray tubes, old TVs etc
- Make sure you know when to use E = V/d
- 5 time constant is effectively fully charged or discharged