PEARSON EDEXCEL IAL PHYSICS · YPH11

PHYSICS



EXAM QUESTION PACK

UNIT 4: ELECTRIC AND MAGNETIC FIELDS

SCORE	PERCENTAGE
/94	%

STEMUP

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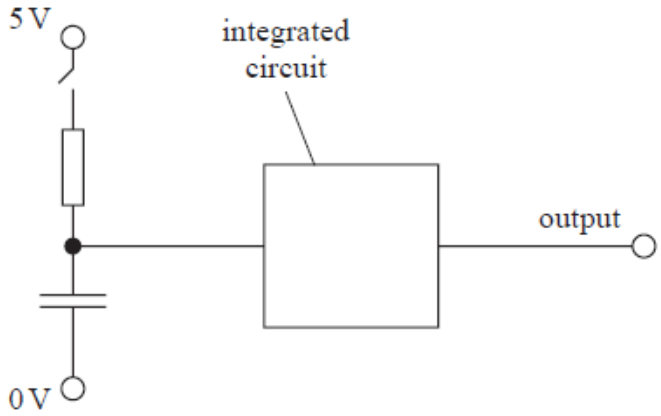
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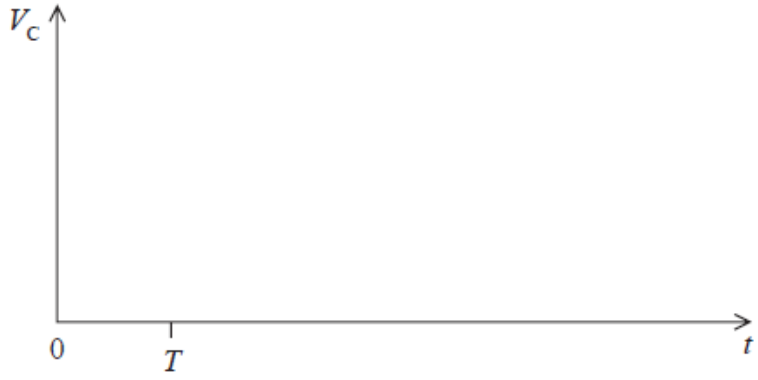
Q1.

A resistor-capacitor circuit provides an input for an integrated circuit as shown.
The integrated circuit can be assumed to have infinite resistance.



(a)(i) Sketch a graph to show how the potential difference V_C across the capacitor varies with time t as the switch is closed. The time constant T for this circuit is marked on the time axis.

(2)



(ii) Explain how the potential difference V_R across the resistor varies with time after the switch is closed.

(2)

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(iii) Show that V_C is given by the equation

$$V_C = 5 - 5e^{-\frac{t}{RC}}$$

where R is the resistance of the resistor
and C is the capacitance of the capacitor.

(2)

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(b) The input to the integrated circuit should be 3.3 V at a time 3.5 seconds after the switch is closed.

The following capacitors are available:

4.7 μF 10 μF 15 μF 47 μF 150 μF

Deduce which capacitor should be used.

R = 68 kΩ

(3)

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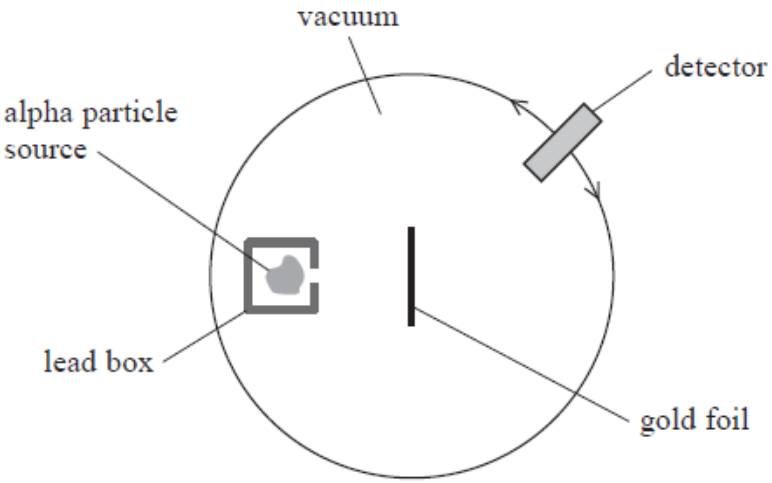
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(Total for question = 9 marks)

Q2.

In the early 20th century, experiments were carried out in which alpha particles were directed towards thin gold foil.

A simplified diagram of the apparatus used is shown.



(a) State three observations and the corresponding conclusions made from the alpha particle scattering experiment.

(6)

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(b) One experiment used gold foil made from the gold isotope $^{197}_{79}\mathrm{Au}$. The alpha particles had an initial
kinetic energy of 4.7 MeV.

(i) Show that the closest distance these alpha particles can get to a gold nucleus is about 5×10^{-14} m.

(4)

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(ii) Calculate the strength of the electric field due to the gold nucleus at this distance.

(3)

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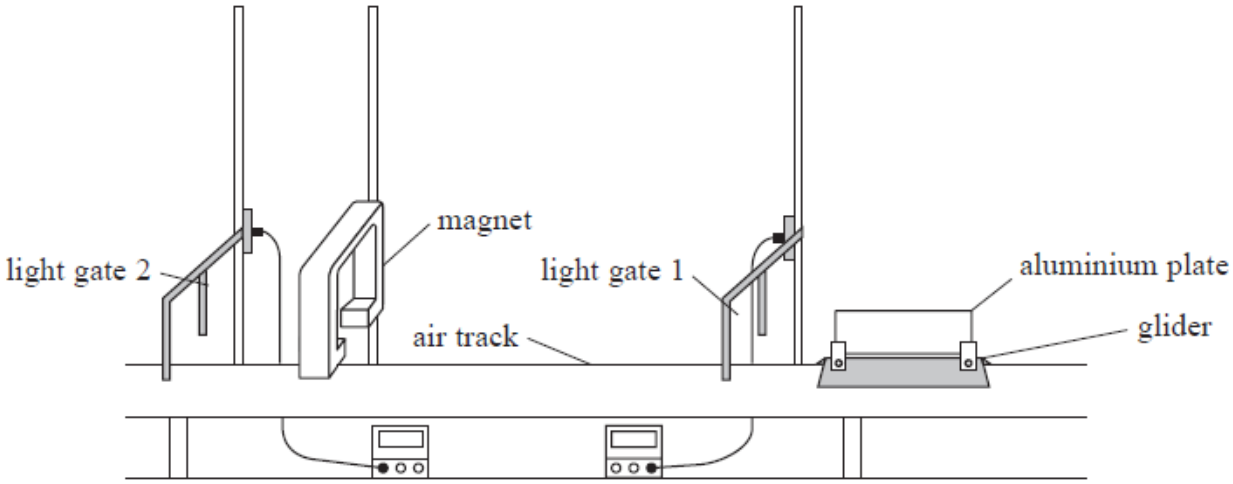
Strength of electric field = ...

(Total for question = 13 marks)

Q3.

A student investigated electromagnetic braking using the apparatus shown.

A vehicle consisting of a glider and aluminium plate was placed on an air track. A powerful magnet was positioned between the two light gates so that the aluminium plate could pass between the poles of the magnet. The air resistance on the vehicle was negligible.



(a)(i) The vehicle was given a push. The aluminium plate took 0.19 s to pass through light gate

1.

Show that the momentum of the vehicle was about 0.3 N s.

length of plate = 15.0 cm
mass of vehicle = 0.40 kg

(3)

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(ii) The vehicle then moved between the poles of the magnet before passing through light gate 2.

The magnet caused the kinetic energy of the vehicle to reduce by 10%.

Calculate the velocity of the vehicle at light gate 2.

(3)

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Velocity = ...

(b) (i) Explain why a current was produced in the aluminium plate as it passed between the poles of the magnet.

(2)

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(ii) The kinetic energy of the vehicle decreased as the aluminium plate moved between the poles of the magnet.

Explain why.

(2)

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(c) The investigation was repeated using different aluminium plates with the same length but different thicknesses. The vehicle was given the same approximate initial velocity each time. The table shows the thickness of each aluminium plate and the corresponding percentage reduction in the kinetic energy of the vehicle.

	Thickness / mm	Percentage reduction in kinetic energy
Initial plate	0.50	10
Second plate	0.80	16
Third plate	1.1	22

(i) Show that the percentage reduction in kinetic energy is proportional to the thickness of the plate.

(2)

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(ii) Suggest why the percentage reduction in kinetic energy increases as the thickness of the plate increases.

(3)

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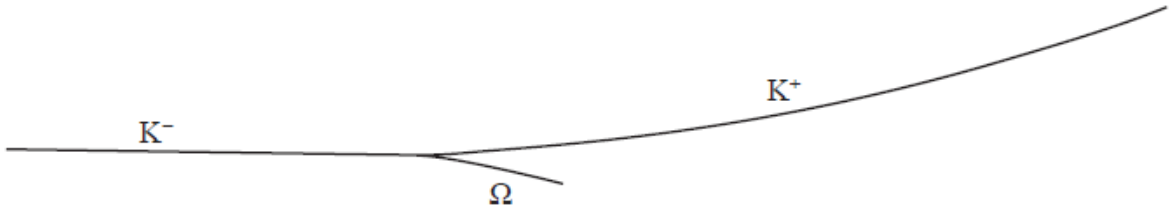
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(Total for question = 15 marks)

Q4.

The diagram shows particle tracks in a detector. A negative K meson collided with a stationary proton. An omega baryon and a positive K meson were produced after the impact.



(a) Explain the process that enables a particle detector to detect charged particles.

(2)

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(b) (i) Describe the structure of a baryon and a meson.

(2)

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(ii) A magnetic field acts in the detector.

State the direction of the magnetic field.

(1)

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(iii) Deduce the charge and baryon number for the omega particle.

(3)

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* (c) The rest mass of the omega baryon is significantly larger than the rest mass of the proton.

Discuss how energy and momentum are conserved during this collision.

(6)

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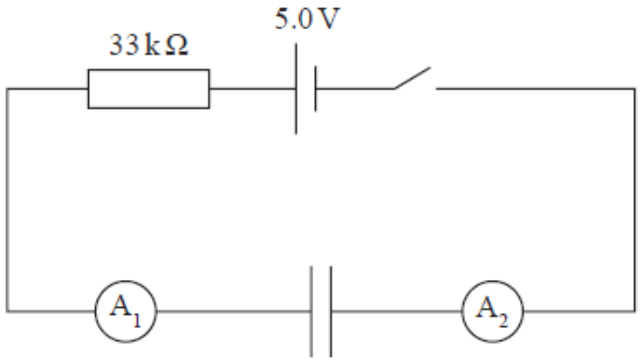
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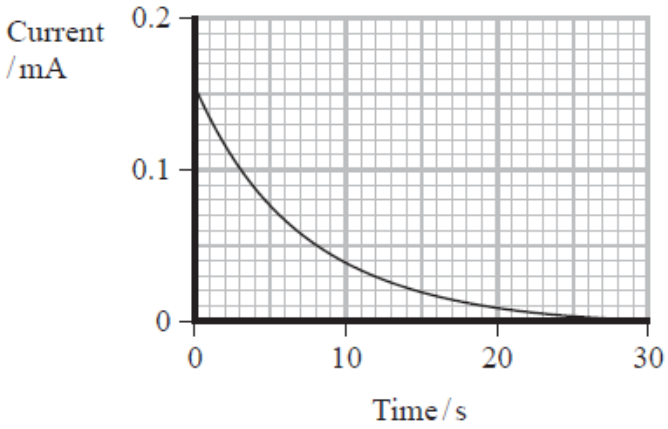
(Total for question = 14 marks)

Q5.

A student built the circuit shown. The capacitor was initially uncharged.



She closed the switch and plotted a graph of current on ammeter A_1 against time.



(a) Determine whether the initial value of current on the graph is consistent with the values stated on the circuit diagram.

(2)

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(b) Explain how the current on ammeter A_2 would vary over the same time interval.

(2)

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(c) Determine the capacitance of the capacitor.

(3)

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Capacitance = ...

(d) Determine the charge stored on the capacitor after 30 s.

(2)

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Charge stored on capacitor after 30 s = ...

(e) Determine the maximum energy stored by the capacitor.

(2)

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Maximum energy = ...

(Total for question = 11 marks)

Q6.

Faraday's law can be written as $\mathscr{E} = \frac{-\mathrm{d}(N\phi)}{\mathrm{d}t}$

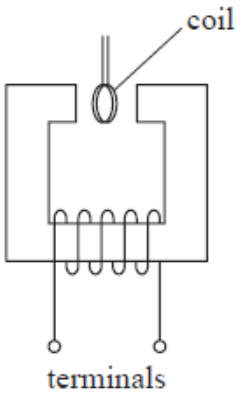
(a) State the name of the term $N\phi$ and its unit.

(2)

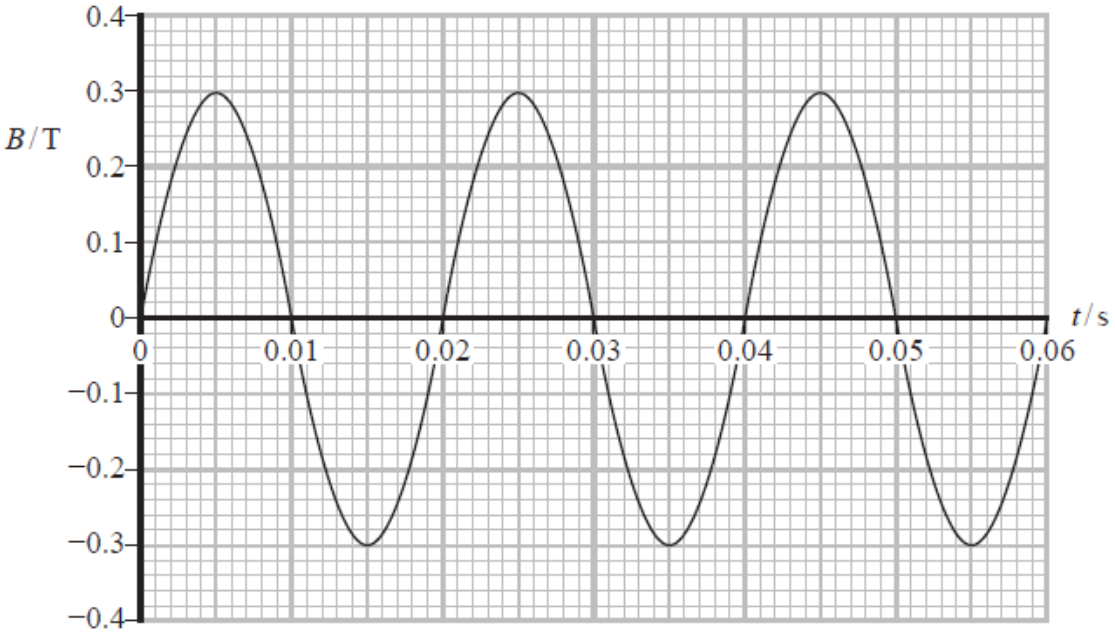
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(b) A coil of 500 turns and radius 3.0 mm is placed between two poles of an electromagnet as shown. The terminals are connected to an a.c. power supply.



The magnetic flux density B perpendicular to the plane of the coil varies with time t as shown below.



Determine the maximum e.m.f. across the coil.

(6)

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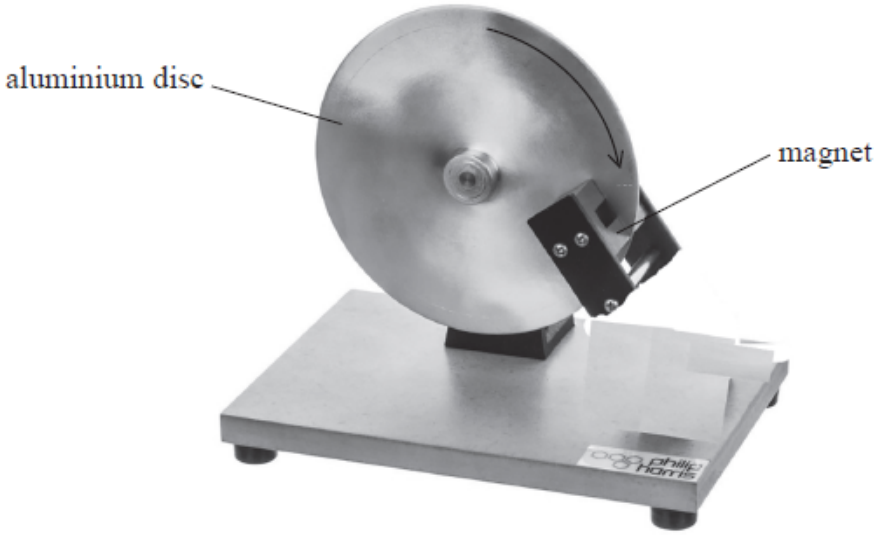
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Maximum emf = ...

(c) Some electric motor designs rely on electromagnetic induction.

A laboratory demonstration of the principle of an induction motor is shown. An aluminium disc is free to rotate and is initially stationary. A powerful magnet is moved around the disc in the direction of the arrow, without touching the disc.



(Source: https://www.philipharris.co.uk/product/physics/electricity-and-electromagnetism/magnetism/eddy-current-unit/b8h79908)

A student suggests that the disc will start to rotate as the magnet is moved and that the disc will rotate in the same direction as the movement of the magnet.

Discuss this suggestion.

(6)

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(Total for question = 14 marks)

Q7.

The surface of a balloon can become charged by rubbing it against clothing. The charge on the surface of the balloon can be assumed to act as if it was concentrated at the balloon's centre.

Two balloons are suspended by cotton threads so that they just touch each other as shown in diagram 1. The two balloons are then given an equal negative charge and repel as shown in diagram 2. The dots represent the centre of each balloon.

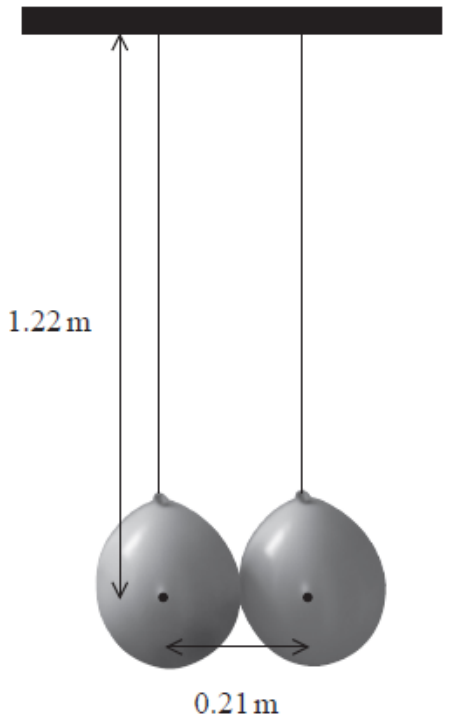


Diagram 1

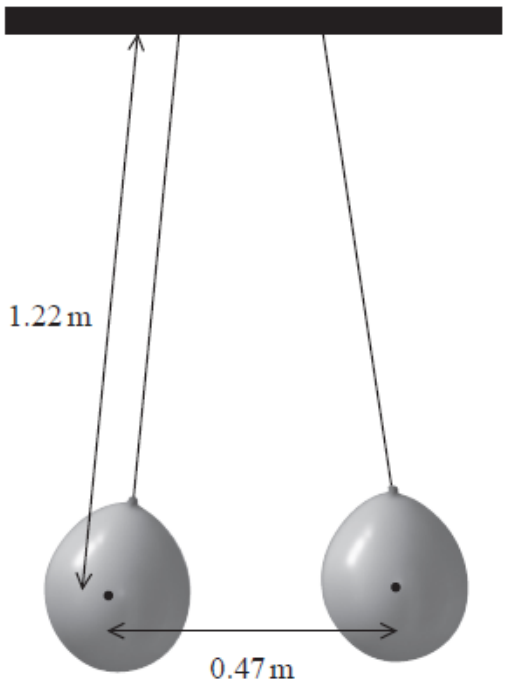


Diagram 2

(a) (i) Show that the force of repulsion between the balloons in diagram 2 is about 1×10^{-3} N.

mass of each balloon = 1.1 grams

(4)

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(ii) Show that the charge on each balloon is about 2×10^{-7} C.

(2)

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(b) One balloon is removed and the remaining balloon returns to its original position.

Calculate the electric potential at a distance of 0.30 m from the centre of the remaining balloon.

(2)

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Electric potential = ...

(Total for question = 8 marks)

Q8.

The diagram represents a negative point charge.

Draw field lines to show the electric field around the charge.



(Total for question = 3 marks)

Q9.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Two equally-charged ions exert a force of 4.0×10^{-9}N on each other. The distance between the centres of the ions is 2.4×10^{-10}m.

Which of the following is equal to the charge on each ion?

☐ **A** $\sqrt{\dfrac{4.0 \times 10^{-9} \times (2.4 \times 10^{-10})^2}{8.99 \times 10^{9}}}$

☐ **B** $\sqrt{\dfrac{4.0 \times 10^{-9} \times (2.4 \times 10^{-10})^2}{4 \times \pi \times 8.85 \times 10^{-12}}}$

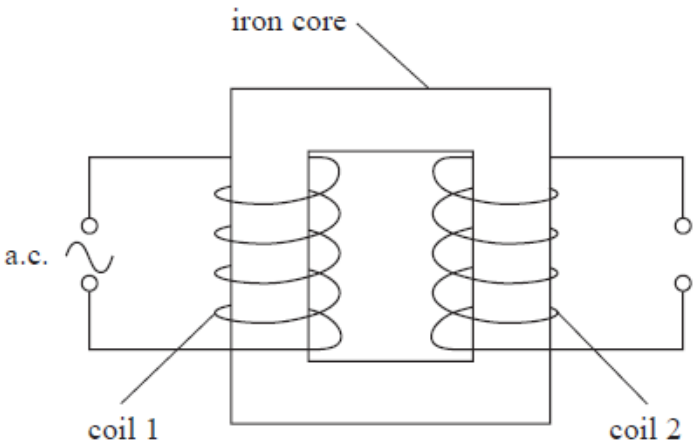
☐ **C** $\dfrac{4.0 \times 10^{-9} \times (2.4 \times 10^{-10})^2}{8.99 \times 10^{9}}$

☐ **D** $\dfrac{4.0 \times 10^{-9} \times (2.4 \times 10^{-10})^2}{4 \times \pi \times 8.85 \times 10^{-12}}$

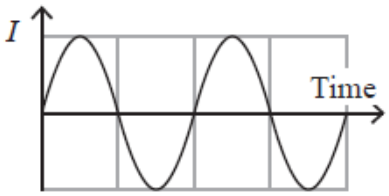
(Total for question = 1 mark)

Q10.

Two coils are linked by an iron core as shown. Coil 1 carries an alternating current *I*.

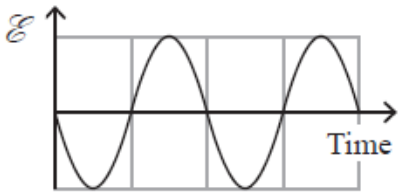


The graph shows the variation of I with time for two complete cycles.

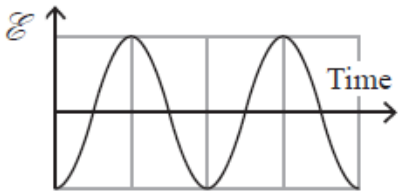


Which of the following graphs gives the corresponding induced e.m.f. $\mathscr{E}$ across coil 2?

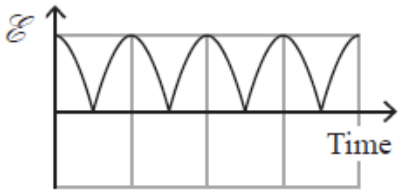
☒ **A**



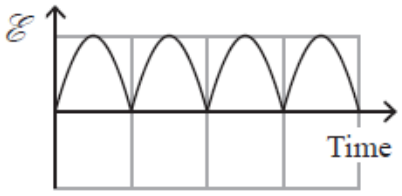
☒ **B**



☒ **C**



☒ **D**

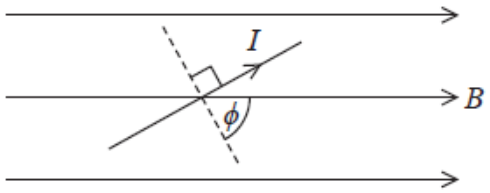


(Total for question = 1 mark)

Q11.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A wire is in the same plane as a magnetic field of magnetic flux density B as shown.
The wire is of length l and carries a current I.



Which row of the table gives the magnitude and direction of the force on the wire?

	Magnitude	Direction
☒ **A**	$BIl\cos\phi$	into page
☒ **B**	$BIl\cos\phi$	out of page
☒ **C**	$BIl\sin\phi$	into page
☒ **D**	$BIl\sin\phi$	out of page

(Total for question = 1 mark)

Q12.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

When the potential difference across a capacitor is V, the energy stored by the capacitor is W.

Which of the following gives the energy stored by the capacitor when the potential difference across the capacitor is $2V$?

☒ **A** W

☒ **B** $2W$

☒ **C** $3W$

☒ **D** $4W$

(Total for question = 1 mark)

Q13.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Which of the following units is equivalent to the farad?

☒ **A** $C\ V^{-1}$

☒ **B** $J\ V^{-1}$

☒ **C** Ωs^{-1}

☒ **D** sJ^{-1}

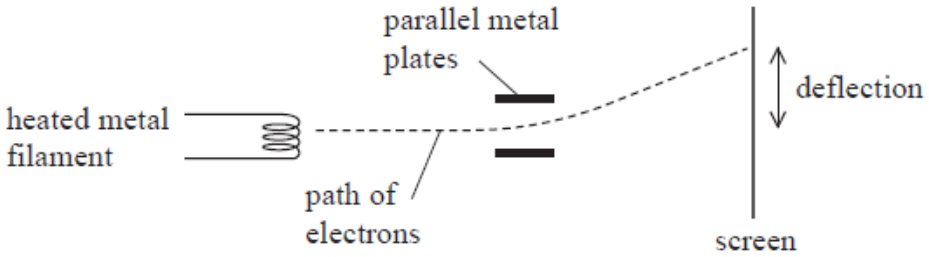
(Total for question = 1 mark)

Q14.

Select one answer from A to D and put a cross in the box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

This question refers to a cathode ray tube.

The diagram shows some of the components in a cathode ray tube.



When a potential difference is applied across the parallel metal plates, the electrons are deflected.

Which of the following changes would decrease the deflection of the electrons?

☒ **A** increasing the current in the metal filament

☒ **B** increasing the distance between the plates

☒ **C** increasing the length of the plates

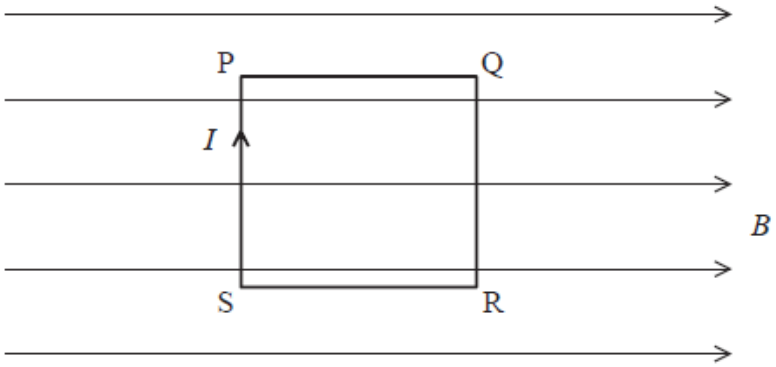
☒ **D** increasing the potential difference across the plates

(Total for question = 1 mark)

Q15.

Select one answer from A to D and put a cross in the box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A square coil PQRS has sides of length *l*. There is a clockwise current *I* in the coil as shown. The plane of the coil is parallel to a magnetic field of magnetic flux density *B*.



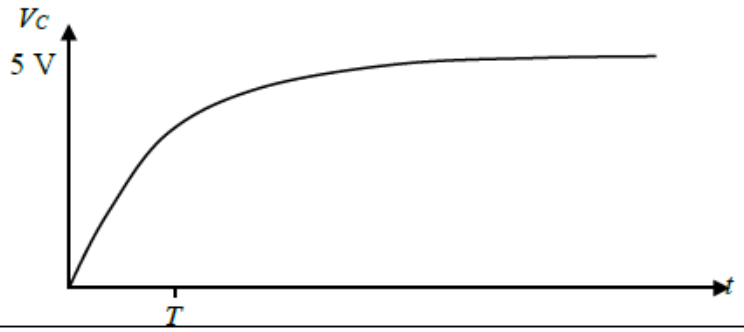
Which row of the table is correct?

	Side of coil	Magnetic force
☒ **A**	PQ	0
☒ **B**	QR	0
☒ **C**	RS	*BIl* into page
☒ **D**	SP	*BIl* out of page

(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number	Answer	Mark
ai	exponential growth curve starting at origin and levelling at 5 V (accept V_0) (1) levelling off after at approx. 4 to 5 time constants **Or** curve through approx 2/3 of maximum at T (accept labelled as 3.2 V or 63%) (1) Example of graph  	**2**
aii	**Either** (1) p.d. would decrease exponentially from 5 V Or p.d. would decrease exponentially to 0 V Because the sum of the p.ds across the capacitor and resistor must always add up to the supply p.d. (1) **Or** as capacitor charges then p.d. across resistor must decrease from 5 V. (1) so current in resistor decreases so rate of change of p.d. decreases (1)	**2**
aiii	$5 = V_R + V_C$ (1) Use of $V_R = V_0 e^{-t/RC}$ and $V_0 = 5$ to give required equation (1)	**2**

b	Use of $V_C = 5 - 5e^{-t/RC}$	(1)	**3**
	Takes ln of both sides of equation	(1)	
	$C = 48$ μF so select 47 μF	(1)	
	Example of calculation		
	$3.3 = 5 - 5e^{-3.5/68000 \times C}$		
	$\ln\frac{1.7}{5} = -\frac{3.5}{68000 \times C}$		
	$1.08\ C = 5.15 \times 10^{-5}$		
	$C = 4.77 \times 10^{-5}$ F		
	So 47 μF		
	Total for question		**9**

Q2.

Question Number	Answer		Mark
a	Most alpha particles were undeviated **Or** Most particles pass through with little or no deviation	(1)	**6**
	Most of the atom is empty space (MP2 with reference to lack of deviation)	(1)	
	Few alpha particles were scattered by small angles	(1)	
	There is a concentration of charge in the atom (MP4 with reference to scattering)	(1)	
	Very few alpha particles were deviated by more than 90°	(1)	
	Most of the mass is concentrated in a small region of the atom **Or** Most of the mass is concentrated in nucleus (Accept Mass of nucleus much greater than mass of alpha particle) (MP6 with reference to back scattering)	(1)	

bi	Applies conversion factors for MeV to J (1) Use of $V = {}^{Q}/_{4\pi\varepsilon_0 r}$ (1) Use of $W=VQ$ (1) $r = 4.8 \times 10^{-14}$ (m) (1) <u>Example of calculation</u> $4.7\ \text{MeV} = 4.7 \times 10^{6}\ \text{eV} \times 1.6 \times 10^{-19}\ \text{J/eV} = 7.52 \times 10^{-13}\ \text{J}$ $7.52 \times 10^{-13}\ \text{J} = 8.99 \times 10^{9}\text{Nm}^2\text{C}^2 \times 2 \times 1.6 \times 10^{-19}\text{C} \times 79 \times 1.6 \times 10^{-19}\text{C}/r$ $r = 4.8 \times 10^{-14}$ m	**4**
bii	Use of $E = {}^{Q}/_{4\pi\varepsilon_0 r^2}$ (1) With $Q = 79 \times 1.6 \times 10^{-19}$ (1) $E = 4.9 \times 10^{19}\ \text{NC}^{-1}$ (1) (use of show that value gives $E = 4.5 \times 10^{19}\ \text{NC}^{-1}$) allow ecf from (i) <u>Example of calculation</u> $E = 8.99 \times 10^{9}\text{Nm}^2\text{C}^2 \times 79 \times 1.6 \times 10^{-19}\ \text{C} / (4.8 \times 10^{-14})^2\ \text{m}^2$ $E = 4.9 \times 10^{19}\ \text{NC}^{-1}$	**3**
	Total for question	**13**

Q3.

Question Number	Answer		Mark
ai	Use of $v = s/t$	(1)	**3**
	Use of $p = mv$	(1)	
	$p = 0.32$ (N s)	(1)	
	Example of calculation $v = 0.15$ cm / 0.19 s = 0.79 m s^{-1} $p = 0.40$ kg × 0.79 m s^{-1} = 0.32 N s		
aii	Use of $E_k = \frac{1}{2}mv^2$ **Or** $E_k = \frac{p^2}{2m}$	(1)	**3**
	Final $E_k = 0.9 \times$ Initial E_k **Or** correct use of $E_k \propto v^2$ can be awarded MP1 and 2	(1)	
	At lightgate 2 $v = 0.75$ m s^{-1} allow ecf from (i) 'show that' value gives $v = 0.71$ m s^{-1}	(1)	
	Example of calculation Initial $E_k = ½ \frac{0.32^2 \text{ (N s)}^2}{0.4 \text{ kg}} = 0.125$ J Final $E_k = 0.9 \times 0.125$ J = 0.1125 J = ½ 0.4 kg × v^2 $v = 0.75$ m s^{-1}		

bi	**Max 2 marks from**		**2**
	e.m.f. induced (in plate)	(1)	
	due to change of flux linkage **Or** due to cutting of lines of flux **Or** due to cutting of magnetic field lines	(1)	
	(Leads to current in plate) as the plate provides a (full) conducting path	(1)	
bii	**Either**		**2**
	Current carrying conductor within a magnetic field experiences a force	(1)	
	Force opposite to direction of motion due to Lenz's law (so kinetic energy is reduced)	(1)	
	Or		
	Energy dissipated by current (in plate) (according to $P = I^2R$)	(1)	
	Energy is conserved (so kinetic energy decreases)	(1)	

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ci	Calculates a relevant ratio for a pair of values in the table (1) Shows the ratio is consistent with at least one other pair of values (1) <u>Example of calculation</u> k = 10/0.5 = 20 k = 16/0.8 = 20 k = 22/1.1 = 20	**2**
cii	Reference to $R = \rho l/A$ **Or** refers to resistance of plate decreasing with increasing thickness/CSA (1) So current will increase (as induced emf will be the same) (1) So rate of energy transferred to surroundings increased (1) **Or** larger braking force (MP3 dependent on MP1 and 2)	**3**
	Total for question	**15**

Q4.

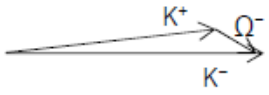
Question Number	Answer	Mark
a	(the particle is) ionising **Or** it knocks electrons out of atoms in its path (1) A track is formed by the ionised particles produced (1)	**2**
bi	A baryon is three quarks (or three antiquarks) (1) A meson is an anti-quark and a quark (1)	**2**
bii	into the page/paper (1)	**1**
biii	charge: applies charge conservation (1) omega baryon charge −1 (1) baryon number: before = 1 identified as the proton so the omega particle = 1 (1)	**3**

* c	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content.	6

Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	Max linkage mark available	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

The following table shows how the marks should be awarded for structure and lines of reasoning.

	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

	Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points which is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages). Indicative content: Energy: IC1 As (Rest) mass-energy of proton and kaon + Initial E_k = (rest) mass-energy of omega and kaon + kinetic energies of both particles **Or** (Total) mass-energy conserved IC2 Incoming K^- had **high** kinetic energy IC3 some of this initial kinetic energy converted to mass of the omega particle (– mass of proton) IC4 $\Delta E = \Delta mc^2$ momentum: IC5 momentum of K^- = sum of x components of $K^+ + \Omega^-$ **Or** vector sum of momentum of $K^+ + \Omega^-$ = momentum of K^- **Or** an attempt to sketch a triangle of vectors eg  IC6 y component of K^+ equals y component Ω^- **Or** all vectors correctly labelled	
	Total for question	**14**

Q5.

Question Number	Answer		Mark
a	Use of $I = V / R$	(1)	2
	$I = 0.15$ mA which is consistent (with the value on the graph)	(1)	
	Example of calculation $I = 5.0\ \text{V} / 33\ \text{k}\Omega = 1.5 \times 10^{-4}\ \text{A} = 0.15\ \text{mA}$		
b	The current would vary with time in the same way as on ammeter A_1	(1)	2
	Because (current is same everywhere) in a series circuit	(1)	
c	**Either** Takes two corresponding values of I and t from graph	(1)	3
	Use of $\ln I = \ln I_0 - t/RC$	(1)	
	$C = 2.27 \times 10^{-4}$ F (2.0×10^{-4} F - 2.3×10^{-4} F)	(1)	
	Or		
	Draws initial tangent to curve and determines t intercept: T (0.65-0.75 s)	(1)	
	Use of $T = RC$	(1)	
	$C = 2.2 \times 10^{-4}$ F (2.0×10^{-4} F - 2.3×10^{-4} F)	(1)	
	Or		
	Read value of t at which $I = I_0 / e$ (0.56 A, 0.7 s)	(1)	
	Use of $T = RC$	(1)	
	$C = 2.1 \times 10^{-4}$ F (2.0×10^{-4} F - 2.3×10^{-4} F)	(1)	
	Example of calculation eg $I = 0.04$ mA and $t = 10$ s		
	$\ln 0.04 = \ln 0.152 - \dfrac{10\text{s}}{C \times 33\text{k}}$		
	$C = 2.27 \times 10^{-4}$ F range: 2.0×10^{-4} F - 2.3×10^{-4} F		
d	Attempt to determine an area under the curve	(1)	2
	$Q = 1.1 \times 10^{-3}$ C (1.0×10^{-3} C to 1.2×10^{-3} C)	(1)	
	Or Use of $Q = CV$ with 5.0 V	(1)	
	$Q = 1.1 \times 10^{-3}$ C (allow ecf from (c))	(1)	
e	Use of $W = \frac{QV}{2}$ or $W = \frac{1}{2}CV^2$ or $W = Q^2/2C$	(1)	2
	$W = 2.8 \times 10^{-3}$ J (allow ecf from 14c and 14d)	(1)	
	Example of calculation $W = 1.1 \times 10^{-3}$ C $\times$ 5 V / 2 $= 2.8 \times 10^{-3}$ J		
	Total for question		11

Q6.

Question Number	Answer		Mark
a	Flux linkage	(1)	2
	weber / Wb	(1)	
b	Evidence of attempt to determine maximum gradient of graph	(1)	6
	Use of $\Delta B / \Delta t$	(1)	
	use of area of coil = πr^2	(1)	
	use of $\emptyset = BA$	(1)	
	Use of $\varepsilon = \frac{d(N\emptyset)}{dt}$	(1)	
	$\mathcal{E}$ = 1.4 V range 1.2 to 1.6 V	(1)	
	Example of calculation		
	gradient = 0.6 T / 0.006 s = 100 T s^{-1}		
	Area of coil = $\pi(0.003\text{ m})^2 = 2.83 \times 10^{-5}\text{ m}^2$		
	$\varepsilon = 500 \times 100\text{ T s}^{-1} \times 2.83 \times 10^{-5}\text{ m}^2$		
	$\mathcal{E}$ = 1.4 V		

c	There is a change in the magnetic flux (linkage with aluminium disc) **Or** disc is cutting magnetic field/flux	(1)	6
	So an e.m.f. is induced	(1)	
	Leads to a current (in the disc) (accept eddy current)	(1)	
	Force acts on the disc, as there is a current in a magnetic field (accept reference to motor effect, FLHR or $F = BIl$ if current in disc has been mentioned) **Or** field due to current in disc interacting with field due to magnet to cause force on disc	(1)	
	According to Lenz's law **Or** the direction of e.m.f./current is such to oppose (the cause of) the change in flux	(1)	
	The disc moves to reduce this change (the same direction as the magnet) so correct suggestion	(1)	
	Total for question		14

Q7.

Question Number	Answer		Mark
ai	Use of trigonometry appropriate for determination of angle	(1)	4
	Use of $W = mg$	(1)	
	Resolves tension in thread vertically or horizontally **Or** draw triangle of forces	(1)	
	Force of repulsion = 1.2×10^{-3} (N)	(1)	
	Example of calculation		
	$\sin\theta = 13/122$ Angle of thread to vertical $\theta = 6.12°$		
	$T\cos 6.12° = 1.1 \times 10^{-3}\text{kg} \times 9.81\text{N kg}^{-1}$		
	Tension in thread = 0.0109 N		
	Force of repulsion = $0.0109 \sin 6.12° = 1.16 \times 10^{-3}$ N		
aii	Use of $F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$ (accept use of $F = \frac{k\,Q_1 Q_2}{r^2}$)	(1)	2
	$Q = 1.7 \times 10^{-7}$ (C) (allow ecf from ai)	(1)	
	Example of calculation		
	$1.16 \times 10^{-3}\text{N} = 8.99 \times 10^{9}\ \text{Nm}^2\text{C}^{-2} \frac{Q^2}{0.47^2\text{m}^2}$		
	$Q = 1.69 \times 10^{-7}$ C		
b	Use of $V = \frac{Q}{4\pi\varepsilon_0 r}$ (accept use of $V = \frac{kQ}{r}$)	(1)	2
	$V = 5100$ V (allow ecf from aii)	(1)	
	Example of calculation		
	$V = 8.99 \times 10^{9}\ \text{Nm}^2\text{C}^{-2} \frac{(-)1.7\times10^{-7}\text{C}}{0.30\ \text{m}} = (-)5094$ V		
	Total for question		8

Q8.

Question Number	Answer		Mark
	at least 4 radial straight lines	(1)	3
	distributed equally	(1)	
	arrow on at least one line pointing towards centre	(1)	
	Total for question		3

Q9.

Question Number	Answer	Mark
	The only correct answer is **A** *B is not correct because* $Q = \sqrt{F \times r^2 \times 4\pi\varepsilon_0}$ *C is not correct because* $Q = \sqrt{F \times r^2 / k}$ *D is not correct because* $Q = \sqrt{F \times r^2 \times 4\pi\varepsilon_0}$	**(1)**

Q10.

Question Number	Answer	Mark
	The only correct answer is **B** *A is not correct because the flux Ø in coil 2 will be proportional to the current and the induced e.m.f. is proportional to* $-\Delta Ø/\Delta t$ *C is not correct because the flux Ø in coil 2 will be proportional to the current and the induced e.m.f. is proportional to* $-\Delta Ø/\Delta t$ *D is not correct because the flux Ø in coil 2 will be proportional to the current and the induced e.m.f. is proportional to* $-\Delta Ø/\Delta t$	**(1)**

Q11.

Question Number	Answer	Mark
	The only correct answer is **A** *B is not correct because FLHR gives force into the page* *C is not correct because in this case the component of field is* $B\cos Ø$ *D is not correct because in this case the component of field is* $B\cos Ø$	**(1)**

Q12.

Question Number	Answer	Mark
	The only correct answer is **D** *A is not correct because* $W \propto V^2$ *B is not correct because* $W \propto V^2$ *C is not correct because* $W \propto V^2$	**(1)**

Q13.

Question Number	Answer	Mark
	The only correct answer is **A** *B is not correct because this is equivalent to coulombs* *C is not correct because this is equivalent to (farad)* $^{-1}$ *D is not correct because this is equivalent to (watt)* $^{-1}$	**(1)**

Q14.

Question Number	Answer	Mark
	The only correct answer is **B** *A is not correct because this would have no effect on the deflection* *C is not correct because this would increase the deflection* *D is not correct because this would increase the deflection*	**1**

Q15.

Question Number	Answer	Mark
	The only correct answer is **A** *B is not correct because force is out of page on QR* *C is not correct because force is zero on RS* *D is not correct because force is into page on SP*	1