AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level PHYSICS A

Unit 4 Fields and Further Mechanics Section A

Thursday 15 June 2017 Morning

Time allowed: The total time for both sections of this paper is 1 hour 45 minutes. You are advised to spend approximately 45 minutes on this section.

Materials

In addition to this paper you will require:
- an objective test answer sheet
- a black ball-point pen
- a calculator
- a question paper/answer book for Section B (enclosed)
- a Data and Formulae booklet.

Instructions
- Use a black ball-point pen.
- Answer **all** questions in this section.
- For each question there are four responses. When you have selected the response which you think is the most appropriate answer to a question, mark this response on your answer sheet.
- Mark all responses as instructed on your answer sheet. If you wish to change your answer to a question, follow the instructions on your answer sheet.
- Do all rough work in this book **not** on the answer sheet.

Information
- The maximum mark for this section is 25.
- All questions in Section A carry equal marks. No deductions will be made for incorrect answers.
- A *Data and Formulae Booklet* is provided as a loose insert.
- The question paper/answer book for Section B is enclosed within this question paper.

Multiple choice questions

Each of Questions **1** to **25** is followed by four responses, **A**, **B**, **C** and **D**. For each question select the best response and mark its letter on the answer sheet.

You are advised to spend about **45 minutes** on this section.

1 A ball of mass $0.40\ \text{kg}$ falls vertically to the floor. It strikes the floor at a speed of $5.9\ \text{m s}^{-1}$ and then rebounds vertically at a speed of $4.9\ \text{m s}^{-1}$.

What is the magnitude of the change of momentum of the ball during its collision with the floor?

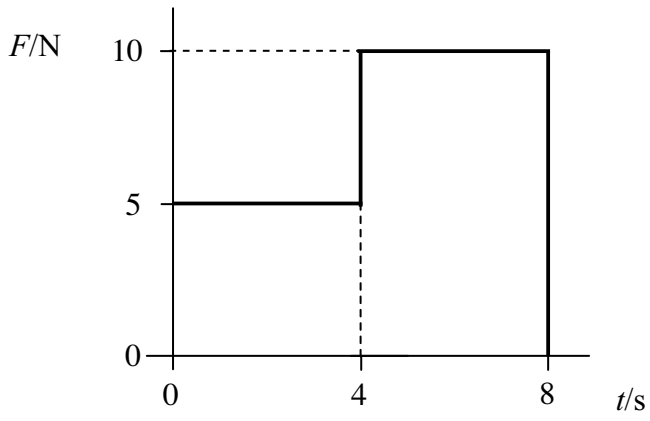
A $0.44\ \text{N s}$

B $1.2\ \text{N s}$

C $4.3\ \text{N s}$

D $4.7\ \text{N s}$

2 An object which is initially at rest is acted on by a force F which varies with time t as shown by the graph.



What is the momentum of the object after $8.0\ \text{s}$?

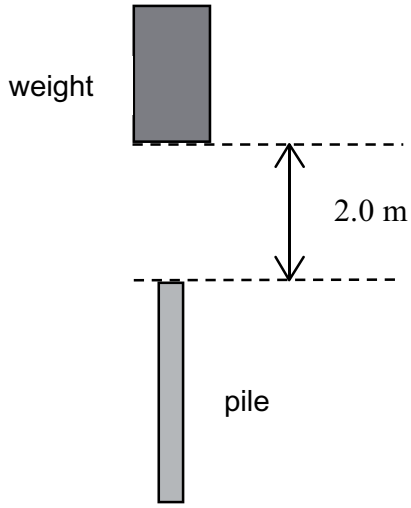
A $20\ \text{kg m s}^{-1}$

B $40\ \text{kg m s}^{-1}$

C $60\ \text{kg m s}^{-1}$

D $80\ \text{kg m s}^{-1}$

3 A pile driver drops a weight of $4900\ \text{N}$ through a vertical distance of $2.0\ \text{m}$ onto a stationary pile of mass $1500\ \text{kg}$.



The weight does not rebound.

What is the best estimate of the downward speed of the combined masses immediately after the impact?

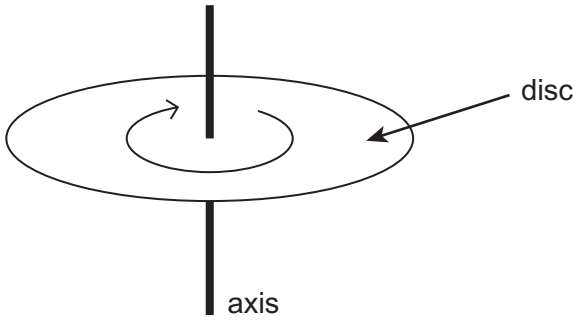
A $1.6\ \text{m s}^{-1}$

B $2.1\ \text{m s}^{-1}$

C $9.8\ \text{m s}^{-1}$

D $15\ \text{m s}^{-1}$

4 The diagram shows a disc of diameter $120\ \text{mm}$ that can turn about an axis through its centre.



The disc is turned through an angle of 30^{o} in a time of $20\ \text{ms}$.

What is the average speed of a point on the edge of the disc during this time?

A $0.5\pi\ \text{m s}^{-1}$

B $\pi\ \text{m s}^{-1}$

C $1.5\pi\ \text{m s}^{-1}$

D $2\pi\ \text{m s}^{-1}$

5 A mass on the end of a string is whirled round in a horizontal circle at increasing speed until the string breaks. The subsequent path taken by the mass is

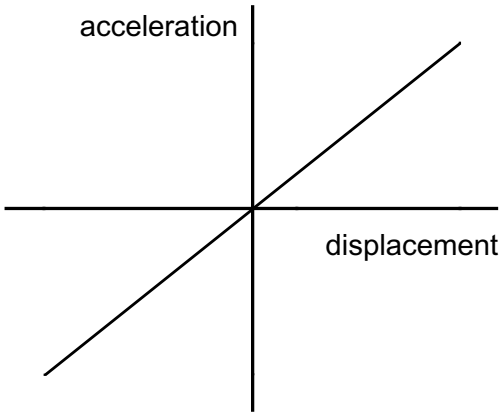
A a straight line along a radius of the circle.

B a horizontal circle.

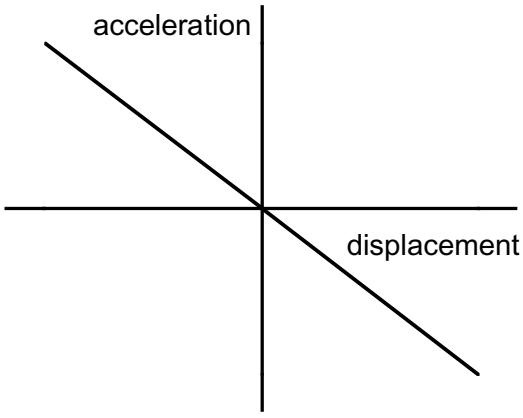
C a parabola in a horizontal plane.

D a parabola in a vertical plane.

6 Which graph best shows the variation in acceleration with displacement for an object performing simple harmonic motion?



A



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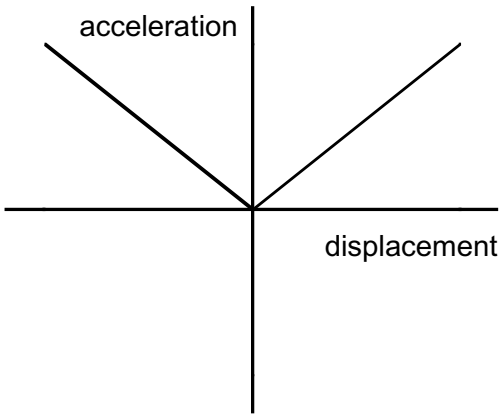

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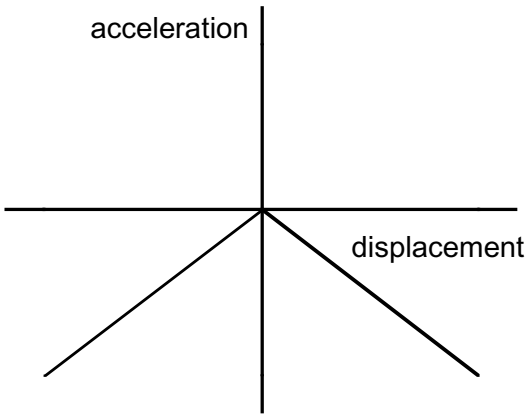
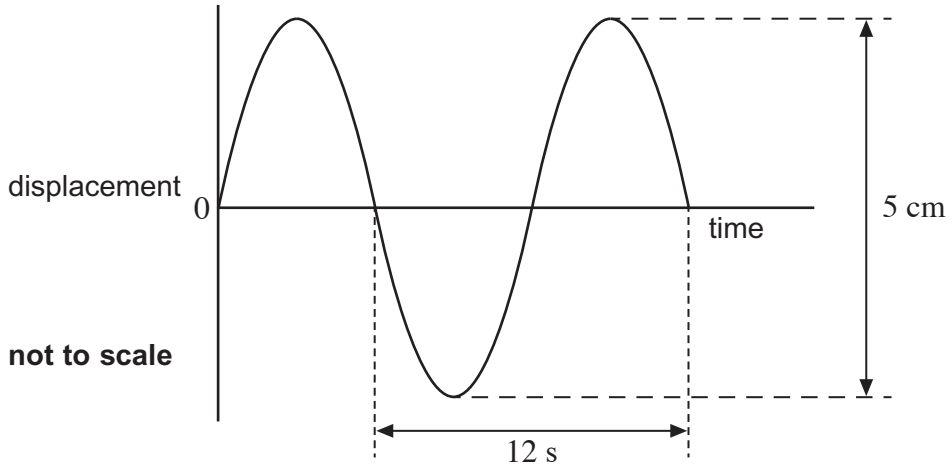


D

7 The graph shows how the displacement varies with time for a body performing simple harmonic motion.



What is the maximum speed of the body?

A $0.013\ \text{m s}^{-1}$

B $0.016\ \text{m s}^{-1}$

C $0.021\ \text{m s}^{-1}$

D $0.032\ \text{m s}^{-1}$

8 A lightly damped system is forced to vibrate at its natural frequency.

Which statement is **incorrect**?

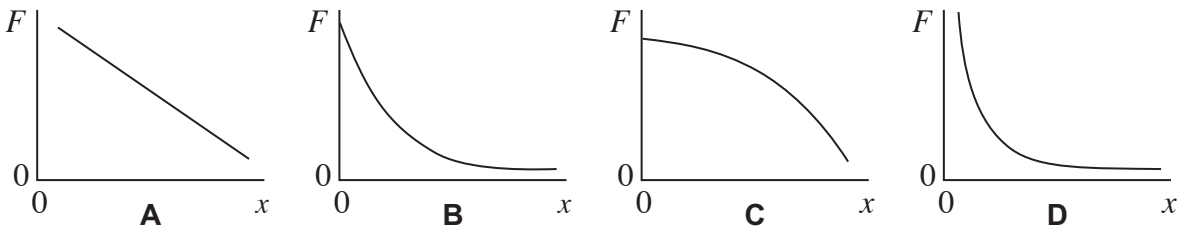
A The amplitude of vibration of the driven system is larger than at other frequencies.

B Energy is transferred from the driving system to the driven system.

C The driver system's displacement is in phase with the driven system's displacement.

D Resonance occurs.

9 Which graph best shows how the gravitational force F between two point masses varies with the separation x of the masses?



10 The radius of a planet is x times the radius of the Earth. The gravitational field strength at its surface is y times that at the surface of the Earth.

What is the ratio $\left(\frac{\text{mass of the planet}}{\text{mass of the Earth}} \right)$?

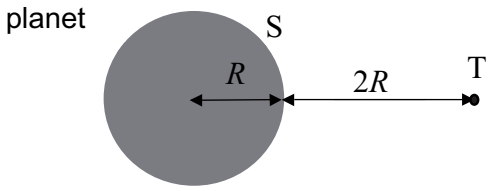
A xy

B x^2y

C xy^2

D x^2y^2

11 The gravitational potential at the surface S of a planet of radius R is V. Point T is a distance $2R$ away from the surface.



A spacecraft of mass m travels **from** T **to** S.

What is the change in its gravitational potential energy?

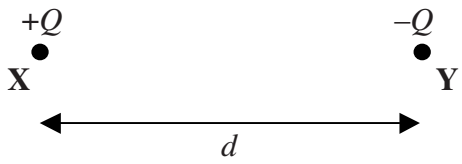
A It increases by $\frac{mV}{3}$.

B It decreases by $\frac{mV}{3}$.

C It increases by $\frac{2mV}{3}$.

D It decreases by $\frac{2mV}{3}$.

12 Two small charged objects **X** and **Y** have charges of $+Q$ and $-Q$ respectively. When they are at a separation d, the force between them is F.



A charge of $+2Q$ is added to each point charge and their separation is increased to $2d$.

Which line, **A** to **D**, in the table gives the magnitude and direction of the force on **X**?

	magnitude	direction
A	$\frac{F}{4}$	towards **Y**
B	$\frac{3F}{4}$	towards **Y**
C	$\frac{F}{4}$	away from **Y**
D	$\frac{3F}{4}$	away from **Y**

13 Which one of the following statements is correct?

The electrical potential V at a point **O** due to a negative charge at **X**

A is directly proportional to the distance between **O** and **X**.

B can be measured in J C^{-1}.

C is independent of the magnitude of the charge placed at **X**.

D is a vector quantity.

Turn over for the next question

14 The relationship between two physical quantities may be inverse, inverse square or exponential.

Which line, **A** to **D**, in the table shows correct relationships for

(i) pd and time in capacitor discharge
(ii) electric field strength and distance in a radial field
(iii) gravitational potential and distance in a radial field?

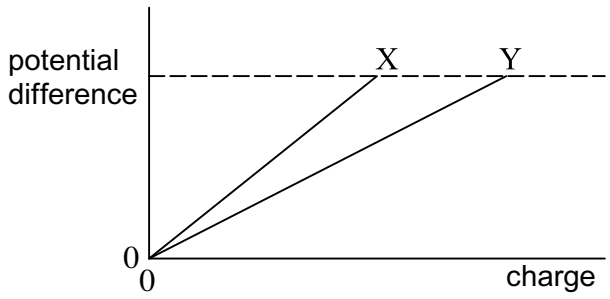
	(i) capacitor discharge	**(ii) electric field strength**	**(iii) gravitational potential**
A	exponential	inverse	inverse square
B	inverse	inverse square	exponential
C	inverse square	exponential	inverse
D	exponential	inverse square	inverse

15 A capacitor is charged until the potential difference (pd) across it is 12 V. When an additional charge of 36 μC is added, the pd increases to 30 V.

Which line, **A** to **D**, in the table gives correct values for the capacitance of the capacitor and for the charge it stored initially?

	capacitance/μF	initial charge/μC
A	0.5	24
B	2.0	24
C	0.5	36
D	2.0	36

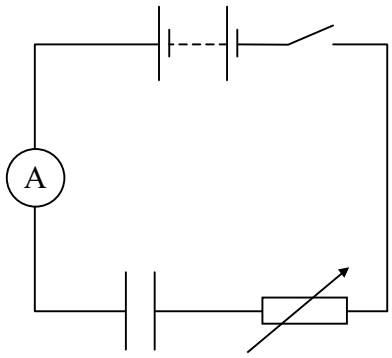
16 The graph shows how the potential differences across capacitors X and Y vary with the charge stored.



Which line, **A** to **D**, in the table shows correct relationships for the capacitances of X and Y and for the energy they store when at the same potential difference?

	capacitance	energy stored
A	X > Y	X > Y
B	X < Y	X > Y
C	X > Y	X < Y
D	X < Y	X < Y

17 A capacitor in series with an ammeter is charged through a variable resistor. The capacitor is initially uncharged.



The switch is closed and the variable resistor is continually adjusted to maintain a constant current I for time t. At the end of this time, the pd across the capacitor is V.

What is the energy stored in the capacitor at time t?

A $\frac{IVt}{4}$

B $\frac{IVt}{2}$

C IVt

D $2IVt$

18 A capacitor with an initial charge of $0.22\ \text{mC}$ is discharged through a resistor. The charge falls to $0.10\ \text{mC}$ in $10\ \text{s}$.

What is the time constant for the circuit?

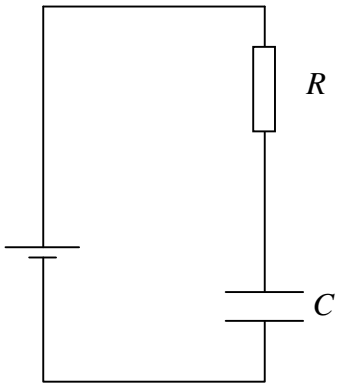
A $9\ \text{s}$

B $10\ \text{s}$

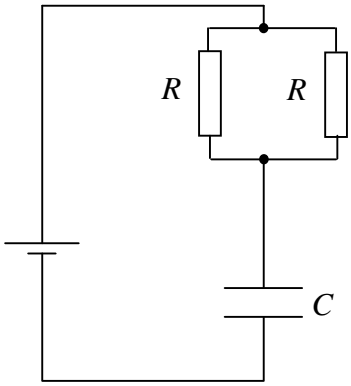
C $13\ \text{s}$

D $15\ \text{s}$

19 The time constant for circuit X is T.



circuit X



circuit Y

What is the time constant for circuit Y?

A $\frac{T}{2}$

B T

C $2T$

D $4T$

Turn over for the next question

20 An electron moving with a constant speed enters a uniform magnetic field in a direction perpendicular to the magnetic field.

What is the shape of the path that the electron follows?

A parabolic

B circular

C elliptical

D a line parallel to the magnetic field

21 An electron moves due north in a horizontal plane with uniform speed. It enters a uniform magnetic field directed due south in the same plane.

Which one of the following statements concerning the motion of the electron in the magnetic field is correct?

A It is accelerated due west.

B It slows down to zero speed and then accelerates due south.

C It continues to move north with its original speed.

D It is accelerated due north.

22 A proton in a uniform magnetic field of flux density B moves in a circle of radius r at speed v.

What would be the flux density of the field that would keep an α particle moving in a circle of the same radius at the same speed?

A $\frac{B}{2}$

B B

C $2B$

D $4B$

23 The table shows data for four different rectangular coils.

coil	length of longest side/m	length of shortest side/m	number of turns
W	0.05	0.05	2
X	0.10	0.08	20
Y	0.15	0.10	15
Z	0.20	0.12	5

The coils are placed in a uniform magnetic field which acts at right angles to the plane of the coils.

Which one of the following shows the coils arranged in order of greatest to least flux linkage?

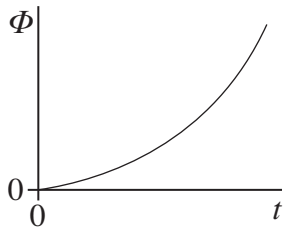
A YXZW

B XYZW

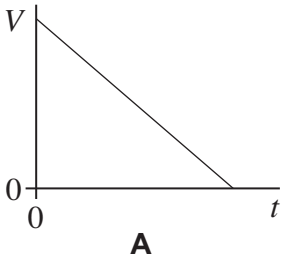
C ZYXW

D WXYZ

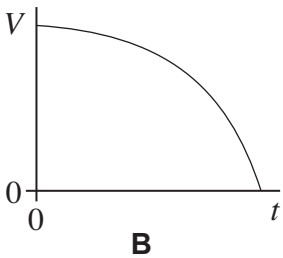
24 The graph shows how the magnetic flux Φ passing through a coil changes with time t.



Which graph best shows how the magnitude of the emf V induced in the coil varies with t?



A



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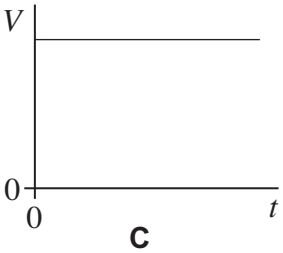

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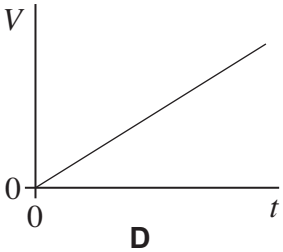

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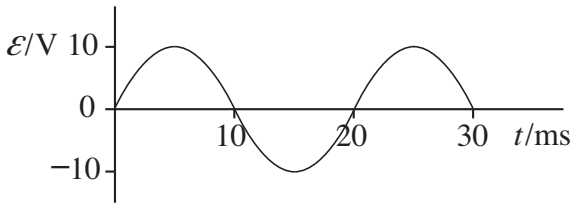
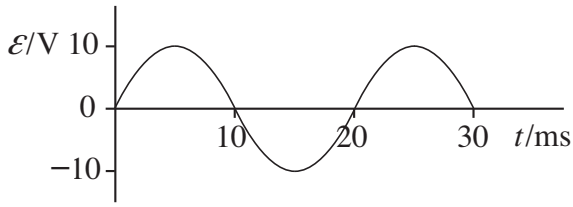
25 The graph shows how the output emf $\mathcal{E}$ varies with time t for a coil rotating at angular speed ω in a uniform magnetic field of flux density B.



The same coil is rotated at angular speed 2ω in a uniform magnetic field of flux density $0.5B$.

Which graph best shows how $\mathcal{E}$ varies with t?

A



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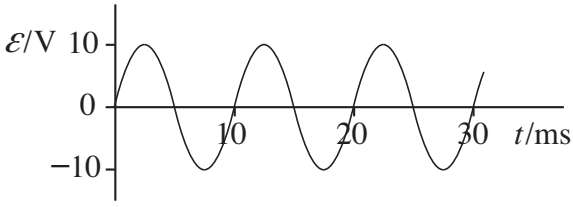

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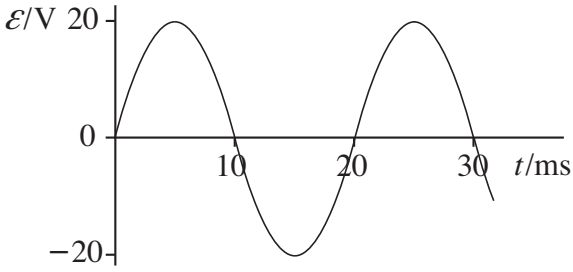

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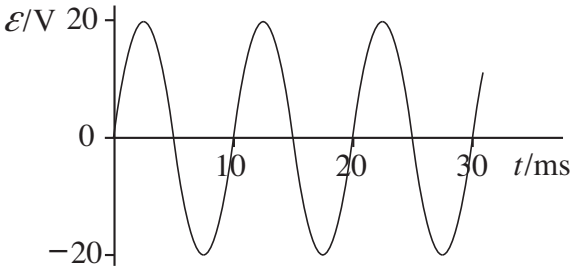

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