AQA

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A-level PHYSICS A

Unit 4 Fields and Further Mechanics Section A

Monday 20 June 2016 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.

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Multiple choice questions

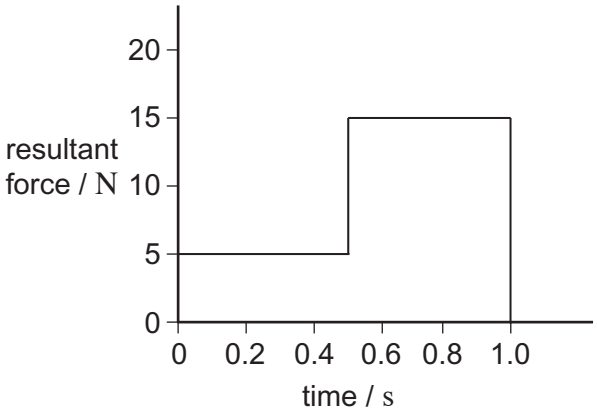
Each of Questions **1** to **25** is followed by four responses, **A**, **B**, **C**, and **D**. For each question select the best response and mark its letter on the answer sheet.

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

1 Which line, **A** to **D**, in the table correctly shows what is conserved in an elastic collision?

	Mass	Momentum	Kinetic energy	Total energy
A	conserved	not conserved	conserved	conserved
B	not conserved	conserved	conserved	not conserved
C	conserved	conserved	not conserved	conserved
D	conserved	conserved	conserved	conserved

2 The graph shows how the resultant force applied to an object of mass $2.0\ \text{kg}$, initially at rest, varies with time.



What is the speed of the object after $1.0\ \text{s}$?

A $2.5\ \text{m s}^{-1}$

B $5.0\ \text{m s}^{-1}$

C $7.5\ \text{m s}^{-1}$

D $10\ \text{m s}^{-1}$

3 What is the angular speed of a car wheel of diameter $0.400\ \text{m}$ when the speed of the car is $108\ \text{km h}^{-1}$?

A $75\ \text{rad s}^{-1}$

B $150\ \text{rad s}^{-1}$

C $270\ \text{rad s}^{-1}$

D $540\ \text{rad s}^{-1}$

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4 A ball of mass $0.30\ \text{kg}$ is attached to a string and moves in a **vertical** circle of radius $0.60\ \text{m}$ at a constant speed of $5.0\ \text{m s}^{-1}$.

Which line, **A** to **D**, in the table gives the correct values of the minimum and maximum tension in the string?

	Minimum tension / N	Maximum tension / N
A	2.5	5.4
B	6.7	9.6
C	13	13
D	9.6	15

5 Which one of the following statements is true when an object performs simple harmonic motion about a central point?

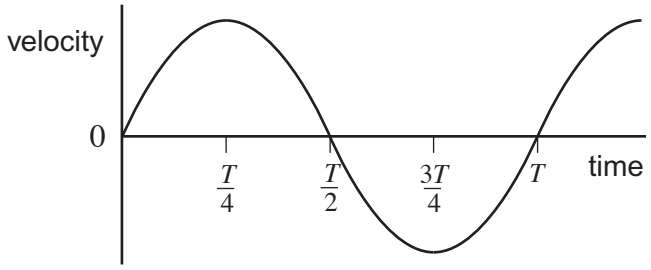
A The acceleration is always directed away from the central point.

B The acceleration and velocity are always 180° out of phase.

C The velocity and displacement are always in the same direction.

D Acceleration and displacement are always 180° out of phase.

6 The graph shows how velocity changes with time for a simple pendulum moving with simple harmonic motion.



Which one of the following statements related to the motion of the pendulum is **incorrect**?

A The acceleration is a minimum at $\frac{T}{4}$.

B The acceleration is a maximum at $\frac{T}{2}$.

C The kinetic energy is a maximum at $\frac{T}{2}$.

D The restoring force is a minimum at $\frac{3T}{4}$.

7 A mass hanging on the end of a spring undergoes vertical simple harmonic motion. At which point(s) is the magnitude of the resultant force on the mass a minimum?

A at both the top and bottom of the oscillation

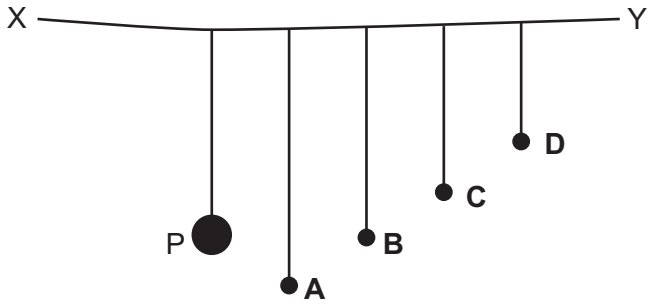
B only at the top of the oscillation

C only at the bottom of the oscillation

D at the centre of the oscillation

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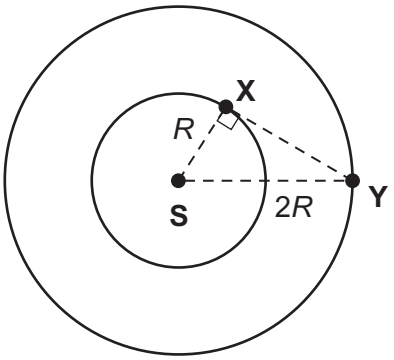
8 The diagram shows a string XY supporting a heavy pendulum P and four pendulums **A**, **B**, **C** and **D** of smaller mass.



Pendulum P is set in oscillation perpendicular to the plane of the diagram.

Which one of the pendulums, **A** to **D**, then oscillates with the largest amplitude?

9 Two planets **X** and **Y** are in concentric circular orbits about a star **S**. The radius of the orbit of **X** is R and the radius of orbit of **Y** is $2R$.



The gravitational force between **X** and **Y** is F when angle **SXY** is 90°, as shown in the diagram.
What is the gravitational force between **X** and **Y** when they are nearest to each other?

A $2F$

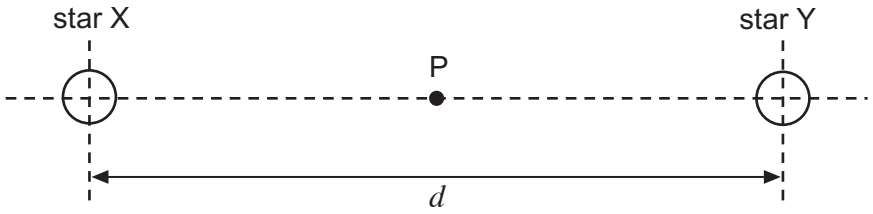
B $3F$

C $4F$

D $5F$

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10 X and Y are two stars of equal mass M. The distance between their centres is d.



What is the gravitational potential at the mid-point P between them?

A $\frac{GM}{2d}$

B $-\frac{GM}{d}$

C $-\frac{4GM}{d}$

D $-\frac{8GM}{d}$

11 A geosynchronous satellite is in a constant radius orbit around the Earth. The Earth has a mass of 6.0×10^{24} kg and a radius of 6.4×10^{6} m.

What is the height of the satellite above the Earth's surface?

A 1.3×10^{7} m

B 3.6×10^{7} m

C 4.2×10^{7} m

D 4.8×10^{7} m

12 A +2.0 nC point charge X is at a fixed distance from a −1.0 nC point charge Y. The force between the two charges is F.

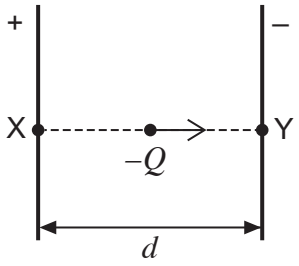


If an **additional** charge of +2.0 nC is supplied to both X and Y, which line, **A** to **D**, in the table gives the magnitude and direction of the force on X?

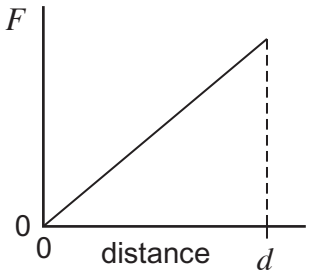
	Magnitude	Direction
A	$2F$	from X to Y
B	$4F$	from X to Y
C	$2F$	from Y to X
D	$4F$	from Y to X

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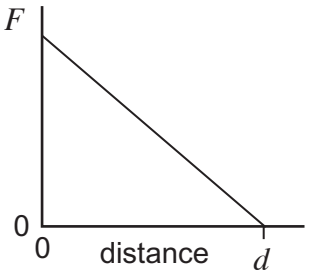
13 The diagram shows a charge $-Q$ being moved from point X to point Y between two charged parallel plates separated by a distance d.



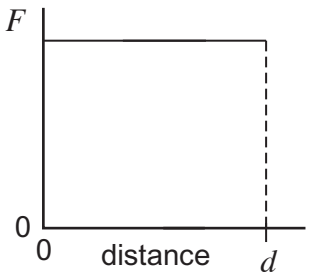
Which one of the following graphs best illustrates how the magnitude of force F on the charge varies with distance as it moves towards Y?



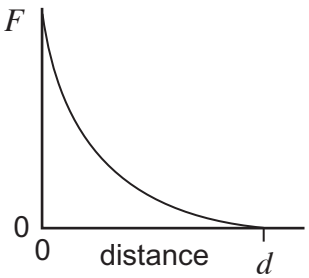
A



B



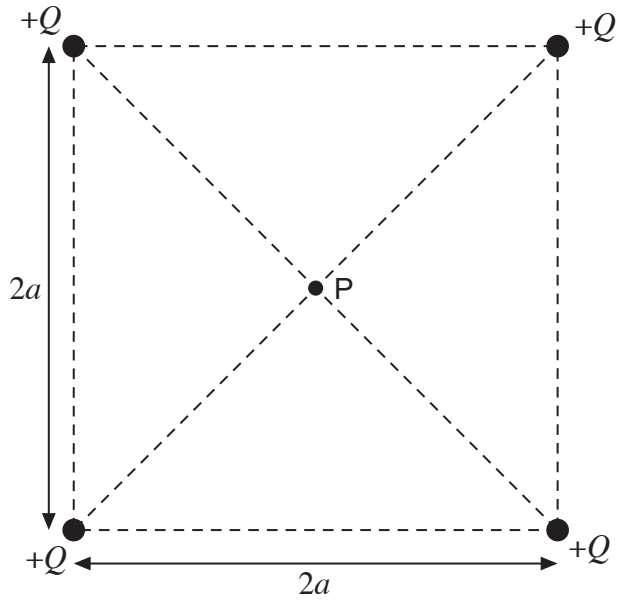
C



D

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14 The diagram shows four point charges, each $+Q$, at the corners of a square of side $2a$.



What is the electric field strength at P, the centre of the square?

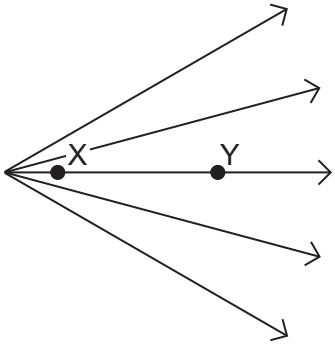
A zero

B $\dfrac{Q}{4\pi\varepsilon_0 a^2}$

C $\dfrac{Q}{2\pi\varepsilon_0 a^2}$

D $\dfrac{Q}{\pi\varepsilon_0 a^2}$

15 The diagram shows the field lines in a region of an electric field created by a positive charge.



Which one of the following statements is correct?
When moving from X to Y

A the electric potential is constant.

B the electric potential increases.

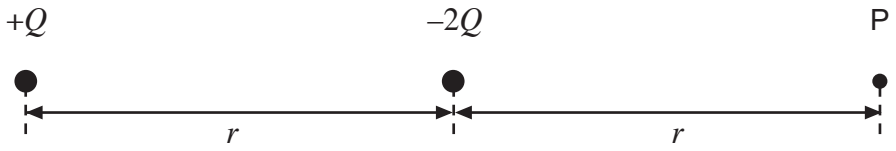
C the electric potential decreases.

D the electric potential changes from positive to negative.

Turn over ▶

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16 The diagram shows two point charges of magnitude $+Q$ and $-2Q$ placed a distance r apart.



What is the electric potential at point P, a distance r to the right of the $-2Q$ charge?

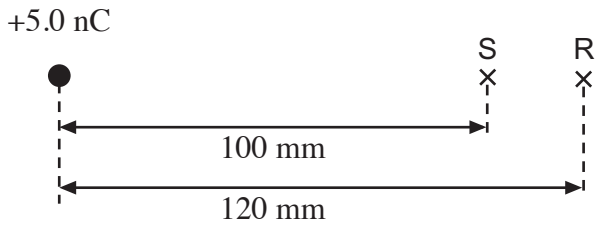
A $-\dfrac{3Q}{8\pi\varepsilon_0 r}$

B $-\dfrac{Q}{2\pi\varepsilon_0 r}$

C $+\dfrac{Q}{8\pi\varepsilon_0 r}$

D $+\dfrac{5Q}{8\pi\varepsilon_0 r}$

17



The potentials at points R and S due to the +5.0 nC charge are 375 V and 450 V respectively.

How much work is done when a +2.0 nC charge is moved from R to S?

A 0.12 μJ

B 0.15 μJ

C 0.19 μJ

D 0.38 μJ

18 The gravitational constant, G, is a constant of proportionality in Newton's law of gravitation. The permittivity of free space, ε_0, is a constant of proportionality in Coulomb's law.

When comparing the electrostatic force acting on a pair of charged particles to the gravitational force between them, the product $\varepsilon_0 G$ can appear in the calculation.

Which is a unit for $\varepsilon_0 G$?

A $C^2\ kg^{-2}$

B $C^2\ m^{-2}$

C $F\ kg^2\ N^{-1}\ m^{-2}$

D it has no unit

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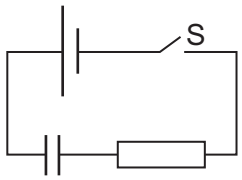
19 A variable capacitor has a capacitance which can be varied from 6.0×10^{-12} F to 3.0×10^{-12} F. The capacitor is set to its maximum capacitance and fully charged using a 48 V supply. The capacitor is then disconnected from the supply and isolated. Finally the capacitance is reduced to its minimum value without any charge being lost by the capacitor.

Which line, **A** to **D**, in the table correctly shows the potential difference (pd) across the capacitor and the charge it stores after the capacitance has been reduced?

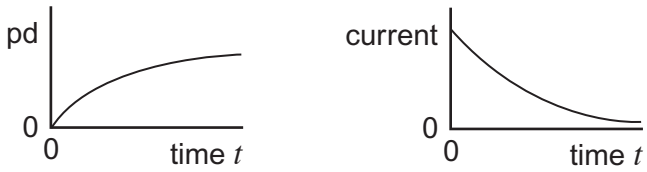
	pd / V	Charge / C
A	48	2.9×10^{-10}
B	24	2.9×10^{-10}
C	96	2.9×10^{-10}
D	96	1.4×10^{-10}

20 The capacitor in the circuit is initially uncharged. The switch S is closed at time $t = 0$.

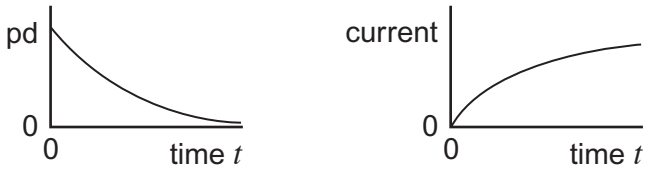
Which pair of graphs, **A** to **D**, correctly shows how the pd across the capacitor and the current in the circuit change with time?



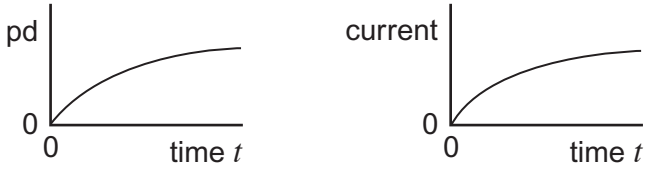
A



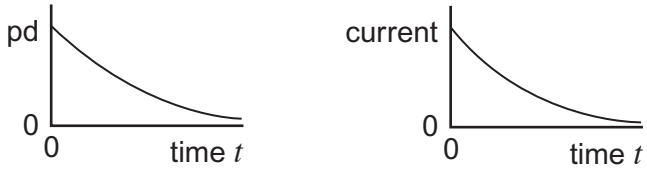
B



C

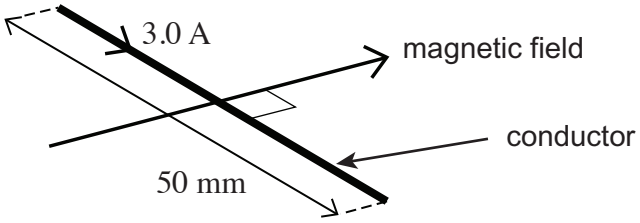


D



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21 The diagram shows a horizontal conductor of length $50\ \text{mm}$ carrying a current of $3.0\ \text{A}$ at right angles to a uniform horizontal magnetic field of flux density $0.50\ \text{T}$.



What is the magnitude and direction of the magnetic force on the conductor ?

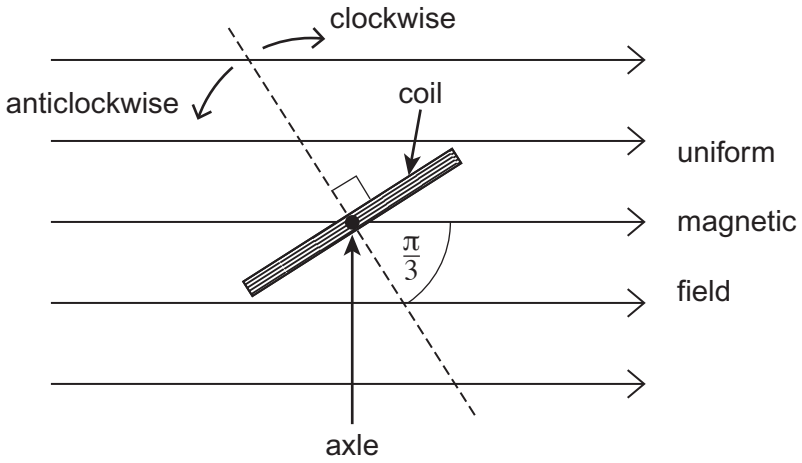
A $0.075\ \text{N}$ vertically upwards

B $0.075\ \text{N}$ vertically downwards

C $75\ \text{N}$ vertically upwards

D $75\ \text{N}$ vertically downwards

22 The diagram shows a coil placed in a uniform magnetic field. In the position shown, the angle between the normal to the plane of the coil and the magnetic field is $\frac{\pi}{3}$ rad.



Which line, **A** to **D**, in the table shows the angles through which the coil should be rotated, and the direction of rotation, so that the flux linkage becomes (i) a maximum, and (ii) a minimum?

	Angle of rotation / rad	
	(i) for maximum flux linkage	**(ii) for minimum flux linkage**
A	$\frac{\pi}{6}$ clockwise	$\frac{\pi}{3}$ anticlockwise
B	$\frac{\pi}{6}$ anticlockwise	$\frac{\pi}{3}$ clockwise
C	$\frac{\pi}{3}$ clockwise	$\frac{\pi}{6}$ anticlockwise
D	$\frac{\pi}{3}$ anticlockwise	$\frac{\pi}{6}$ clockwise

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23 A train is travelling at $20\ \text{m s}^{-1}$ along a horizontal track through a uniform magnetic field of flux density $4.0 \times 10^{-5}\ \text{T}$ acting vertically downwards.

What is the emf induced between the ends of an axle $1.5\ \text{m}$ long?

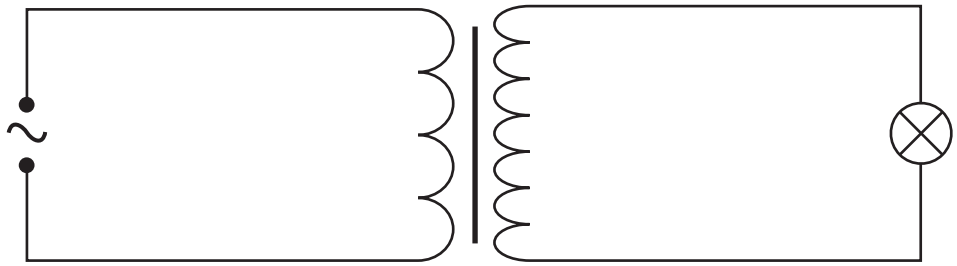
A $3.0 \times 10^{-6}\ \text{V}$

B $5.3 \times 10^{-4}\ \text{V}$

C $1.2 \times 10^{-3}\ \text{V}$

D $7.5 \times 10^{5}\ \text{V}$

24 The primary coil of a step-up transformer is connected to a source of alternating pd. The secondary coil is connected to a lamp.



Which line, **A** to **D**, in the table correctly describes the ratios of flux linkages and currents through the secondary coil in relation to the primary coil?

	$\frac{\text{Secondary magnetic flux linkage}}{\text{Primary magnetic flux linkage}}$	$\frac{\text{Secondary current}}{\text{Primary current}}$
A	< 1	< 1
B	> 1	< 1
C	> 1	> 1
D	< 1	> 1

25 Which one of the following statements is the main reason for operating power lines at high voltage?

A Transformers are never perfectly efficient.

B High voltages are required by many industrial users of electricity.

C Electrical generators produce alternating current.

D For a given amount of transmitted power, increasing the voltage decreases the current.

END OF QUESTIONS

There are no questions printed on this page

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