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Centre number

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Candidate number

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# A-level PHYSICS A

Unit 4 Fields and Further Mechanics  
Section A

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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.

**Multiple choice questions**

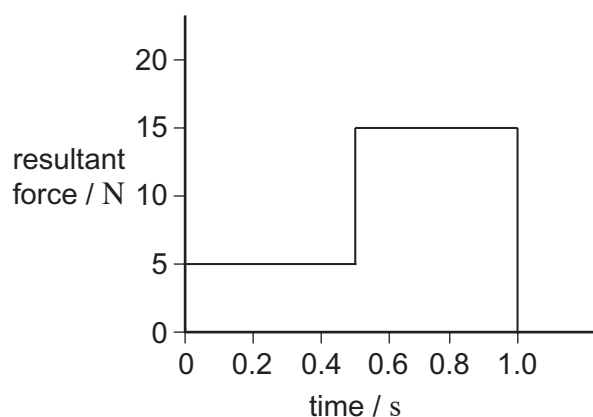
Each of Questions 1 to 25 is followed by four responses, **A**, **B**, **C**, and **D**. For each question select the best response and mark its letter on the answer sheet.

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?

	<b>Mass</b>	<b>Momentum</b>	<b>Kinetic energy</b>	<b>Total energy</b>
<b>A</b>	conserved	not conserved	conserved	conserved
<b>B</b>	not conserved	conserved	conserved	not conserved
<b>C</b>	conserved	conserved	not conserved	conserved
<b>D</b>	conserved	conserved	conserved	conserved

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



What is the speed of the object after 1.0 s?

- A** 2.5 m s<sup>-1</sup>  
**B** 5.0 m s<sup>-1</sup>  
**C** 7.5 m s<sup>-1</sup>  
**D** 10 m s<sup>-1</sup>
- 3 What is the angular speed of a car wheel of diameter 0.400 m when the speed of the car is 108 km h<sup>-1</sup>?
- A** 75 rad s<sup>-1</sup>  
**B** 150 rad s<sup>-1</sup>  
**C** 270 rad s<sup>-1</sup>  
**D** 540 rad s<sup>-1</sup>



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

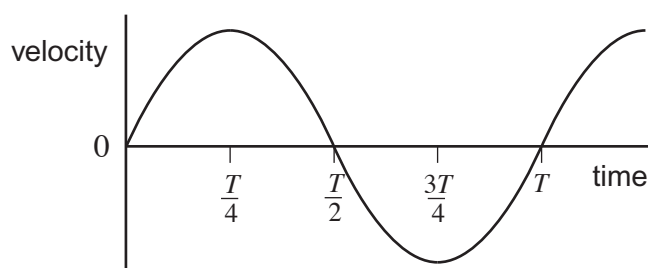
Which line, **A** to **D**, in the table gives the correct values of the minimum and maximum tension in the string?

	Minimum tension / N	Maximum tension / N
<b>A</b>	2.5	5.4
<b>B</b>	6.7	9.6
<b>C</b>	13	13
<b>D</b>	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  $180^\circ$  out of phase.  
**C** The velocity and displacement are always in the same direction.  
**D** Acceleration and displacement are always  $180^\circ$  out of phase.

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



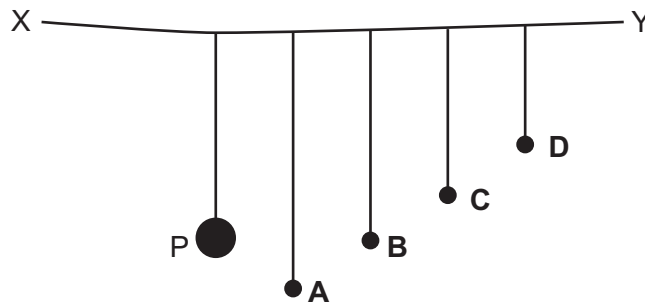
Which one of the following statements related to the motion of the pendulum is **incorrect**?

- 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

Turn over ►



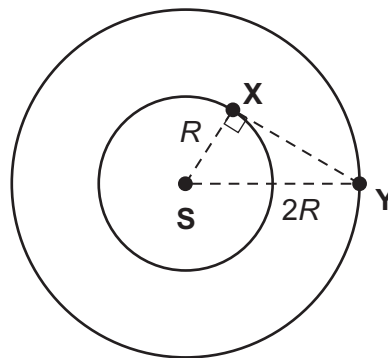
- 8 The diagram shows a string  $XY$  supporting a heavy pendulum  $P$  and four pendulums  $A$ ,  $B$ ,  $C$  and  $D$  of smaller mass.



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  $2R$ .



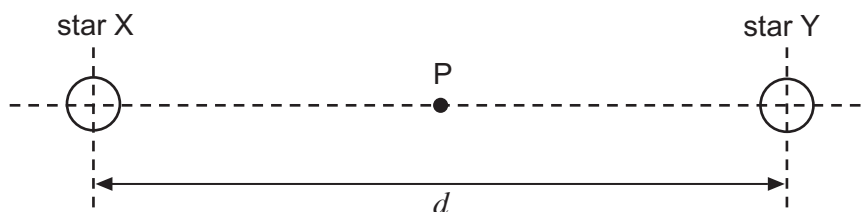
The gravitational force between  $X$  and  $Y$  is  $F$  when angle  $SXY$  is  $90^\circ$ , as shown in the diagram.

What is the gravitational force between  $X$  and  $Y$  when they are nearest to each other?

- A  $2F$
- B  $3F$
- C  $4F$
- D  $5F$



- 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  $6.0 \times 10^{24}$  kg and a radius of  $6.4 \times 10^6$  m.

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

- A  $1.3 \times 10^7$  m  
 B  $3.6 \times 10^7$  m  
 C  $4.2 \times 10^7$  m  
 D  $4.8 \times 10^7$  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?

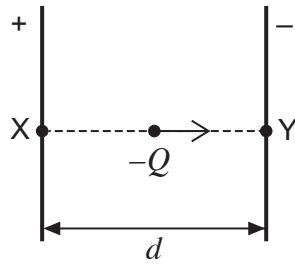
	Magnitude	Direction
A	$2F$	from X to Y
B	$4F$	from X to Y
C	$2F$	from Y to X
D	$4F$	from Y to X

Turn over ►

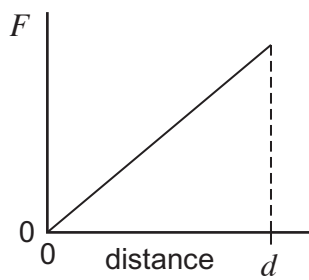


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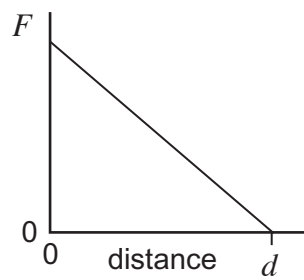
The diagram shows a charge  $-Q$  being moved from point X to point Y between two charged parallel plates separated by a distance  $d$ .



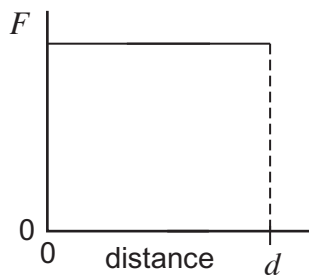
Which one of the following graphs best illustrates how the magnitude of force  $F$  on the charge varies with distance as it moves towards Y?



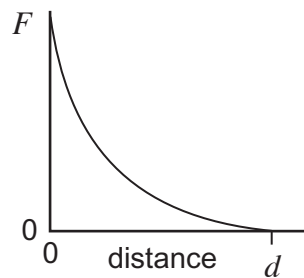
A



B



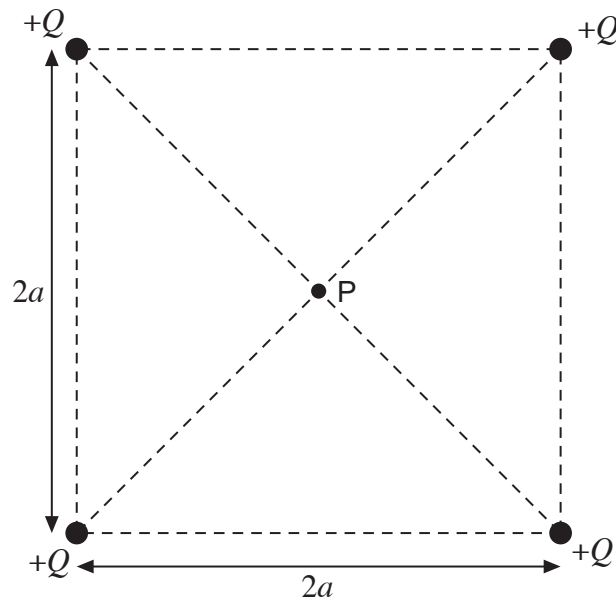
C



D

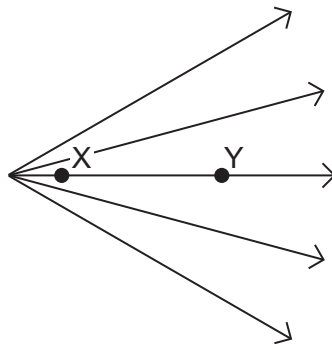


- 14 The diagram shows four point charges, each  $+Q$ , at the corners of a square of side  $2a$ .



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

- A zero
- B  $\frac{Q}{4\pi\epsilon_0 a^2}$
- C  $\frac{Q}{2\pi\epsilon_0 a^2}$
- D  $\frac{Q}{\pi\epsilon_0 a^2}$
- 15 The diagram shows the field lines in a region of an electric field created by a positive charge.



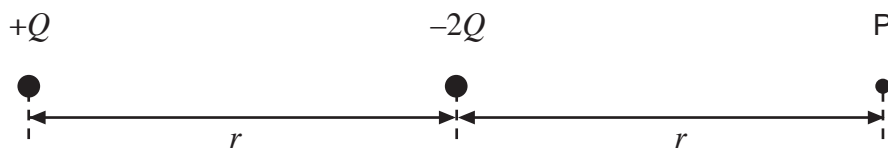
Which one of the following statements is correct?  
When moving from X to Y

- 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 ►



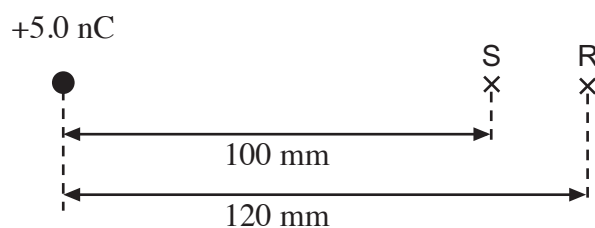
- 16 The diagram shows two point charges of magnitude  $+Q$  and  $-2Q$  placed a distance  $r$  apart.



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

- A  $-\frac{3Q}{8\pi\epsilon_0 r}$
- B  $-\frac{Q}{2\pi\epsilon_0 r}$
- C  $+\frac{Q}{8\pi\epsilon_0 r}$
- D  $+\frac{5Q}{8\pi\epsilon_0 r}$

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

How much work is done when a  $+2.0 \text{ nC}$  charge is moved from R to S?

- A  $0.12 \mu\text{J}$
- B  $0.15 \mu\text{J}$
- C  $0.19 \mu\text{J}$
- D  $0.38 \mu\text{J}$
- 18 The gravitational constant,  $G$ , is a constant of proportionality in Newton's law of gravitation. The permittivity of free space,  $\epsilon_0$ , 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  $\epsilon_0 G$  can appear in the calculation.
- Which is a unit for  $\epsilon_0 G$ ?
- A  $\text{C}^2 \text{ kg}^{-2}$
- B  $\text{C}^2 \text{ m}^{-2}$
- C  $\text{F kg}^2 \text{ N}^{-1} \text{ m}^{-2}$
- D it has no unit





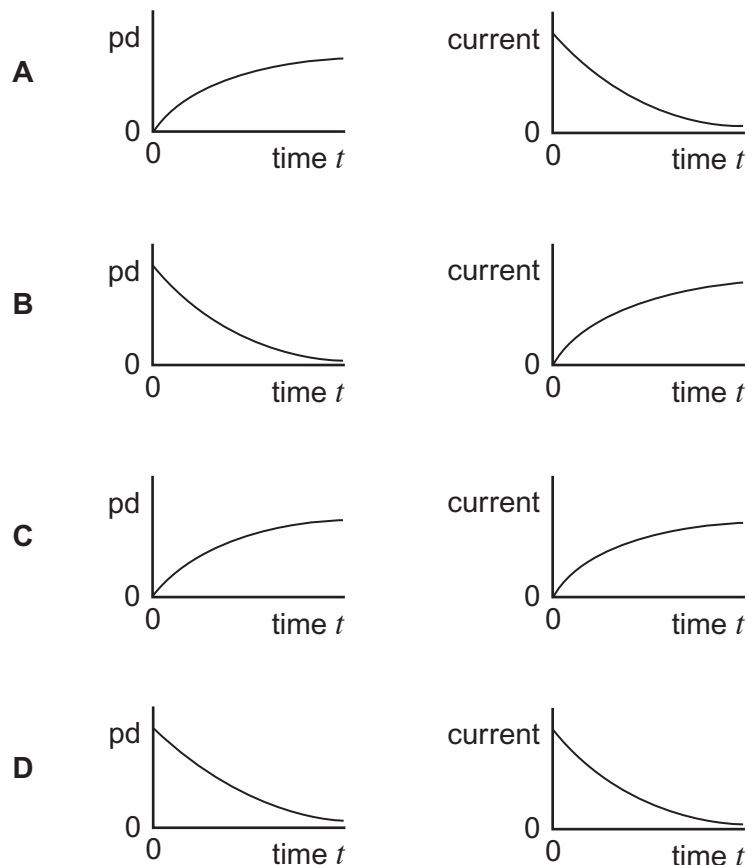
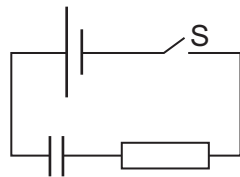
- 19** A variable capacitor has a capacitance which can be varied from  $6.0 \times 10^{-12} \text{ F}$  to  $3.0 \times 10^{-12} \text{ F}$ . The capacitor is set to its maximum capacitance and fully charged using a  $48 \text{ V}$  supply. The capacitor is then disconnected from the supply and isolated. 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
<b>A</b>	48	$2.9 \times 10^{-10}$
<b>B</b>	24	$2.9 \times 10^{-10}$
<b>C</b>	96	$2.9 \times 10^{-10}$
<b>D</b>	96	$1.4 \times 10^{-10}$

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

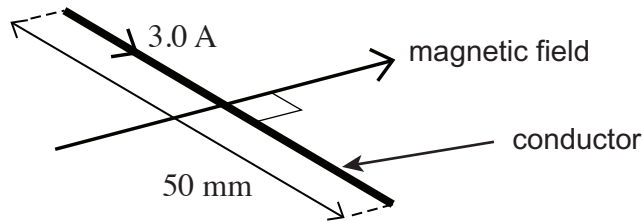
Which pair of graphs, **A** to **D**, correctly shows how the pd across the capacitor and the current in the circuit change with time?



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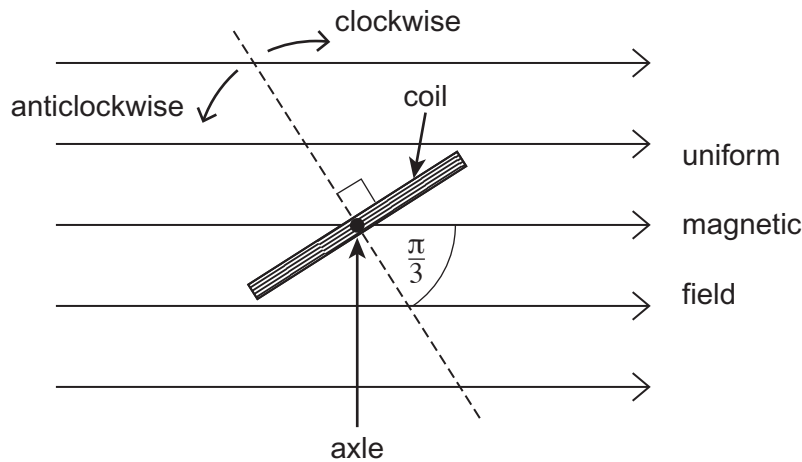


- 21 The diagram shows a horizontal conductor of length 50 mm carrying a current of 3.0 A at right angles to a uniform horizontal magnetic field of flux density 0.50 T.



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

- A 0.075 N vertically upwards  
 B 0.075 N vertically downwards  
 C 75 N vertically upwards  
 D 75 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?

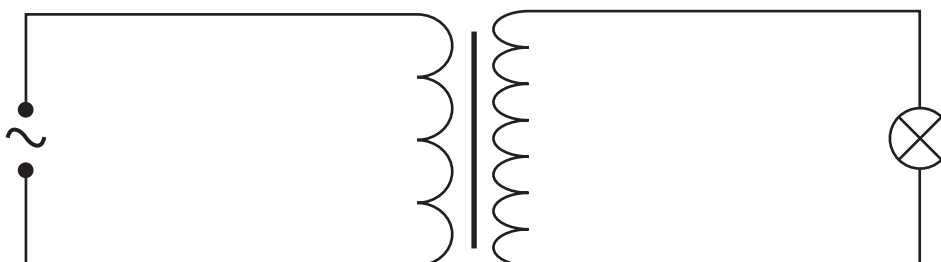
	Angle of rotation / rad	
	(i) for maximum flux linkage	(ii) for minimum flux linkage
<b>A</b>	$\frac{\pi}{6}$ clockwise	$\frac{\pi}{3}$ anticlockwise
<b>B</b>	$\frac{\pi}{6}$ anticlockwise	$\frac{\pi}{3}$ clockwise
<b>C</b>	$\frac{\pi}{3}$ clockwise	$\frac{\pi}{6}$ anticlockwise
<b>D</b>	$\frac{\pi}{3}$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



- 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 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?

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

- 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**



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