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General Certificate of Education  
Advanced Level Examination  
January 2010

## Physics A

## PHYA4/1

### Unit 4 Fields and Further Mechanics Section A

Thursday 28 January 2010 1.30 pm to 3.15 pm

**In addition to this paper you will require:**

- an objective test answer sheet
- a black ink or black ball-point pen
- a calculator
- a question paper/answer book for Section B (enclosed).

**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.

**Instructions**

- Use black ink or black ball-point pen. Do **not** use pencil.
- 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**

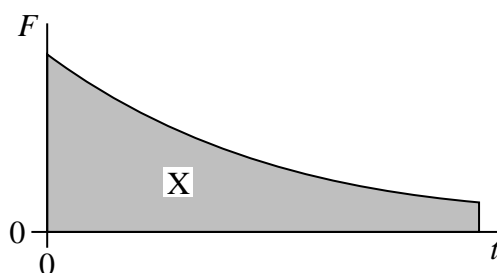
- The maximum mark for this section is 25.
- Section A and Section B of this paper together carry 20% of the total marks for Physics Advanced.
- All questions in Section A carry equal marks. No deductions will be made for incorrect answers.
- A *Data and Formulae Booklet* is provided as a loose insert.
- 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 approximately **45 minutes** on this section.

- 1 The graph shows the variation with time,  $t$ , of the force,  $F$ , acting on a body.



What physical quantity does the area X represent?

- A** the displacement of the body  
**B** the acceleration of the body  
**C** the change in momentum of the body  
**D** the change in kinetic energy of the body
- 2 Water of density  $1000 \text{ kg m}^{-3}$  flows out of a garden hose of cross-sectional area  $7.2 \times 10^{-4} \text{ m}^2$  at a rate of  $2.0 \times 10^{-4} \text{ m}^3$  per second. How much momentum is carried by the water leaving the hose per second?
- A**  $5.6 \times 10^{-5} \text{ N s}$   
**B**  $5.6 \times 10^{-2} \text{ N s}$   
**C**  $0.20 \text{ N s}$   
**D**  $0.72 \text{ N s}$
- 3 Which row, **A** to **D**, in the table correctly shows the quantities conserved in an inelastic collision?

	mass	momentum	kinetic energy	total energy
<b>A</b>	conserved	not conserved	conserved	conserved
<b>B</b>	not conserved	conserved	conserved	not conserved
<b>C</b>	conserved	conserved	conserved	conserved
<b>D</b>	conserved	conserved	not conserved	conserved

- 4 What is the angular speed of a point on the Earth's equator?
- A  $7.3 \times 10^{-5} \text{ rad s}^{-1}$   
 B  $4.2 \times 10^{-3} \text{ rad s}^{-1}$   
 C  $2.6 \times 10^{-1} \text{ rad s}^{-1}$   
 D  $15 \text{ rad s}^{-1}$
- 5 Which one of the following does **not** involve a centripetal force?
- A an electron in orbit around a nucleus  
 B a car going round a bend  
 C an  $\alpha$  particle in a magnetic field, travelling at right angles to the field  
 D an  $\alpha$  particle in a electric field, travelling at right angles to the field
- 6 Which one of the following gives the phase difference between the particle velocity and the particle displacement in simple harmonic motion?
- A  $\frac{\pi}{4} \text{ rad}$   
 B  $\frac{\pi}{2} \text{ rad}$   
 C  $\frac{3\pi}{4} \text{ rad}$   
 D  $2\pi \text{ rad}$
- 7 A mass  $M$  hangs in equilibrium on a spring.  $M$  is made to oscillate about the equilibrium position by pulling it down 10 cm and releasing it. The time for  $M$  to travel back to the equilibrium position for the first time is 0.50 s. Which row, **A** to **D**, in the table is correct for these oscillations?

	amplitude/cm	period/s
<b>A</b>	10	1.0
<b>B</b>	10	2.0
<b>C</b>	20	2.0
<b>D</b>	20	1.0

Turn over ►

- 8 Which one of the following statements concerning forced vibrations and resonance is correct?
- A An oscillating body that is not resonating will return to its natural frequency when the forcing vibration is removed.
  - B At resonance, the displacement of the oscillating body is  $180^\circ$  out of phase with the forcing vibration.
  - C A pendulum with a dense bob is more heavily damped than one with a less dense bob of the same size.
  - D Resonance can only occur in mechanical systems.
- 9 Two identical spheres exert a gravitational force  $F$  on each other. What is the gravitational force between two spheres, each twice the mass of one of the original spheres, when the separation of their centres is twice the original separation?
- A  $F$
  - B  $2F$
  - C  $4F$
  - D  $8F$
- 10 A planet of mass  $M$  and radius  $R$  rotates so rapidly that loose material at the equator only just remains on the surface. What is the period of rotation of the planet?

$G$  is the universal gravitational constant.

- A  $2\pi \sqrt{\frac{R}{GM}}$
- B  $2\pi \sqrt{\frac{R^2}{GM}}$
- C  $2\pi \sqrt{\frac{GM}{R^3}}$
- D  $2\pi \sqrt{\frac{R^3}{GM}}$

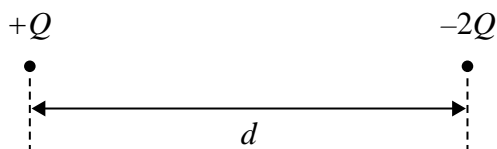
- 11 The radius of a certain planet is  $x$  times the radius of the Earth and its surface gravitational field strength is  $y$  times that of the Earth.

Which one of the following gives the ratio  $\left(\frac{\text{mass of the planet}}{\text{mass of the Earth}}\right)$ ?

- A  $xy$   
B  $x^2y$   
C  $xy^2$   
D  $x^2y^2$
- 12 Which one of the following could be a unit of gravitational potential?

- A N  
B J  
C  $\text{Nkg}^{-1}$   
D  $\text{Jkg}^{-1}$

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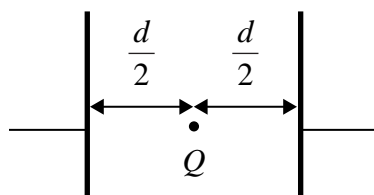
The diagram shows two particles at a distance  $d$  apart. One particle has charge  $+Q$  and the other  $-2Q$ . The two particles exert an electrostatic force of attraction,  $F$ , on each other. Each particle is then given an additional charge  $+Q$  and their separation is increased to a distance  $2d$ . Which one of the following gives the force that now acts between the two particles?

- A an attractive force of  $\frac{F}{4}$   
B a repulsive force of  $\frac{F}{4}$   
C an attractive force of  $\frac{F}{2}$   
D a repulsive force of  $\frac{F}{2}$

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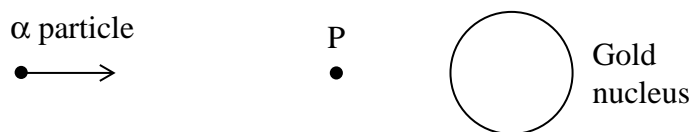
- 14 Which one of the following statements about a charged particle in an electric field is correct?
- A No work is done when a charged particle moves along a field line.
  - B No force acts on a charged particle when it moves along a field line.
  - C No work is done when a charged particle moves along a line of constant potential.
  - D No force acts on a charged particle when it moves along a line of constant potential.

- 15 Two parallel metal plates separated by a distance  $d$  have a potential difference  $V$  across them. What is the magnitude of the electrostatic force acting on a charge  $Q$  placed midway between the plates?



- A  $\frac{2VQ}{d}$
  - B  $\frac{VQ}{d}$
  - C  $\frac{VQ}{2d}$
  - D  $\frac{Qd}{V}$
- 16 Which one of the following statements about *electric field strength* and *electric potential* is **incorrect**?
- A Electric potential is a scalar quantity.
  - B Electric field strength is a vector quantity.
  - C Electric potential is zero whenever the electric field strength is zero.
  - D The potential gradient is proportional to the electric field strength.

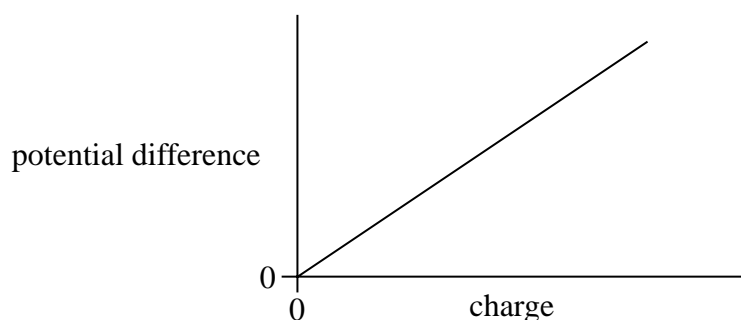
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An  $\alpha$  particle travels towards a gold nucleus and at P reverses its direction. Which one of the following statements is **incorrect**?

- A The electric potential energy of the  $\alpha$  particle is a maximum at P.
- B The kinetic energy of the  $\alpha$  particle is a minimum at P.
- C The total energy of the  $\alpha$  particle is zero.
- D The total energy of the  $\alpha$  particle has a constant positive value.

18 The graph shows how the potential difference across a capacitor varies with the charge stored by it.



Which one of the following statements is correct?

- A The gradient of the line equals the capacitance of the capacitor.
- B The gradient of the line equals the energy stored by the capacitor.
- C The reciprocal of the gradient equals the energy stored by the capacitor.
- D The reciprocal of the gradient equals the capacitance of the capacitor.

19 An initially uncharged capacitor of capacitance  $10\ \mu\text{F}$  is charged by a **constant** current of  $200\ \mu\text{A}$ . After what time will the potential difference across the capacitor be  $2000\ \text{V}$ ?

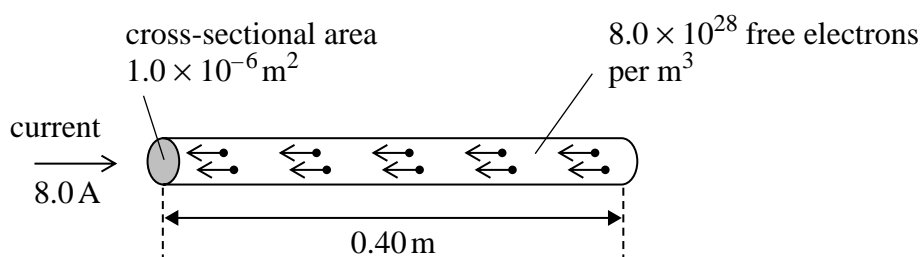
- A 50 s
- B 100 s
- C 200 s
- D 400 s

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- 20 A  $1000\mu\text{F}$  capacitor, X, and a  $100\mu\text{F}$  capacitor, Y, are charged to the same potential difference. Which row, **A** to **D**, in the table gives correct ratios of charge stored and energy stored by the capacitors?

	$\frac{\text{charge stored by X}}{\text{charge stored by Y}}$	$\frac{\text{energy stored by X}}{\text{energy stored by Y}}$
<b>A</b>	1	1
<b>B</b>	1	10
<b>C</b>	10	1
<b>D</b>	10	10

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A current of  $8.0\text{ A}$  is passed through a conductor of length  $0.40\text{ m}$  and cross-sectional area  $1.0 \times 10^{-6}\text{ m}^2$ . The conductor contains  $8.0 \times 10^{28}$  free electrons per  $\text{m}^3$ . When the conductor is at right angles to a magnetic field of flux density  $0.20\text{ T}$ , it experiences a magnetic force. What is the average magnetic force that acts on **one** of the free electrons in the wire?

- A**  $8.0 \times 10^{-30}\text{ N}$   
**B**  $5.0 \times 10^{-29}\text{ N}$   
**C**  $8.0 \times 10^{-24}\text{ N}$   
**D**  $2.0 \times 10^{-23}\text{ N}$



- 22 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 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.
- 23 Particles of mass  $m$ , each carrying charge  $Q$  and travelling with speed  $v$ , enter a magnetic field of flux density  $B$  at right angles. Which one of the following changes would produce an increase in the radius of the path of the particles?
- A an increase in  $Q$
  - B an increase in  $m$
  - C a decrease in  $v$
  - D an increase in  $B$
- 24 The magnetic flux through a coil of  $N$  turns is increased uniformly from zero to a maximum value in a time  $t$ . An emf,  $E$ , is induced across the coil.  
What is the maximum value of the magnetic flux through the coil?
- A  $\frac{Et}{N}$
  - B  $\frac{N}{Et}$
  - C  $EtN$
  - D  $\frac{E}{Nt}$
- 25 An aircraft, of wing span 60 m, flies horizontally at a speed of  $150 \text{ m s}^{-1}$ . If the vertical component of the Earth's magnetic field in the region of the plane is  $1.0 \times 10^{-5} \text{ T}$ , what emf is induced across the wing tips of the plane?
- A 0.09 V
  - B 0.90 V
  - C 9.0 V
  - D 90 V

**END OF QUESTIONS**

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