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| Centre Number       |  |  |  |  |  | Candidate Number |  |  |  |  |
| Surname             |  |  |  |  |  |                  |  |  |  |  |
| Other Names         |  |  |  |  |  |                  |  |  |  |  |
| Candidate Signature |  |  |  |  |  |                  |  |  |  |  |



General Certificate of Education  
Advanced Level Examination  
June 2014

## Physics A

## PHYA4/1

### Unit 4 Fields and Further Mechanics Section A

Wednesday 11 June 2014 1.30 pm to 3.15 pm

**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.

#### 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 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

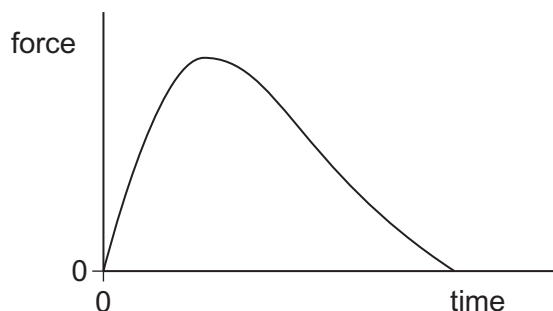
- The maximum mark for this section is 25.
- All questions in Section A carry equal marks. No deductions will be made for incorrect answers.
- A *Data and Formulae Booklet* is provided as a loose insert.
- The question paper/answer book for Section B is enclosed within this question paper.

**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 The graph shows how the force acting on a rocket varies with time.

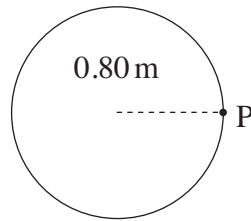


Which one of the following is represented by the area under the graph?

- A** distance travelled  
**B** gain in kinetic energy  
**C** change in velocity  
**D** change in momentum
- 2 A golf club strikes a stationary golf ball of mass  $4.8 \times 10^{-2} \text{ kg}$  and the ball leaves the club with a speed of  $95 \text{ m s}^{-1}$ . If the average force exerted on the ball is  $7800 \text{ N}$ , how long are the ball and club in contact?
- A**  $5.8 \times 10^{-4} \text{ s}$   
**B**  $1.2 \times 10^{-2} \text{ s}$   
**C**  $0.51 \text{ s}$   
**D**  $0.58 \text{ s}$
- 3 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**  $0.72 \text{ N s}$

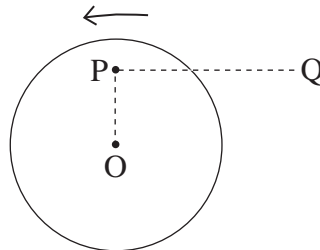


- 4 A model car moves in a circular path of radius 0.80 m at an angular speed of  $\frac{\pi}{2} \text{ rad s}^{-1}$ .



What is its displacement from point P 6.0 s after passing P?

- A zero  
 B  $0.4\pi \text{ m}$   
 C 1.6 m  
 D  $1.6\pi \text{ m}$
- 5 A small mass is placed at P on a horizontal disc which has its centre at O. The disc rotates anti-clockwise about a vertical axis through O with constant angular speed.



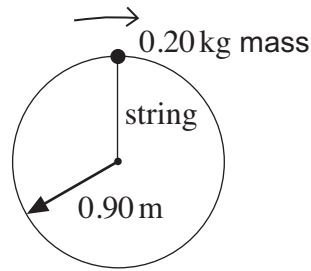
Which one of the following describes the force which keeps the mass at rest relative to the disc when in the position shown?

- A the weight of the mass  
 B a frictional force from P to Q  
 C a frictional force directed away from O  
 D a frictional force directed towards O

Turn over ►



- 6 A 0.20 kg mass is whirled round in a vertical circle on the end of a light string of length 0.90 m.



At the top point of the circle the speed of the mass is  $8.2 \text{ m s}^{-1}$ . What is the tension in the string at this point?

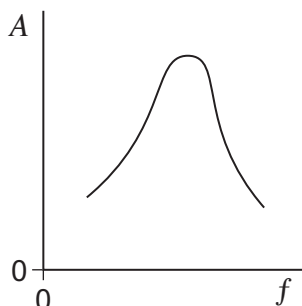
- A 10 N  
 B 13 N  
 C 17 N  
 D 20 N
- 7 Which line, **A** to **D**, in the table gives the amplitude and frequency of a body performing simple harmonic motion whose displacement  $x$  at time  $t$  is given by the equation  $x = P \cos Qt$ ?

|          | Amplitude     | Frequency        |
|----------|---------------|------------------|
| <b>A</b> | $\frac{P}{2}$ | $\frac{Q}{2\pi}$ |
| <b>B</b> | $P$           | $2\pi Q$         |
| <b>C</b> | $P$           | $\frac{Q}{2\pi}$ |
| <b>D</b> | $2P$          | $\frac{Q}{2\pi}$ |

- 8 The tip of each prong of a tuning fork emitting a note of 320 Hz vibrates in simple harmonic motion with an amplitude of 0.50 mm. What is the speed of each tip when its displacement is zero?
- A zero  
 B  $0.32\pi \text{ mm s}^{-1}$   
 C  $160\pi \text{ mm s}^{-1}$   
 D  $320\pi \text{ mm s}^{-1}$



- 9 A periodic force is applied to a lightly-damped object causing the object to oscillate. The graph shows how the amplitude  $A$  of the oscillations varies with the frequency  $f$  of the periodic force.



Which one of the following statements best describes how the shape of the curve would differ if the damping had been greater?

- A The curve would be lower at all frequencies.
- B The curve would be higher at all frequencies.
- C The curve would be unchanged except at frequencies above the resonant frequency where it would be lower.
- D The curve would be unchanged except at frequencies above the resonant frequency where it would be higher.
- 10 A spacecraft of mass  $m$  is at the mid-point between the centres of a planet of mass  $M_1$  and its moon of mass  $M_2$ . If the distance between the spacecraft and the centre of the planet is  $d$ , what is the magnitude of the resultant gravitational force on the spacecraft?
- A  $\frac{Gm(M_1 - M_2)}{d}$
- B  $\frac{Gm(M_1 + M_2)}{d^2}$
- C  $\frac{Gm(M_1 - M_2)}{d^2}$
- D  $\frac{Gm(M_1 + M_2)}{d}$

Turn over ►

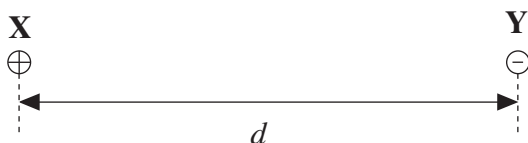


- 11 Which one of the following statements about gravitational potential is correct?
- A Gravitational potential can have a positive value.
  - B The gravitational potential at the surface of the Earth is zero.
  - C The gravitational potential gradient at a point has the same numerical value as the gravitational field strength at that point.
  - D The unit of gravitational potential is  $\text{N kg}^{-1}$ .

- 12 Which one of the following statements is correct?

The force between two charged particles

- A is always attractive.
  - B can be measured in  $\text{C}^2 \text{F}^{-1} \text{m}^{-1}$ .
  - C is directly proportional to the distance between them.
  - D is independent of the magnitude of the charges.
- 13 Two point charges, **X** and **Y**, exert a force  $F$  on each other when they are at a distance  $d$  apart.



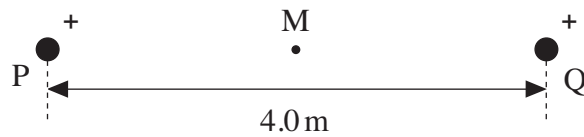
When the distance between them is 20 mm, the force they exert on each other is  $0.5 F$ .

What is the distance  $d$ ?

- A 7 mm
  - B 14 mm
  - C 15 mm
  - D 28 mm
- 14 Which one of the following statements is correct?
- When a negative ion is projected into an electric field
- A the field can change the magnitude of the velocity but not its direction.
  - B the field can change the direction of the velocity but not its magnitude.
  - C the field can change both the magnitude and the direction of the velocity.
  - D the ion will accelerate in the direction of the field.

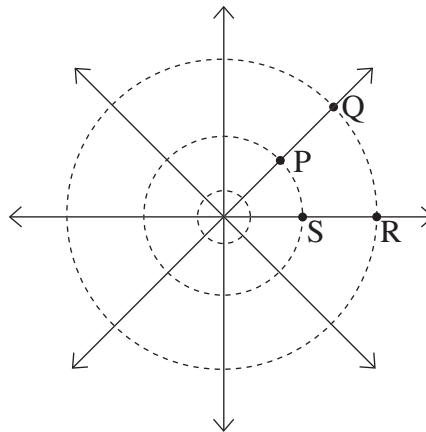


- 15 Two identical positive point charges, P and Q, are separated by a distance of 4.0 m. The resultant electric potential at point M, which is mid-way between the charges, is 25.0 V.



What would be the resultant electrical potential at a point 1.0 m closer to P?

- A 8.3 V  
 B 12.5 V  
 C 33.3 V  
 D 37.5 V
- 16 The diagram below shows the field lines and equipotential lines around an isolated positive point charge.



Which one of the following statements concerning the work done when a small charge is moved in the field is **incorrect**?

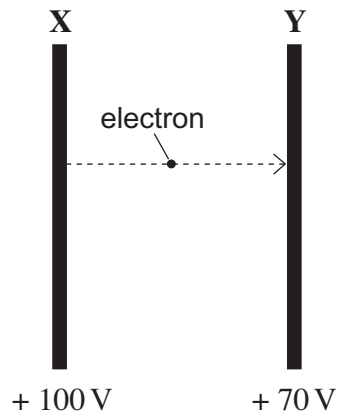
- A When it is moved from either P to Q or S to R, the work done is the same in each case.  
 B When it is moved from Q to R no work is done.  
 C When it is moved around the path PQRS, the overall work done is zero.  
 D When it is moved around the path PQRS, the overall work done is equal to twice the work done in moving from P to Q.

Turn over ►



17

Two fixed parallel metal plates **X** and **Y** are at constant potentials of + 100 V and + 70 V respectively. An electron travelling from **X** to **Y** experiences a change of potential energy  $\Delta E_p$



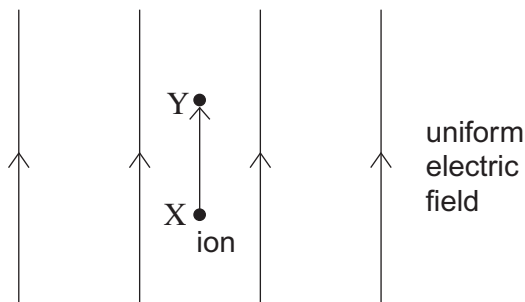
Which line, **A** to **D**, in the table shows correctly the direction of the electrostatic force  $F$  on the electron and the value of  $\Delta E_p$ ?

|          | Direction of $F$   | $\Delta E_p$ |
|----------|--------------------|--------------|
| <b>A</b> | towards <b>X</b>   | + 30 eV      |
| <b>B</b> | towards <b>Y</b>   | - 30 eV      |
| <b>C</b> | away from <b>X</b> | + 30 eV      |
| <b>D</b> | away from <b>Y</b> | - 30 eV      |





- 18** A uniform electric field of electric field strength  $E$  is aligned so it is vertical. An ion moves vertically through a small distance  $\Delta d$  from point X to point Y in the field. There is a uniform gravitational field of field strength  $g$  throughout the region.



Which line, **A** to **D**, in the table correctly gives the gravitational potential difference, and the electric potential difference, between X and Y?

|          | Gravitational potential difference | Electric potential difference |
|----------|------------------------------------|-------------------------------|
| <b>A</b> | $g\Delta d$                        | $E\Delta d$                   |
| <b>B</b> | $g\Delta d$                        | $\frac{E}{\Delta d}$          |
| <b>C</b> | $\frac{g}{\Delta d}$               | $E\Delta d$                   |
| <b>D</b> | $\frac{g}{\Delta d}$               | $\frac{E}{\Delta d}$          |

- 19** Initially a charged capacitor stores  $1600 \mu\text{J}$  of energy. When the pd across it decreases by  $2.0 \text{ V}$ , the energy stored by it becomes  $400 \mu\text{J}$ .

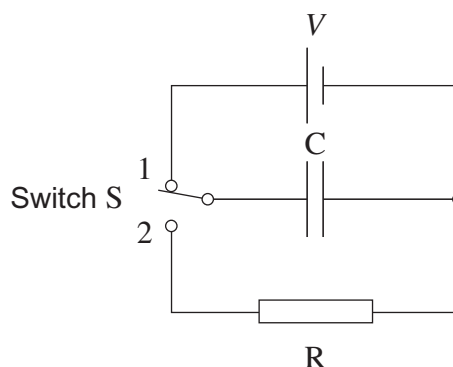
What is the capacitance of this capacitor?

- A**  $100 \mu\text{F}$   
**B**  $200 \mu\text{F}$   
**C**  $400 \mu\text{F}$   
**D**  $600 \mu\text{F}$

Turn over ►



- 20 Switch  $S$  in the circuit is held in position 1, so that the capacitor  $C$  becomes fully charged to a pd  $V$  and stores energy  $E$ .



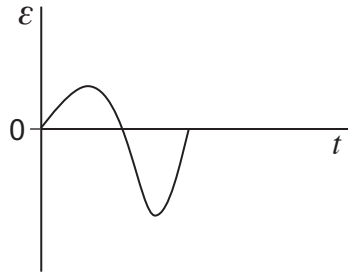
The switch is then moved quickly to position 2, allowing  $C$  to discharge through the fixed resistor  $R$ . It takes 36 ms for the pd across  $C$  to fall to  $\frac{V}{2}$ . What period of time must elapse, after the switch has moved to position 2, before the energy stored by  $C$  has fallen to  $\frac{E}{16}$ ?

- A 51 ms  
 B 72 ms  
 C 432 ms  
 D 576 ms
- 21 The path followed by an electron of momentum  $p$ , carrying charge  $-e$ , which enters a magnetic field at right angles, is a circular arc of radius  $r$ .
- What would be the radius of the circular arc followed by an  $\alpha$  particle of momentum  $2p$ , carrying charge  $+2e$ , which entered the same field at right angles?
- A  $\frac{r}{2}$   
 B  $r$   
 C  $2r$   
 D  $4r$
- 22 In which one of the following applications does electromagnetic induction **not** take place?
- A the generators at a nuclear power station  
 B the ac power adapter for a laptop computer  
 C the wings of an aircraft cutting through the Earth's magnetic field  
 D the back up capacitor of an electric timer



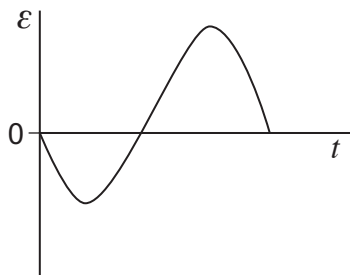
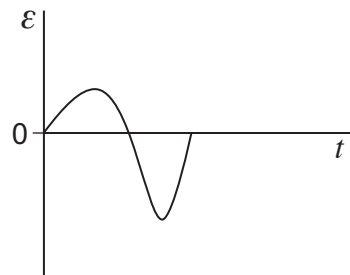
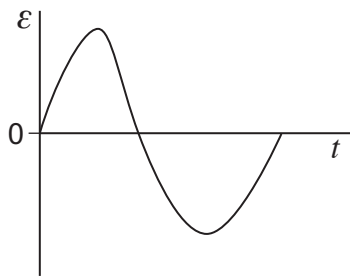
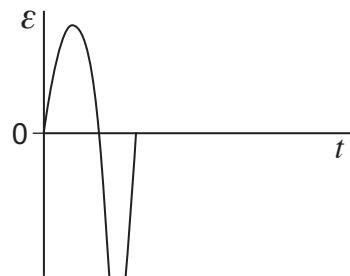
23

When a magnet is dropped through an aluminium ring an emf is induced. A data logger connected to the ring records the variation of the induced emf  $\varepsilon$  with time  $t$  as shown below.



In a second experiment, the magnet is dropped from a greater height.

Which one of the following graphs best represents the induced emf in the second experiment?

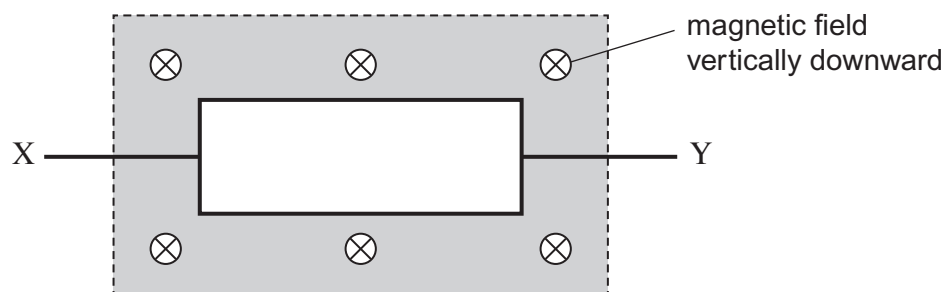
**A****B****C****D**

Turn over ►



- 24** A rectangular coil of area  $A$  has  $N$  turns of wire. The coil is in a uniform magnetic field, as shown in the diagram.

When the coil is rotated at a constant frequency  $f$  about its axis  $XY$ , an alternating emf of peak value  $\varepsilon_0$  is induced in it.



What is the maximum value of the magnetic flux linkage through the coil?

- A**  $\frac{\varepsilon_0}{2\pi f}$
- B**  $\frac{\varepsilon_0}{\pi f}$
- C**  $\pi f \varepsilon_0$
- D**  $2\pi f \varepsilon_0$
- 25** A transformer has 1150 turns on the primary coil and 500 turns on the secondary coil. The primary coil draws a current of 0.26 A from a 230 V ac supply. The current in the secondary coil is 0.50 A. What is the efficiency of the transformer?
- A** 42%
- B** 50%
- C** 84%
- D** 100%

**END OF QUESTIONS**

