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

General Certificate of Education
Advanced Level Examination
June 2013

# Physics A PHYA4/1

## Unit 4 Fields and Further Mechanics
## Section A

**Thursday 13 June 2013 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 approximately **45 minutes** on this section.

**1** Which one of the following is a possible unit of impulse?

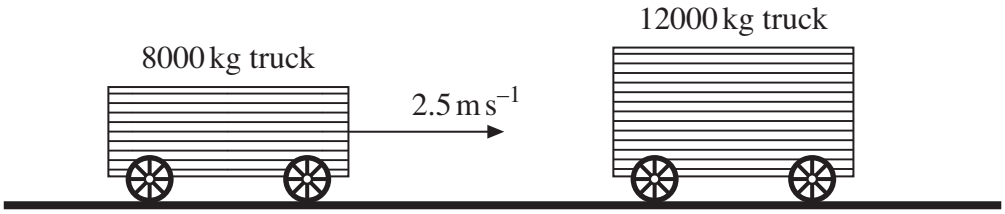
**A** $N\,s^{-1}$

**B** $kg\,m\,s^{-1}$

**C** $kg\,m\,s^{-2}$

**D** $s\,N^{-1}$

**2** A railway truck of mass 8000 kg travels along a level track at a velocity of $2.5\,m\,s^{-1}$ and collides with a stationary truck of mass 12000 kg. The two trucks move together at the same velocity after the collision.




What is the change in momentum of the 8000 kg truck due to the impact?

**A** 8000 N s

**B** 12000 N s

**C** 20000 N s

**D** 25000 N s

**3** A gas molecule of mass $m$ moving at velocity $u$ collides at right angles with the side of a container and rebounds elastically. Which one of the following statements concerning the motion of the molecule is **incorrect**?

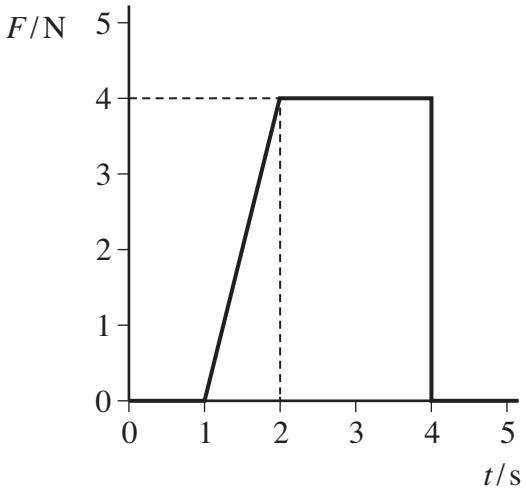
**A** The magnitude of the change in momentum of the molecule is zero.

**B** The magnitude of the change in momentum of the molecule is $2mu$.

**C** The force exerted by the molecule on the side of the container is equal to the force exerted by the container on the molecule.

**D** The change in kinetic energy of the molecule is zero.

**4** The graph shows how the resultant force, $F$, acting on a body varies with time, $t$.




What is the change in momentum of the body over the 5 s period?

**A** 2 N s

**B** 8 N s

**C** 10 N s

**D** 12 N s

**5** The wheel of the London Eye has a diameter of 130 m and rotates at a steady speed, completing one rotation every 30 minutes. What is the centripetal acceleration of a person in a capsule at the rim of the wheel?

**A** $1.2 \times 10^{-4}\,\text{m s}^{-2}$

**B** $2.5 \times 10^{-4}\,\text{m s}^{-2}$

**C** $3.9 \times 10^{-4}\,\text{m s}^{-2}$

**D** $7.9 \times 10^{-4}\,\text{m s}^{-2}$

**6** A small body of mass $m$ rests on a horizontal turntable at a distance $r$ from the centre. If the maximum frictional force between the body and the turntable is $\frac{mg}{2}$, what is the angular speed at which the body starts to slip?

**A** $\sqrt{\frac{gr}{2}}$

**B** $\frac{g}{r}$

**C** $\sqrt{\frac{g}{2r}}$

**D** $\frac{1}{2}\sqrt{\frac{g}{r}}$

**7** A body of mass 0.50 kg, fixed to one end of a string, is rotated in a vertical circle of radius 1.5 m at an angular speed of 5.0 rad $s^{-1}$. What is the maximum tension in the string?

**A** 5.0 N

**B** 9.0 N

**C** 14 N

**D** 24 N

**8** A particle of mass $m$ oscillates in a straight line with simple harmonic motion of constant amplitude. The total energy of the particle is $E$. What is the total energy of another particle of mass $2m$, oscillating with simple harmonic motion of the same amplitude but double the frequency?

**A** $E$

**B** $2E$

**C** $4E$

**D** $8E$

**9** When a mass suspended on a spring is displaced, the system oscillates with simple harmonic motion. Which one of the following statements regarding the energy of the system is **incorrect**?

**A** The potential energy has a minimum value when the spring is fully compressed or fully extended.

**B** The kinetic energy has a maximum value at the equilibrium position.

**C** The sum of the kinetic and potential energies at any time is constant.

**D** The potential energy has a maximum value when the mass is at rest.

**10** When a mass M attached to a spring X, as shown in **Figure 1**, is displaced downwards and released it oscillates with time period $T$. An identical spring is connected in series and the same mass M is attached, as shown in **Figure 2**.

What is the new time period?

**Figure 1**

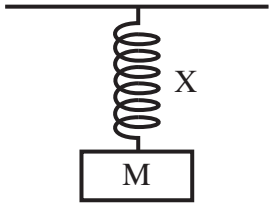
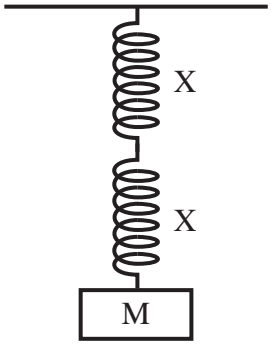



**Figure 2**




**A** $\frac{T}{2}$

**B** $\frac{T}{\sqrt{2}}$

**C** $\sqrt{2}T$

**D** $2T$

**11** When a space shuttle is in a low orbit around the Earth it experiences gravitational forces $F_E$ due to the Earth, $F_M$ due to the Moon and $F_S$ due to the Sun. Which one of the following correctly shows how the magnitudes of these forces are related to each other?

mass of Sun = $1.99 \times 10^{30}$ kg
mass of Moon = $7.35 \times 10^{22}$ kg
mean distance from Earth to Sun = $1.50 \times 10^{11}$ m
mean distance from Earth to Moon = $3.84 \times 10^{8}$ m

**A** $F_E > F_S > F_M$

**B** $F_S > F_E > F_M$

**C** $F_E > F_M > F_S$

**D** $F_M > F_E > F_S$

**12** The gravitational field strengths at the surfaces of the Earth and the Moon are $9.8\,N\,kg^{-1}$ and $1.7\,N\,kg^{-1}$ respectively. If the mass of the Earth is 81 × the mass of the Moon, what is the ratio of the radius of the Earth to the radius of the Moon?

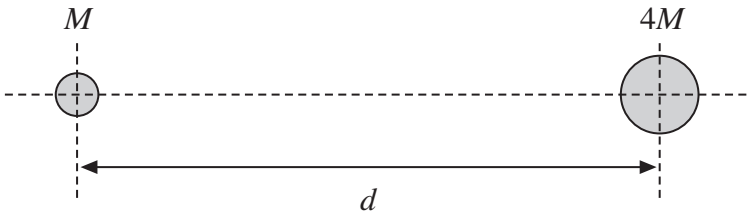
**A** 3.7

**B** 5.8

**C** 14

**D** 22

**13** Two stars of mass $M$ and $4M$ are at a distance $d$ between their centres.




The resultant gravitational field strength is zero along the line between their centres at a distance $y$ from the centre of the star of mass $M$.

What is the value of the ratio $\frac{y}{d}$?

**A** $\frac{1}{2}$

**B** $\frac{1}{3}$

**C** $\frac{2}{3}$

**D** $\frac{3}{4}$

**14** Mars has a diameter approximately 0.5 that of the Earth, and a mass of 0.1 that of the Earth.
The gravitational potential at the Earth's surface is $-63\,\text{MJ kg}^{-1}$.
What is the approximate value of the gravitational potential at the surface of Mars?

**A** $-13\,\text{MJ kg}^{-1}$

**B** $-25\,\text{MJ kg}^{-1}$

**C** $-95\,\text{MJ kg}^{-1}$

**D** $-320\,\text{MJ kg}^{-1}$

**15** Two satellites P and Q, of equal mass, orbit the Earth at radii $R$ and $2R$ respectively.
Which one of the following statements is correct?

**A** P has less kinetic energy and more potential energy than Q.

**B** P has less kinetic energy and less potential energy than Q.

**C** P has more kinetic energy and less potential energy than Q.

**D** P has more kinetic energy and more potential energy than Q.

**16** Two horizontal parallel plate conductors are separated by a distance of 5.0 mm in air. The lower plate is earthed and the potential of the upper plate is +50 V.

Which line, **A** to **D**, in the table gives correctly the electric field strength, $E$, and the potential, $V$, at a point midway between the plates?

| | **electric field strength $E$ / V m$^{-1}$** | **potential $V$ / V** |
|---|---|---|
| **A** | $1.0 \times 10^4$ upwards | 25 |
| **B** | $1.0 \times 10^4$ downwards | 25 |
| **C** | $1.0 \times 10^4$ upwards | 50 |
| **D** | $1.0 \times 10^4$ downwards | 50 |

**17** Two identical positive point charges, P and Q, separated by a distance $r$, repel each other with a force $F$. If $r$ is decreased so that the electrical potential energy of Q is doubled, what is the force of repulsion?

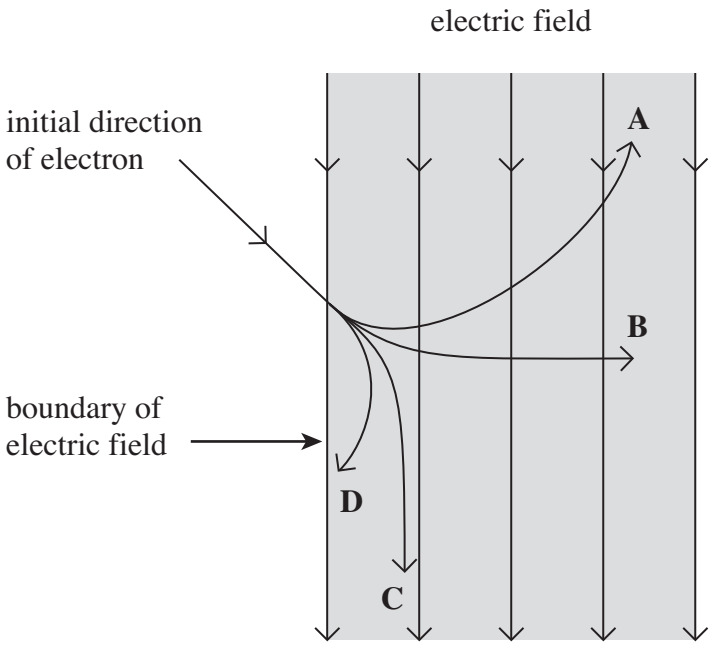
**A** $0.5F$

**B** $F$

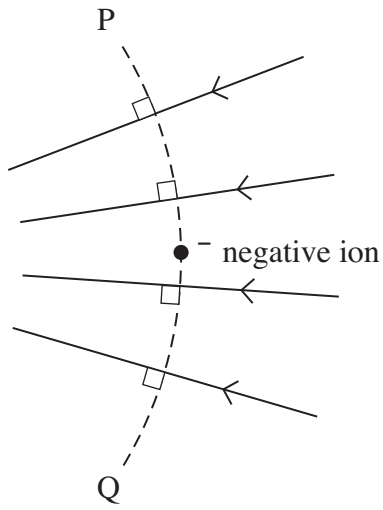
**C** $2F$

**D** $4F$

**18** Which path, **A** to **D**, shows how an electron moves in the uniform electric field represented in the diagram?



**19** The diagram shows a negative ion at a point in an electric field, which is represented by the arrowed field lines.




Which one of the following statements correctly describes what happens when the ion is displaced?

When the negative ion is displaced

**A** to the left the magnitude of the electric force on it decreases.

**B** to the right its potential energy increases.

**C** along the line PQ towards Q its potential energy decreases.

**D** along the line PQ towards P the magnitude of the electric force on it is unchanged.

**20** A nuclear fusion device is required to deliver at least 1 MJ of energy using capacitors. If the largest workable potential difference is 10 kV, what is the minimum capacitance of the capacitors that should be used?

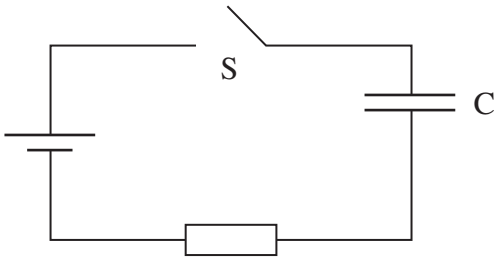
**A** 0.01 F

**B** 0.02 F

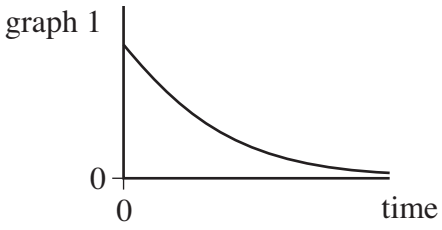
**C** 2 F

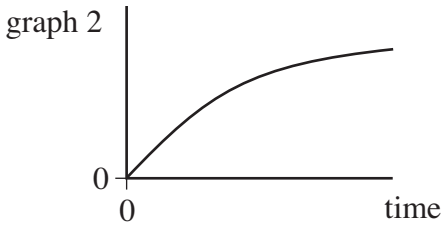
**D** 100 F

**21** In the circuit shown the capacitor C charges when switch S is closed.




Which line, **A** to **D**, in the table gives a correct pair of graphs showing how the charge on the capacitor and the current in the circuit change with time after S is closed?




| | **charge** | **current** |
|---|---|---|
| **A** | graph 1 | graph 1 |
| **B** | graph 1 | graph 2 |
| **C** | graph 2 | graph 2 |
| **D** | graph 2 | graph 1 |

**Turn over for the next question**

**22** The voltage across a capacitor falls from 10 V to 5 V in 48 ms as it discharges through a resistor.
What is the time constant of the circuit?

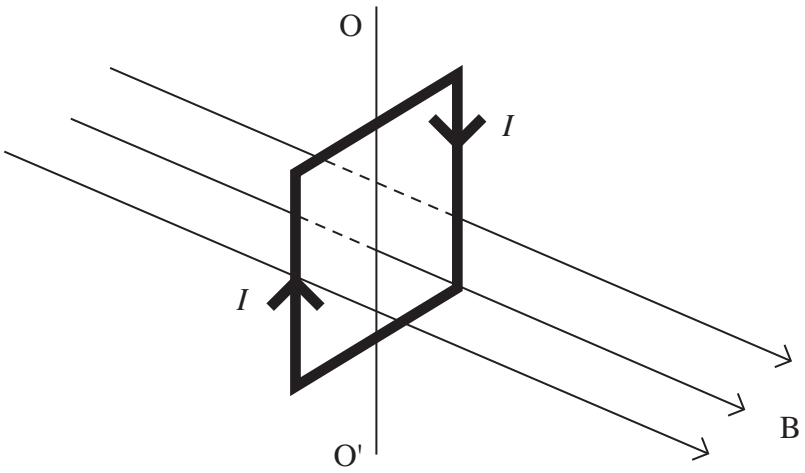
**A** 24 ms

**B** 33 ms

**C** 69 ms

**D** 96 ms

**23** The diagram shows a vertical square coil whose plane is at right angles to a horizontal uniform magnetic field B. A current, *I*, is passed through the coil, which is free to rotate about a vertical axis OO'.




Which one of the following statements is correct?

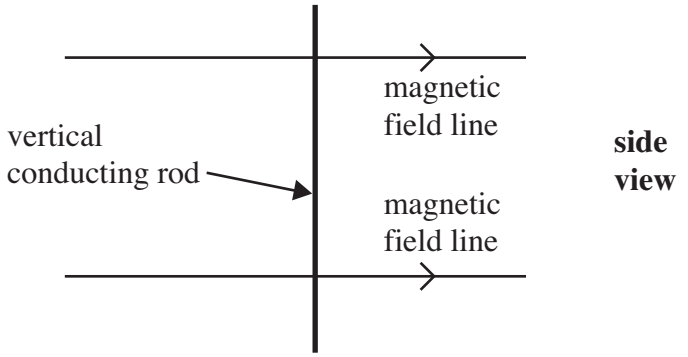
**A** The forces on the two vertical sides of the coil are equal and opposite.

**B** A couple acts on the coil.

**C** No forces act on the horizontal sides of the coil.

**D** If the coil is turned through a small angle about OO' and released, it will remain in position.

**24** A vertical conducting rod of length $l$ is moved at a constant velocity $v$ through a uniform horizontal magnetic field of flux density $B$.




Which line, **A** to **D**, in the table gives a correct expression for the induced emf for the stated direction of the motion of the rod?

| | **direction of motion** | **induced emf** |
|---|---|---|
| **A** | vertical | $\frac{B}{lv}$ |
| **B** | horizontal at right angles to the field | $Blv$ |
| **C** | vertical | $Blv$ |
| **D** | horizontal at right angles to the field | $\frac{B}{lv}$ |

**25** A transformer, which is not perfectly efficient, is connected to a 230 V rms mains supply and is used to operate a 12 V rms, 60 W lamp at normal brightness. The secondary coil of the transformer has 24 turns.

Which line, **A** to **D**, in the table is correct?

| | **number of turns on primary coil** | **rms current in primary coil** |
|---|---|---|
| **A** | 92 | less than 0.26 A |
| **B** | 92 | more than 0.26 A |
| **C** | 460 | less than 0.26 A |
| **D** | 460 | more than 0.26 A |

**END OF QUESTIONS**

**There are no questions printed on this page**

**DO NOT WRITE ON THIS PAGE**
**ANSWER IN THE SPACES PROVIDED**