Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

General Certificate of Education
Advanced Level Examination
June 2015

Physics A PHYA4/1

Unit 4 Fields and Further Mechanics
Section A

Thursday 11 June 2015 9.00 am to 10.45 am

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.

Do not write outside the box

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 one of the following has the same unit as the rate of change of momentum?

A work

B energy

C acceleration

D weight

2 The nucleus of a radioactive isotope X is at rest and decays by emitting an α particle so that a new nuclide Y is formed.
Which one of the following statements about the decay is correct?

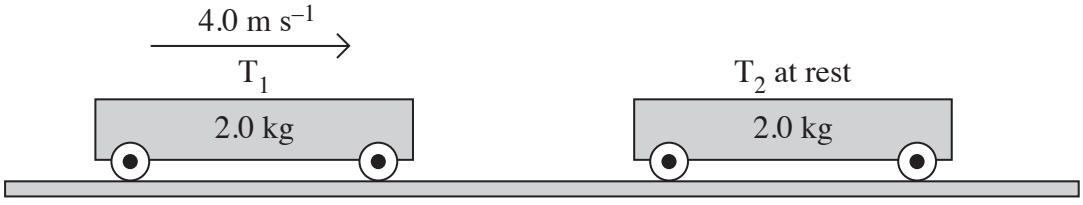
A The momentum of Y is equal and opposite to the momentum of the α particle.

B The momentum of Y is equal to the momentum of X.

C The kinetic energy of Y is equal to the kinetic energy of the α particle.

D The total kinetic energy is the same before and after the decay.

3 Trolley T_1, of mass $2.0\ kg$, collides on a horizontal surface with trolley T_2, which is also of mass $2.0\ kg$. The collision is elastic. Before the collision T_1 was moving at $4.0\ m\ s^{-1}$ and T_2 was at rest.



Which one of the following statements is correct?

Immediately after the collision

A T_1 is at rest and T_2 moves at $4.0\ m\ s^{-1}$.

B T_1 will rebound from T_2 at $4.0\ m\ s^{-1}$.

C T_1 and T_2 will both move at $2.8\ m\ s^{-1}$.

D T_1 and T_2 will both move at $1.4\ m\ s^{-1}$.

Do not write outside the box

4 For a body performing simple harmonic motion, which one of the following statements is correct?

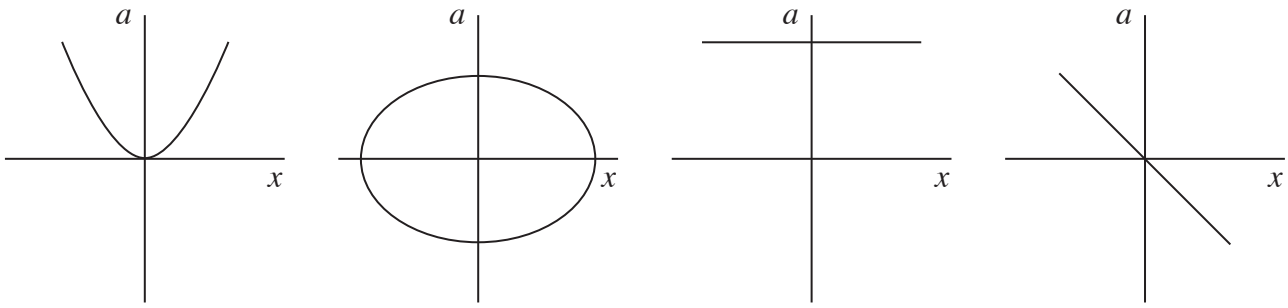
A The maximum kinetic energy is directly proportional to the frequency.

B The time for one oscillation is directly proportional to the frequency.

C The speed at any instant is directly proportional to the displacement.

D The maximum acceleration is directly proportional to the amplitude.

5 Which one of the following graphs shows how the acceleration, a, of a body moving with simple harmonic motion varies with its displacement, x?



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

6 A particle of mass 5.0×10^{-3} kg, moving with simple harmonic motion of amplitude 0.15 m, takes 47 s to make 50 oscillations.
What is the maximum kinetic energy of the particle?

A 2.0×10^{-3} J

B 2.5×10^{-3} J

C 3.9×10^{-3} J

D 5.0×10^{-3} J

7 A simple pendulum has a time period of 1.42 s on Earth. The gravitational field strength at the surface of Mars is 0.37 times that at the surface of the Earth.
What is the time period of the pendulum on Mars?

A 0.53 s

B 0.86 s

C 2.33 s

D 3.84 s

Do not write outside the box

8 Two identical uniform spheres each of radius R are placed in contact. The gravitational force between them is F.

The spheres are now separated until the force of attraction is $\frac{F}{9}$.

What is the distance between the **surfaces** of the spheres after they have been separated?

A $2R$

B $4R$

C $8R$

D $12R$

9 A satellite of mass m is in a circular orbit at height R above the surface of a uniform spherical planet of radius R and density ρ.

What is the force of gravitational attraction between the satellite and the planet?

A $\frac{\pi\rho GmR}{3}$

B $\frac{2\pi\rho GmR}{3}$

C $\frac{\pi\rho GmR^2}{3}$

D $\frac{2\pi\rho GmR^2}{3}$

10 The following data refer to two planets, P and Q.

	Radius / km	**Density / kg m^{-3}**
planet P	8000	6000
planet Q	16 000	3000

The gravitational field strength at the surface of P is $13.4\ \text{N kg}^{-1}$.
What is the gravitational field strength at the surface of Q?

A $3.4\ \text{N kg}^{-1}$

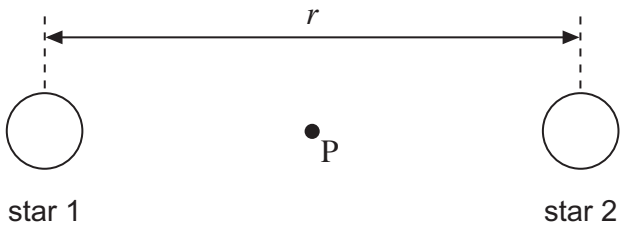
B $13.4\ \text{N kg}^{-1}$

C $53.6\ \text{N kg}^{-1}$

D $80.4\ \text{N kg}^{-1}$

Do not write outside the box

11 The diagram shows an isolated binary star system. The two stars have equal masses, M, and the distance between their centres is r.



The point P is half-way between the two stars.
What is the gravitational field strength at P?

A zero

B $-\frac{GM}{r^2}$

C $-\frac{2GM}{r^2}$

D $-\frac{4GM}{r^2}$

12 Which one of the following statements about gravitational potential is **incorrect**?

A It is analogous to the electric potential at a point in an electric field.

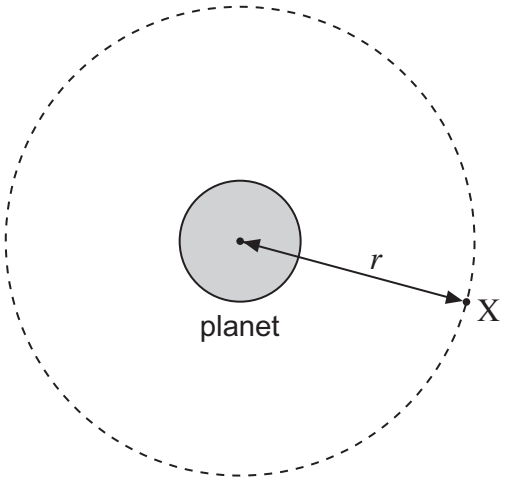
B It is equal to the gravitational potential energy of a mass of $1\ \text{kg}$.

C It is a vector quantity.

D The difference in gravitational potential between two points at different heights above the Earth depends on the position of the points.

Do not write outside the box

13 A satellite X is in a circular orbit of radius r about the centre of a spherical planet of mass M.



Which line, **A** to **D**, in the table gives correct expressions for the centripetal acceleration a and the speed v of the satellite?

	Centripetal acceleration a	**Speed v**
A	$\frac{GM}{2r}$	$\sqrt{\frac{GM}{2r}}$
B	$\frac{GM}{2r}$	$\sqrt{\frac{GM}{r}}$
C	$\frac{GM}{r^2}$	$\sqrt{\frac{GM}{2r}}$
D	$\frac{GM}{r^2}$	$\sqrt{\frac{GM}{r}}$

14 A satellite orbiting the Earth moves to an orbit which is closer to the Earth.

Which line, **A** to **D**, in the table shows correctly what happens to the speed of the satellite and to the time it takes for one orbit of the Earth?

	Speed of satellite	**Time for one orbit of Earth**
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Do not write outside the box

15 A positive ion has a charge-to-mass ratio of 2.40×10^7 C kg^{-1}. It is held stationary in a vertical electric field.
Which line, **A** to **D**, in the table shows correctly both the strength and the direction of the electric field?

	Electric field strength / V m^{-1}	**Direction**
A	4.09×10^{-7}	upwards
B	4.09×10^{-7}	downwards
C	2.45×10^{6}	upwards
D	2.45×10^{6}	downwards

16 In the equation $X = \dfrac{ab}{r^n}$, X represents a physical variable in an electric or a gravitational field, a is a constant, b is either mass or charge and n is a number.

Which line, **A** to **D**, in the table provides a consistent representation of X, a and b according to the value of n?

The symbols E, g, V and r have their usual meanings.

	n	***X***	***a***	***b***
A	1	E	$\dfrac{1}{4\pi\varepsilon_0}$	charge
B	1	V	$\dfrac{1}{4\pi\varepsilon_0}$	mass
C	2	g	G	mass
D	2	V	G	charge

17 An uncharged 4.7 nF capacitor is connected to a 1.5 V supply and becomes fully charged.

How many electrons are transfered to the negative plate of the capacitor during this charging process?

A 2.2×10^{10}

B 3.3×10^{10}

C 4.4×10^{10}

D 8.8×10^{10}

Do not write outside the box

18 When fully charged the $2.0\ \text{mF}$ capacitor used as a backup for a memory unit has a potential difference of $5.0\ \text{V}$ across it. The capacitor is required to supply a constant current of $1.0\ \mu\text{A}$ and can be used until the potential difference across it falls by 10%. For how long can the capacitor be used before it must be recharged?

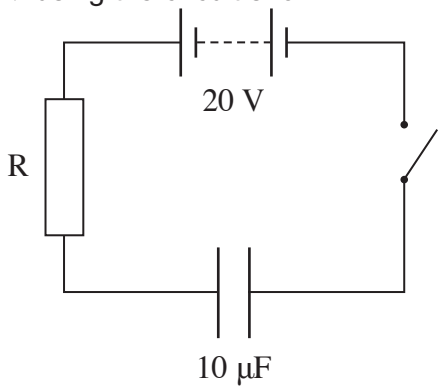
A $10\ \text{s}$

B $100\ \text{s}$

C $200\ \text{s}$

D $1000\ \text{s}$

19 A capacitor of capacitance $10\ \mu\text{F}$ is charged through a resistor R to a potential difference (pd) of $20\ \text{V}$ using the circuit shown.



When the capacitor is fully charged which one of the following statements is **incorrect**?

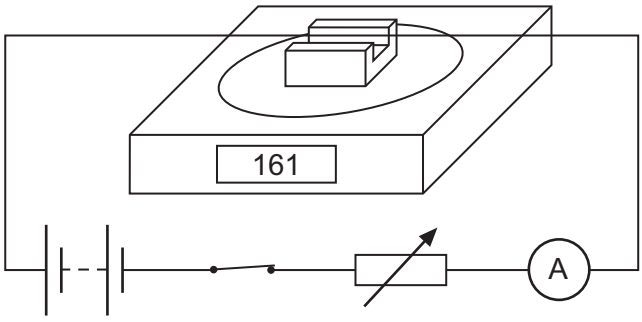
A The energy stored by the capacitor is $2\ \text{mJ}$.

B The total energy taken from the battery during the charging process is $2\ \text{mJ}$.

C The pd across the capacitor is $20\ \text{V}$.

D The pd across the resistor is $0\ \text{V}$.

20 The diagram shows a rigidly-clamped straight horizontal current-carrying wire held mid-way between the poles of a magnet on a top-pan balance. The wire is perpendicular to the magnetic field direction.



The balance, which was zeroed before the switch was closed, read $161\ \text{g}$ after the switch was closed. When the current is reversed and doubled, what would be the new reading on the balance?

A $-322\ \text{g}$

B $-161\ \text{g}$

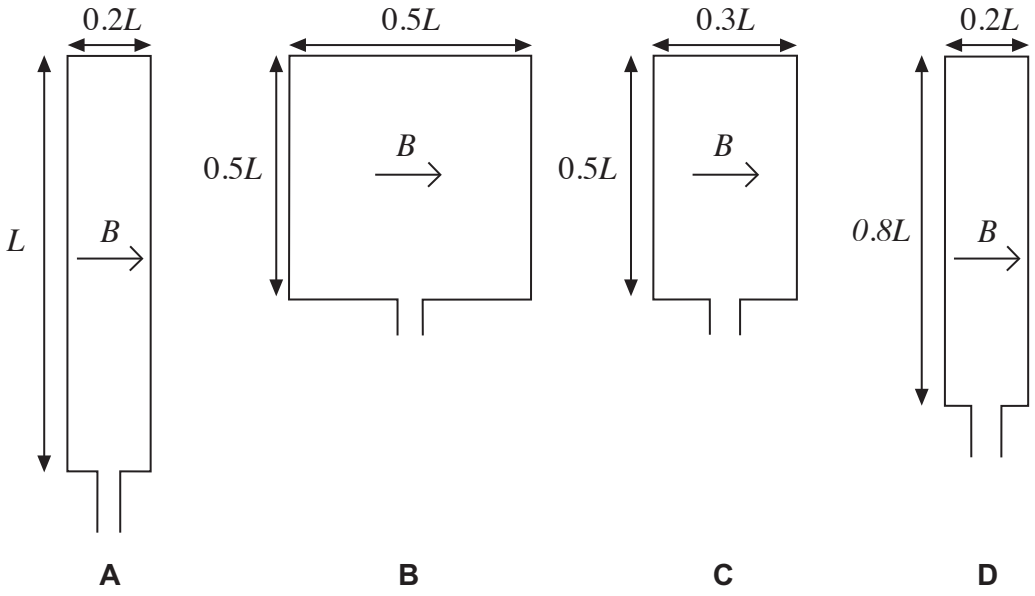
C zero

D $322\ \text{g}$

Do not write outside the box

21 Four rectangular loops of wire **A**, **B**, **C** and **D** are each placed in a uniform magnetic field of the same flux density B. The direction of the magnetic field is parallel to the plane of the loops as shown.

When a current of $1\ \text{A}$ is passed through each of the loops, magnetic forces act on them. The lengths of the sides of the loops are as shown.
Which loop experiences the largest couple?



22 Which one of the following statements is correct?

An electron follows a circular path when it is moving at right angles to

A a uniform magnetic field.

B a uniform electric field.

C uniform electric and magnetic fields which are perpendicular.

D uniform electric and magnetic fields which are in opposite directions.

Do not write outside the box

23 Two electrons, X and Y, travel at right angles to a uniform magnetic field. X experiences a magnetic force, F_X, and Y experiences a magnetic force, F_Y.

What is the ratio $\frac{F_X}{F_Y}$ if the kinetic energy of X is half that of Y?

A $\frac{1}{4}$

B $\frac{1}{2}$

C $\frac{1}{\sqrt{2}}$

D 1

24 A lamp rated at $12\ \text{V}\ 60\ \text{W}$ is connected to the secondary coil of a step-down transformer and is at full brightness. The primary coil is connected to a supply of $230\ \text{V}$. The transformer is 75% efficient.
What is the current in the primary coil?

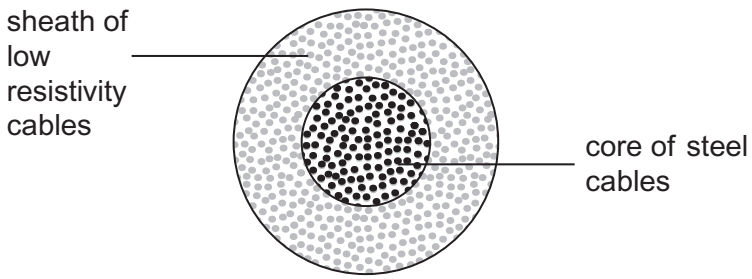
A $0.25\ \text{A}$

B $0.35\ \text{A}$

C $3.75\ \text{A}$

D $5.0\ \text{A}$

25 The overhead cables used to transmit electrical power by the National Grid usually consist of a central core of steel cables surrounded by a sheath of cables of low resistivity material, such as aluminium.



What is the main purpose of the steel core?

A to force more current into the outer sheath

B to provide additional current paths through the cables

C to reduce the power lost from the cables

D to increase the mechanical strength of the cables

END OF SECTION A

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Copyright © 2015 AQA and its licensors. All rights reserved.