Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

General Certificate of Education
Advanced Level Examination
January 2013

Physics A PHYA4/1

Unit 4 Fields and Further Mechanics
Section A

Wednesday 16 January 2013 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)
- 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 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.

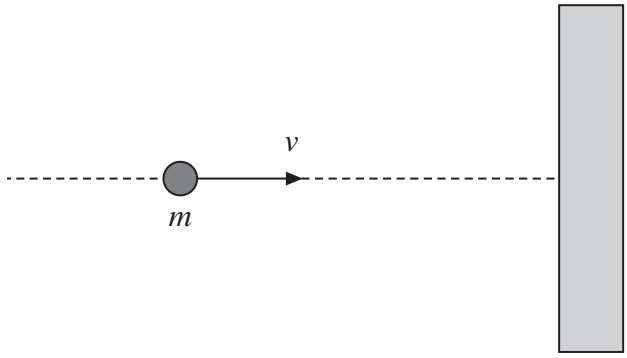
Information
- The maximum mark for this section is 25.
- All questions in Section A carry equal marks. No deductions will be made for incorrect answers.
- A *Data and Formulae Booklet* is provided as a loose insert.
- The question paper/answer book for Section B is enclosed within this question paper.

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 A ball of mass m travelling at velocity v collides normally with a smooth wall, as shown in the diagram, and rebounds elastically.



Which line, **A** to **D**, in the table, gives the correct expressions for the magnitude of the change of momentum, and the change of kinetic energy, of the ball?

	magnitude of change of momentum	**change of kinetic energy**
A	$2mv$	0
B	$2mv$	mv^2
C	0	0
D	0	mv^2

2 A cricket ball of mass 0.16 kg travelling at a speed of 35 m s^{-1} is hit by a bat and, as a result of the impact, leaves the bat in the opposite direction at 30 m s^{-1}. If the duration of the impact is 52 ms, what is the magnitude of the average force on the ball?

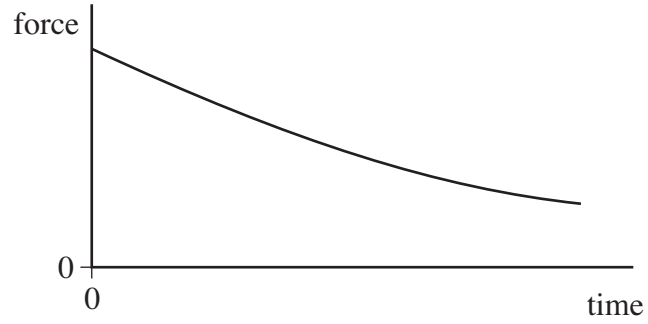
A 0.015 N

B 0.20 N

C 15 N

D 200 N

3 A ball is released so that it falls vertically. The graph shows how the resultant force acting on the ball changes with time.



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

A distance travelled

B gain in kinetic energy

C acceleration

D impulse

4 For a particle moving in a circle with uniform speed, which one of the following statements is **incorrect**?

A There is no displacement of the particle in the direction of the force.

B The force on the particle is always perpendicular to the velocity of the particle.

C The velocity of the particle is constant.

D The kinetic energy of the particle is constant.

5 A revolving mountain top restaurant turns slowly, completing a full rotation in 50 minutes. A man is sitting in the restaurant 15 m from the axis of rotation. What is the speed of the man relative to a stationary point outside the restaurant?

A $\frac{\pi}{100}\ \text{m s}^{-1}$

B $\frac{3\pi}{5}\ \text{m s}^{-1}$

C $\frac{\pi}{200}\ \text{m s}^{-1}$

D $\frac{\pi}{1500}\ \text{m s}^{-1}$

6 A particle of mass 0.20 kg moves with simple harmonic motion of amplitude 2.0×10^{-2} m. If the total energy of the particle is 4.0×10^{-5} J, what is the time period of the motion?

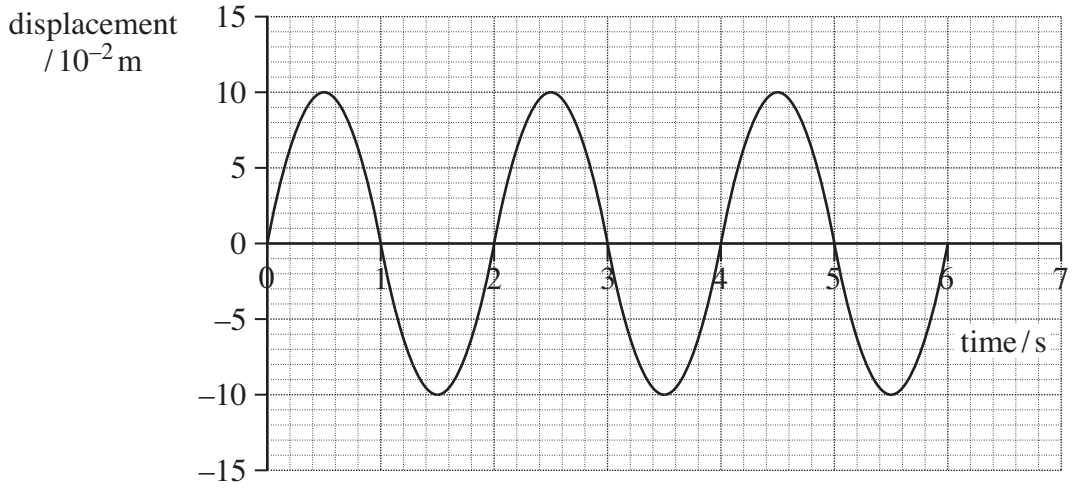
A $\frac{\pi}{4}$ seconds

B $\frac{\pi}{2}$ seconds

C π seconds

D 2π seconds

7 The graph shows the variation in displacement with time for an object moving with simple harmonic motion.



What is the maximum acceleration of the object?

A 0.025 m s^{-2}

B 0.99 m s^{-2}

C 2.5 m s^{-2}

D 9.8 m s^{-2}

8 A simple pendulum and a mass-spring system are taken to the Moon, where the gravitational field strength is less than on Earth. Which line, **A** to **D**, in the table correctly describes the change, if any, in the period when compared with its value on Earth?

	period of pendulum	**period of mass-spring system**
A	increase	no change
B	increase	increase
C	no change	decrease
D	decrease	decrease

9 Two pendulums, P and Q, are set up alongside each other. The period of P is 1.90 s and the period of Q is 1.95 s.

How many oscillations are made by pendulum Q between two consecutive instants when P and Q move in phase with each other?

A 19
B 38
C 39
D 78

10 A small mass is situated at a point on a line joining two large masses m_1 and m_2 such that it experiences no resultant gravitational force. Its distance from the centre of mass of m_1 is r_1 and its distance from the centre of mass of m_2 is r_2.

What is the value of the ratio $\frac{r_1}{r_2}$?

A $\frac{{m_1}^2}{{m_2}^2}$

B $\frac{{m_2}^2}{{m_1}^2}$

C $\sqrt{\frac{m_1}{m_2}}$

D $\sqrt{\frac{m_2}{m_1}}$

11 Which one of the following gives a correct unit for $\left(\frac{g^2}{G}\right)$?

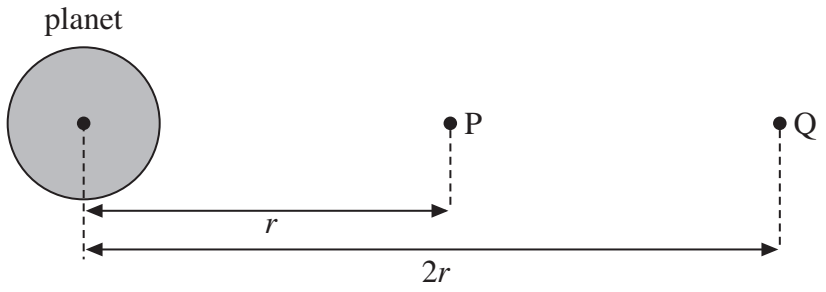
A $\mathrm{N\,m^{-2}}$
B $\mathrm{N\,kg^{-1}}$
C N m
D N

12 The gravitational field strength at the surface of the Earth is 6 times its value at the surface of the Moon. The mean density of the Moon is 0.6 times the mean density of the Earth.

What is the value of the ratio $\left(\frac{\text{radius of Earth}}{\text{radius of Moon}}\right)$?

A 1.8
B 3.6
C 6.0
D 10

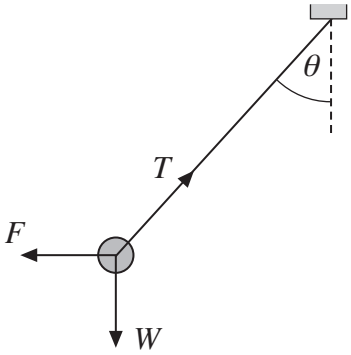
13 The diagram shows two points, P and Q, at distances r and $2r$ from the centre of a planet.



The gravitational potential at P is $-16\,\text{kJ kg}^{-1}$. What is the work done on a 10 kg mass when it is taken from P to Q?

A $-120\,\text{kJ}$
B $-80\,\text{kJ}$
C $+80\,\text{kJ}$
D $+120\,\text{kJ}$

14 A small sphere, of mass m and carrying a charge Q, is suspended from a thread and placed in a uniform horizontal electric field of strength E. When the sphere comes to rest the thread makes an angle θ with the vertical and the tension in it is T, as shown in the diagram. W is the weight of the sphere and F is the electric force acting on it.



Under these conditions, which one of the following equations is **incorrect**?

A $T \sin \theta = EQ$

B $T = mg\cos\theta + EQ\sin\theta$

C $T^2 = (EQ)^2 + (mg)^2$

D $mg = EQ\tan\theta$

15 When a charge moves between two points in an electric field, or a mass moves between two points in a gravitational field, energy may be transferred.
Which one of the following statements is correct?

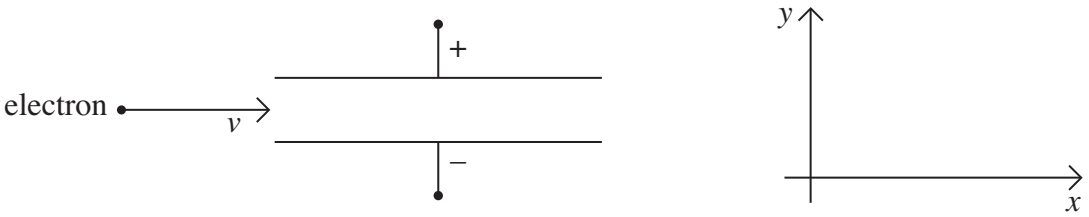
A No energy is transferred when the movement is parallel to the direction of the field.

B The energy transferred is independent of the path followed.

C The energy transferred is independent of the start and finish points.

D Energy is transferred when the movement is perpendicular to the field lines.

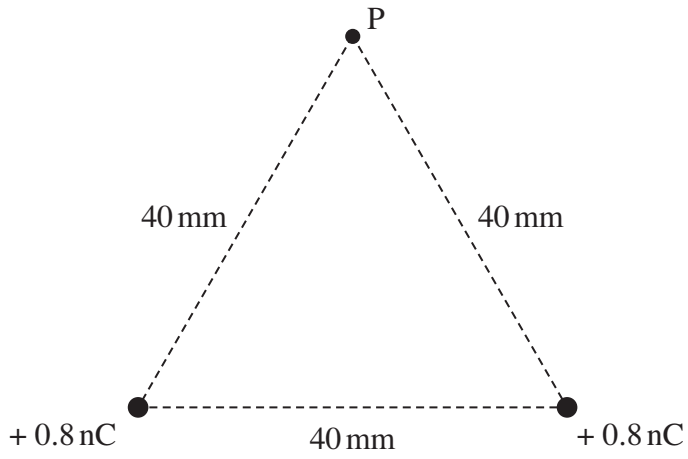
16 A beam of electrons, moving with a constant velocity v in a vacuum, enters a uniform electric field between two metal plates.



Which line, **A** to **D**, in the table describes the components of the acceleration of the electrons in the x and y directions as they move through the field?

	acceleration in *x* direction	**acceleration in *y* direction**
A	zero	zero
B	zero	constant
C	constant	zero
D	constant	constant

17 Two charges, each of +0.8 nC, are 40 mm apart.
Point P is 40 mm from each of the charges.



What is the electric potential at P?

A zero

B 180 V

C 360 V

D 4500 V

18 An initially uncharged capacitor of capacitance 20 μF is charged by a constant current of 80 μA. Which line, **A** to **D**, in the table gives the potential difference across, and the energy stored in, the capacitor after 50 s?

	potential difference / V	**energy stored / J**
A	4.0×10^{-3}	2.0×10^{-3}
B	4.0×10^{-3}	4.0×10^{-1}
C	2.0×10^{2}	2.0×10^{-3}
D	2.0×10^{2}	4.0×10^{-1}

19 Which one of the following statements about a parallel plate capacitor is **incorrect**?

A The capacitance of the capacitor is the amount of charge stored by the capacitor when the pd across the plates is 1 V.

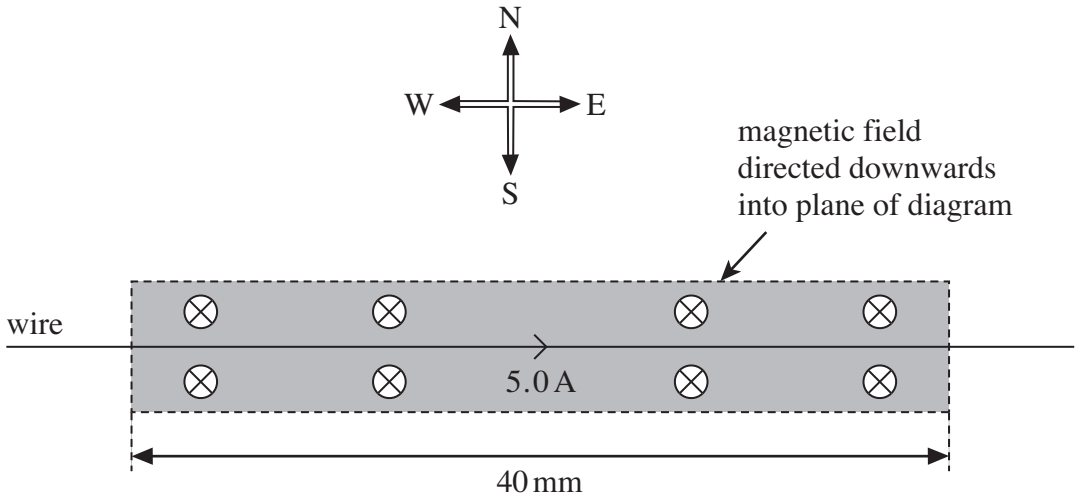
B A uniform electric field exists between the plates of the capacitor.

C The charge stored on the capacitor is inversely proportional to the pd across the plates.

D The energy stored when the capacitor is fully charged is proportional to the square of the pd across the plates.

Turn over for the next question

20 A horizontal straight wire of length 40 mm is in an east-west direction as shown in the diagram. A uniform magnetic field of flux density 50 mT is directed downwards into the plane of the diagram.



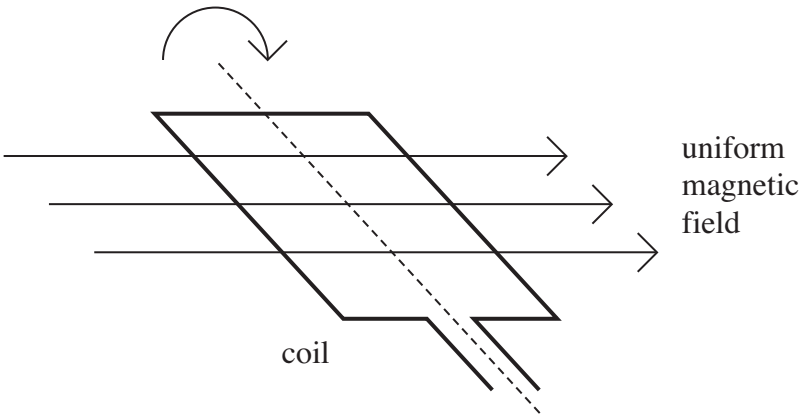
When a current of 5.0 A passes through the wire from west to east, a horizontal force acts on the wire. Which line, **A** to **D**, in the table gives the magnitude and direction of this force?

	magnitude / mN	**direction**
A	2.0	north
B	10.0	north
C	2.0	south
D	10.0	south

21 Which line, **A** to **D**, in the table correctly describes the trajectory of charged particles which enter separately, at right angles, a uniform electric field, and a uniform magnetic field?

	uniform electric field	**uniform magnetic field**
A	parabolic	circular
B	circular	parabolic
C	circular	circular
D	parabolic	parabolic

22 A rectangular coil is rotated in a uniform magnetic field.



When the coil is rotated at a constant rate, an alternating emf ε is induced in it. The variation of emf ε, in volts, with time t, in seconds, is given by

$$\varepsilon = 20 \sin (100 \pi t)$$

Which line, **A** to **D**, in the table gives the peak value ε_0 and the frequency f of the induced emf?

	ε_0 / V	f / Hz
A	10	50
B	10	100
C	20	50
D	20	100

23 The magnetic flux through a coil of 5 turns changes uniformly from 15×10^{-3} Wb to 7.0×10^{-3} Wb in 0.50 s. What is the magnitude of the emf induced in the coil due to this change in flux?

A 14 mV

B 16 mV

C 30 mV

D 80 mV

24 Which one of the following statements concerning power losses in a transformer is **incorrect**?

Power losses can be reduced by

A laminating the core.

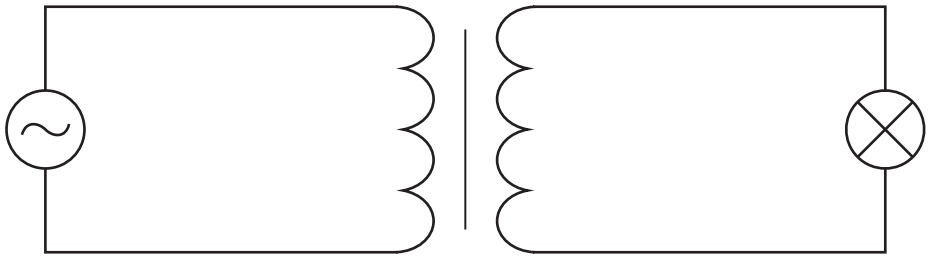
B using high resistance windings.

C using thick wire.

D using a core made of special iron alloys which are easily magnetised.

25 A transformer with 3000 turns in its primary coil is used to change an alternating pd from an rms value of 240 V to an rms value of 12 V.

When a 60 W, 12 V lamp is connected to the secondary coil, the lamp lights at normal brightness and a rms current of 0.26 A passes through the primary coil.



Which line, **A** to **D**, in the table gives correct values for the number of turns on the secondary coil and for the transformer efficiency?

	number of turns on the secondary coil	**efficiency**
A	150	96%
B	60 000	96%
C	150	90%
D	60 000	90%

END OF QUESTIONS