Cambridge Assessment

A Level

Physics A

Session: 2010 June
Type: Question paper
Code: H158-H558
Units: G481; G482; G484; G485

THIS IS A NEW SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

PHYSICS A

G481

Mechanics

Candidates answer on the Question Paper

OCR Supplied Materials:
- Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator
- Ruler (cm/mm)
- Protractor

Thursday 27 May 2010
Afternoon

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but must clearly show your Candidate Number, Centre Number and question number(s).

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

Answer **all** the questions.

1 **(a)** Complete the table of Fig. 1.1 by stating the value or name of each of the remaining three prefixes.

prefix	value
micro (μ)	10^{-6}
mega (M)	
	10^{-9}
tera (T)	

Fig. 1.1

[3]

(b) Circle all the scalar quantities in the list below.

density **weight** **velocity** **volume** **acceleration**

[1]

(c) The distance between the Sun and the Earth is 1.5×10^{11} m. Calculate the time in minutes for light to travel from the Sun to the Earth. The speed of light is 3.0×10^{8} m s^{-1}.

time = ... min **[2]**

(d) The terminal velocity of a raindrop falling vertically through air is 4.0 m s^{-1}.

(i) In terms of the forces acting on the raindrop, explain why it is at terminal velocity.

....

....

.... **[2]**

(ii) Fig. 1.2 shows a velocity vector diagram for the falling raindrop in a horizontal crosswind of speed 1.5 m s^{-1}.

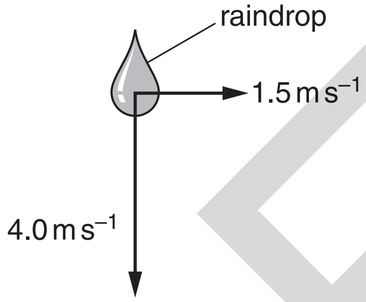

Fig. 1.2

1 On Fig. 1.2, draw an arrow on the raindrop to show the **direction** in which it will travel.

2 Calculate the magnitude of the resultant velocity of the raindrop. Use the space below for your working.

resultant velocity = ... m s^{-1} **[3]**

[Total: 11]

2 **(a)** According to Aristotle (384 – 322 B.C.)

'heavier objects fall faster than lighter ones'.

Explain how one experiment carried out by Galileo (1564 – 1642) overturned Aristotle's ideas of motion.

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.... **[3]**

(b) Fig. 2.1 shows an arrangement used in the laboratory to determine the acceleration *g* of free fall.

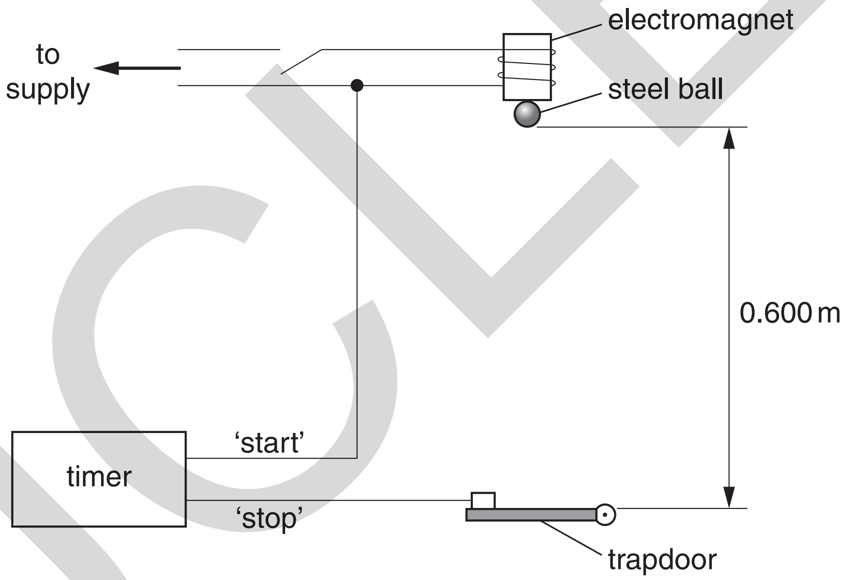

Fig. 2.1

The steel ball is held at rest by an electromagnet. When the electromagnet is switched off, the electronic timer is started and the ball falls. The timer is stopped when the ball opens the trapdoor. The distance between the bottom of the ball and the top of the trapdoor is 0.600 m. The timer records a time of fall of 0.356 s.

(i) Show that the value for the acceleration g of free fall obtained from this experiment is $9.47\,m\,s^{-2}$.

[2]

(ii) State **one** reason why the experimental value in **(i)** is less than $9.81\,m\,s^{-2}$.

....

....

.... **[1]**

(iii) On Fig. 2.2 sketch a graph to show the variation of the vertical distance s fallen by the ball with time t.

Fig. 2.2

[1]

[Total: 7]

3 **(a)** Define the *newton*.

....

.... **[1]**

(b) Fig. 3.1 shows a spaceship on the surface of the Earth.

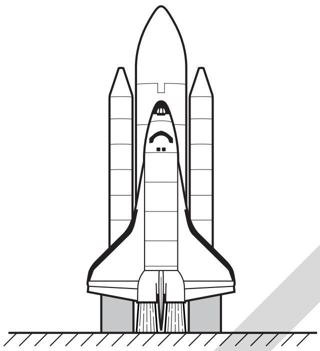

Fig. 3.1

The mass of the spaceship is 1.9×10^{6} kg. During lift off, the spaceship rockets produce a vertical upward force of 3.1×10^{7} N.

(i) Calculate the weight of the spaceship.

weight = ... N **[1]**

(ii) Calculate the initial vertical acceleration as the spaceship lifts off.

acceleration = ... $m\,s^{-2}$ **[2]**

(iii) The vertical upward force on the spaceship stays constant. Explain why the acceleration of the spaceship increases after lift off.

....

....

....

.... **[1]**

[Total: 5]

4 **(a)** Define *work done* by a force.

In your answer, you should use appropriate technical terms, spelled correctly.

....

.... **[1]**

(b) Fig. 4.1 shows a side view of a roller coaster.

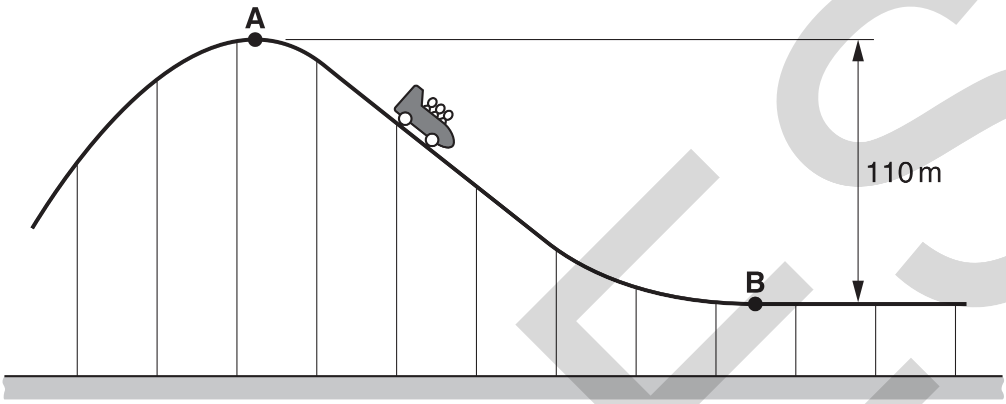

Fig. 4.1

The carriage and its passengers start at rest at **A**. At **B**, the bottom of the ride, the maximum speed of the carriage is 20 m s^{-1}. The vertical distance between **A** and **B** is 110 m. The length of the track between **A** and **B** is 510 m. The mass of the carriage and the passengers is 4000 kg.

(i) Complete the sentence below.

In your answer, you should use appropriate technical terms, spelled correctly.

As the carriage travels from **A** to **B**, ... energy

is transferred to .... energy and heat. **[2]**

(ii) By considering this energy transfer from **A** to **B**, determine the average frictional force acting on the carriage and passengers between **A** and **B**.

force = ... N **[3]**

[Total: 6]

5 **(a)** Define *braking distance* of a car.

....

....

.... **[1]**

(b) Other than the speed of the car, state two factors that affect the braking distance of a car. Describe how the braking distance is affected by each factor.

1. ....

....

....

....

2. ....

....

....

.... **[4]**

(c) Describe and explain how seat belts in cars reduce impact forces on the driver in an accident.

....

....

....

....

....

....

.... **[3]**

(d) Fig. 5.1 shows the variation of braking distance with speed *v* of a car.

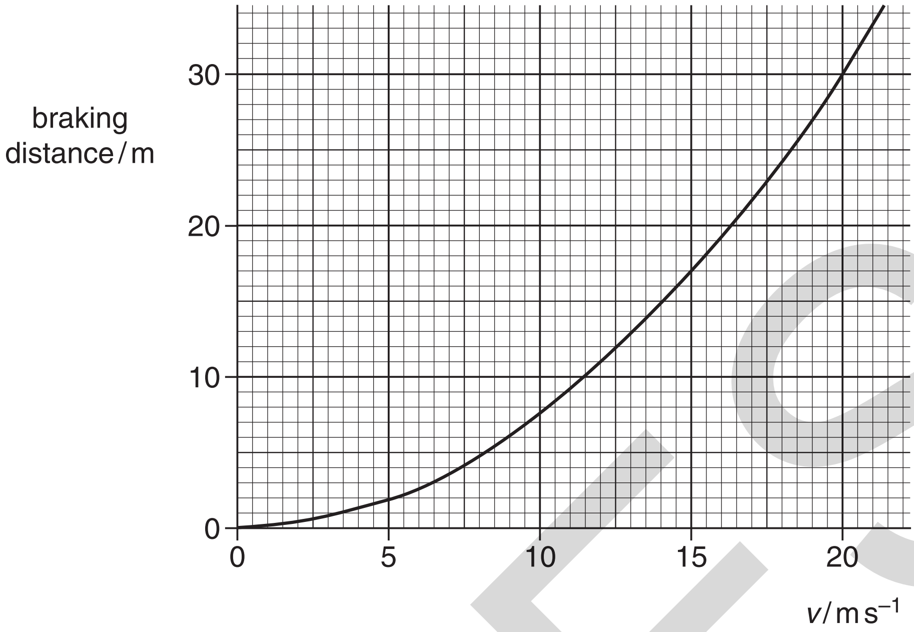

Fig. 5.1

(i) The car is travelling on a level straight road at a speed of $20\,m\,s^{-1}$. The reaction time of the driver is 0.50 s.

1 Calculate the thinking distance.

thinking distance = ... m

2 Hence, determine the stopping distance of the car.

stopping distance = ... m

[3]

(ii) In Fig. 5.1, the braking distance is directly proportional to the square of the speed. Determine the braking distance of the car when travelling at a speed of $32\,m\,s^{-1}$.

braking distance = ... m **[2]**

[Total: 13]

6 **(a)** Fig. 6.1 shows two equal but opposite forces acting on an object.

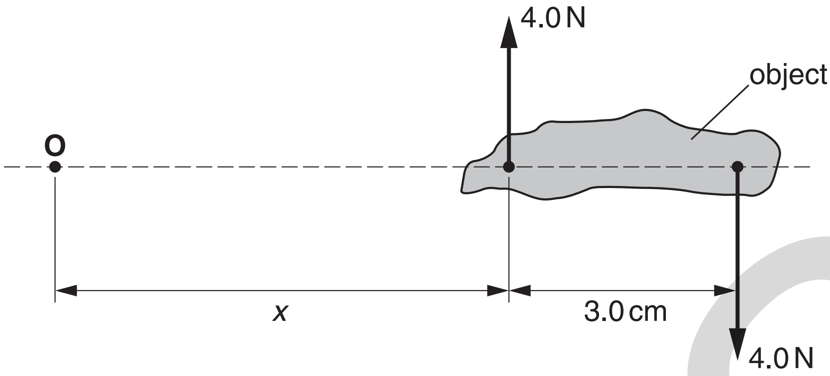

Fig. 6.1

The point **O** is at a distance *x* from the nearer of the two forces.

(i) The separation between the two parallel forces is 3.0 cm. Determine the torque of the couple exerted on the object.

torque = ... N m **[2]**

(ii) Calculate the total moment of the forces about the point **O** and state the significance of this value.

....

.... **[3]**

(b) State two conditions necessary for an object to be in equilibrium.

....

....

.... **[2]**

(c) A concrete paving slab has mass 45 kg and dimensions 0.600 m × 0.600 m × 0.050 m.

(i) Calculate the density of the concrete.

density = ... $kg\,m^{-3}$ **[2]**

(ii) Fig. 6.2 shows the concrete paving slab in equilibrium.

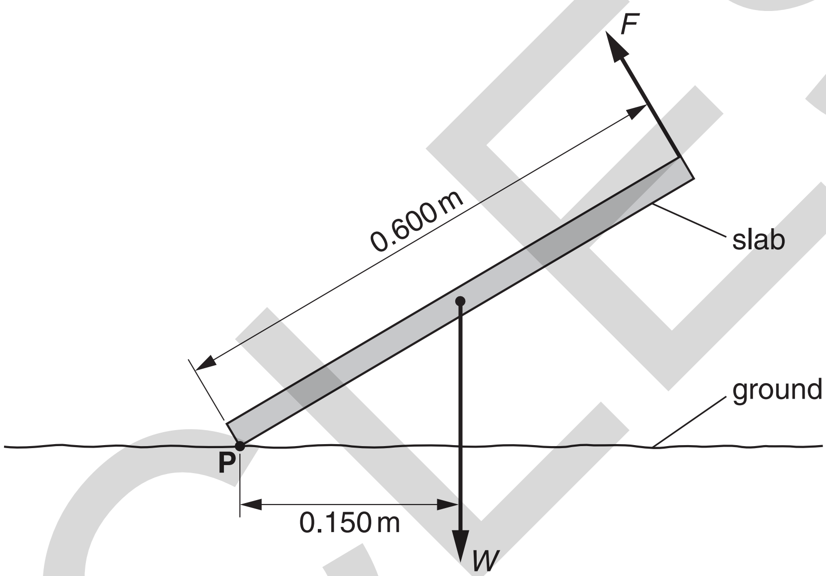

Fig. 6.2

Two forces acting on the slab are shown. The weight of the slab is *W*. The force *F* is applied at right angles to the end of the slab. By taking moments about **P**, determine the size of the force *F*.

F = ... N **[3]**

[Total: 12]

7 **(a)** Fig. 7.1 shows stress against strain graphs for two materials **X** and **Y** up to their breaking points.

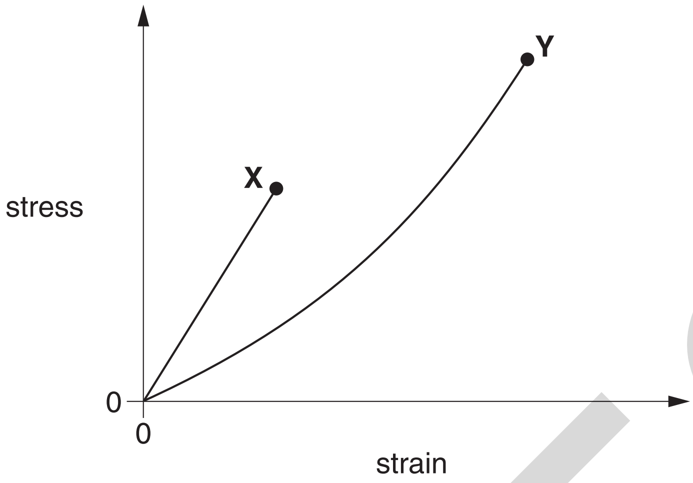

Fig. 7.1

Put a tick (✓) in the appropriate column if the statement applies to the material.

Statement	**X**	**Y**
This material is brittle.		
This material has greater breaking stress.		
This material obeys Hooke's Law.		

[1]

(b) Kevlar is one of the strongest man-made materials. It is used in reinforcing boat hulls, aircraft, tyres and bullet-proof vests. Sudden impacts cause this material to undergo plastic deformation.

(i) Explain what is meant by *plastic deformation*.

....

....

.... **[1]**

(ii) One particular type of Kevlar has breaking stress 3.00×10^9 Pa and Young modulus 1.30×10^{11} Pa. For a Kevlar thread of cross-sectional area 1.02×10^{-7} m^2 and length 0.500 m, calculate

1 the maximum breaking force

force = ... N

2 the extension of the thread when the stress is 1.20×10^9 Pa.

extension = ... m

[4]

[Total: 6]

END OF QUESTION PAPER

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THIS IS A NEW SPECIFICATION

OCR
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ADVANCED SUBSIDIARY GCE

PHYSICS A

G482

Electrons, Waves and Photons

Candidates answer on the Question Paper

OCR Supplied Materials:
- Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator

Wednesday 9 June 2010
Morning

Duration: 1 hour 45 minutes

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

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- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **100**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **20** pages. Any blank pages are indicated.

Turn over

Answer **all** the questions.

1 **(a)** State the difference between the directions of conventional current and electron flow.

....

.... **[1]**

(b) Circle one or more of the combinations of units which could act as a unit for current.

J s $C\,s^{-1}$ $V\,\Omega^{-1}$ $J\,C^{-1}$

[2]

(c) Fig. 1.1 shows a current I in a thick metal wire **X** connected to a longer thinner wire **Y** of the same metal as shown in Fig. 1.1.

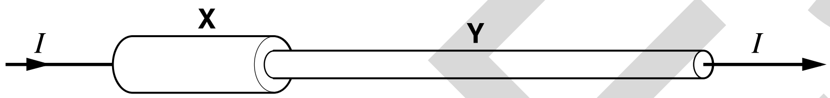

Fig. 1.1

(i) State why the current in **Y** must also be I.

....

.... **[1]**

(ii) Wire **Y** has half the cross-sectional area of the thicker wire **X** and is three times as long.

The resistance R_X of **X** is 12.0 Ω.

1 Show that the resistance R_Y of **Y** is 72 Ω.

2 Calculate the total resistance R of both wires.

R = ... Ω **[4]**

(iii) The mean drift velocity v_X of electrons in **X** is $2.0 \times 10^{-5}\,m\,s^{-1}$.

Use the fact that **X** has twice the cross-sectional area of the thinner wire **Y** to calculate the mean drift velocity v_Y of electrons in **Y**. Show your working.

v_Y = ... $m\,s^{-1}$ **[2]**

[Total: 10]

2 **(a)** Two filament lamps are described as being 230V, 25W and 230V, 60W.

(i) Describe what is meant by '230V, 25W' for a lamp.

....

....

....

.... **[2]**

(ii) Calculate the resistance of the 25W lamp when connected to a 230V supply.

resistance = ... Ω **[2]**

(iii) Each of the two lamps is connected across a 230V supply. Explain which lamp has the greater current.

....

....

....

.... **[2]**

(iv) Both lamps are connected in parallel across the 230V supply. The resistance of the 60W lamp in the circuit is 880 Ω. Calculate

1 the total resistance *R* across the supply

R = ... Ω

2 the current *I* drawn from the supply.

I = ... A **[4]**

(b) The 60 W filament lamp is connected to a 6.0 V battery. The resistance of the lamp in this circuit is 70 Ω. Explain why this value differs from the value given in **(a)(iv)** when the lamp is connected to the 230 V supply.

In your answer, you should make clear how your explanation links with the observations.

....

....

....

....

.... **[2]**

(c) By mistake a householder leaves a 60 W filament lamp switched on overnight for a period of 8.0 hours.

The cost of 1.0 kilowatt-hour of electricity is 21 pence.

(i) Define the *kilowatt-hour* (kWh).

....

....

.... **[1]**

(ii) Calculate the cost of this mistake to the householder.

cost = ... pence **[2]**

[Total: 15]

3 **(a)** A student wishes to determine the power dissipated in a variable resistor connected to a cell.

(i) Part of the circuit for this experiment is shown in Fig. 3.1. Complete the circuit of Fig. 3.1 showing how the variable resistor is connected and how the potential difference across it is measured. **[3]**

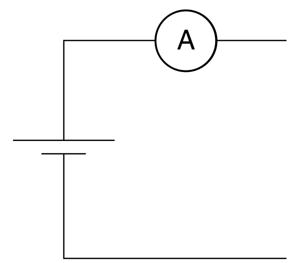

Fig. 3.1

(ii) Fig. 3.2 shows the variation of the potential difference V across the variable resistor with the current I in it.

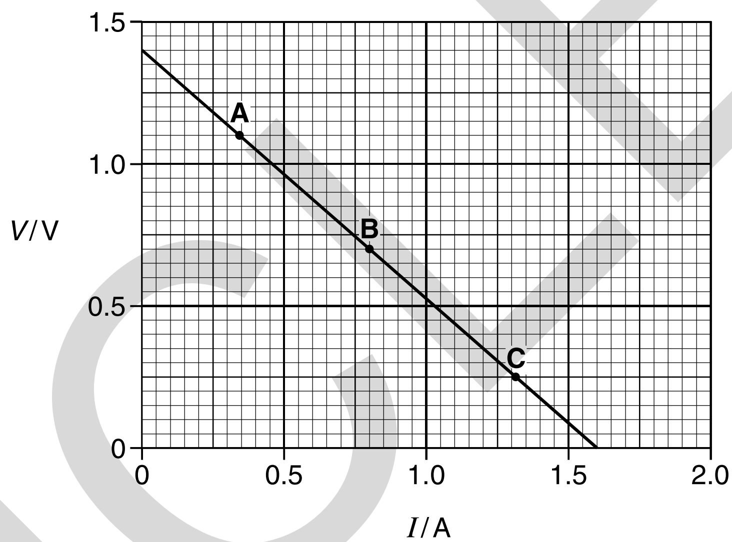

Fig. 3.2

1 The potential difference V across the variable resistor is also the terminal p.d. across the cell. Describe how the potential difference across the cell varies with the **resistance** R of the variable resistor. Suggest why the terminal p.d. varies in this way.

....

....

....

....

....

.... **[3]**

2 By referring to the points **A** and **C**, justify that the power dissipated in the variable resistor is a maximum at or near point **B**.

....

....

....

....

.... **[3]**

3 Determine the e.m.f. E of the cell.

E = ... V **[1]**

4 Calculate the internal resistance r of the cell.

r = ... Ω **[2]**

(b) In Fig. 3.1, the cell is replaced by a solar cell as the source of e.m.f.
A solar cell transforms light energy into electrical energy. The maximum intensity of sunlight on the solar cell is 800 W m^{-2}. The surface area of the cell is 2.5×10^{-3} m^2.

(i) Define the term *intensity*.

....

.... **[1]**

(ii) The maximum power delivered by the solar cell to the variable resistor is 0.25 W. Determine the maximum efficiency of the solar cell.

maximum efficiency = ... **[3]**

[Total: 16]

4 Fig. 4.1 shows how the resistance of a light-dependent resistor (LDR) varies with the intensity of the light incident on it.

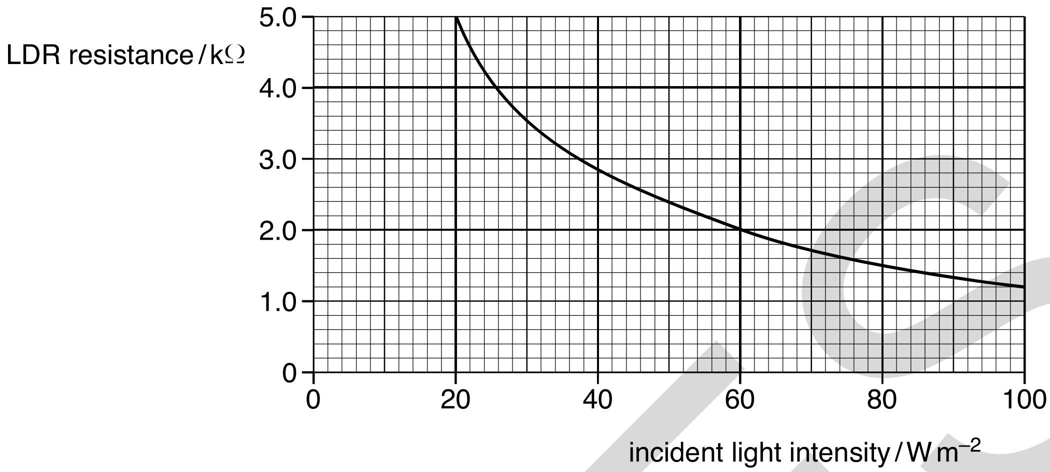

Fig. 4.1

(a) State how the resistance of the LDR changes with light intensity.

.... **[1]**

(b) Fig. 4.2 shows a light-sensing potential divider circuit where the LDR is connected in parallel to a voltmeter and data-logger.

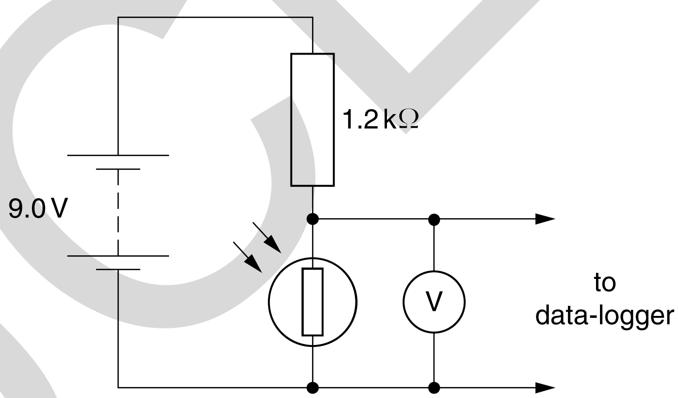

Fig. 4.2

The battery has an e.m.f. of 9.0 V and negligible internal resistance. The 1.2 kΩ resistor is made of carbon. The potential difference across the LDR is 6.0 V.

(i) State the potential difference across the 1.2 kΩ resistor.

potential difference = ... V **[1]**

(ii) Calculate the resistance R of the LDR.

R = ... kΩ **[3]**

(iii) Use Fig. 4.1 to determine the light intensity when the p.d. across the LDR is 6.0V.

light intensity = ... $W\,m^{-2}$ **[1]**

(c) **(i)** Fig. 4.1 shows that the change in resistance when the light intensity rises from $60\,W\,m^{-2}$ to $80\,W\,m^{-2}$ is 0.5kΩ. State the change in resistance when the light intensity rises from $20\,W\,m^{-2}$ to $40\,W\,m^{-2}$.

change in resistance = ... kΩ **[1]**

(ii) Larger changes in data-logger voltage are observed for changes at low light intensity rather than at high light intensity. Explain this.

....

....

....

.... **[2]**

(d) When the circuit of Fig. 4.2 is operated for a long time, the carbon resistor becomes hot. The resistivity of carbon falls as the temperature rises. State and explain the effect on the potential difference across the LDR.

....

....

....

....

....

.... **[3]**

(e) Describe briefly **two** advantages of using a data-logger to monitor the variation of light intensity falling on the LDR.

....

....

....

....

.... **[2]**

[Total: 14]

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5 **(a)** Name one common property of electromagnetic waves not shared by other waves.

.... **[1]**

(b) Fig. 5.1 shows a block diagram of the seven regions of the electromagnetic spectrum, labelled **A** to **G**.

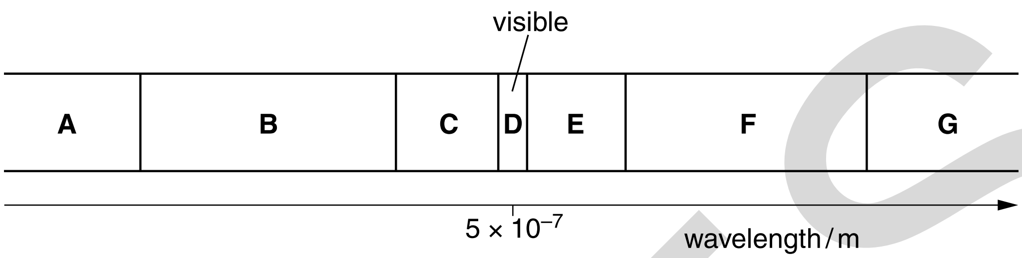

Fig. 5.1

Name the principal radiation in each of the regions **A**, **C** and **F**.

A .... **C** ....

F .... **[3]**

(c) An aerial mounted vertically transmits vertically polarised radio waves of frequency 1.0×10^9 Hz. The waves are detected by a receiving aerial some distance away. Initially the receiving aerial is also mounted vertically as shown in Fig. 5.2.

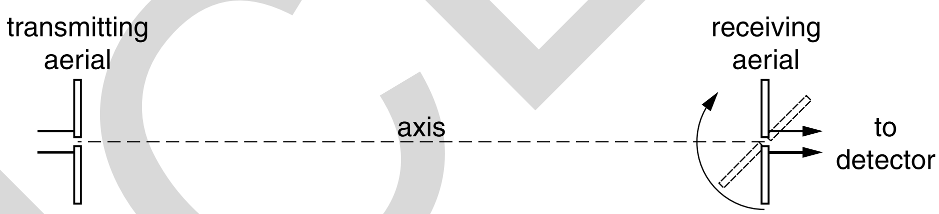

Fig. 5.2

The length of each aerial is half the wavelength of the radio waves.

(i) Calculate the wavelength of the waves.

wavelength = ... m **[2]**

(ii) Calculate the length of an aerial.

length = ... m **[1]**

(iii) The receiving aerial is rotated through 180° about the axis joining the centres of the two aerials. See Fig. 5.2. Describe and explain how the output signal from the receiving aerial changes with the angle of rotation.

....

....

....

....

....

.... **[3]**

(d) Ultra-violet radiation from the Sun is often divided into three regions UV-A, UV-B and UV-C.

(i) Describe the characteristics and dangers of UV-A, UV-B and UV-C radiations.

....

....

....

....

....

.... **[3]**

(ii) Explain how sunscreen protects the human skin.

....

....

.... **[1]**

(e) Explain why electrons can be emitted from a clean metal surface illuminated with bright ultra-violet light but never when infra-red light is used, however intense.

....

....

....

.... **[2]**

[Total: 16]

6 **(a)** Describe, in terms of vibrations, the difference between a longitudinal and a transverse wave. Give one example of each wave.

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....

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....

.... **[4]**

(b) Fig. 6.1 shows a loudspeaker fixed near the end of a tube of length 0.6 m.

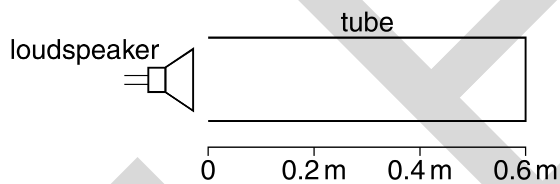

Fig. 6.1

The far end of the tube is closed. The frequency of the sound emitted from the loudspeaker is increased from zero. At a particular frequency a stationary wave is set up in the tube and the sound heard is much louder.

Explain how a stationary wave is formed in the tube.

In your answer, you should make clear how the stationary wave arises.

....

....

....

....

....

....

....

....

.... **[3]**

(c) Figs. 6.2 and 6.3 show stationary wave patterns of amplitude against position along the tube at the fundamental frequency f_0 and the next possible harmonic at frequency $3f_0$.

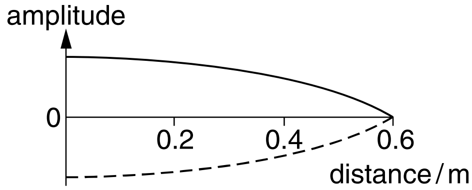

Fig. 6.2

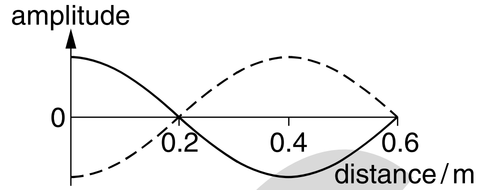

Fig. 6.3

Describe the motion of the air in the tube containing the stationary wave

(i) at points 0 m, 0.2 m and 0.6 m in Fig. 6.2

....

....

.... **[2]**

(ii) at points 0 m, 0.2 m and 0.4 m in Fig. 6.3.

....

....

.... **[2]**

(d) The end of the tube at 0.6 m from the loudspeaker is now opened.

(i) On Fig. 6.4 sketch the stationary wave pattern of amplitude against position along the tube at the new fundamental frequency. **[2]**

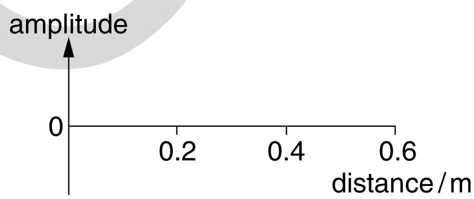

Fig. 6.4

(ii) State how the frequency of this stationary wave is related to the frequency f_0 of Fig. 6.2.

.... **[1]**

[Total: 14]

7 **(a)** When a glowing gas discharge tube is viewed through a diffraction grating an emission line spectrum is observed.

(i) Explain what is meant by a *line spectrum*.

....

....

.... **[2]**

(ii) Describe how an absorption line spectrum differs from an emission line spectrum.

....

.... **[1]**

(b) A fluorescent tube used for commercial lighting contains excited mercury atoms. Two bright lines in the visible spectrum of mercury are at wavelengths 436 nm and 546 nm.

$1\,\text{nm} = 10^{-9}\,\text{m}$

Calculate

(i) the energy of a photon of violet light of wavelength 436 nm

energy = ... J **[3]**

(ii) the energy of a photon of green light of wavelength 546 nm.

energy = ... J **[1]**

(c) Electron transitions between the three levels **A**, **B** and **C** in the energy level diagram for a mercury atom (Fig. 7.1) produce photons at 436 nm and 546 nm. The energy *E* of an electron bound to an atom is negative. The ionisation level, not shown on the diagram, defines the zero of the vertical energy scale.

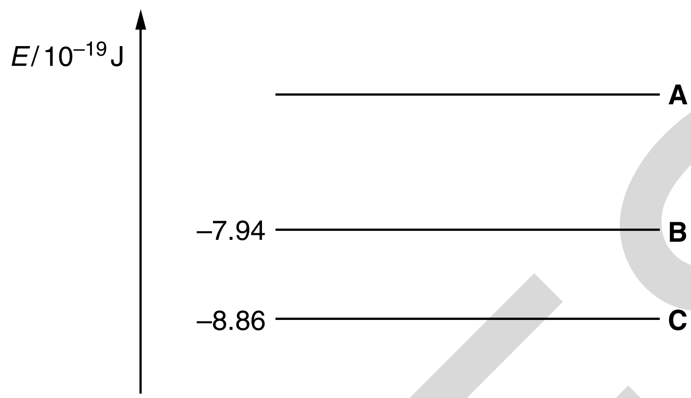

Fig. 7.1

(i) Draw two arrows on Fig. 7.1 to represent the transitions which give rise to these photons. Label each arrow with its emitted photon wavelength. **[3]**

(ii) Use your values for the energy of the photons from **(b)** to calculate the value of the energy level **A**.

E = ... J **[2]**

(d) The light from a distant fluorescent tube is viewed through a diffraction grating aligned so that the tube and the lines on the grating are parallel. The light from the tube is incident as a parallel beam at right angles to the diffraction grating.

The line separation on the grating is 3.3×10^{-6} m.

Calculate the angle to the straight through direction of the first order green (546 nm) image of the tube seen through the grating.

angle = ... ° **[3]**

[Total: 15]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

ADDITIONAL PAGE

ADDITIONAL PAGE

OCR
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OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE
PHYSICS A
The Newtonian World

G484

Candidates answer on the Question Paper

OCR Supplied Materials:
- Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator

Tuesday 29 June 2010
Afternoon

Duration: 1 hour

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **12** pages. Any blank pages are indicated.

Answer **all** the questions.

1 **(a)** A particular collision between two objects is *inelastic*. Place a tick (✓) at the end of each statement that applies to such a collision. **[2]**

Statement	
The magnitude of the impulse on each object is the same.	
Kinetic energy and momentum for the objects are conserved.	
Total energy is conserved.	
After the collision, the objects have the same momentum.	

(b) Fig. 1.1 shows a tennis ball before and after striking a wall at right angles.

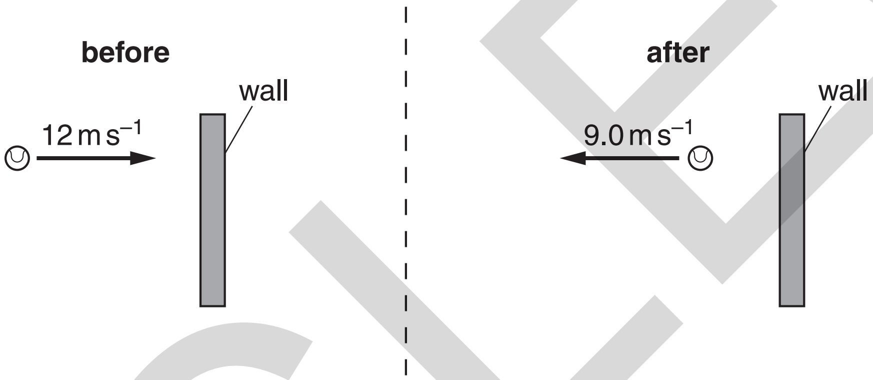

Fig. 1.1

The ball of mass 0.060 kg hits the wall at a speed of $12\,m\,s^{-1}$. The ball is in contact with the wall for 0.15 s. It rebounds with a speed of $9.0\,m\,s^{-1}$. Calculate

(i) the loss of kinetic energy during the collision

loss of kinetic energy = ... J **[2]**

(ii) the magnitude of the average force exerted on the ball by the wall

average force on ball = ... N **[2]**

(iii) the magnitude of the average force exerted on the wall by the ball during this collision.

average force on wall = ... N **[1]**

(c) **(i)** State **three** assumptions of the kinetic model of ideal gases.

....

....

....

....

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....

....

.... **[3]**

(ii) Use the kinetic theory of gases to explain how a gas exerts a pressure.

....

....

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....

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....

....

....

....

.... **[3]**

[Total: 13]

2 **(a)** Fig. 2.1 shows an aeroplane flying in a horizontal circle at constant speed. The weight of the aeroplane is W and L is the lift force acting at right angles to the wings.

Fig. 2.1

(i) Explain how the lift force L maintains the aeroplane flying in a **horizontal** circle.

....

....

....

.... **[2]**

(ii) The aeroplane of mass 1.2×10^5 kg is flying in a horizontal circle of radius 2.0 km.

The centripetal force acting on the aeroplane is 1.8×10^6 N. Calculate the speed of the aeroplane.

speed = ... $m\,s^{-1}$ **[2]**

(b) Fig. 2.2 shows a satellite orbiting the Earth at a constant speed v. The radius of the orbit is r.

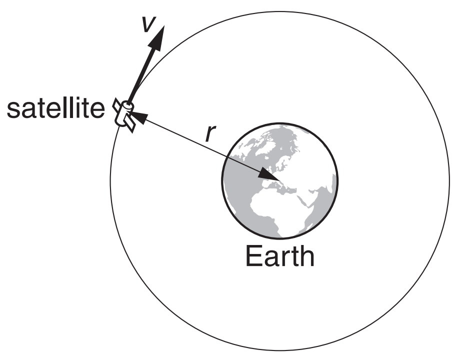

Fig. 2.2

Show that the orbital period T of the satellite is given by the equation

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

where M is the mass of the Earth and G is the gravitational constant.

[3]

(c) The satellites used in television communication systems are usually placed in geostationary orbits.

In your answer, you should use appropriate technical words spelled correctly.

(i) State two features of geostationary orbits.

1. ....

....

2. ....

.... **[2]**

(ii) Calculate the radius of orbit of a geostationary satellite.

The mass of the Earth is 6.0×10^{24} kg.

radius = ... m **[3]**

[Total: 12]

3 **(a)** State two conditions concerning the **acceleration** of an oscillating object that must apply for simple harmonic motion.

1. ....

....

2. ....

....

.... **[2]**

(b) Fig. 3.1 shows how the potential energy, in mJ, of a simple harmonic oscillator varies with displacement.

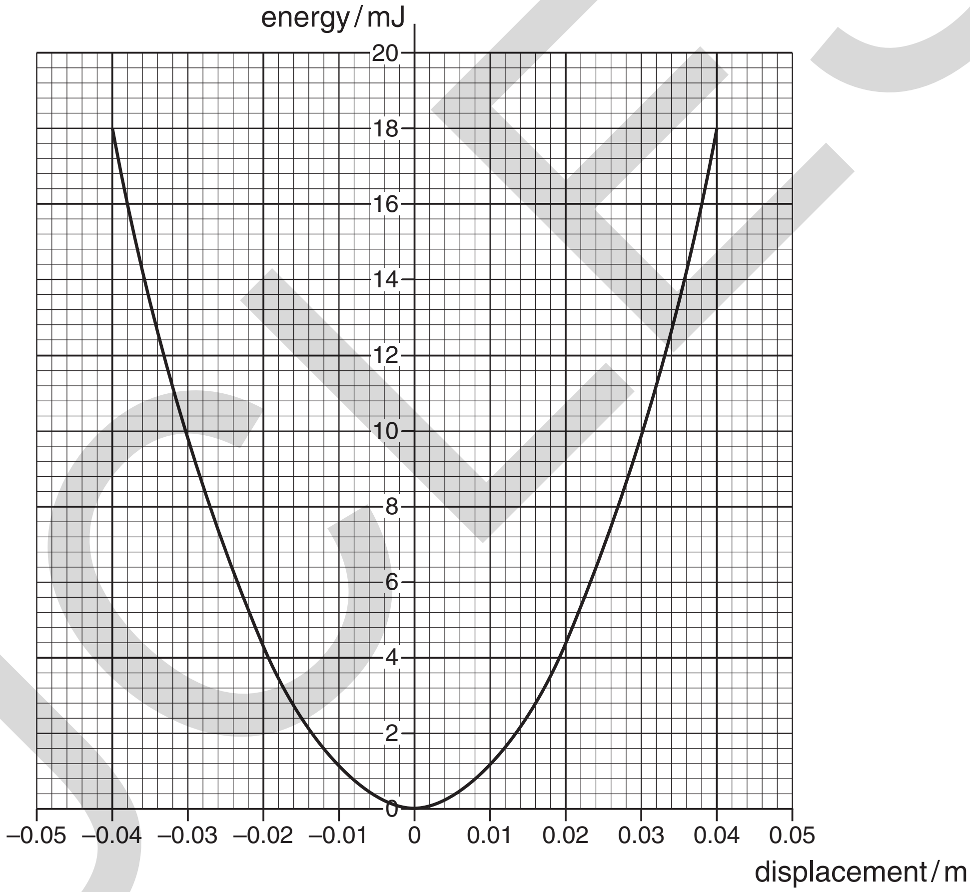

Fig. 3.1

On Fig. 3.1 sketch graphs to show the variation of

(i) kinetic energy of the oscillator with displacement – label this graph **K** **[2]**

(ii) the total energy of the oscillator with displacement – label this graph **T**. **[1]**

(c) Use Fig. 3.1 to determine

(i) the amplitude of the oscillations

amplitude = ... m **[1]**

(ii) the maximum speed of the oscillator of mass 0.12 kg

maximum speed = ... $m\,s^{-1}$ **[2]**

(iii) the frequency of the oscillations.

frequency = ... Hz **[2]**

(d) Resonance can either be useful or a problem. Describe one example where resonance has a useful application and one example where resonance is a problem or nuisance. For each example identify what is oscillating and what causes these oscillations.

(i) useful application

....

....

....

....

.... **[2]**

(ii) problem

....

....

....

....

.... **[2]**

[Total: 14]

4 Fig. 4.1 shows smoke particles suspended in air. The arrows indicate the directions in which the smoke particles are moving at a particular instant. The lengths of the arrows indicate the different speeds of the particles.

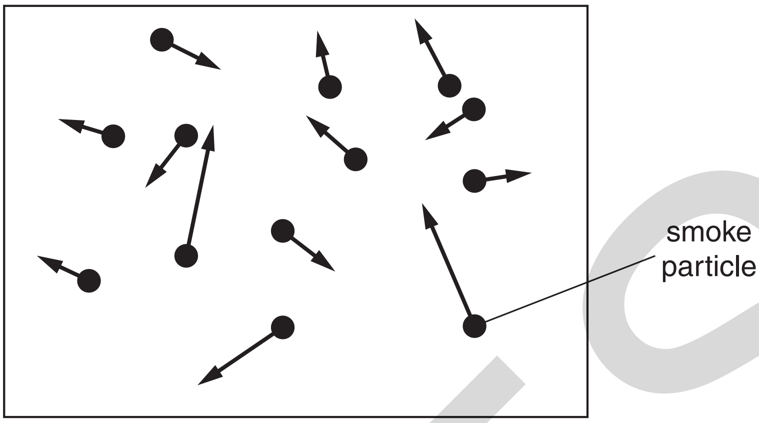

Fig. 4.1

(a) (i) State the name given to this type of random motion of smoke particles in air.

In your answer, you should use appropriate technical terms spelled correctly.

....

.... **[1]**

(ii) State **two** conclusions about the air molecules that may be deduced from the observed motion of the smoke particles.

....

....

....

.... **[2]**

(b) (i) The radius of an inflated football is 0.11 m. The temperature of the air inside the ball is 17 °C. Calculate the mass of air in the ball when the pressure inside it is 2.6×10^5 Pa.

The mass of one mole of air is 0.028 kg.

mass of air = ... kg **[4]**

(ii) The football is left in a room at a temperature of 0 °C until it reaches thermal equilibrium.

1 Explain the term *thermal equilibrium*.

....

....

.... **[1]**

2 Calculate the pressure exerted by the air inside the football when the temperature drops to 0 °C.

pressure = ... Pa **[2]**

[Total: 10]

5 A car of mass 970 kg is travelling at 27 m s^{-1} when the brakes are applied. The car is brought to rest in a distance of 40 m.

(a) (i) Calculate the kinetic energy of the car when it is travelling at 27 m s^{-1}.

kinetic energy = ... J **[1]**

(ii) Hence calculate the average braking force on the car stating any assumption that you make.

average braking force = ... N

assumption ....

.... **[3]**

(b) The car has four brake discs each of mass 1.2 kg. The material from which the discs are made has a specific heat capacity of 520 J kg^{-1} K^{-1}.

(i) Calculate the temperature rise of each disc after braking from a speed of 27 m s^{-1}. Assume all the kinetic energy of the car is converted into internal energy of the brake discs equally during braking.

temperature rise = ... °C **[2]**

(ii) State and explain **two** reasons why the actual temperature rise will be different.

....

....

....

....

....

....

....

.... **[4]**

(iii) Suggest one modification to the design of the disc braking system that could reduce the temperature rise of the discs.

....

....

.... **[1]**

[Total: 11]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE

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OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

PHYSICS A

G485

Fields, Particles and Frontiers of Physics

Candidates answer on the Question Paper

OCR Supplied Materials:
- Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator

Friday 18 June 2010
Morning

Duration: 1 hour 45 minutes

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
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- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **100**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- This document consists of **20** pages. Any blank pages are indicated.

DC (SHW 00376 12/08) 23020/4

Turn over

Answer **all** the questions.

1 **(a)** Define *capacitance*.

....

.... **[1]**

(b) Fig. 1.1 shows a circuit consisting of a resistor and a capacitor of capacitance 4.5 μF.

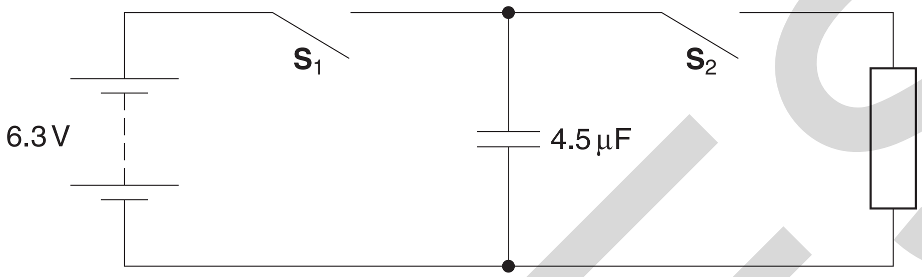

Fig. 1.1

Switch $\mathbf{S_1}$ is closed and switch $\mathbf{S_2}$ is left open. The potential difference across the capacitor is 6.3 V.

Calculate

(i) the charge stored by the capacitor

charge = ... μC **[1]**

(ii) the energy stored by the capacitor.

energy = ... J **[2]**

(c) Switch $\mathbf{S}_1$ is opened and switch $\mathbf{S}_2$ is closed.

(i) Describe and explain in terms of the movement of electrons how the potential difference across the capacitor changes.

....

....

....

.... **[3]**

(ii) The energy stored in the capacitor decreases to zero. State where the initial energy stored in the capacitor is dissipated.

....

.... **[1]**

(d) Fig.1.2 shows the 4.5 μF capacitor now connected in parallel with a capacitor of capacitance 1.5 μF. Both switches are open and both capacitors are uncharged.

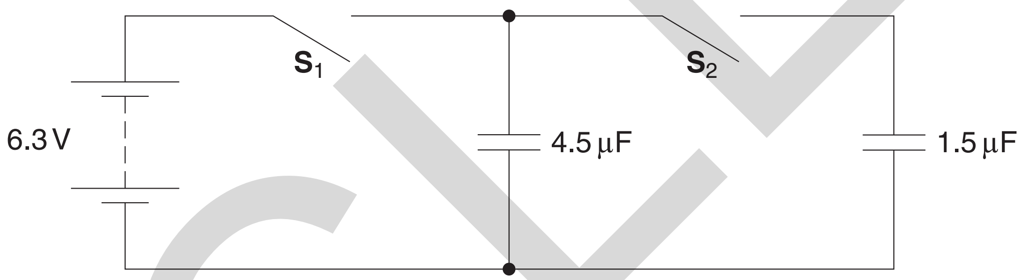

Fig. 1.2

Switch $\mathbf{S}_1$ is closed. The potential difference across the 4.5 μF capacitor is now 6.3 V. Switch $\mathbf{S}_1$ is opened and then switch $\mathbf{S}_2$ is closed.

(i) Calculate the total capacitance of the circuit when $\mathbf{S}_2$ is closed.

capacitance = ... μF **[1]**

(ii) Calculate the final potential difference across the capacitors.

potential difference = ... V **[2]**

[Total: 11]

2 **(a)** Olbers' paradox is based on two assumptions about the nature of our Universe. State these two assumptions.

....

....

.... **[2]**

(b) Fig. 2.1 shows how the recessional speed *v* of galaxies varies with their distance *d* from the Earth.

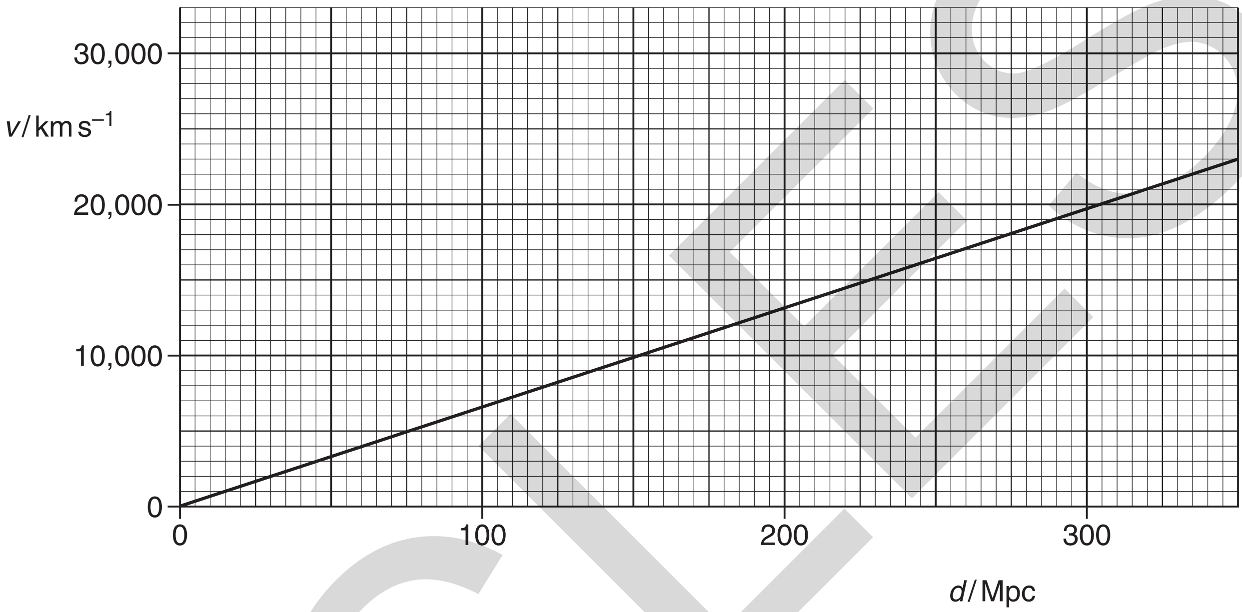

Fig. 2.1

(i) Use Fig. 2.1 to determine the Hubble constant.

Hubble constant = ... $km\,s^{-1}\,Mpc^{-1}$ **[2]**

(ii) Hence estimate the age of the Universe in years.

1 year = 3.2×10^7 s and 1 pc = 3.1×10^{16} m

age = ... y **[3]**

(c) **(i)** Calculate the critical density of the Universe using the Hubble constant determined in **(b)(i)**.

critical density = ... kg m^{-3} **[2]**

(ii) Describe how the fate of the Universe depends on its average density.

....

....

....

....

....

.... **[3]**

(d) Describe the evidence for the hot big bang model of the Universe.

....

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....

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....

....

.... **[4]**

[Total: 16]

3 **(a)** Fig. 3.1 shows two charged horizontal plates.

Fig. 3.1

The potential difference across the plates is 60 V. The separation of the plates is 5.0 mm.

(i) On Fig. 3.1 draw the electric field pattern between the plates. **[2]**

(ii) Calculate the electric field strength between the plates.

electric field strength = ... V m^{-1} **[1]**

(b) Positive ions are accelerated from rest in the horizontal direction through a potential difference of 400 V. The charged plates in **(a)** are then used to deflect the ions in the vertical direction. Fig. 3.2 shows the path of these ions.

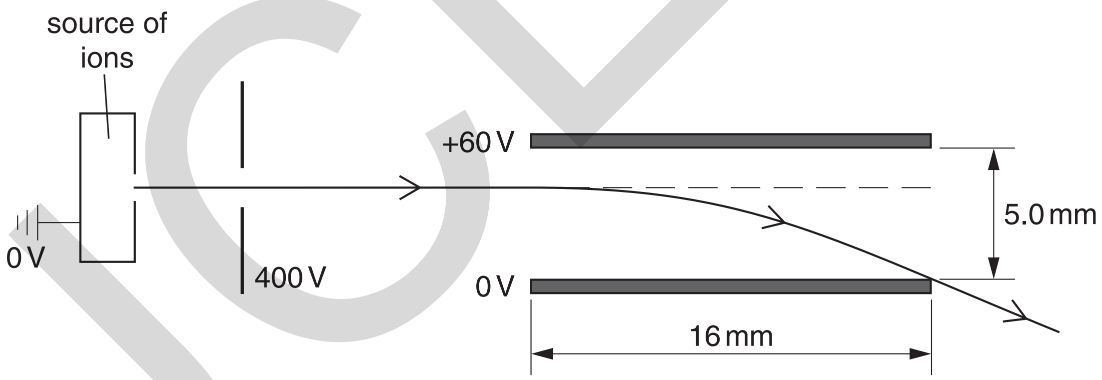

Fig. 3.2

Each ion has a mass of 6.6×10^{-27} kg and a charge of 3.2×10^{-19} C.

(i) Show that the horizontal velocity of an ion after the acceleration by the 400 V potential difference is $2.0 \times 10^{5}\,\mathrm{m\,s^{-1}}$.

[2]

(ii) The ions enter at right angles to the uniform electric field between the plates. Calculate the vertical acceleration of an ion due to this electric field.

acceleration = ... $\mathrm{m\,s^{-2}}$ **[2]**

(iii) The length of each of the charged plates is 16 mm.

1 Show that an ion takes about 8.0×10^{-8} s to travel through the plates.

[1]

2 Calculate the vertical deflection of an ion as it travels through the plates.

deflection = ... m **[2]**

(c) A uniform magnetic field is applied in the region between the plates in Fig. 3.2. The magnetic field is perpendicular to both the path of the ions and the electric field between the plates.

Calculate the magnitude of the magnetic flux density of field needed to make the ions travel horizontally through the plates.

magnetic flux density = ... T **[3]**

(d) Ions of the same charge but greater mass are accelerated by the potential difference of 400 V described in **(b)**. Describe and explain the effect on the deflection of the ions after they have travelled between the plates using the same electric and magnetic fields of **(c)**.

....

....

....

.... **[2]**

[Total: 15]

4 **(a)** Define *magnetic flux*.

....

.... **[1]**

(b) Fig. 4.1 shows a generator coil of 500 turns and cross-sectional area $2.5 \times 10^{-3}\,m^2$ placed in a magnetic field of magnetic flux density 0.035T. The plane of the coil is perpendicular to the magnetic field.

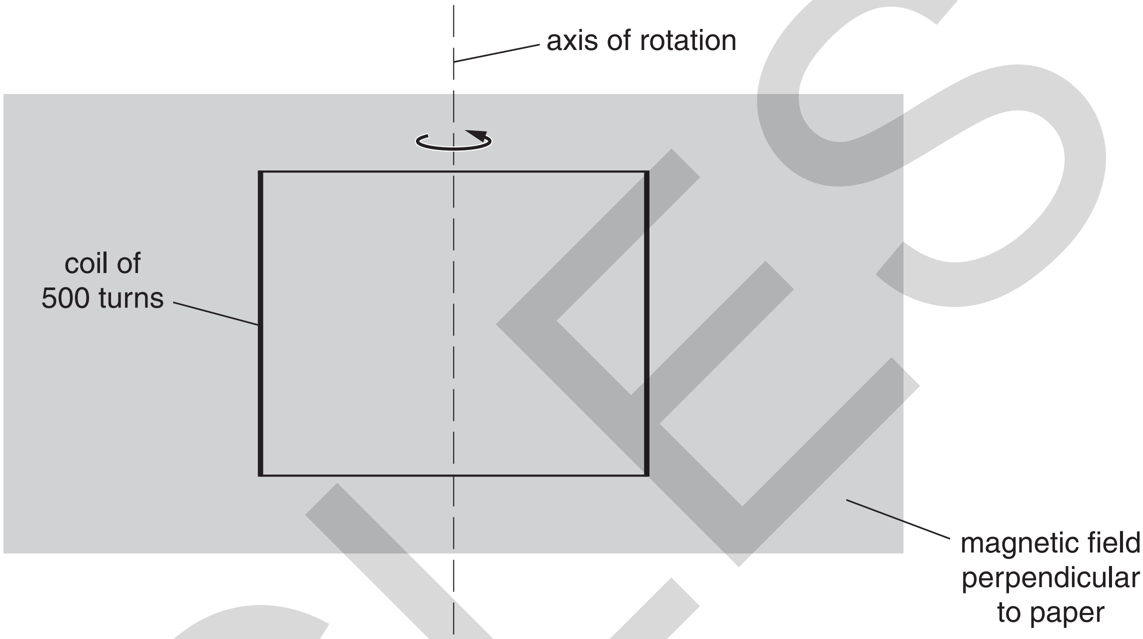

Fig. 4.1

Calculate the magnetic flux linkage for the coil in this position. Give a unit for your answer.

magnetic flux linkage = ... unit .... **[3]**

(c) The coil is rotated about the axis in the direction shown in Fig. 4.1.

Fig. 4.2 shows the variation of the magnetic flux ϕ against time t as the coil is rotated.

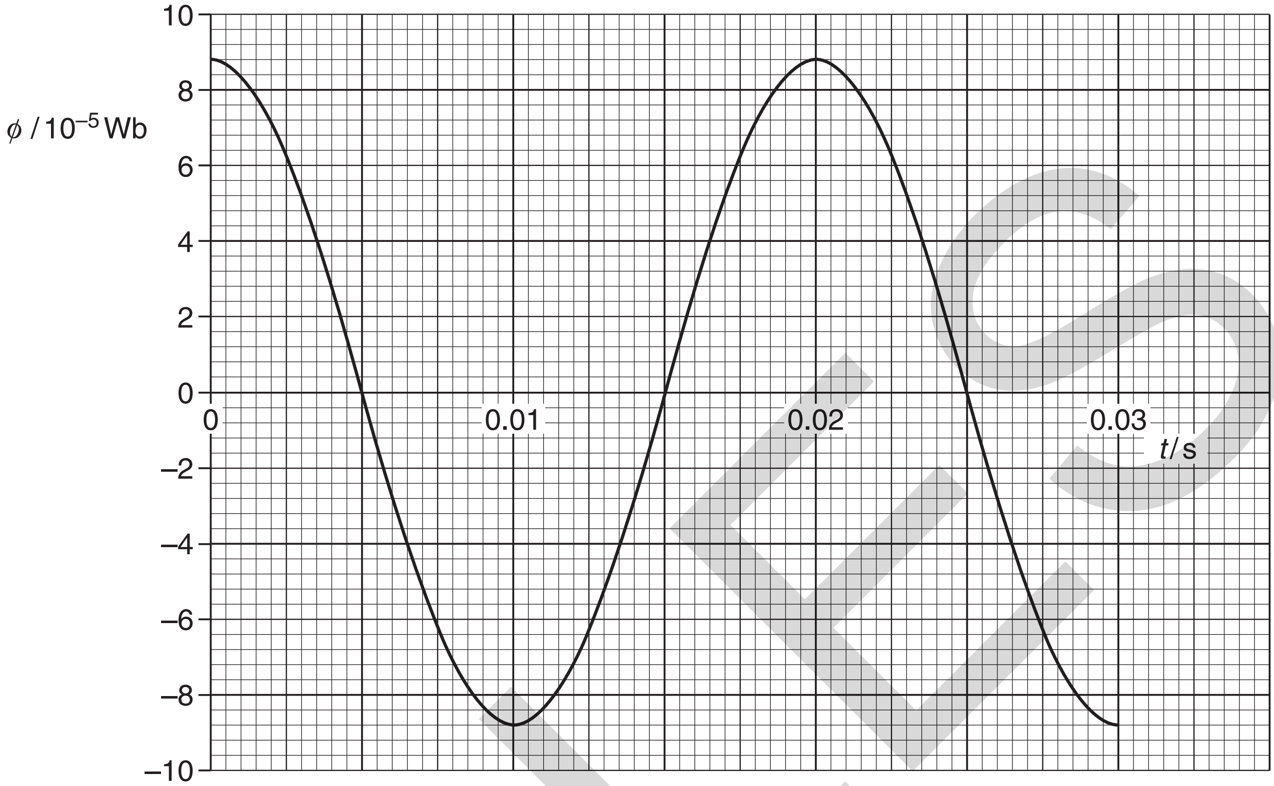

Fig. 4.2

(i) Explain why the magnitude of the magnetic flux through the coil varies as the coil rotates.

....

....

....

.... **[2]**

(ii) State Faraday's law of electromagnetic induction.

....

.... **[1]**

(iii) Use Fig. 4.2 to describe and explain the variation with time of the induced e.m.f. across the ends of the coil.

....

....

....

....

.... **[3]**

(iv) Use Fig. 4.2 to determine the magnitude of the average induced e.m.f. for the coil between the times 0 s and 0.005 s.

average e.m.f. = ... V **[2]**

(v) State and explain the effect on the magnitude of the maximum induced e.m.f. across the ends of the coil when the coil is rotated at twice the frequency.

....

....

.... **[2]**

[Total: 14]

5 **(a)** Outline the main principles of the use of magnetic resonance to obtain diagnostic information about internal organs.

In your answer, you should make clear how the principles you describe allow body structures to be distinguished.

[8]

(b) Describe one advantage and one disadvantage of MRI.

[2]

[Total: 10]

6 (a) A sample of a radioactive isotope contains 4.5×10^{23} active undecayed nuclei. The half-life of the isotope is 12 hours. Calculate

(i) the initial activity of the sample

activity = ... s^{-1} [2]

(ii) the number of active nuclei of the isotope remaining after 36 hours

number = ... [1]

(iii) the number of active nuclei of the isotope remaining after 50 hours.

number = ... [2]

(b) Explain why the activity of a radioactive material is a major factor when considering the safety precautions in the disposal of nuclear waste.

....

....

....

.... [2]

[Total: 7]

7 There are two types of beta decay, beta-plus and beta-minus. An isotope of carbon ${}^{15}_{6}C$ decays by beta emission into an isotope of nitrogen ${}^{15}_{7}N$. An isotope of phosphorus ${}^{30}_{15}P$ decays by beta emission into an isotope of silicon ${}^{30}_{14}Si$.

(a) Complete the following decay equations for the carbon and phosphorus isotopes.

(i) carbon decay

$${}^{15}_{6}C \rightarrow {}^{\cdots}_{\cdots}e + {}^{\cdots}_{\cdots}N + \ldots\ldots$$

(ii) phosphorus decay

$${}^{30}_{15}P \rightarrow {}^{\cdots}_{\cdots}e + {}^{\cdots}_{\cdots}Si + \ldots\ldots$$

[3]

(b) State the two beta decays in terms of a quark model of the nucleons.

(i) beta-plus decay

(ii) beta-minus decay

[2]

(c) Name the force responsible for beta decay.

.... **[1]**

[Total: 6]

8 **(a)** The following nuclear reaction occurs when a slow-moving neutron is absorbed by an isotope of uranium-235.

$$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n$$

(i) Explain how this reaction is able to produce energy.

....

....

.... **[2]**

(ii) State in what form the energy is released in such a reaction.

.... **[1]**

(b) The binding energy per nucleon of each isotope in **(a)** is given in Fig. 8.1.

isotope	binding energy per nucleon / MeV
$^{235}_{92}U$	7.6
$^{141}_{56}Ba$	8.3
$^{92}_{36}Kr$	8.7

Fig. 8.1

(i) Explain why the neutron $^{1}_{0}n$ does not appear in the table above.

....

.... **[1]**

(ii) Calculate the energy released in the reaction shown in **(a)**.

energy = ... MeV **[2]**

[Total: 6]

9 A proton travelling at a high velocity is fired at a stationary proton. It stops momentarily at a distance of 2.0×10^{-15} m from the stationary proton.

(a) Calculate the electrostatic force acting on each proton when separated by 2.0×10^{-15} m.

force = ... N **[2]**

(b) The two protons fuse together. Explain how the protons are able to remain together.

....

.... **[1]**

(c) Explain why the proton must have a very large velocity for the fusion to occur and the protons to remain together.

....

....

....

.... **[2]**

[Total: 5]

10 **(a)** State and describe **one** way in which X-ray photons interact with matter.

....

....

....

.... **[2]**

(b) The intensity of a collimated beam of X-rays is reduced to 10% of its initial value after passing through 3.0 mm of soft tissue. Calculate the thickness of soft tissue that reduces the intensity to 50% of its initial value.

thickness = ... mm **[3]**

(c) X-rays are used to image internal body structures.

(i) Explain how image intensifiers are used to improve the quality of the X-ray image.

In your answer, you should explain clearly the process involved which makes the image brighter.

....

....

....

....

.... **[3]**

(ii) Explain how contrast media are used to improve the quality of the X-ray image.

....

....

....

.... **[2]**

[Total: 10]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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