Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	7	5	2	/	0	1	Signature	

Paper Reference(s)

6752/01

Edexcel GCE

Salters Horners Physics

Advanced Subsidiary

Unit Test PSA2

Wednesday 17 January 2007 – Afternoon

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
Total	

Materials required for examination
Nil

Items included with question papers
Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature.
Answer **ALL** of the questions, writing your answers in this question booklet.
In calculations you should show all the steps in your working, giving your answer at each stage.
Calculators may be used.
Include diagrams in your answers where these are helpful.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets. There are seven questions in this paper. The total mark for this paper is 60.
The list of data, formulae and relationships is printed at the end of this booklet.

Advice to Candidates

You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

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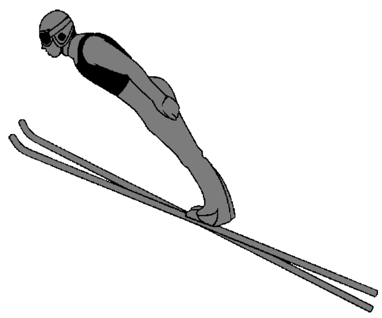
1. When going downhill, ski jumpers reach speeds of up to 30 m s^{-1} in order to jump great distances. As they move through the air, their body and ski position determines how far they jump.

(a) (i) Use one word to describe the type of airflow that the ski jumper is trying to achieve in mid-air.

....

(1)

(ii) The diagram shows a ski jumper in mid-air. Sketch the airflow pattern.



(2)

(iii) Suggest one way in which the ski jumper's equipment is designed to produce the maximum possible speed.

....

....

(1)

(b) Below is a list of material properties. Select one that is desirable and one that is undesirable for material from which the jumper's skis are made. Explain your choices.

Elastic Tough Plastic

(i) Desirable property: ....

Reason: ....

....

(ii) Undesirable property: ....

Reason: ....

....

(4)

Q1

(Total 8 marks)

N 2 2 0 9 9 A 0 2 2 0

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2. The British inventor Heinz Lipschutz spent much of his life trying to persuade the Royal Navy to make submarines out of concrete. Concrete is less dense than steel. Also, concrete is much cheaper than metals like steel, so larger submarines could be built for the same cost.

Another reason for using concrete was Lipschutz's claim that it would be more difficult to detect these submarines using sonar. Sonar uses ultrasound and detects submarines using a pulse-echo technique.

(a) (i) Describe how the distance to a submarine can be determined using the pulse-echo technique.

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(2)

(ii) Suggest why concrete would produce a weaker sonar signal than a metal such as steel.

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(2)

Leave blank

(b) (i) A high strength concrete has been developed that can withstand a maximum compressive stress of 800 MPa, double that of steel. A sample of this concrete has a cross-sectional area of $20\,m^2$. Calculate the maximum force that it could be subjected to before breaking.

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....

....

Force = ...

(2)

(ii) This concrete has a Young modulus of 5.0×10^9 Pa. Calculate its strain when under maximum compressive stress.

....

....

....

Strain = ...

(2)

(iii) Unfortunately, concrete has a relatively low tensile strength. This could result in the concrete cracking.

What word describes the behaviour of the concrete in this case?

....

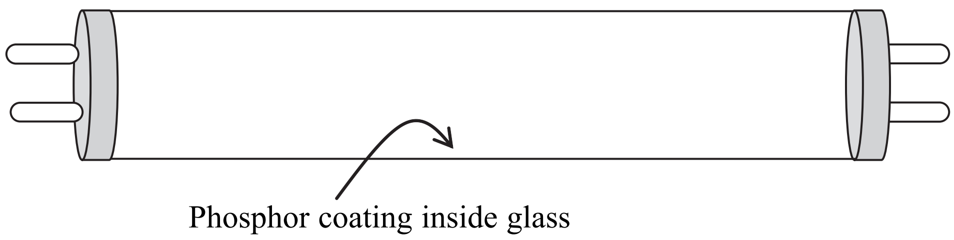
(1)

Q2

(Total 9 marks)

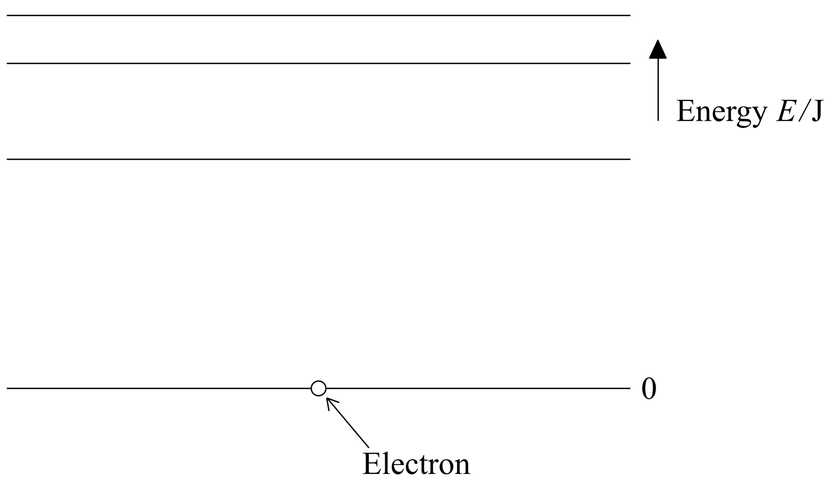
Leave blank

3. A fluorescent lamp consists of a glass tube containing a small amount of mercury vapour. When the lamp is switched on the mercury atoms emit photons of ultraviolet (UV) radiation. A phosphor coating inside the tube converts this radiation into visible light.



When a UV photon hits the coating it excites an electron into a higher energy level. As the electron falls back down, it emits a photon of visible light.

(a) (i) Add labelled arrows to the following electron energy level diagram for an atom of the phosphor coating, to illustrate this process. Start with the absorption of a UV photon and end with the emission of a photon of visible light.



(2)

(ii) The visible light photon emitted has less energy than the UV photon. What has happened to the rest of the energy?

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....

(1)

N 2 2 0 9 9 A 0 6 2 0

Leave blank

(iii) UV radiation with wavelengths in the range 320 nm–400 nm is emitted by the mercury atoms. Show that the emitted photons have a minimum energy of about 3 eV.

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

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(4)

(b) 'Black lights' are basically the same tubes without the phosphor coating. These have many applications; for example, they can be used to detect forgeries of old paintings, as older paints did not contain phosphors.

What difference would you see between a real painting and a forgery when viewed with a black light?

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....

....

(1)

Q3

(Total 8 marks)

Leave blank

4. Diamonds are one of the most beautiful but expensive jewels available today. Their beauty is due largely to the way in which they sparkle when light falls on them. The way a jewel sparkles is related to how light is reflected inside the jewel which depends upon its refractive index.

(a) (i) Diamond has a refractive index of 2.42. Show that the critical angle *C* for light passing from diamond into air is about 24°.

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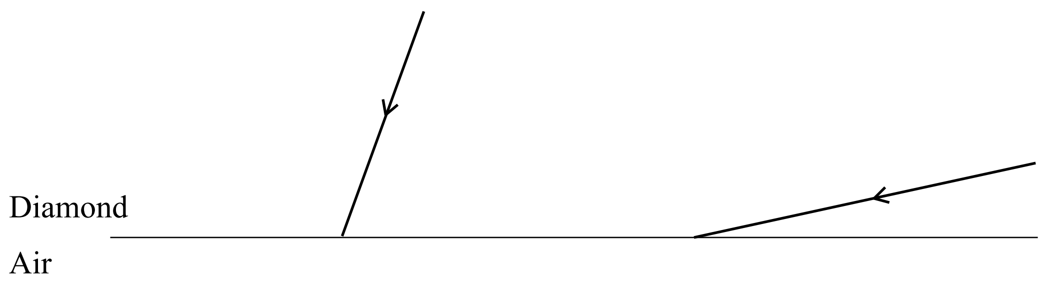
....

....

(2)

(ii) Add appropriate normals to the following diagram at the diamond-air interface and then sketch the paths that the two light rays would follow. One of them hits the interface at an angle smaller than *C*, and the other at an angle greater than *C*.



(2)

(iii) On the above diagram label

1. an incident angle *i*,

2. an angle of refraction *r*.

(2)

Leave blank

(iv) Explain how the amount of light reflected inside the jewel depends on the refractive index, using the terms **critical angle** and **total internal reflection**.

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....

(3)

(b) There have been many attempts to make imitation diamonds but they have always lacked the sparkle of the real thing. Recently, however, a semiconductor company has manufactured a mineral called moissanite. This has similar properties to diamond, but is much cheaper.

The refractive index of moissanite is about 2.67. Comment on the critical angle and hence the sparkle of this mineral compared with diamond.

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(1)

Q4

(Total 10 marks)

N 2 2 0 9 9 A 0 9 2 0

Leave blank

5. A website, launched on 1st April 2004, claimed that a nuclear powered car, called the *nCar*, was about to be manufactured. The site claimed that the *nCar* could run for its lifetime with its initial fuel load of 100 g of uranium-235, so it would never need refuelling!

Another claim was that the radioactive decay of uranium-235 would generate 35 kW of heat, continuously. This would be used to boil water for turbines which would generate electricity.

(a) (i) Suggest a problem caused by this continuous power production.

....

....

(1)

(ii) The data given on the website is wrong, as 100 g of uranium-235 generates only 2.0×10^{-6} W of heat. What mass of uranium-235 would actually be needed to provide 35 kW?

....

....

Mass = ...

(2)

(iii) Comment on your answer.

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....

....

(1)

Leave blank

(b) If such a car were to be produced, suggest two safety precautions to protect workers from the radiation while assembling the car.

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....

(2)

(c) Some people suggest that widespread use of nuclear powered transport would lead to an increase in the background radiation level.

(i) What is meant by background radiation?

....

....

....

(ii) Comment on their suggestion.

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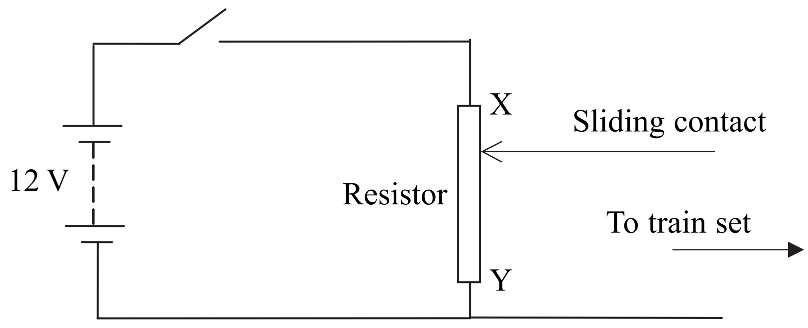
(2)

Q5

(Total 8 marks)

6. A child wants to power his model train set from a 12 V battery. He also wants to be able to control the speed of his trains.

His sister is studying Physics and suggests using the following circuit.



She has the following materials to choose from to make the resistor.

Material	Resistivity / Ω m
Copper	1.8×10^{-8}
Iron	1.2×10^{-7}
Constantan	4.9×10^{-7}
Carbon	1.4×10^{-5}

(a) The resistivity of the materials varies greatly. What type of scale could be used to plot them most easily on a graph?

....

(1)

Leave blank

N 2 2 0 9 9 A 0 1 2 2 0

Leave blank

(b) (i) She chooses a carbon rod. Explain why this is a good choice.

....

....

....

....

(2)

(ii) The carbon rod she uses has a cross-sectional area of 3.0×10^{-6} m^2 and a length of 40 cm. Show that the total resistance of the carbon rod is about 2 Ω.

....

....

....

(3)

(iii) Assuming that the internal resistance of the battery and the resistance of the connecting wires is negligible, state the potential difference available to the train set when the sliding contact is at:

X .... Y ....

(1)

(iv) The total resistance of the wires connecting the battery to the resistor is about 0.5 Ω. Explain whether this would have a significant effect on the potential difference available for the train set.

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(2)

Q6

(Total 9 marks)

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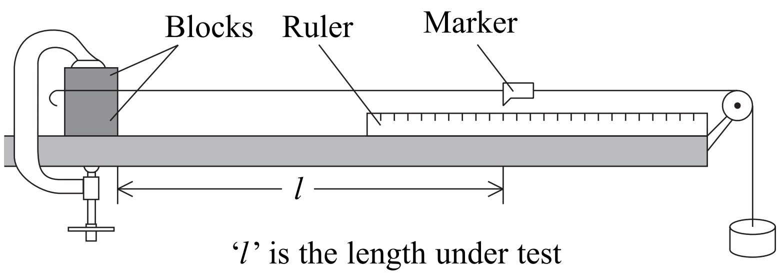
7. A student carries out an experiment to investigate the extension x of a clamped copper wire when he applies a varying force F to the free end.



'l' is the length under test

(a) The graph on the opposite page shows his results.

(i) Add a line of best fit to the graph.

(1)

(ii) Add an X to the line to mark the limit of proportionality.

(1)

(b) (i) Calculate the energy stored in the copper wire due to a 20 N load.

....

....

....

....

Energy stored = ...

(3)

(ii) What property of the wire could be determined by calculating the gradient of this graph?

....

(1)

(c) Explain how the graph would be different if the student had used a thicker piece of copper wire.

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(2)

Q7

(Total 8 marks)

N 2 2 0 9 9 A 0 1 4 2 0

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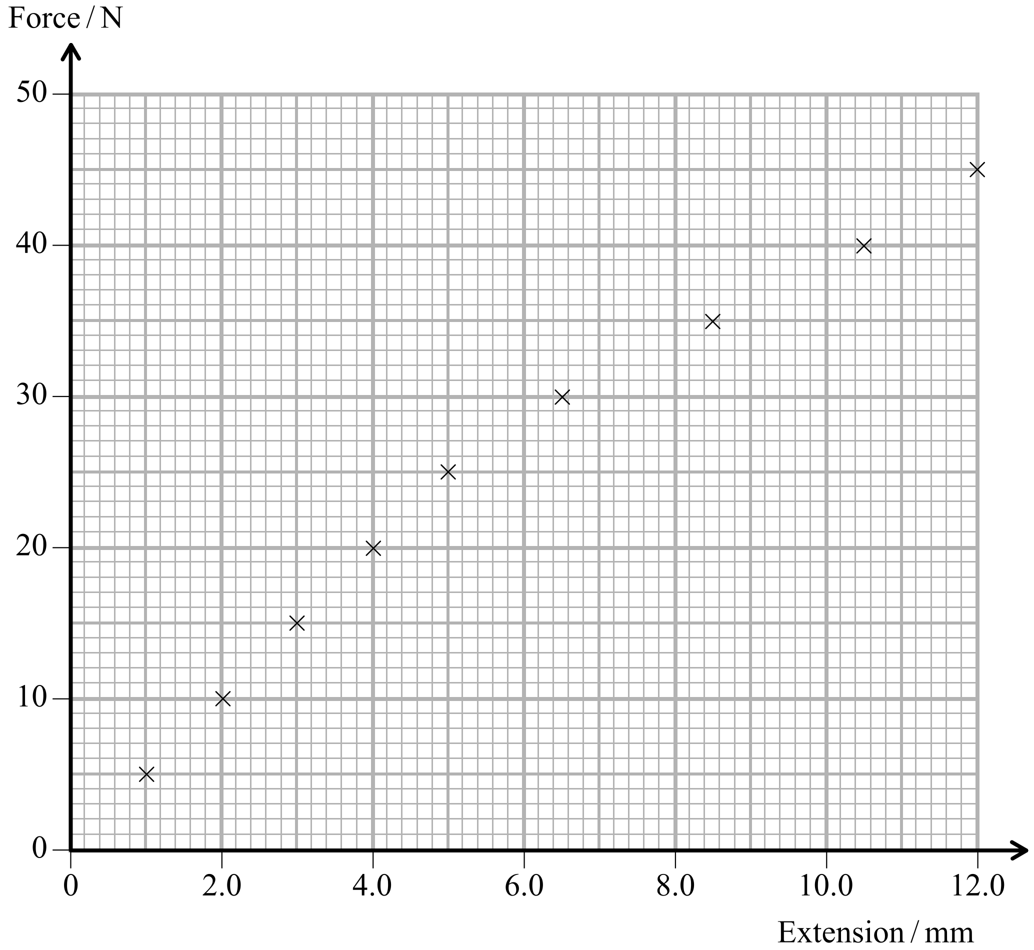

TOTAL FOR PAPER: 60 MARKS

END

N 2 2 0 9 9 A 0 1 5 2 0

List of data, formulae and relationships

Data

Gravitational constant	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}}$	
Acceleration of free fall	$g = 9.81\ \mathrm{m\,s^{-2}}$	(close to Earth's surface)
Gravitational field strength	$g = 9.81\ \mathrm{N\,kg^{-1}}$	(close to Earth's surface)
Electronic charge	$e = -1.60 \times 10^{-19}\ \mathrm{C}$	
Electronic mass	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$	
Electronvolt	$1\ \mathrm{eV} = 1.60 \times 10^{-19}\ \mathrm{J}$	
Proton mass	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$	
Planck constant	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$	
Molar gas constant	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$	
Boltzmann constant	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$	
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$	
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{N\,A^{-2}}$	

Unit 1

Physics at work, rest and play

Mechanics

Kinematic equations of motion $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

Energy

% *efficiency* = [*useful energy* (or power) *output/total energy* (or power) *input*] × 100%

Heating $\Delta E = mc\Delta\theta$

Quantum Phenomena

Photon model $E = hf$

Waves and Oscillations

For waves on a wire or string $v = \sqrt{(T/\mu)}$

For a lens $P = 1/f$

Unit 2

Physics for life

Quantum Phenomena

Photoelectric effect $hf = \phi + \frac{1}{2}mv_{max}^2$

Materials

Elastic strain energy $E_{el} = F\Delta x/2$

Stress $\sigma = F/A$

Strain $\varepsilon = \Delta x/x$

Young modulus $E = \sigma/\varepsilon$

Stokes' law $F = 6\pi\eta rv$

Waves and Oscillations

Refraction $\mu = \sin i/\sin r = v_1/v_2$

For lenses $P = P_1 + P_2$

$1/v + 1/u = 1/f$

Mathematics

Volume of sphere $V = \frac{4}{3}\pi r^3$

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