Centre No.						Paper Reference	Surname	Other names
Candidate No.						6 7 3 5 / 2 A	Signature	

Edexcel GCE

Physics

Advanced Level

Unit Test PHY5 Practical Test
Group 1

Monday 18 May 2009 – Afternoon

Time: 1 hour 30 minutes

Supervisor's Data and Comments	
A	Height h_0
Comments	

For Examiner's use only

For Team Leader's use only

Question numbers	Leave blank
A	
B	
C	
Total	

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, other names and signature.

PHY5 consists of questions A, B and C. Each question is allowed 20 minutes plus 5 minutes writing-up time. There is a further 15 minutes for writing-up at the end. The Supervisor will tell you which experiment to attempt first.

Write all your results, calculations and answers in the spaces provided in this question booklet.

In calculations you should show all the steps in your working, giving your answer at each stage.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets.

The total mark for this paper is 48.

The list of data, formulae and relationships is printed at the end of this booklet.

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Question 1A

(a) (i) Measure the height of the capillary tube outlet above the bench.

....

Measure the height above the bench of the zero mark on the burette.

....

Hence calculate the height h_0 of the zero mark above the capillary outlet.

....

(2)

(ii) Ensure that the burette is filled to the zero mark. You may run out water into the top-up beaker or add water to the burette using water from the beaker.

You are to determine the height of the water above the capillary outlet after it has been flowing out of the burette for different times.

Open the tap and allow water to run out of the burette for 15.0 s and close the tap. Measure the height of the water in the burette above the bench.

....

Without disturbing the arrangement, refill the burette to the zero mark using water from the top-up beaker and repeat your reading.

....

....

....

....

Hence determine a mean value for the height h_1 of the water in the burette above the capillary outlet.

....

....

Leave blank

Now refill the burette to the zero mark and take measurements to find the height h_2 of the water in the burette above the capillary outlet after 30.0 s.

....

....

....

....

Calculate the ratios h_0/h_1 and h_1/h_2.

....

....

....

(4)

(iii) It is suggested that these two ratios should be the same. Calculate the percentage difference between the two ratios and explain whether your readings support the suggestion.

....

....

....

....

....

....

(2)

QUESTION 1A CONTINUES ON THE NEXT PAGE

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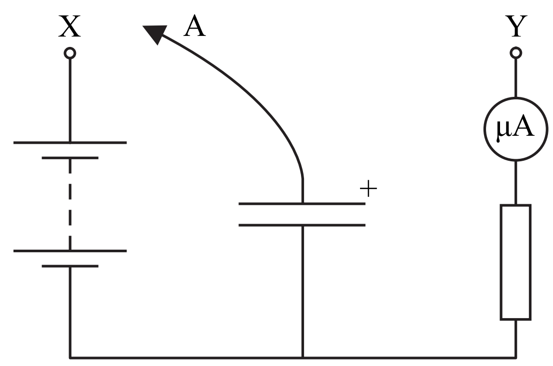
(b) (i) The circuit shown below has been set up for you. Identify the points in the circuit labelled A, X, and Y.



Use the spare lead to connect point X to point Y. Record the current I_0.

I_0 = ...

Disconnect the spare lead from X and Y.

Write down the value of $I_0/2$ and $I_0/4$.

$I_0/2$ = ... $I_0/4$ = ...

You are to measure the time it takes for the current I to fall to $I_0/2$ and $I_0/4$ as the capacitor discharges through the resistor.

Charge the capacitor by connecting point A to point X for a short time. Then disconnect A from X, and discharge the capacitor by connecting point A to point Y. As you make this connection start the stopwatch.

Record your values in the first two columns of the table below.

	t_1 / s = time when $I = I_0/2$	t_2 / s = time when $I = I_0/4$	t_3 / s = $(t_2 - t_1)$ / s
Mean values			

Hence calculate t_3, the time to fall from $I_0/2$ to $I_0/4$. Show these values in the third column.

(6)

Leave blank

(ii) Estimate the uncertainties in your values for t_1 and t_3. Use these to comment on the suggestion that t_1 and t_3 should be the same.

....

....

....

....

....

(2)

Q1A

(Total 16 marks)

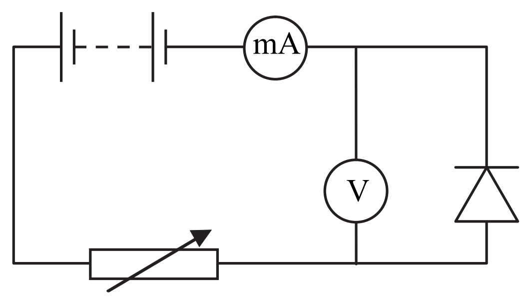
Leave blank

Question 1B

(a) Read room temperature θ using the thermometer.

θ = ...

The circuit shown in the diagram below has been set up for you.



(b) Connect the battery and adjust the variable resistor until the current I is 5.0 mA. Record below the corresponding reading V on the voltmeter.

You are to take readings of V for different values of I between 5.0 mA and approximately 50 mA. Record your readings for V and I below. Disconnect the battery after you have taken your readings.

I / mA	V / V	ln(I / mA)
5.0		

(6)

Leave blank

(c) It is suggested that the values of V and I are related by the equation

$$I = I_0 e^{aV}$$

and hence

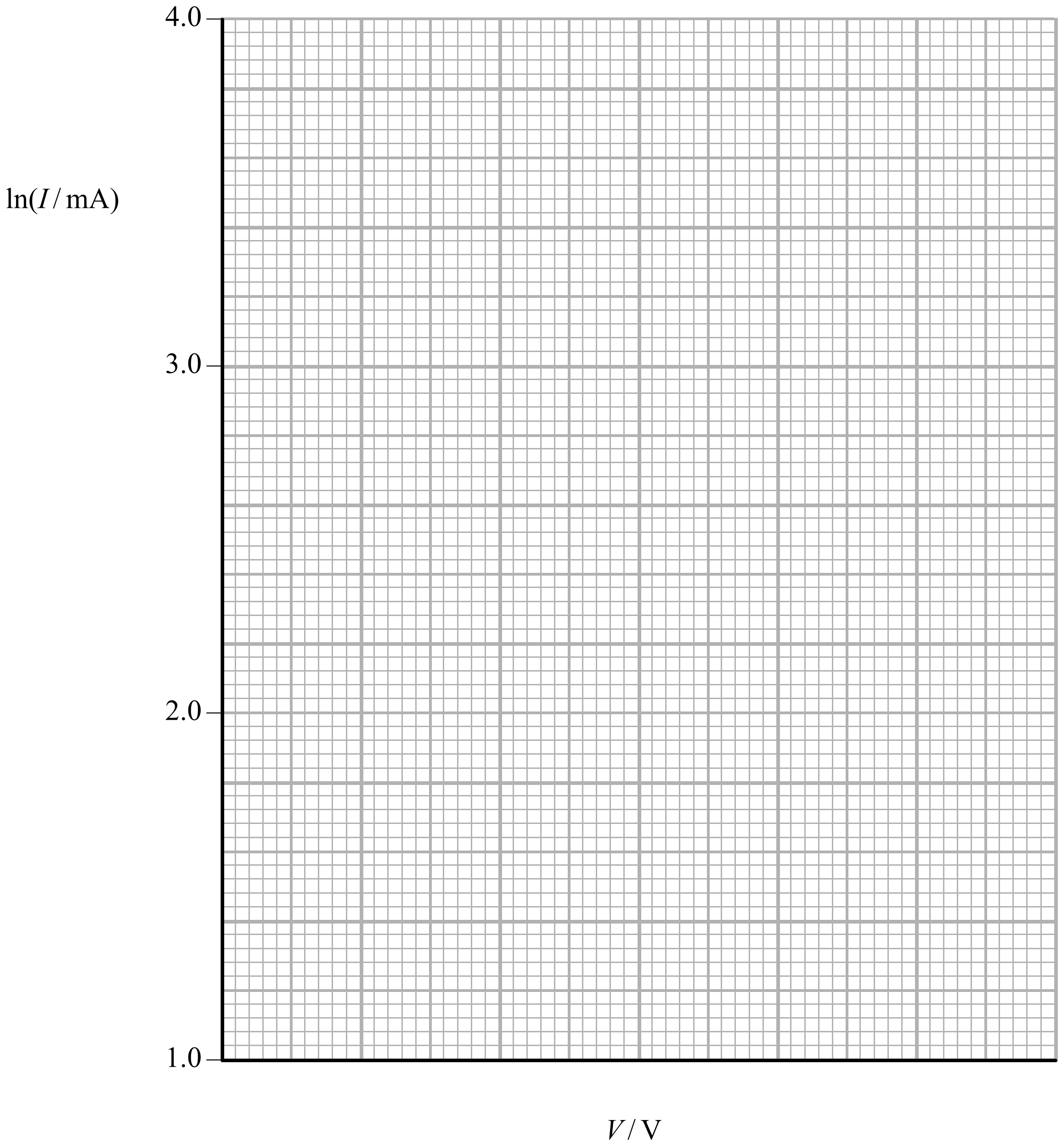
$$\ln I = aV + \ln I_0$$

where I_0 and a are constants.

Calculate the values of ln I and tabulate these in the third column.

Plot a graph of ln I against V on the grid below.

(3)



QUESTION 1B CONTINUES ON THE NEXT PAGE

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(d) (i) Use the gradient of your graph to find a value for the constant a.

....

....

....

(ii) The constant a is related to the charge on the electron e by the equation

$$a = \frac{e}{2kT}$$

where T is room temperature in kelvin, and $k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$.

Use your values for room temperature and a to find a value for e.

....

....

....

(iii) Calculate the percentage difference between your value for e and the accepted value.

....

....

(4)

(e) (i) Use your largest values of V and I to explain why it was not necessary to take any particular precautions to keep the temperature of the diode constant.

....

....

....

(ii) Look at your data and explain why it is a good idea to take your readings with steady intervals in V rather than I. Do not worry if you have not done this.

....

....

....

(3)

Q1B

(Total 16 marks)

Question 1C

You are to plan an experiment on a sample of gas using computer technology to capture the data. You will then analyse a set of data from a similar experiment.

(a) A sample of gas is held in a container at constant volume. The pressure of the gas is monitored by a pressure sensor mounted through the top of the container. The temperature of the gas is varied by placing the container in a water bath and the temperature of the bath is monitored by a temperature sensor. The output from each sensor is sent to a computer to record the data.

Draw a block diagram to show how the data is fed to the computer.

The temperature is to be varied from the ice point to the boiling point of the water.

How should the computer be used to record an appropriate set of data for this experiment?

....

....

....

Suggest two experimental precautions that you would take to ensure that the data are accurate.

....

....

(5)

QUESTION 1C CONTINUES ON THE NEXT PAGE

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(b) By considering the Ideal Gas Equation

$$pV = nRT$$

explain why a graph of p against T will be a straight line through the origin.

....

....

....

....

Write down the expression for the gradient of such a graph.

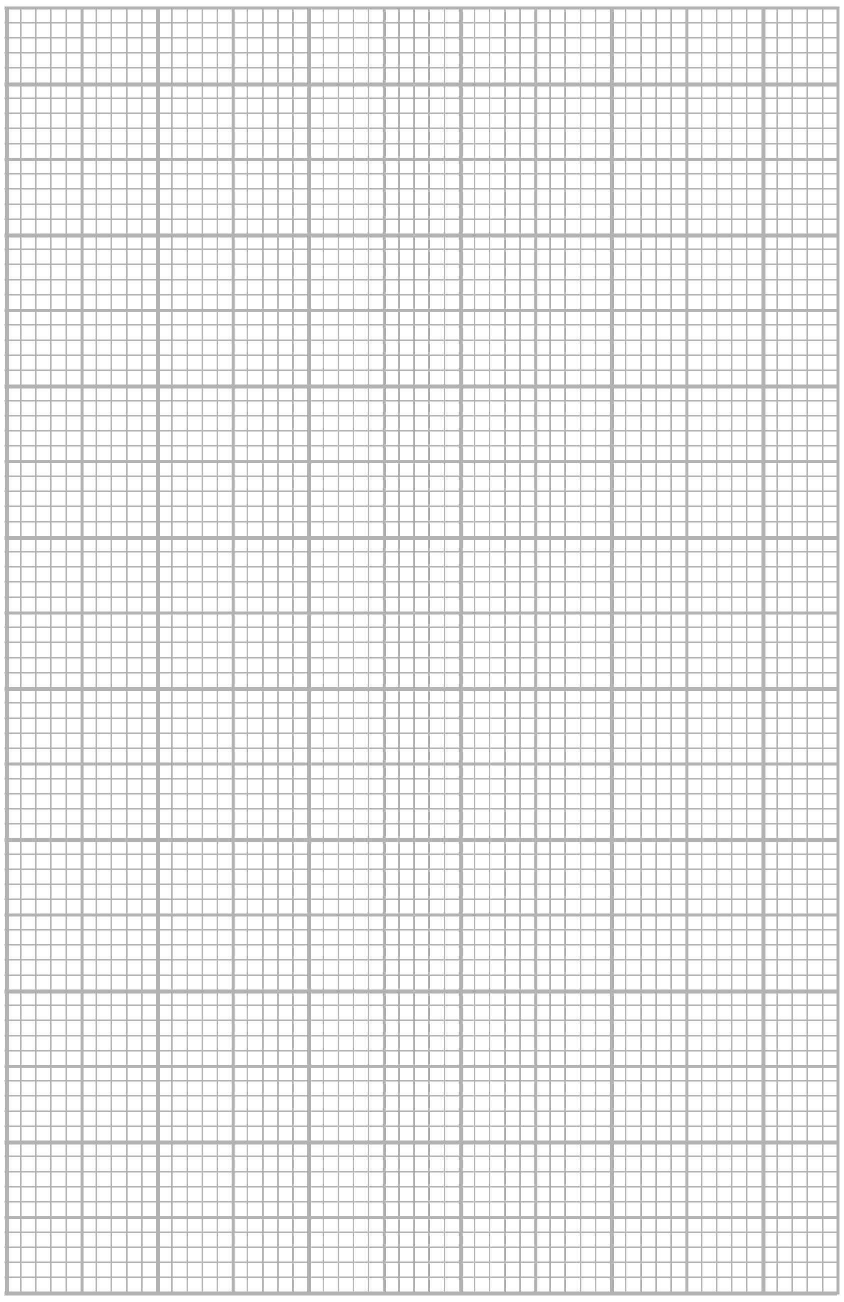
....
(4)

(c) In such an experiment the following data were recorded.

θ / °C	p / kPa	
0	101	
10	105	
22	110	
37	115	
47	118	
61	124	
75	129	
87	133	
100	138	

Plot a graph of p against T on the grid opposite. Use the additional column for any processed data.

Leave blank



(3)

QUESTION 1C CONTINUES ON THE NEXT PAGE

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(d) Determine the gradient of your graph.

....

....

....

Given that the volume of the container is 500 cm^3, use your value for the gradient to calculate the number of moles of gas in the container.

....

....

....

(4) **Q1C**

(Total 16 marks)

TOTAL FOR PAPER: 48 MARKS

END

List of data, formulae and relationships

Data

Speed of light in vacuum	$c = 3.00 \times 10^{8}\ \mathrm{m\ s^{-1}}$	
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 the Earth)
Gravitational field strength	$g = 9.81\ \mathrm{N\ kg^{-1}}$	(close to the Earth)
Elementary (proton) charge	$e = 1.60 \times 10^{-19}\ \mathrm{C}$	
Electronic mass	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$	
Electronvolt	$1\ \mathrm{eV} = 1.60 \times 10^{-19}\ \mathrm{J}$	
Planck constant	$h = 6.62 \times 10^{-34}\ \mathrm{J\ s}$	
Unified atomic mass unit	$\mathrm{u} = 1.66 \times 10^{-27}\ \mathrm{kg}$	
Molar gas constant	$R = 8.31\ \mathrm{J\ K^{-1}\ mol^{-1}}$	
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\ m^{-1}}$	
Coulomb law constant	$k = 1/4\pi\varepsilon_0$ $= 8.99 \times 10^{9}\ \mathrm{N\ m^{2}\ C^{-2}}$	
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{N\ A^{-2}}$	

Rectilinear motion

For uniformly accelerated motion:

$$v = u + at$$

$$x = ut + \tfrac{1}{2}at^{2}$$

$$v^{2} = u^{2} + 2ax$$

Forces and moments

Moment of F about O = $F \times$ (Perpendicular distance from F to O)

Sum of clockwise moments about any point in a plane = Sum of anticlockwise moments about that point

Dynamics

Force $$F = m\frac{\Delta v}{\Delta t} = \frac{\Delta p}{\Delta t}$$

Impulse $$F\Delta t = \Delta p$$

Mechanical energy

Power $$P = Fv$$

Radioactive decay and the nuclear atom

Activity $A = \lambda N$ (Decay constant λ)

Half-life $\lambda t_{\frac{1}{2}} = 0.69$

Electrical current and potential difference

Electric current $I = nAQv$

Electric power $P = I^2R$

Electrical circuits

Terminal potential difference $V = \mathcal{E} - Ir$ (E.m.f. $\mathcal{E}$; Internal resistance r)

Circuit e.m.f. $\Sigma\mathcal{E} = \Sigma IR$

Resistors in series $R = R_1 + R_2 + R_3$

Resistors in parallel $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Heating matter

Change of state: energy transfer $= l\Delta m$ (Specific latent heat or specific enthalpy change l)

Heating and cooling: energy transfer $= mc\Delta T$ (Specific heat capacity c; Temperature change ΔT)

Celsius temperature $\theta/°\text{C} = T/\text{K} - 273$

Kinetic theory of matter

Temperature and energy $T \propto$ Average kinetic energy of molecules

Kinetic theory $p = \frac{1}{3}\rho\langle c^2\rangle$

Conservation of energy

Change of internal energy $\Delta U = \Delta Q + \Delta W$ (Energy transferred thermally ΔQ; Work done on body ΔW)

Efficiency of energy transfer $= \frac{\text{Useful output}}{\text{Input}}$

Heat engine maximum efficiency $= \frac{T_1 - T_2}{T_1}$

Circular motion and oscillations

Angular speed $\omega = \frac{\Delta\theta}{\Delta t} = \frac{v}{r}$ (Radius of circular path r)

Centripetal acceleration $a = \frac{v^2}{r}$

Period $T = \frac{1}{f} = \frac{2\pi}{\omega}$ (Frequency f)

Simple harmonic motion:

displacement $x = x_0 \cos 2\pi ft$

maximum speed $= 2\pi f x_0$

acceleration $a = -(2\pi f)^2 x$

For a simple pendulum $T = 2\pi\sqrt{\frac{l}{g}}$

For a mass on a spring $T = 2\pi\sqrt{\frac{m}{k}}$ (Spring constant k)

Waves

Intensity	$I = \dfrac{P}{4\pi r^2}$	(Distance from point source r; Power of source P)

Superposition of waves

Two slit interference	$\lambda = \dfrac{xs}{D}$	(Wavelength λ; Slit separation s; Fringe width x; Slits to screen distance D)

Quantum phenomena

Photon model	$E = hf$	(Planck constant h)
Maximum energy of photoelectrons	$= hf - \varphi$	(Work function φ)
Energy levels	$hf = E_1 - E_2$	
de Broglie wavelength	$\lambda = \dfrac{h}{p}$	

Observing the Universe

Doppler shift	$\dfrac{\Delta f}{f} = \dfrac{\Delta\lambda}{\lambda} \approx \dfrac{v}{c}$	
Hubble law	$v = Hd$	(Hubble constant H)

Gravitational fields

Gravitational field strength	$g = F/m$	
for radial field	$g = Gm/r^2$, numerically	(Gravitational constant G)

Electric fields

Electrical field strength	$E = F/Q$	
for radial field	$E = kQ/r^2$	(Coulomb law constant k)
for uniform field	$E = V/d$	
For an electron in a vacuum tube	$e\Delta V = \Delta(\frac{1}{2}m_e v^2)$	

Capacitance

Energy stored	$W = \frac{1}{2}CV^2$	
Capacitors in parallel	$C = C_1 + C_2 + C_3$	
Capacitors in series	$\dfrac{1}{C} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3}$	
Time constant for capacitor discharge	$= RC$	

Magnetic fields

Force on a wire	$F = BIl$	
Magnetic flux density (Magnetic field strength)		
in a long solenoid	$B = \mu_0 nI$	(Permeability of free space μ_0)
near a long wire	$B = \mu_0 I/2\pi r$	
Magnetic flux	$\Phi = BA$	
E.m.f. induced in a coil	$\mathcal{E} = -\frac{N\Delta\Phi}{\Delta t}$	(Number of turns N)

Accelerators

Mass-energy	$\Delta E = c^2 \Delta m$
Force on a moving charge	$F = BQv$

Analogies in physics

Capacitor discharge	$Q = Q_0 e^{-t/RC}$
	$\frac{t_{\frac{1}{2}}}{RC} = \ln 2$
Radioactive decay	$N = N_0 e^{-\lambda t}$
	$\lambda t_{\frac{1}{2}} = \ln 2$

Experimental physics

$$\text{Percentage uncertainty} = \frac{\text{Estimated uncertainty} \times 100\%}{\text{Average value}}$$

Mathematics

$$\sin(90° - \theta) = \cos\theta$$

$$\ln(x^n) = n \ln x$$

$$\ln(e^{kx}) = kx$$

Equation of a straight line	$y = mx + c$	
Surface area	cylinder $= 2\pi rh + 2\pi r^2$	
	sphere $= 4\pi r^2$	
Volume	cylinder $= \pi r^2 h$	
	sphere $= \frac{4}{3}\pi r^3$	
For small angles:	$\sin\theta \approx \tan\theta \approx \theta$	(in radians)
	$\cos\theta \approx 1$	