Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | Candidate Number

Wednesday 6 May 2020

Afternoon (Time: 1 hour 20 minutes) | Paper Reference **WPH13/01**

Physics

Advanced Subsidiary
Unit 3: Practical Skills in Physics I

You must have:
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working in calculations and include units where appropriate.**

Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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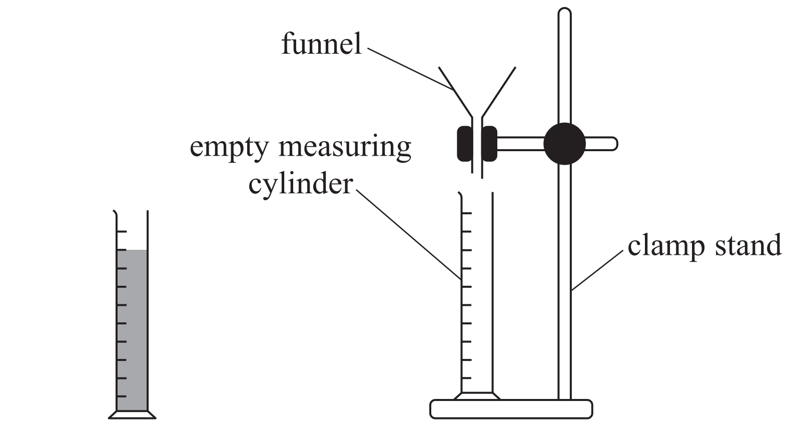
Pearson

Answer ALL questions.

1 A student is investigating the effect of temperature on the viscosity of oil by measuring how fast the oil flows through a funnel. He uses the apparatus shown.



(a) (i) State a piece of apparatus the student could use to vary the temperature of the oil.

(1)

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(ii) State a piece of apparatus the student could use to measure the time taken for the oil to flow through the funnel.

(1)

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(b) The two thermometers shown below are available.

liquid-in-glass thermometer

digital thermometer

He chooses to use the digital thermometer.

Justify his choice.

(2)

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(c) (i) Identify one control variable in this investigation.

(1)

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(ii) Describe how this variable can be controlled.

(1)

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(d) The student initially measures the time from starting to pour the oil into the funnel to the last drop of oil falling from the funnel.

(i) State how the rate of flow of the oil should be calculated.

(1)

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(ii) Describe how the same apparatus could be used to calculate a more accurate value for the rate of flow of the oil.

(2)

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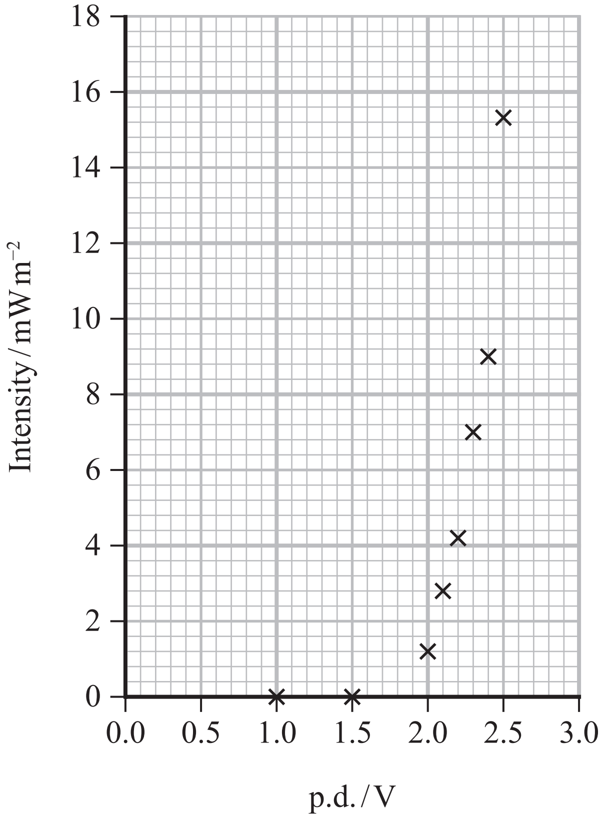
(Total for Question 1 = 9 marks)

2 A student investigated how the intensity of light emitted by a light emitting diode (LED) varied with the potential difference (p.d.) applied across the LED. She measured the intensity of the light using a lightmeter which was shielded from external light sources.

She plotted her results on a graph as shown.



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

(1)

(b) (i) Give the value of the p.d. at which the LED starts to conduct.

(1)

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(ii) Calculate the minimum energy that must be transferred to an electron in the LED for light to be emitted.

(2)

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Minimum electron energy = ... J

(c) Light is emitted when the electron releases energy as a photon.

The student tested a second LED which emitted light of wavelength 625 nm.

From her results she determined the minimum electron energy to be 3.1×10^{-19} J.

Calculate the value of the Planck constant from this data.

(3)

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The Planck constant = ...

(d) The LED does not produce monochromatic light.

Explain how this would affect the value of the Planck constant calculated.

(3)

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(e) The accuracy of the value of the Planck constant calculated depends on the minimum p.d. determined from the graph.

Explain how the student could reduce the uncertainty in her value of the minimum p.d.

(2)

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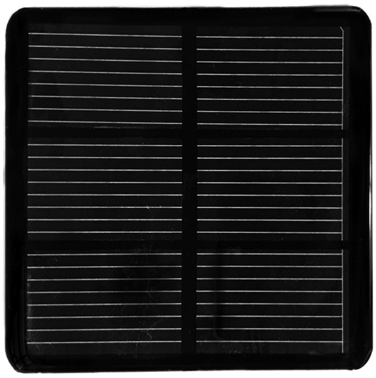
(Total for Question 2 = 12 marks)

3 A student investigated how the power output of a solar cell is affected by temperature. The intensity of light incident on the solar cell remained constant.

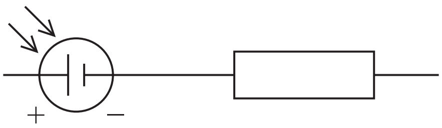
He used a square solar cell, as shown.



The student determined the power output of the solar cell at different temperatures.

(a) Complete the diagram to show a circuit that would allow him to determine the power output of the solar cell.

(2)



(b) Describe how the student could ensure that the intensity of light incident on the solar cell remained constant.

(2)

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(c) State a method the student could use to increase the temperature of the solar cell.

(1)

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(d) At room temperature, the student measured a potential difference of 2.74 V and a current of 45 mA for the solar cell.

Calculate the power output of the solar cell.

(2)

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Power output = ...

(e) He measured the intensity of the light incident on the solar cell to be $200\,\mathrm{W\,m^{-2}}$.

Calculate the efficiency of the solar cell at room temperature.

dimensions of solar cell = 60 mm × 60 mm

(3)

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Efficiency = ...

(f) The student made measurements of the potential difference V and current I for the solar cell over a range of temperatures.

His results are recorded in the table.

Temperature / °C	***V* / V**	***I* / mA**
15	2.76	45.8
20	2.62	47
30	2.46	48
50	2.05	51.5

(i) Criticise these results.

(2)

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(ii) Over the range of temperatures shown, the relationship between the power output of the solar cell and its temperature is linear.

Describe how the student could use a graphical method to determine the change in power output for each 1 °C of temperature increase.

(3)

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(Total for Question 3 = 15 marks)

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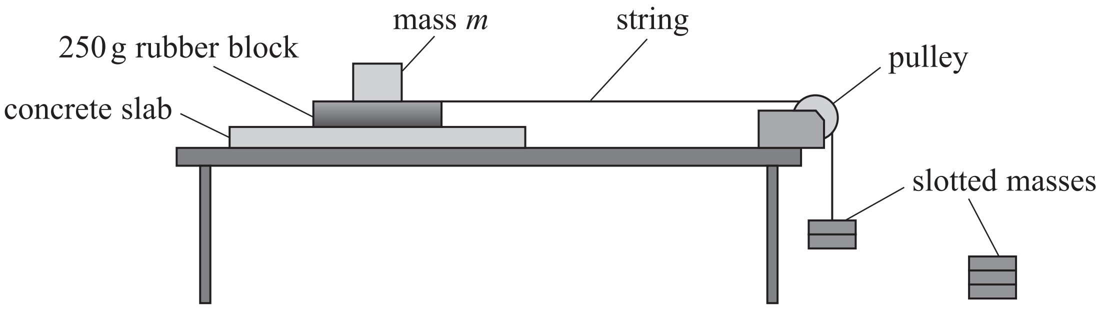
4 When an object is in contact with a horizontal surface, there is a maximum frictional force F between the object and the surface before sliding occurs.

F is given by the equation

$$F = \mu N$$

where μ is a constant and N is the normal contact force between the object and the surface.

A student investigated this relationship for a rubber block on a concrete surface. She set up the apparatus as shown in the diagram.



(a) Describe how the student can determine F for the situation shown.

(2)

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(b) The student varied the mass m placed on top of the rubber block and determined corresponding values of F.

Her results are shown in the table.

m / g	N / N	F / N
0	2.45	1.4
200	4.41	2.5
400	6.38	4.0
600	8.34	4.6
800	10.3	5.8

(i) Explain how the values of N are calculated.

(2)

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(ii) Plot a graph of F on the y-axis against N on the x-axis using the grid below.

(5)

(c) Determine a value for μ.

(3)

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μ = ...

(d) A tyre manufacturer carries out similar tests on samples of the rubber used for tyres.

Suggest why these tests are necessary.

(2)

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(Total for Question 4 = 14 marks)

TOTAL FOR PAPER = 50 MARKS

List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Electron charge	$e = -1.60 \times 10^{-19}\ \text{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$	
Electronvolt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$	
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	

Unit 1

Mechanics

Kinematic equations of motion

$$s = \frac{(u+v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

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

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

$$E_k = \frac{1}{2}mv^2$$

$$\Delta E_{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Materials

Density $\rho = \dfrac{m}{V}$

Stokes' law $F = 6\pi\eta r v$

Hooke's law $F = k\Delta x$

Elastic strain energy $\Delta E_{el} = \dfrac{1}{2}F\Delta x$

Young modulus $E = \dfrac{\sigma}{\varepsilon}$ where

Stress $\sigma = \dfrac{F}{A}$

Strain $\varepsilon = \dfrac{\Delta x}{x}$

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Unit 2

Waves

Wave speed	$v = f\lambda$
Speed of a transverse wave on a string	$v = \sqrt{\dfrac{T}{\mu}}$
Intensity of radiation	$I = \dfrac{P}{A}$
Refractive index	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
	$n = \dfrac{c}{v}$
Critical angle	$\sin C = \dfrac{1}{n}$
Diffraction grating	$n\lambda = d\sin\theta$

Electricity

Potential difference	$V = \dfrac{W}{Q}$
Resistance	$R = \dfrac{V}{I}$
Electrical power, energy	$P = VI$
	$P = I^2R$
	$P = \dfrac{V^2}{R}$
	$W = VIt$
Resistivity	$R = \dfrac{\rho l}{A}$
Current	$I = \dfrac{\Delta Q}{\Delta t}$
	$I = nqvA$
Resistors in series	$R = R_1 + R_2 + R_3$
Resistors in parallel	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Particle nature of light

Photon model	$E = hf$
Einstein's photoelectric equation	$hf = \phi + \frac{1}{2}mv^2_{max}$
de Broglie wavelength	$\lambda = \dfrac{h}{p}$

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