Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | Candidate Number

Friday 10 January 2020

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

Physics

International Advanced Subsidiary / Advanced Level
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** with **your answer clearly identified** at the **end of your solution**.

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 ▶

1/1/1/1/1/

Answer ALL questions.

1 A student was asked to investigate how changing the temperature of a diode will change the potential difference at which the diode starts to conduct.

(a) Draw a labelled diagram showing how she could carry out this investigation using school laboratory apparatus.

(4)

(b) Identify one safety issue with this investigation and how it may be dealt with.

(2)

....

....

....

....

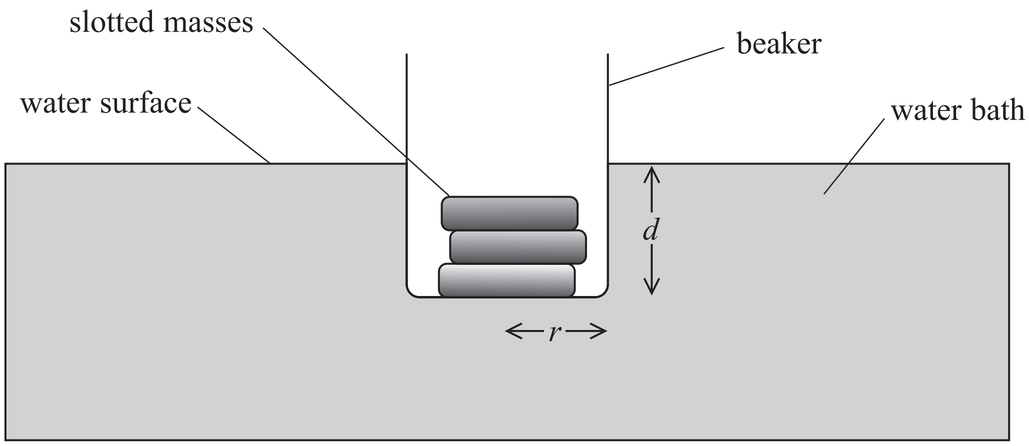
(Total for Question 1 = 6 marks)

BLANK PAGE

2 A student investigated the relationship between the mass m a boat can carry and the depth d below the water surface of the lowest point of the boat.

He modelled the boat using a glass beaker.

He added 10 gram slotted masses and marked the position of the water surface on the beaker, as shown.



The student assumed the beaker was a cylinder with radius r cm and the water had a density of 1 g cm^{-3}.

(a) Show that the upthrust U on the beaker could be calculated using the equation

$$U = \frac{\pi r^2 dg}{1000}$$

where d is in cm and U is in N.

(4)

....

....

....

....

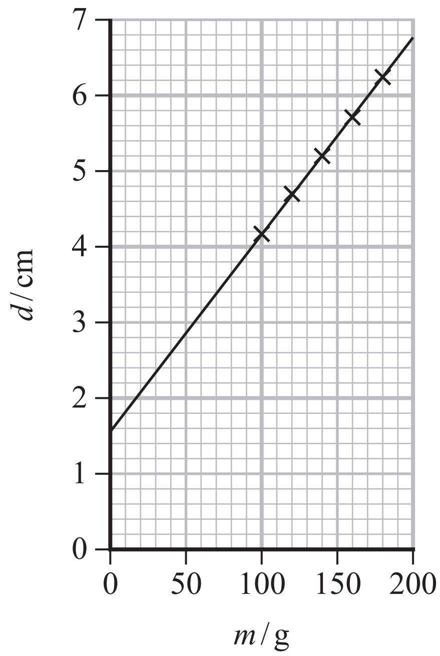
....

....

....

....

(b) The student marked the position of the water surface on the beaker for different values of m. He plotted a graph of d in cm against m in g.



When the beaker is in equilibrium upthrust = weight, leading him to the following equation

$$m = \rho \pi r^2 d$$

where $\rho = 1\,\text{g}\,\text{cm}^{-3}$.

Determine the diameter of the beaker, using information from the graph.

(3)

....

....

....

....

....

....

Diameter of beaker = ...

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(c) The graph shows that the beaker would have a depth under the water surface with no mass added.

Identify the source of the systematic error and how it could be corrected.

(2)

....

....

....

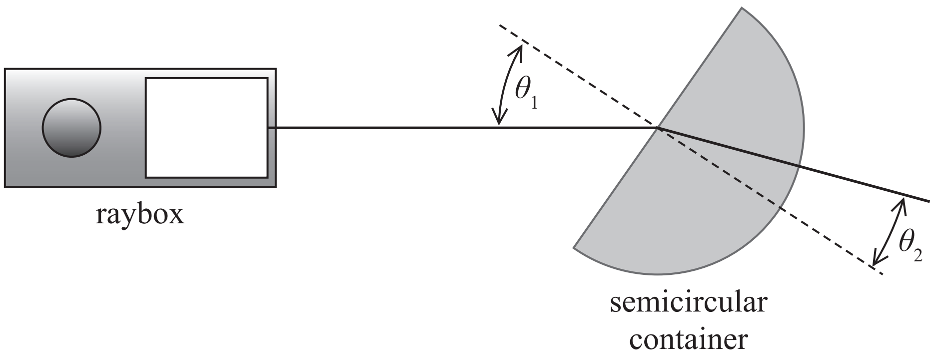
....

(Total for Question 2 = 9 marks)

3 A student investigated the refraction of light as it travelled into salt solutions of different densities.

For a salt solution, as the density increases, the speed of light in the salt solution decreases.

She put the salt solution into a transparent semicircular container, as shown.



(a) Describe a method the student could use to determine the density of the salt solution.

(3)

....

....

....

....

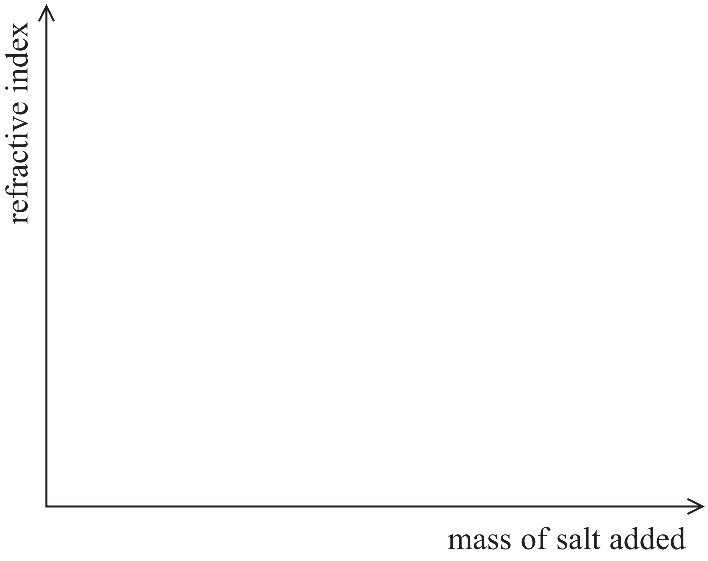
....

....

(b) The student increased the density of the salt solution by adding different masses of salt.

Sketch, on the axes below, a graph to show how the refractive index of the salt solution varies with the mass of salt added.

(2)



(c) The relationship between the refractive index n, the angle of incidence θ_1 and the angle of refraction θ_2 is given by the equation

$$\sin\theta_1 = n\sin\theta_2$$

Describe a graphical method she could use to determine n.

(4)

....

....

....

....

....

....

....

....

....

....

(d) The student measured only one pair of angles for each salt solution.

The measurements the student recorded for one salt solution were:

Angle of incidence θ_1	33.0°
Angle of refraction θ_2	24.0°
Refractive index n	1.34

(i) The uncertainty in the measurement of the angles was ± 0.5°.

Calculate the maximum and minimum values of n.

(3)

Maximum value of n = ...

Minimum value of n = ...

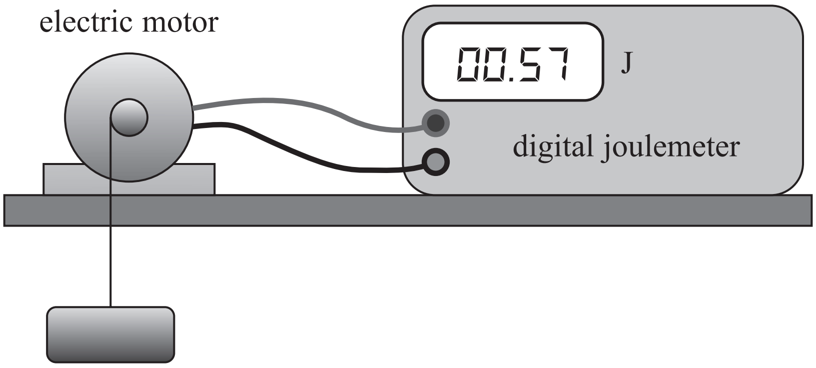
(ii) Calculate the percentage uncertainty in the student's value of n.

(2)

Percentage uncertainty = ...

(Total for Question 3 = 14 marks)

4 A group of students investigated the efficiency of an electric motor when lifting a mass.



The students used a joulemeter to measure the energy supplied to the motor to lift a mass a distance of 75 cm. They repeated the experiment twice before increasing the mass.

They calculated the change in gravitational potential energy of the mass and the mean energy supplied. Their results are shown in the table below.

Mass / kg	Change in gravitational potential energy / J	Energy supplied / J			
		Trial 1	Trial 2	Trial 3	Mean
0.02	0.147	0.57	0.55	0.60	0.573
0.04	0.29	1.12	1.10	1.15	1.12
0.06	0.441	1.67	1.71	1.65	1.7
0.08	0.59	2.21	2.25	2.23	2.23
0.10	0.74	2.78	2.82	2.91	2.84
0.12		3.32	3.36	3.33	

(a) Criticise these results.

(2)

....

....

....

....

(b) Complete the last row of the table.

(3)

....

....

(c) Plot a graph of change in gravitational potential energy on the *y*-axis against mean energy supplied on the *x*-axis.

(5)

(d) Determine the efficiency of the motor.

(2)

....

....

....

....

Efficiency = ...

(e) The students repeated the experiment with a much larger mass and determined that the efficiency of the motor was decreased.

Describe how they should collect and use data to determine the mass at which the efficiency starts to decrease.

(3)

....

....

....

....

....

....

....

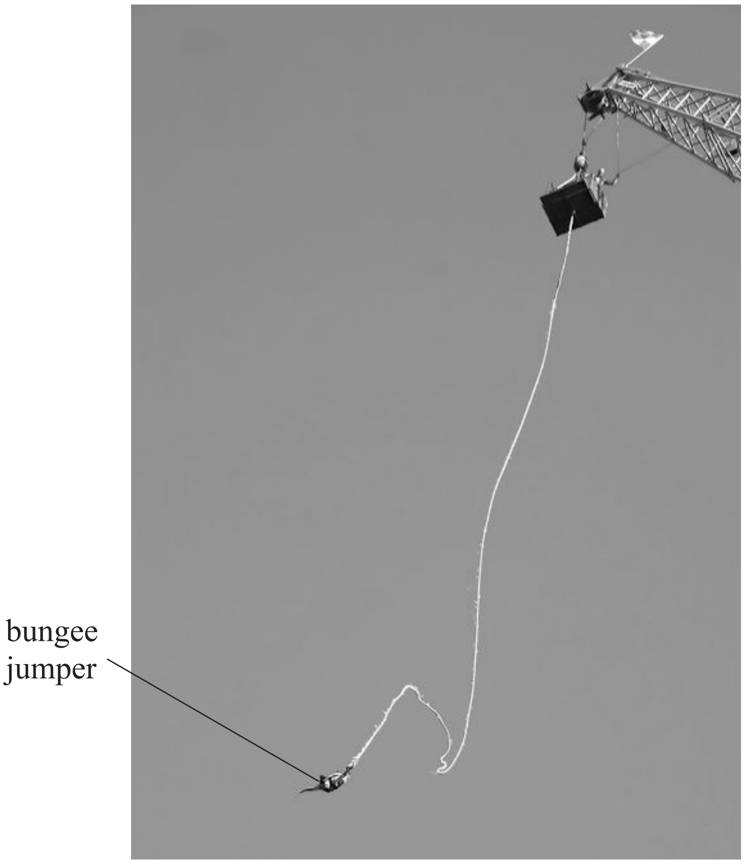
....

(Total for Question 4 = 15 marks)

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

BLANK PAGE

5 The photograph shows a bungee jumper. The bungee jumper falls through a large distance and is then decelerated by the bungee rope.



(Source: © ELINA/Pearson Asset Library)

For safety, a bungee rope needs to be tested to ensure it can withstand the stress applied as it decelerates the falling bungee jumper.

One bungee rope has a diameter of 2 cm. The manufacturer states that the rope can withstand a maximum force of 8000 N.

(a) A teacher is given a sample of the same material with diameter 1 mm.

Justify the teacher's decision that it would be safe for her students to determine the breaking stress of the sample.

(2)

....

....

....

....

(b) To determine the breaking stress, a student used 100 g slotted masses hung vertically from the sample.

The maximum mass that the sample could hold before breaking was 1.9 kg.
The diameter was 0.95 mm.

The manufacturer gives the breaking stress of the rope as 2.55×10^7 Pa.

Determine whether the student's result supports the manufacturer's value.

(4)

....

....

....

....

....

....

....

....

(Total for Question 5 = 6 marks)

TOTAL FOR PAPER = 50 MARKS

List of data, formulae and relationships

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

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

$$= Fx$$

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 $\rho = \frac{m}{V}$

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

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

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

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

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

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

Unit 2

Waves

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

Electricity

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

Quantum physics

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

BLANK PAGE

BLANK PAGE

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

P60485A02020