Oxford Cambridge and RSA

Accredited

AS Level Physics B (Advancing Physics)
H157/01 Foundations of physics
Sample Question Paper

Date – Morning/Afternoon
Version 2.1

Time allowed: 1 hour 30 minutes

You must have:
- the Data, Formulae and Relationships Booklet

You may use:
- a scientific or graphical calculator

First name										
Last name										
Centre number						**Candidate number**				

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **24** pages.

SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

1 Here is a list of combinations of base units of the SI system.

Which combination of units is equivalent to a newton, N?

A kg m s^{-1}

B kg m s^{-2}

C kg m^2 s^{-2}

D kg m^2 s^{-3}

Your answer ☐ **[1]**

2 Here is a list of combinations of base units of the SI system.

Which combination of units is equivalent to watt, W?

A kg m s^{-1}

B kg m s^{-2}

C kg m^2 s^{-2}

D kg m^2 s^{-3}

Your answer ☐ **[1]**

3 Which of these quantities would be measured in pascals?

A weight

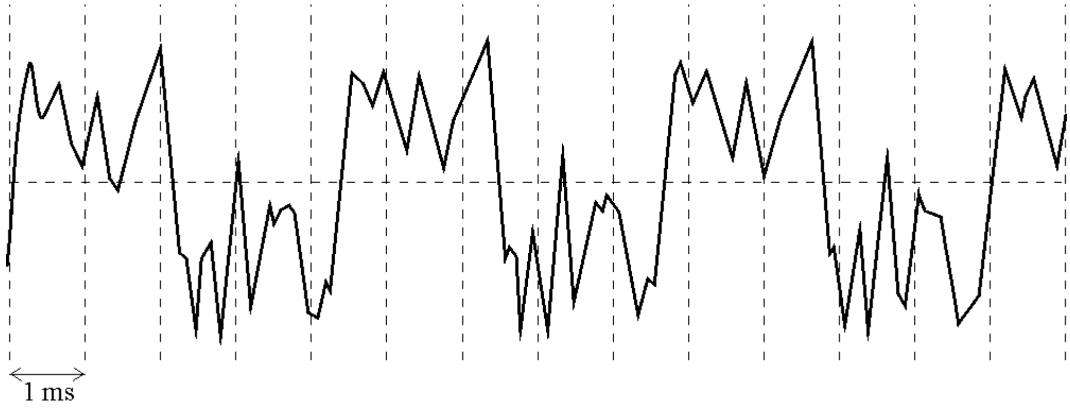
B strain

C stress

D tension

Your answer ☐ **[1]**

4 A musical note played by a clarinet is recorded. The signal is shown in the diagram with the time-scale indicated.



What is the fundamental frequency of the note played by the clarinet, expressed to two significant figures?

A 77 Hz

B 120 Hz

C 230 Hz

D 2200 Hz

Your answer ☐ **[1]**

5 A sound signal is to be digitised for high quality reproduction.

Which of the following statements is/are true?

1 The sound signal should be sampled at half the highest frequency present in the signal.

2 The bits per sample determine the resolution of the signal amplitude.

3 Noise on a digital signal is less problematic than on an analogue signal.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

6 A digital camera has 8 megapixels. Each pixel codes 14 bits of information. A photographer requires a memory card which could hold 120 images.

What is the minimum capacity of the card that they should purchase?

A 1.7 Mbyte

B 13 Mbyte

C 1.7 Gbyte

D 13 Gbyte

Your answer ☐ **[1]**

7 A current of 3 μA flows through a resistor for 1.5 minutes.

How much charge flows through the resistor during this time?

A 4.5×10^{-6} C

B 2.7×10^{-4} C

C 4.5×10^{-3} C

D 2.7×10^{-1} C

Your answer ☐ **[1]**

8 Two electrical heating coils **L** and **M** are made from wires of the same material. The wires are of equal length but different diameters. **L** runs at twice the voltage of **M** but both coils dissipate the same power.

What is the correct conductance ratio for the two coils $G_{\mathbf{L}} / G_{\mathbf{M}}$?

A $\frac{1}{4}$

B $\frac{1}{2}$

C 2

D 4

Your answer ☐ **[1]**

The circuit in **Fig. 9.1** below is referred to in both question 9 and 10.

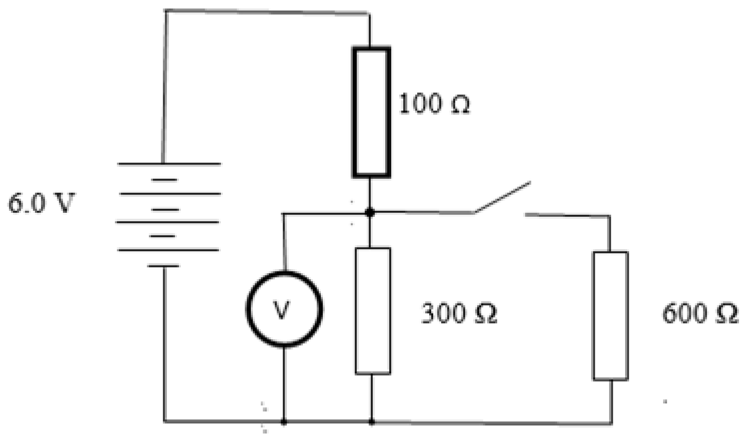


Fig. 9.1

9 The switch in this circuit is **open**.

What is the potential difference across the 100 Ω resistor?

A 1.5 V

B 2.0 V

C 4.5 V

D 6.0 V

Your answer ☐ **[1]**

10 The switch in **Fig. 9.1** is now **closed**.

What is the power dissipated in the 100 Ω resistor?

A 0.012 W

B 0.027 W

C 0.040 W

D 0.090 W

Your answer ☐ **[1]**

11 A d.c. supply has an internal resistance of 10 Ω. It is connected to a torch bulb rated at 6.0 V, 0.30 A. The lamp lights to normal brightness.

What is the e.m.f. of the d.c. supply?

A 3.0 V

B 6.0 V

C 9.0 V

D 12 V

Your answer ☐ **[1]**

12 A student correctly uses an ammeter and a voltmeter to measure the resistance of a component. She obtains the readings $I = 0.38 \pm 0.02$ A and $V = 11.75 \pm 0.01$ V.

What is the best estimate for the resistance value and its uncertainty?

A 30.9 ± 1.6 Ω

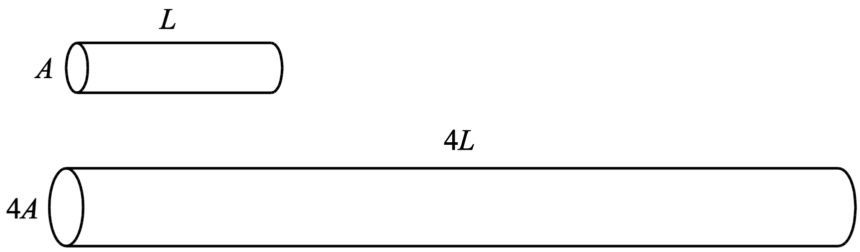
B 30.92 ± 1.63 Ω

C 30.92 ± 0.03 Ω

D 31 ± 2 Ω

Your answer ☐ **[1]**

13 A graph is produced of linear force F (y-axis) against extension x (x-axis) for a metal wire of length L and cross-sectional area A. A second wire of the same material has length $4L$ and cross-sectional area $4A$.



The gradient $k = F/x$ for the second wire will be how many times that for the first wire?

A 1

B 4

C 8

D 16

Your answer **[1]**

14 Ceramics are brittle materials.

Which of the following statements is/are true?

1 Slip is prevented in ceramics by impurity atoms pinning dislocations.

2 Cracks spread because stress is concentrated at the crack tip.

3 The atoms in the material are bonded in random positions and there are no slip planes.

A 1, 2 and 3

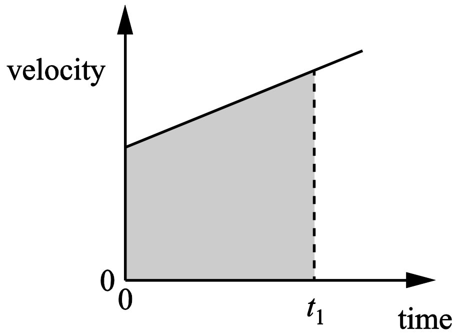
B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer **[1]**

15 Here is a velocity–time graph.



Which statement/s about the graph is/are correct?

1 The gradient represents acceleration.

2 The shaded area represents the change of displacement from time = 0 to time = t_1.

3 The graph shows that velocity is proportional to distance.

A 1, 2 and 3

B Only 1 and 2

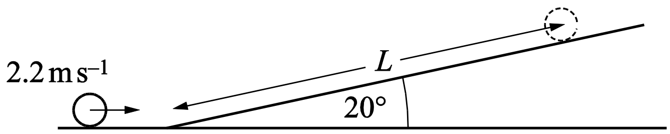
C Only 2 and 3

D Only 1

Your answer

[1]

16 A ball rolls up a ramp which is at angle of 20° to the horizontal. The speed of the ball at the bottom of the ramp is $2.2\ \text{m s}^{-1}$. L is the distance the ball moves along the ramp before coming to rest.



What is distance L? Ignore the effects of friction and rotation in your answer.

A 0.25 m

B 0.26 m

C 0.68 m

D 0.72 m

Your answer

[1]

17 A firework rocket with a mass of 0.40 kg is launched vertically upwards with an initial acceleration of $6.2\ \text{m s}^{-2}$.

What is the force on the rocket from the burning fuel?

A 1.4 N

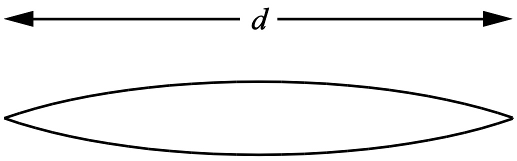
B 2.5 N

C 3.9 N

D 6.4 N

Your answer **[1]**

18 A standing wave is formed on a string of length *d* as shown.



Which of the following statements is/are true?

1 Progressive waves are travelling along the string in both directions.

2 The standing wave is an example of superposition.

3 The wavelength of the standing wave is *d*.

A 1, 2 and 3

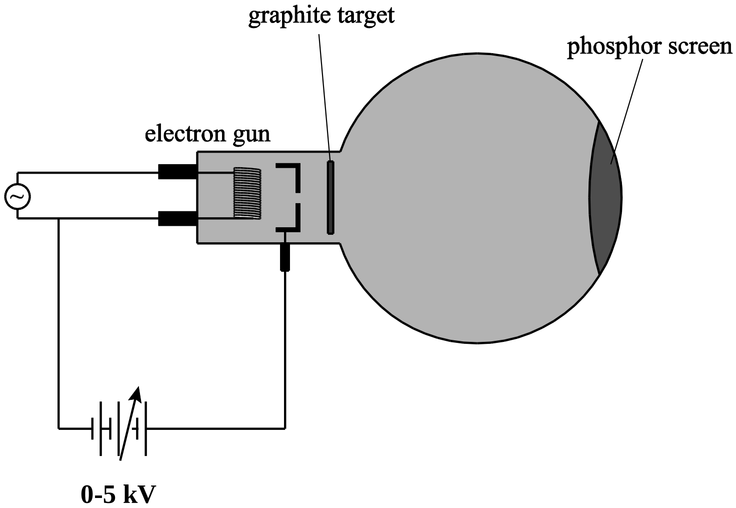
B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer **[1]**

19 In the apparatus shown in the diagram, a beam of electrons hits the graphite target. This target acts as a diffraction grating. Diffraction maxima are seen on the phosphor screen.



When the voltage of the power supply is increased, the diffraction maxima become brighter and closer to the centre of the pattern.

Which of the following statements correctly describe the effect of increasing the voltage?

1 The kinetic energy of the electrons increases.

2 The wavelength of the electrons increases.

3 The charge of the electrons increases.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

20 An electron has a kinetic energy of 2.0×10^{-17} J. The mass of an electron is 9.1×10^{-31} kg.

What is the value for the de Broglie wavelength of the electron?

A 1.1×10^{-10} m

B 1.5×10^{-10} m

C 3.3×10^{-17} m

D 6.6×10^{-17}m

Your answer ☐ **[1]**

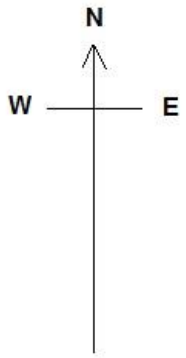
SECTION B

Answer **all** the questions.

21 In still air an aircraft flies at 200 m s^{-1}. The aircraft is heading due north in still air when it flies into a steady wind of 50 m s^{-1} blowing from the west.

(a) Calculate the magnitude and direction of the resultant velocity by sketching a vector diagram to show the new resultant velocity of the aircraft by the addition of vectors.

Label the resultant velocity clearly.



magnitude = **………………….** m s^{-1} direction = **………………..** ° **[3]**

(b) The pilot now heads slightly to the west of north with the same speed setting of 200 m s^{-1} in order to regain his original northerly direction.

Calculate the magnitude of his new northerly velocity.

magnitude = **………………..** m s^{-1} **[1]**

22 A teacher explaining refraction of light at a plane boundary draws a diagram (**Fig. 22.1**) which shows adjacent wavefronts moving down across a boundary. The incident wavefront arrives at angle of incidence *i* to the boundary as shown.

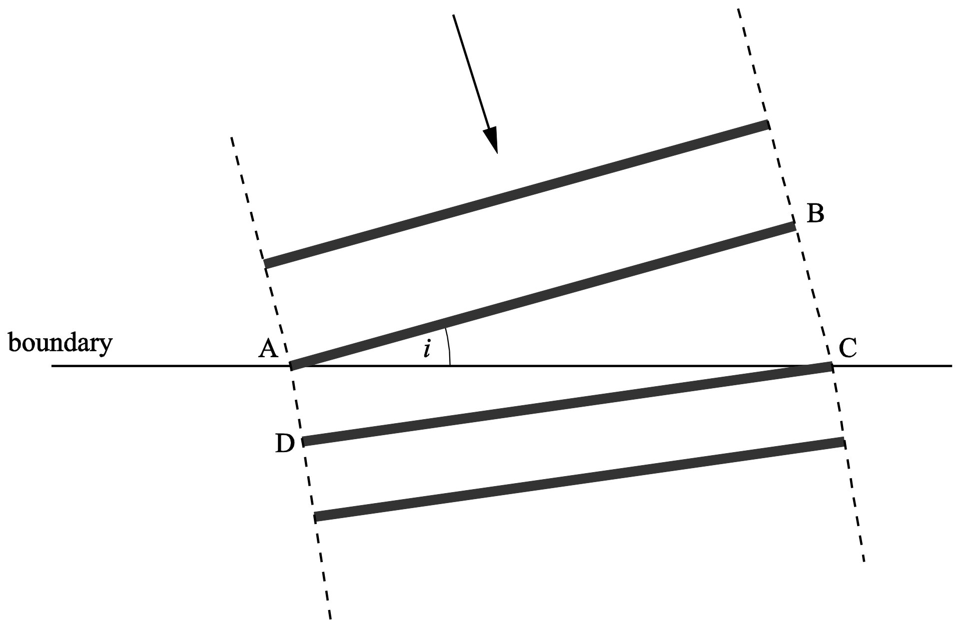


Fig. 22.1

(a) State how the diagram indicates that the light is slowing as it crosses the boundary.

………

………

………

……… **[1]**

(b) On **Fig. 22.1** indicate and label the angle of refraction *r*.

[1]

(c) The time it takes the wavefront **AB** to move forward to position **DC** is Δt.

The teacher explains Snell's law using **Fig. 22.1**.

Complete the teacher's reasoning in deriving Snell's law.

$$\frac{\text{speed in 1st medium}}{\text{speed in 2nd medium}} = \frac{\mathbf{BC}/\Delta t}{\mathbf{AD}/\Delta t} = \underline{\qquad\qquad}$$

$$\frac{\sin i}{\sin r} = \frac{\mathbf{BC}\ /\underline{\qquad}}{\mathbf{AD}\ /\underline{\qquad}} = \underline{\qquad\qquad}$$

Therefore $$\frac{\sin i}{\sin r} = \frac{\text{speed in 1st medium}}{\text{speed in 2nd medium}}$$

[2]

23 A guitar string of length 0.75 m is shown in **Fig. 23.1.**

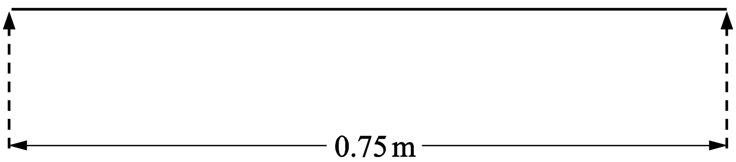


Fig. 23.1

(a) The string is plucked. On **Fig. 23.1** sketch the simplest standing wave vibration that can be formed on the string.

Label the antinode(s) on **Fig. 23.1**

[1]

(b) The speed of the wave on the string is 660 m s^{-1}.

Calculate the frequency of the vibrating string.

frequency = **………………..** Hz **[2]**

24 The lens in a digital projector has a focal length f = 0.080 m.

(a) Calculate the curvature that this lens adds to wavefronts that are incident upon it.

curvature = ………………. D **[1]**

(b) The object distance u = – 0.082 m.

Calculate the image distance.

image distance = …………….. m **[2]**

(c) Calculate the linear magnification for this image.

linear magnification = …………….. **[1]**

25 **Fig. 25.1** shows an original image. **Fig. 25.2** shows a processed version.

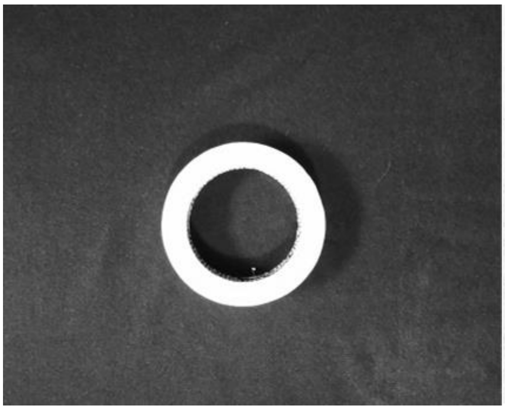


Fig. 25.1

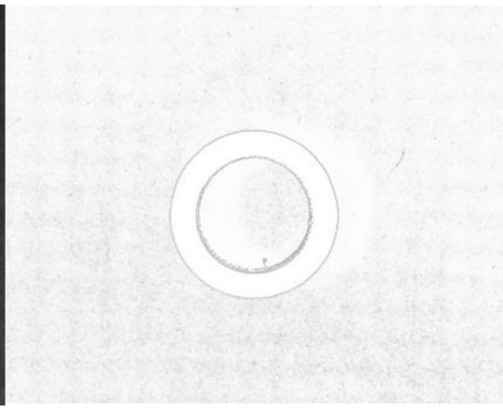


Fig. 25.2

(a) State the kind of image processing that has been applied to this image.

.... **[1]**

(b) Each image is 315 × 260 pixels. The roll of tape has an external diameter of 0.10 m.

Calculate the resolution of the image.

resolution = ... m pixel^{-1} **[2]**

26 A student is trying to understand how electric currents can be compared to the steady flow of water in a river.

Complete the following table to help them understand this analogy.

	river	**electric currents**
quantity which flows / unit	water mass / kg	.... / ....
what drives the flow	water is falling down a gradient leading to transfer of energy measured in J/kg	e.m.f. of power supply leading to transfer of energy measured in....................

[2]

Section C

Answer **all** the questions.

27 **Fig. 27.1** shows a graph of the force against compression for a compression spring.

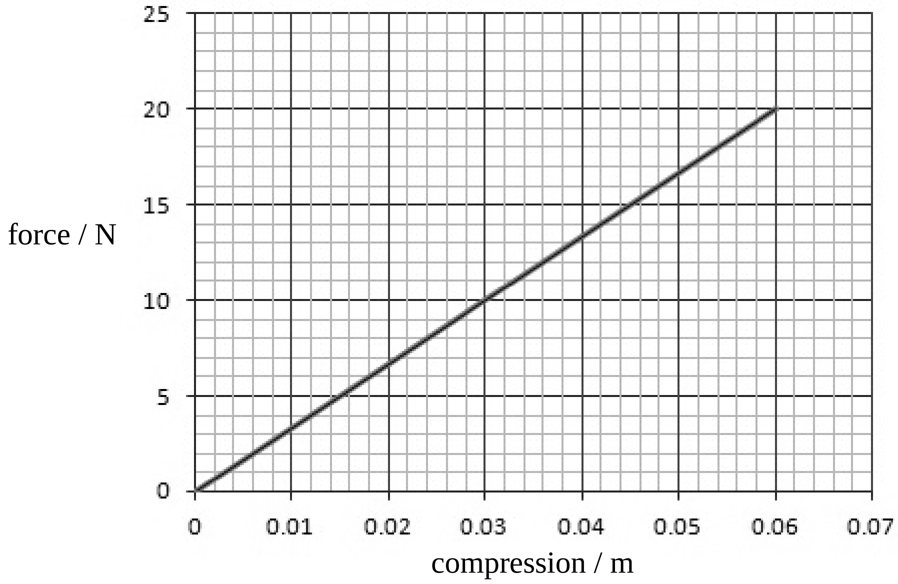


Fig. 27.1

(a) State the relationship between force and compression shown by the data in **Fig.27.1.**

…………………………………………………………………………………………………….........

……

……………………………………………………………………………………………………….. **[1]**

(b) Show that the energy stored by the spring when compressed elastically by 0.060 m is 0.60 J.

[2]

(c) The compressed spring is used to launch a ball bearing from a tube placed at 60° to the horizontal as shown in **Fig. 27.2.**

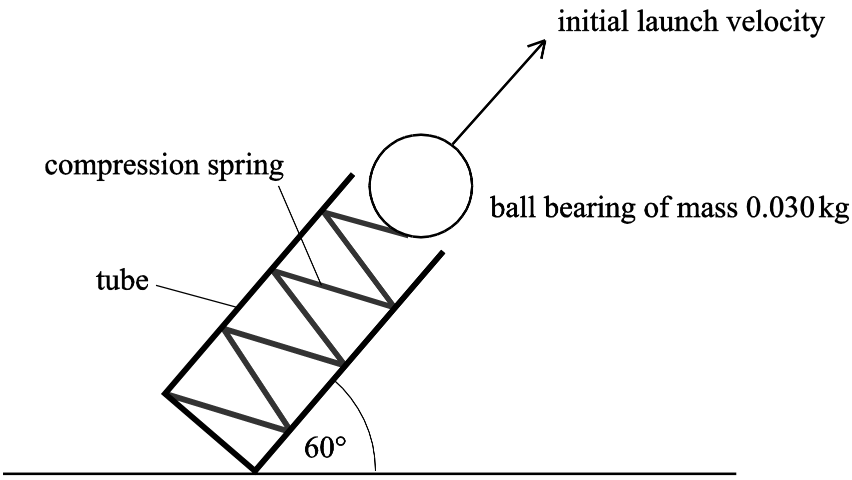


Fig. 27.2

data:

compression of spring = 0.060 m as in part **(b)**
mass of ball bearing = 0.030 kg

(i) Using the data above, calculate the initial horizontal and vertical components of the launch velocity.

velocity$_{\text{horizontal}}$ = **…………….** m s^{-1} velocity$_{\text{vertical}}$ = ……………….. m s^{-1} **[4]**

(ii) Calculate the maximum height the ball bearing reaches above its launch position. State the physics reasoning behind your method.

maximum height = **………………….** m **[3]**

28 **Fig. 28.1** shows the number density of mobile charge carriers in insulators, semiconductors and metals. The grey areas show the range of values of number density within each type of material.

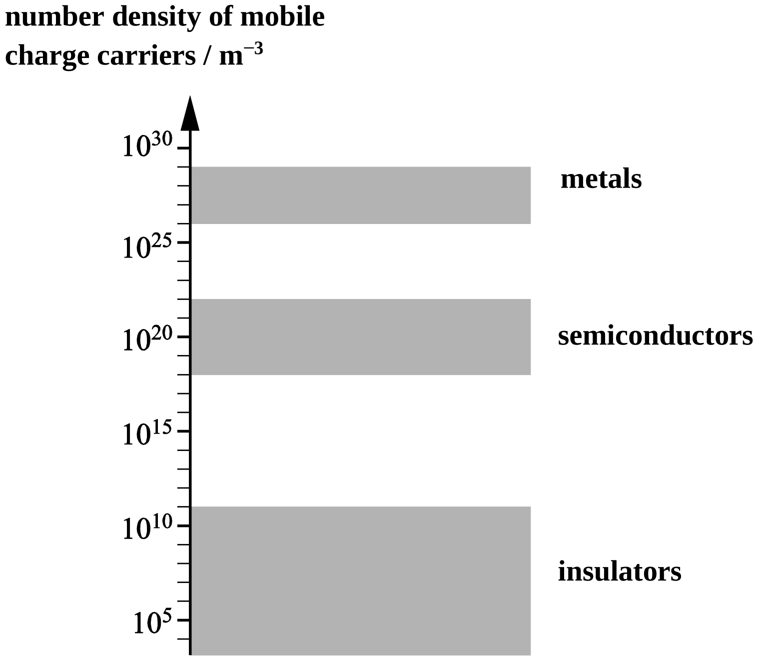


Fig. 28.1

(a) State how you recognise that the scale of **Fig. 28.1** is logarithmic.

……………………………………………………………………………………………………..........

……………………………………………………………………………………………………..........

…………………………………………………………………………………………………........ **[1]**

(b) State the factor by which the number density of mobile charge carriers is greater for the **most** conductive metal compared to the **least** conductive semiconductor using **Fig. 28.1**.

factor = ……………….. **[1]**

(c) **(i)** State what is meant by the *number density of mobile charge carriers.*

....

....

.... **[1]**

(ii) The diameter of a copper atom is 2.6×10^{-10} m. Use this value to estimate the number density of mobile charge carriers in copper metal.

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

(d) A student is measuring the conductivity of a cylindrical pencil lead and obtains the following measurements:

length of pencil lead = 0.15 m
diameter of pencil lead = 2.2 mm
resistance of pencil lead = 25 Ω

Calculate the conductivity of the material of the pencil lead.

conductivity = ... $S\ m^{-1}$ **[2]**

29 This question is about an experiment to determine the Planck constant using LEDs. To achieve a reliable value it is important to measure the value at which the LEDs **just** turn on, the threshold voltage.

(a) (i) Describe **one** technique you could use to measure the threshold voltage for LEDs.

....

....

....

....

.... **[2]**

(ii) Draw a diagram of a circuit you would use to make these measurements.

[1]

(b) A student obtains several results for red, green and blue light LEDs as shown in the table in **Fig. 29.1** below.

LED colour	**manufacturer's stated frequency** f **/ Hz × 10**^{14}	**threshold voltage**			**processed data**		
		V_1 **/ V**	V_2 **/ V**	V_3 **/ V**	V_{av}**/ V**	eV_{av} **/ J ×10**$^{-19}$	$h = \frac{eV_{av}}{f}$ **/ J s × 10**$^{-34}$
red	4.58	2.43	2.49	2.25	2.39	3.82	8.3
green	5.94	2.95	3.10	2.80	2.95	4.72	7.9
blue	6.98	3.50	3.25	5.38			

Fig. 29.1

(i) The table in **Fig. 29.1** contains a recording error. Complete table **Fig. 29.1.**

Calculate the Planck constant h using this data with an estimate of its uncertainty and comment on your result.

h = ………………….. ± ……………….. J s **[4]**

(ii) Plot a suitable best fit linear graph V_{av} against f on **Fig. 29.2.**

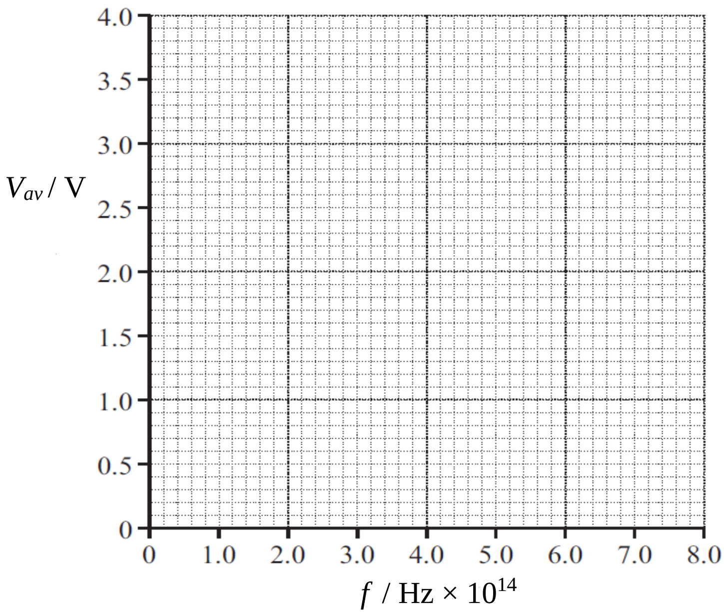


Fig. 29.2

Using the graph gradient and the equation $V = \frac{hf}{e}$, make a further estimate for the Planck constant h with an estimate of the uncertainty.

h = ………………….. ± ……………….. J s **[4]**

(iii) Comment critically on your values for h and suggest how you might go about trying to improve the method or equipment used for this experiment.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

……………………………………………………………………………………………......

……………………………………………………………………………………………......

……………………………………………………………………………………………**[2]**

END OF QUESTION PAPER

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…day June 20XX – Morning/Afternoon

AS Level Physics B (Advancing Physics)

H157/01 Foundations of physics

SAMPLE MARK SCHEME

Duration: 1 hour 30 minutes

MAXIMUM MARK 70

This document consists of 16 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.

5. Work crossed out:

   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks

   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)

   - if there is nothing written at all in the answer space

   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')

   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or e-mail.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. **Annotations**

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

11. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Section A

Question	Answer	Marks	Guidance
1	B	**1**	
2	D	**1**	
3	C	**1**	
4	C	**1**	
5	C	**1**	
6	C	**1**	
7	B	**1**	
8	A	**1**	
9	A	**1**	
10	C	**1**	
11	C	**1**	
12	D	**1**	
13	A	**1**	
14	C	**1**	
15	B	**1**	
16	D	**1**	
17	D	**1**	
18	B	**1**	
19	D	**1**	
20	A	**1**	
	Total	**20**	

Section B

Question			Answer	Marks	Guidance
21	(a)		correct orientated vector triangle with resultant labelled ✓ mag. = $\sqrt{(200^2 + 50^2)}$ = 206 **or** 210 (m s^{-1}) ✓ direction θ (E of N **or** bearing) = $\tan^{-1}$ (50/200) =14° ✓	3	diagram correct evaluation evaluation accept scale drawing method for full marks in ranges: 210 ± 10 m s^{-1} and 14° ± 2°
	(b)		$\sqrt{(200^2 - 50^2)}$ = 194 (m s^{-1})**or** 190 (m s^{-1}) ✓	1	no credit for just correct new vector diagram
			Total	**4**	

Question			Answer	Marks	Guidance
22	(a)		**AD** ‹ **BC** both distances covered in same time **or** λ decreases in 2nd medium ✓	1	 (whilst *f* remains constant)
	(b)		angle *r* = angle ACD correctly indicated and labelled ✓	1	
	(c)		= **BC** / **AD** ✓ = (**BC**/**AC**)/(**AD**/**AC**) **and** = **BC** / **AD** ✓	2	first equation Δ*t*'s cancel second equation **AC**'s cancel and both elements for 1 mark
			Total	4	

Question			Answer	Marks	Guidance
23	(a)		½ λ vibration shown with antinode at centre ✓	1	
	(b)		$f = v / \lambda$ = 660/(2 x 0.75) ✓ = 440 (Hz) ✓	2	allow ecf from **3(a)** method must remember to take λ = 2 x *L* of string evaluation 880 (Hz) scores 1 mark
			Total	3	

Question			Answer	Marks	Guidance
24	(a)		(curvature added P = 1/(0.080)) = 12.5 (D) ✓	1	Correct answer gains 1 mark
	(b)		1/v = curvature out of lens = -1/0.082 + 12.5 = 0.305 (D) ✓ v = 1/0.305 = 3.28 **or** 3.3 (m) ✓	2	Method evaluation
	(c)		(M = v/u = 3.28/0.082) = 40 ✓	1	ecf on v from (b) Correct answer gains 1 mark
			Total	**4**	
Question			**Answer**	**Marks**	**Guidance**
25	(a)		edge detection ✓	1	
	(b)		pixels across D = (2.2/6.5) x 315 ≈ 110 ✓ resolution = 0.1/110 = 9.4 x 10^{-4} (m pixel^{-1}) ✓	2	**allow** (2.2/5.3) x 260 ≈ 110 **accept** in range 105 to 115 **accept** in range (9.0 to 9.8) x 10^{-4} (m pixel^{-1})
			Total	**3**	
Question			**Answer**	**Marks**	**Guidance**
26			(electric) charge / C ✓ J C^{-1} **or** V ✓	2	**accept** electronic charges or electrons / C
			Total	**2**	

SECTION C

Question			Answer	Marks	Guidance
27	(a)		$F \alpha x$ **or** force directly proportional to compression **or** linear **and** through origin ✓	1	accept proportionalities with variables reversed
	(b)		$E = ½ F x$ **or** area under the graph ✓ = ½ x 20 x 0.06 (= 0.60 J) ✓	2	accept $E = ½ k x^2$ with k = 330 N m^{-1}
	(c)	(i)	$½ m v^2 = ½ Fx \rightarrow v = \sqrt{(Fx/m)}$ ✓ $v = \sqrt{(20 \times 0.06/0.03)}$ = 6.3 (m s^{-1}) ✓ v_h = 6.3 cos 60° = 3.2 (m s^{-1}) ✓ v_v = 6.3 sin 60° = 5.5 (m s^{-1}) ✓	4	accept $½ m v^2 = 0.60 \rightarrow v = \sqrt{(2 \times 0.60/m)}$
	(c)	(ii)	p.e. gained = k.e. lost **or** apply equations of motion ✓ $mgh = ½ mv_v^2 \rightarrow h = v_v^2/(2g)$ ✓ = 1.5(2) (m) ✓	3	*alternative method* $v^2 = u^2 + 2as$ $0^2 = v_v^2 - 2gs \rightarrow s = v_v^2/(2g)$ **allow** 1 mark for using v_{total} gives 2.0(3) (m)
			Total	**10**	

Question			Answer	Marks	Guidance
28	(a)		equal increments on axis represent equal factors **or** each small division is x10 **or** each large division is x10^5 ✓	1	
	(b)		$(10^{29} / 10^{18}) = 10^{11}$ ✓	1	Correct answer gains 1 mark
	(c)	(i)	the number of free electrons per m^3 of material ✓	1	**accept** ions **or** holes free to move per m^3 of material
	(c)	(ii)	1 m^3/(volume per atom) **or** sensible assumption ✓ accept answers in range 5 x 10^{28} to 2 x10^{29} m^{-3} ✓	2	method stated find number of atoms m^{-3} **or** any sensible assumption from: • packing fraction between 0.6 and 1 • volume of atom D^3 **or** $4\pi R^3/3$ • 1 or 2 free electrons per atom credit bare estimates in this range 1 mark max
	(d)		$\sigma = GL/A = 4L/(R \times \pi D^2)$ **or** correct values ✓ = 1.6 x 10^3 (S m^{-1}) ✓	2	method **accept** $\sigma = L/(R \times \pi r^2)$ **or** $\rho = RA/L$ correct evaluation
			Total	**7**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>29</td><td>(a)</td><td>(i)</td><td>1 a sensitive ammeter in series with LED as V increased find the p.d. value when it starts conducting ✓

2 black-out and shaded vision tube to judge V value when visible light is first observed as V increased ✓</td><td>2</td><td>accept galvanometer or μA or mA meter

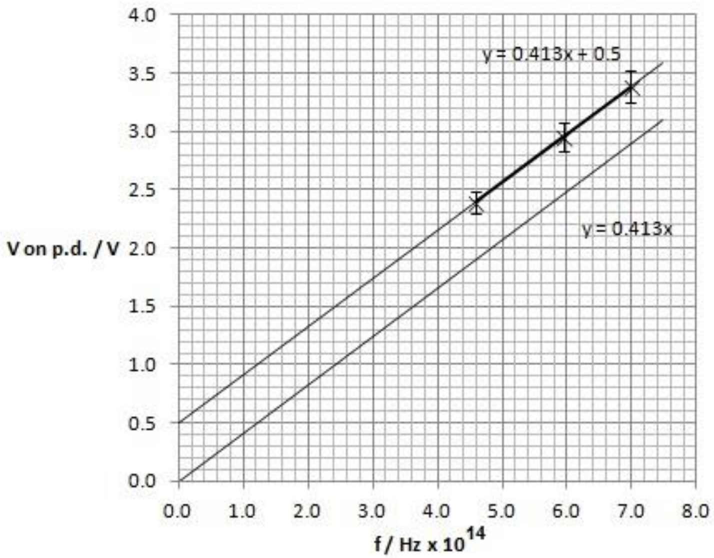
accept 1 & 2 either way round</td></tr>
<tr><td></td><td>(a)</td><td>(ii)</td><td>fully functioning circuit with variable supply / potential divider, LED with voltmeter in parallel(if ammeter used must be in series) ✓</td><td>1</td><td>with series current limiting resistor good but
NOT a series variable resistor to control circuit</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>bottom line of table completed correctly ✓

h = 8.0 ± 0.3 x 10^{-34} Js ✓

estimate with uncertainty in range (0.2 to 0.5) x 10^{-34} Js ✓

anomaly of 5.38 identified in the table ✓</td><td>4</td><td>allow table<table><tr><td>inc all data</td><td>4.04</td><td>6.46</td><td>9.3</td></tr><tr><td>exc V_3 = 5.38</td><td>3.38</td><td>5.41</td><td>7.7</td></tr><tr><td>inc V_3 = 3.38</td><td>3.38</td><td>5.41</td><td>7.7</td></tr></table>
allow 1 S.F. estimates i.e. (8 or 9) x 10^{-34} Js
allow ecf if outlier counted in</td></tr>
</table>

Question			Answer	Marks	Guidance
29	(b)	(ii)	points with uncertainties plotted by dot plot or ± bars ✓ extended best fit line, not through origin – see below ✓ *V* = *hf/e* → *h* =*e* xgradient / $1.6 \times 10^{-19} \times 0.41 \times 10^{-14}$ ✓ *h* = $(6.6 \pm 0.3) \times 10^{-34}$(Js) ✓	4	allow ecf if outlier is used for a point allow ecf if outlier used in best fit line correct method attempted: algebra / numbers / words **accept** uncertainties in range (0.2 to 0.5) x 10^{-34} (Js) **NOT** ecf on use of outlier for evaluation mark



Question			Answer	Marks	Guidance
29	(b)	(iii)	better value *h* from gradient of graph because: range includes h_{true} **or** smaller ± uncertainty **or** more precise **or** effect of systematic error can be seen and eliminated✓ repeat and check linearity for more colours of LED **or** systematic error on voltmeter used of + 0.50 V due to graph intercept **or** check calibration of voltmeter **or** change voltmeter and repeat due to graph intercept ✓	2	comment on *h* suggestion for improvement
			Total	**13**	

Summary of updates

Date	Version	Change
January 2019	2.0	Addition to the rubric clarifying the general rule that working should be shown for any calculation questions
October 2020	2.1	Updated copyright acknowledgements.

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