Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE AS Physics

Topic 1: Working as a Physicist

Test 1

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

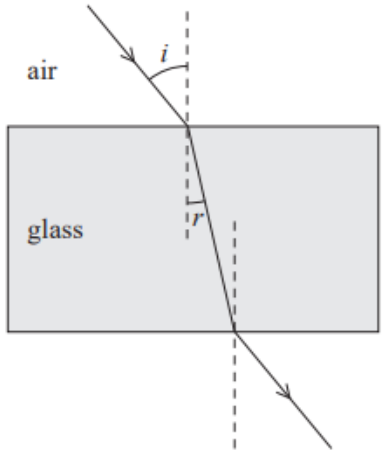
Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1

11 A student is carrying out an experiment to identify which type of glass a rectangular block is made from.

The student shines a ray of light onto one surface of the rectangular block.



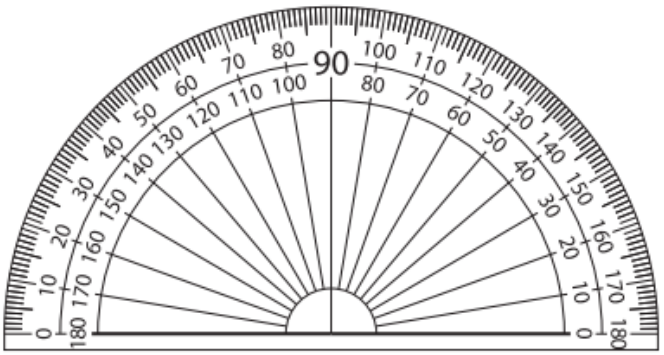
The student marks the path of the ray on paper. He takes corresponding measurements of the angle of incidence *i* and the angle of refraction *r* at the air-glass interface.

(a) State two precautions the student should take to improve the accuracy of these measurements.

(2)

1. use large angles of incidence.
2. do the experiment in a dark room so the ray is easy to see and draw over.

(b) The student uses the protractor shown.



He records his results in the table.

i / °	*r* / °
10	5
20	13
30	17
40	24
50	29
62	37

(i) Comment on whether the student has recorded his measurements of *i* and *r* to the correct number of significant figures.

(2)

The resolution of a protractor is 0.5° therefore the student has not recorded his measurements to the right amount of significant figures

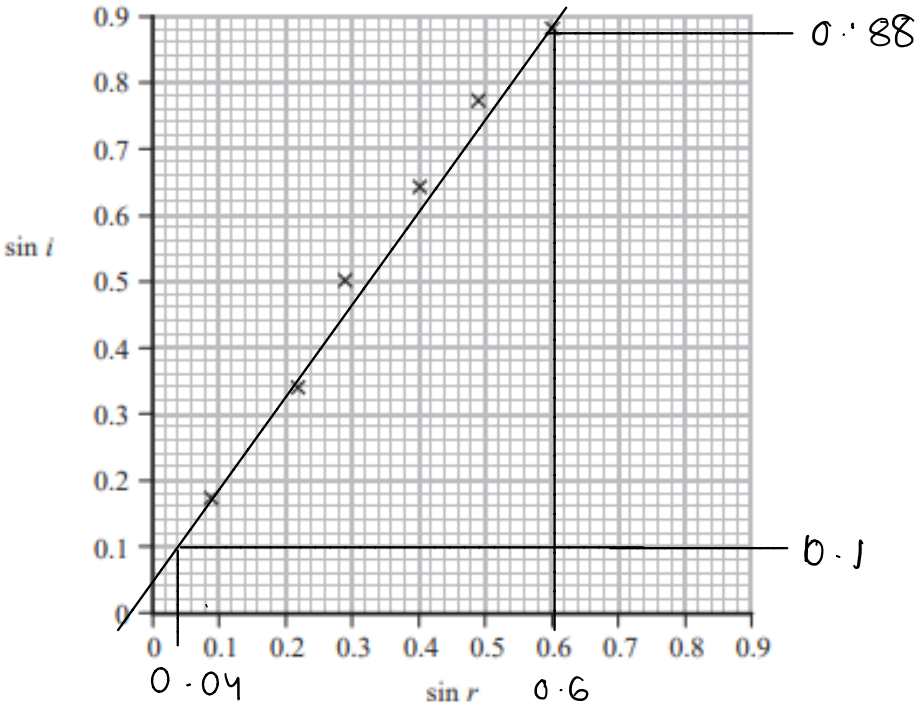
(ii) Calculate the percentage uncertainty in the value of *r* when $i = 50°$. , $r = 29°$

(2)

$$\frac{0.5}{29} \times 100 = 1.72\,\% \approx 2\,\%$$

Percentage uncertainty in *r* = 2 %

(c) The student plots his results on a graph of sin i against sin r.



The refractive index for three types of glass is shown.

Type of glass	Refractive index
Silica	1.458
Crown	1.755
Flint	1.925

(i) Draw a line of best fit.

(1)

(ii) Deduce which type of glass the rectangular block is made from.

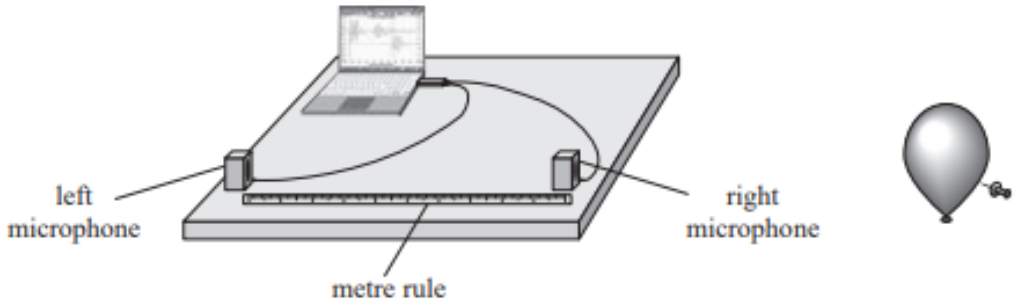
(3)

refractive index = $\frac{\sin i}{\sin r}$ = $\frac{y}{x}$ = gradient

$\therefore \frac{0.88 - 0.1}{0.6 - 0.02} = 1.344827586 \approx 1.34 \approx 1.458$

Type of glass Silica

15 A student carried out an experiment to determine the speed of sound in air. A short pulse of sound was produced by bursting a balloon near two microphones. The microphones were placed 1.00 m apart and connected to a computer.



The computer was used to determine the time interval between the sound wave being received at the right microphone and being received at the left microphone.

The separation of the microphones was decreased several times and the corresponding time intervals recorded. The student obtained the following results.

Microphone separation / m	Time interval / ms
1.00	3.2
0.90	2.8
0.80	2.4
0.70	2.1
0.60	1.9
0.50	1.5

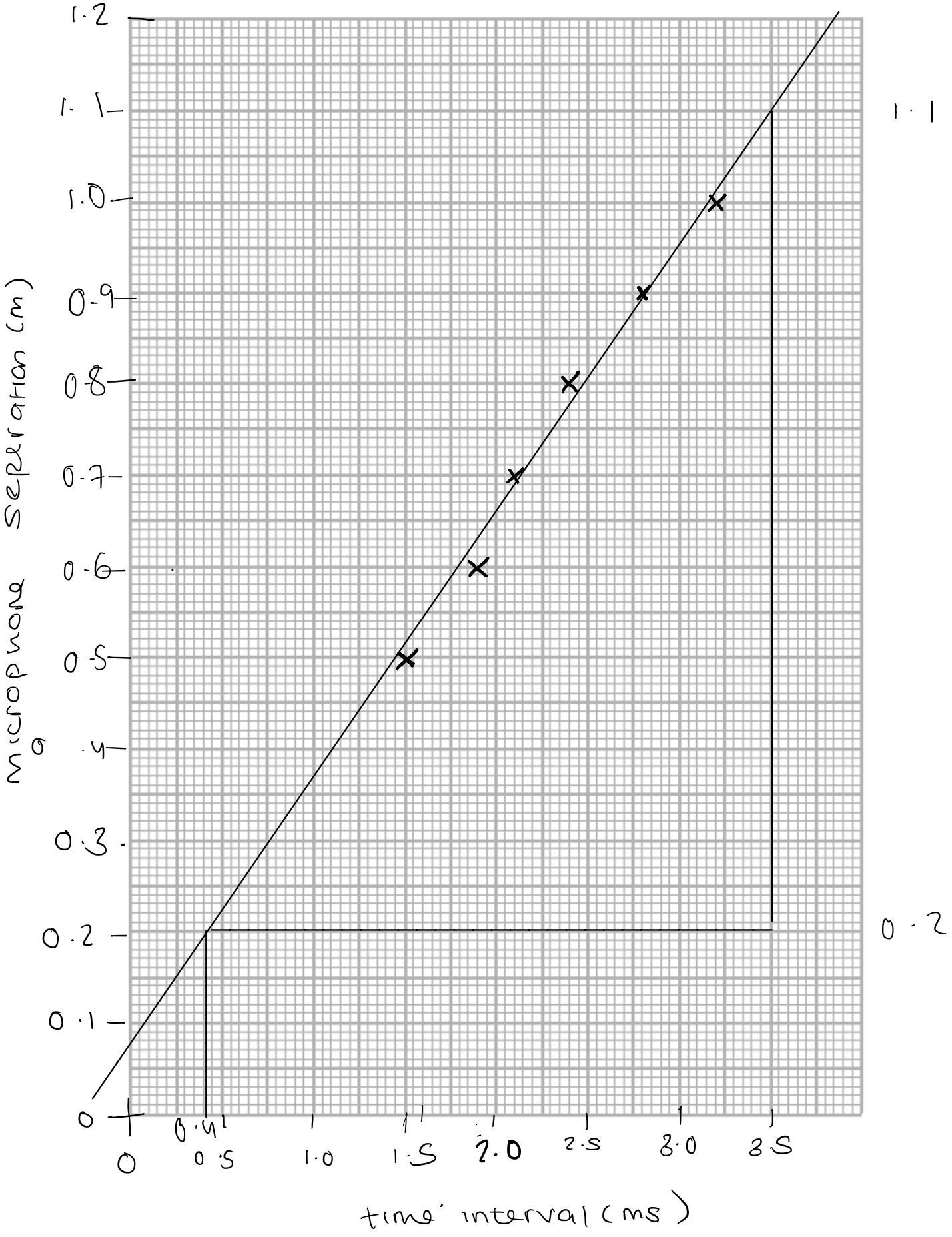
(a) Criticise these results.

(1)

The readings should have been repeated so a mean could be taken and range too small.

(b) (i) Plot a graph of microphone separation against time interval.

(4)



Speed = dist. / time

(ii) Determine a value for the speed of sound in air.

(2)

∴ Speed = microphone seperation / time = gradient = $\frac{y}{x} = \frac{1.1 - 0.2}{(3.5 - 0.4) \times 10^{-3}}$

$= 290.32...$

Speed of sound in air = 290 m/s

(c) The actual speed of sound in air is $330\,m\,s^{-1}$.

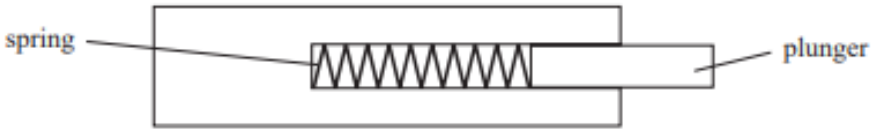
Comment on the value for the speed of sound in air at this temperature obtained from the student's results, referring to any possible sources of error.

(3)

The value obtained from the Student's results is lower than the actual speed of sound. Possible sources of error during the experiment could be due to a large percentage uncertainty for time and the measured times being too small.

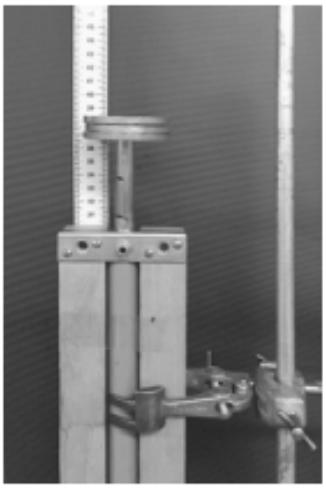
(Total for Question 15 = 10 marks)

16 A school dynamics trolley has a plunger attached to a spring. When the plunger is pushed in, the spring is compressed. When the plunger is released, it is pushed back out by the spring.



(a) A student investigated the spring to determine whether it obeys Hooke's law in compression.

The trolley was placed vertically in front of a scale and weights were added in turn to the top of the plunger, as shown. The position of the end of the plunger was recorded each time.

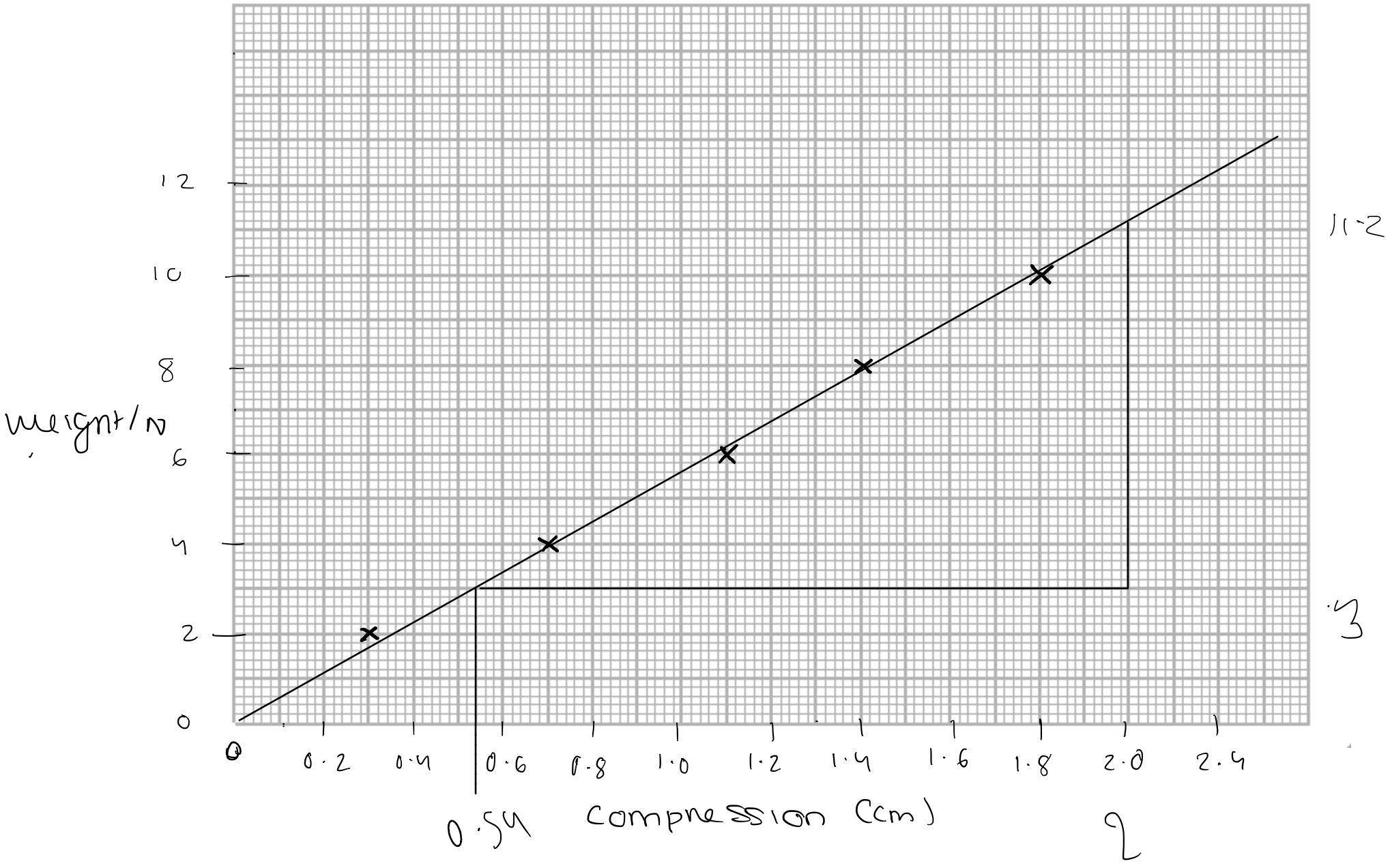


The recorded results are shown in the table.

Weight /N	Position of plunger /cm	Compression/cm
0.00	37.3	0.0
2.00	37.0	0.3
4.00	36.6	0.7
6.00	36.2	1.1
8.00	35.9	1.4
10.00	35.5	1.8

(i) Use the results to plot a graph of weight against compression. You may use the additional column for your processed data.

(5)


12
10
8
6
4
2
0
Weight/N
0
0·2
0·4
0·6
0·8
1·0
1·2
1·4
1·6
1·8
2·0
2·4
Compression (cm)
11-2
·3
0·54
2

(ii) The student concluded that the spring obeys Hooke's law with a spring constant of about 600 $N\,m^{-1}$.

Determine whether the student's conclusion is justified.

(4)

Hooke's Law → $F = kx$, $F \propto x$

The students conclusion is justified as extension is proportional to force (weight) and the line of best fit starts at 0,0 (origin)

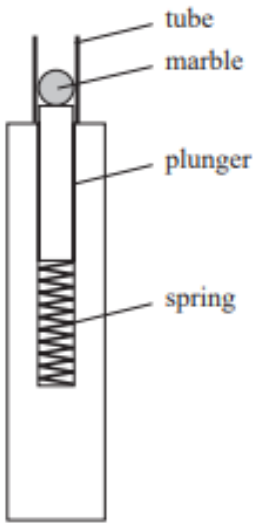
$F = k(0) = 0$.

Spring constant = $\frac{F}{x}$ = gradient = $\frac{11.2 - 2}{(2 - 0.54) \div 100}$ = 630.137

≈ 600 (1sf)

their conclusion is justified

(b) Another trolley was adapted by placing a tube around the plunger so that it could be used to launch marbles. A marble was placed in the tube while the plunger was depressed. When the plunger was released it launched the marble.



Determine the maximum possible launch velocity of the marble when the spring is compressed by 5.4 cm.

spring constant = 610 N m^{-1}

mass of marble = 4.1 g

mass of plunger = 35.4 g

(4)

$F = kx = 610 \times \left(\frac{5.4}{100}\right) = 32.94$

$E_E = \frac{1}{2} F x = \frac{1}{2} (32.94)\left(\frac{5.4}{100}\right) = 0.88938$

$E_E = E_K$

$\therefore 0.88938 = \frac{1}{2}\left(\frac{4.1 + 35.4}{1000}\right) v^2$

$45.03189873 = v^2$

$v = 6.710581103 \approx 6.7$

Maximum launch velocity = 6.7 m/s (1dp)

(c) The launch velocity was measured using a light gate and data logger. This produced a smaller value for the launch velocity than that calculated in (b).

Give a reason why this method produced a smaller value for the launch velocity.

(1)

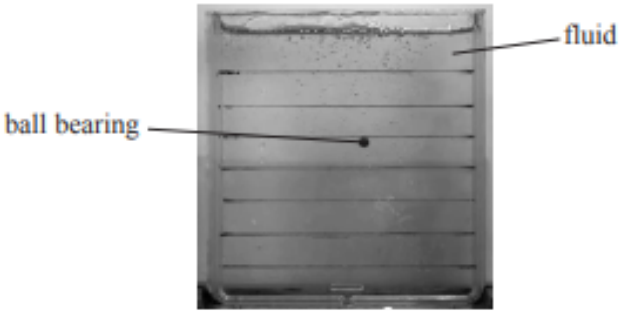
work may be done against friction by the marble, meaning a smaller kinetic energy and $KE \propto v^2$, so smaller velocity.

(Total for Question 16 = 14 marks)

15 A student carried out an experiment to identify a fluid from its viscosity at room temperature.

A ball bearing of diameter d was released at the top of a container containing the fluid. The motion of the ball bearing was recorded using a video camera and hence the terminal velocity v of the ball bearing was determined.

This was repeated for ball bearings of increasing diameter with the fluid at a constant temperature.



(a) To determine the viscosity η, the student used the equation $v = \frac{d^2 g(\rho_b - \rho_f)}{18\eta}$

where ρ_b = density of the material of the ball bearing
ρ_f = density of the fluid.

Explain why a graph of v on the y-axis and d^2 on the x-axis should be a straight line through the origin.

(3)

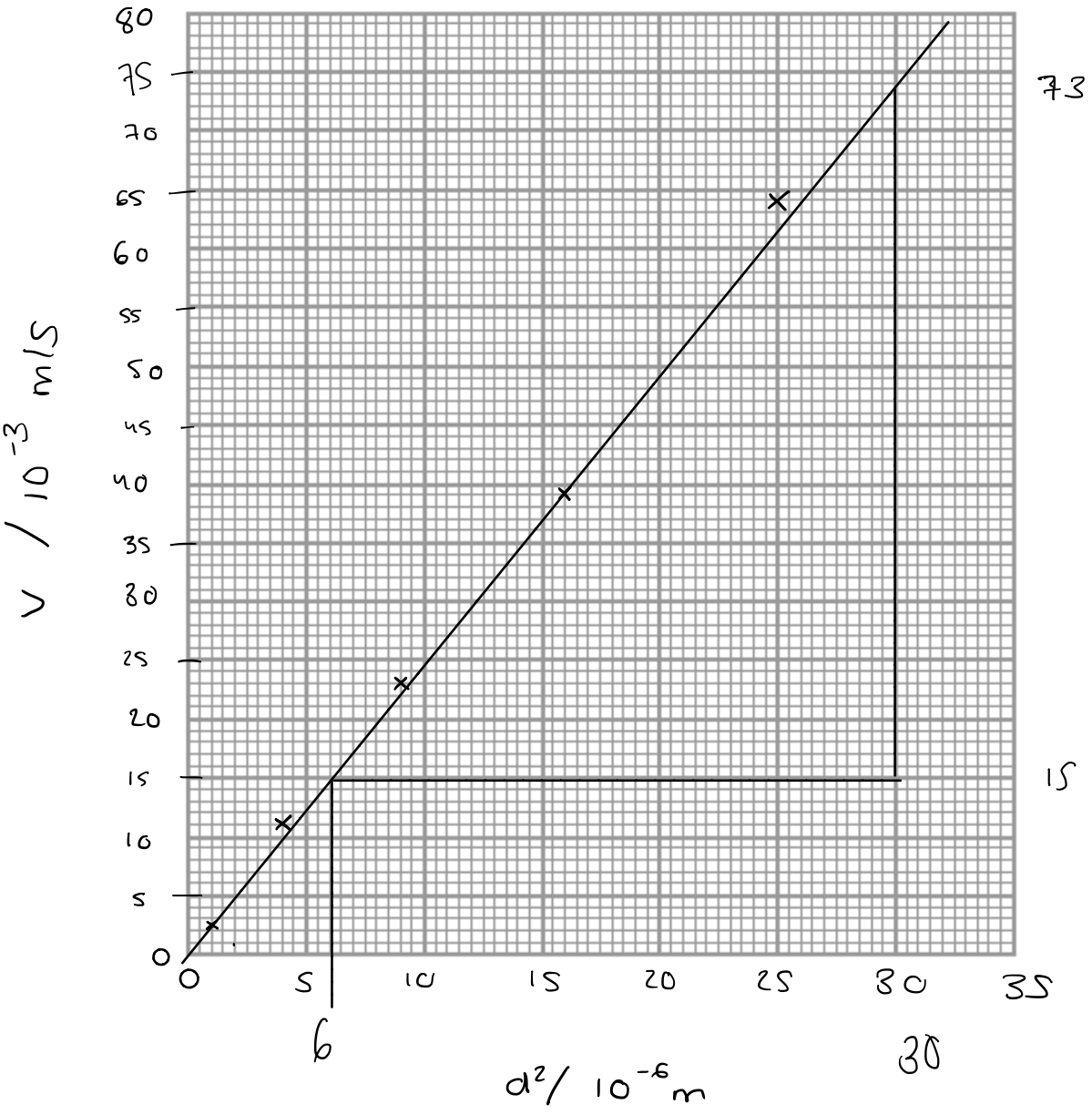
as when $d = 0$, $d^2 = 0$ ∴ $v = 0$ so it must go through the origin.
The value of $g(\rho_s - \rho_r)$ is constant & it acts as a gradient meaning 18η the equation acts as $y = mx + c$, where $c = 0$ ∴ it is a straight line through the origin

(b) The student obtained the following data.

d / 10^{-3} m	d^2 / 10^{-6} m^2	v / 10^{-3} m s^{-1}
1.0	1.0	2.3
2.0	4.0	11
3.0	9.0	23
4.0	16.0	39
5.0	25.0	64

Plot the graph of v against d^2.

(4)



(c) The table shows the viscosity of some different fluids.

Fluid	Viscosity at room temperature / Pa s
castor oil	1.0
glycerol	1.2
corn syrup	1.4
honey	1.9

Use the graph to deduce which fluid the student used.

density of ball bearing = 8000 kg m^{-3}
density of fluid = 1260 kg m^{-3}

(4)

$\frac{v}{a^2} = \frac{g(\rho_s - \rho_f)}{18\eta}$ $\therefore \eta = \frac{g(\rho_s - \rho_f)}{18} \times \frac{a^2}{v}$

$= \frac{g(\rho_s - \rho_f)}{18} \times \frac{1}{\text{gradient}}$

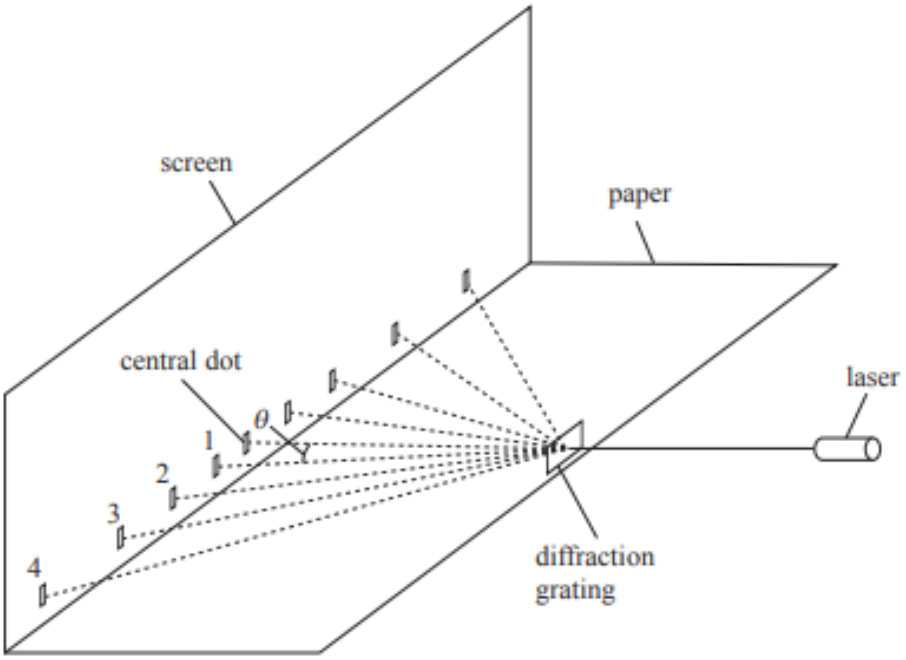
Gradient $= \frac{y}{x} = \frac{(73-15)\times 10^{-3}}{(30-6)\times 10^{-6}} = \frac{7250}{3} \rightarrow \frac{1}{\text{gradient}} = \frac{3}{7250}$

$\therefore \eta = \frac{9.81(8000-1260)}{18} \times \frac{3}{7250} = 1.51999 \simeq 1.5$

$\therefore$ corn syrup

(Total for Question 15 = 11 marks)

15 The arrangement shown was used to determine the wavelength of light emitted by a laser.



A laser light beam was shone at a diffraction grating. A series of dots of light was produced on a screen. The angles θ between the light ray to the central dot and the light rays to the dots labelled 1 to 4 were measured with a protractor.

n	θ/°	sinθ
1	12	0.21
2	23	0.39
3	34	0.56
4	51	0.78

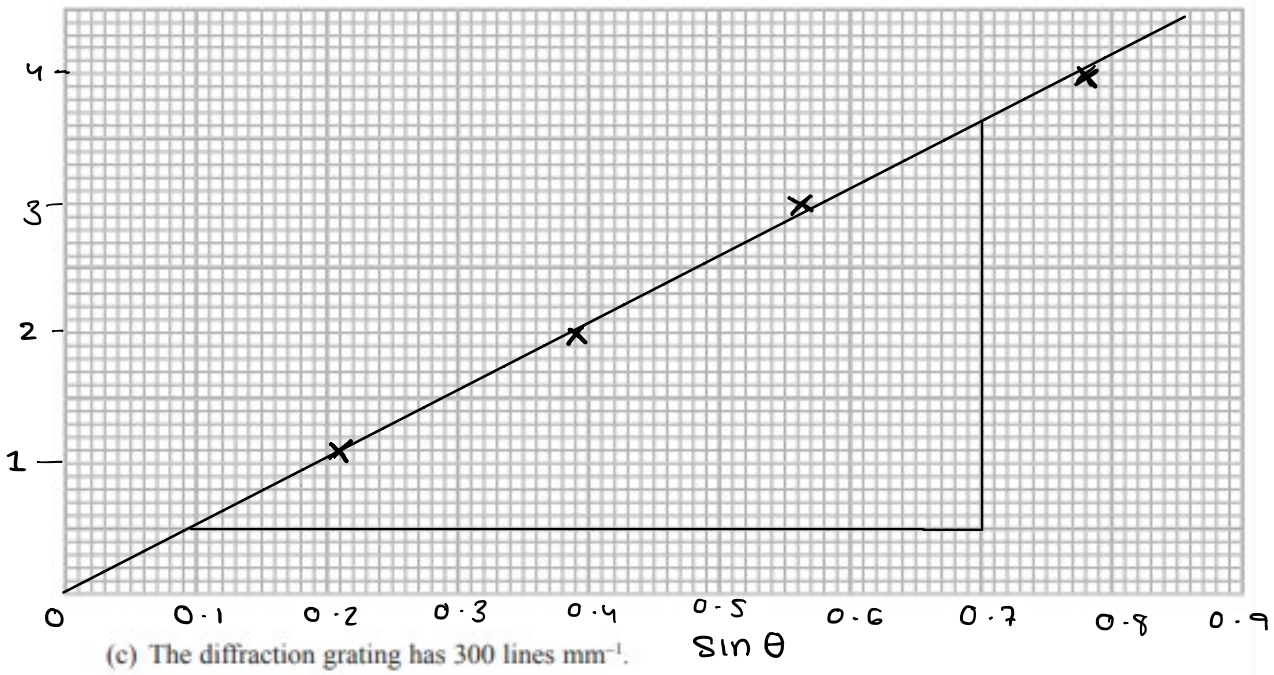
(a) Describe how the angle θ could be determined without using a protractor.

(2)

you could use the formula $n\lambda = d\sin\theta$, where d is the distance between the slits, λ is the wavelength of the light and n is the order. you can rearrange to get $\sin^{-1}\frac{n\lambda}{d} = \theta$

(b) Plot a graph of n against $\sin\theta$ on the grid below.

(4)



(c) The diffraction grating has 300 lines mm^{-1}.

Determine the wavelength of the laser light.

(4)

$\lambda = \frac{d\sin\theta}{n} = d \times \frac{1}{\text{gradient}} = \frac{d}{\text{gradient}}$

$\text{Gradient} = \frac{y}{x} = \frac{3.6 - 0.5}{0.7 - 0.6} = 31$

diffraction grating $= 300\,000$ lines / m

$\therefore d = \frac{1}{300\,000}$

$\lambda = \frac{1/300\,000}{31} = \frac{1}{300\,000 \times 31}$

$= 1.057 \times 10^{-7} \approx 106$ nm

Wavelength = 106 nm (3sf)

(Total for Question 15 = 10 marks)

TOTAL FOR PAPER IS 55 MARKS