Name of the Student:_____
Max. Marks : 24 Marks **Time : 24 Minutes**

Q1.

The photograph shows a stringed instrument called a cello being played with a bow.

(Source: © Vadim Ponomarenko/Alamy Stock Photo)

A standing wave forms on a cello string when the bow moves across the string.

Deduce whether a thicker string will produce a note of higher or lower frequency compared with a thinner string.

Assume each string is the same length and at the same tension.

(4)

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(Total for question = 4 marks)

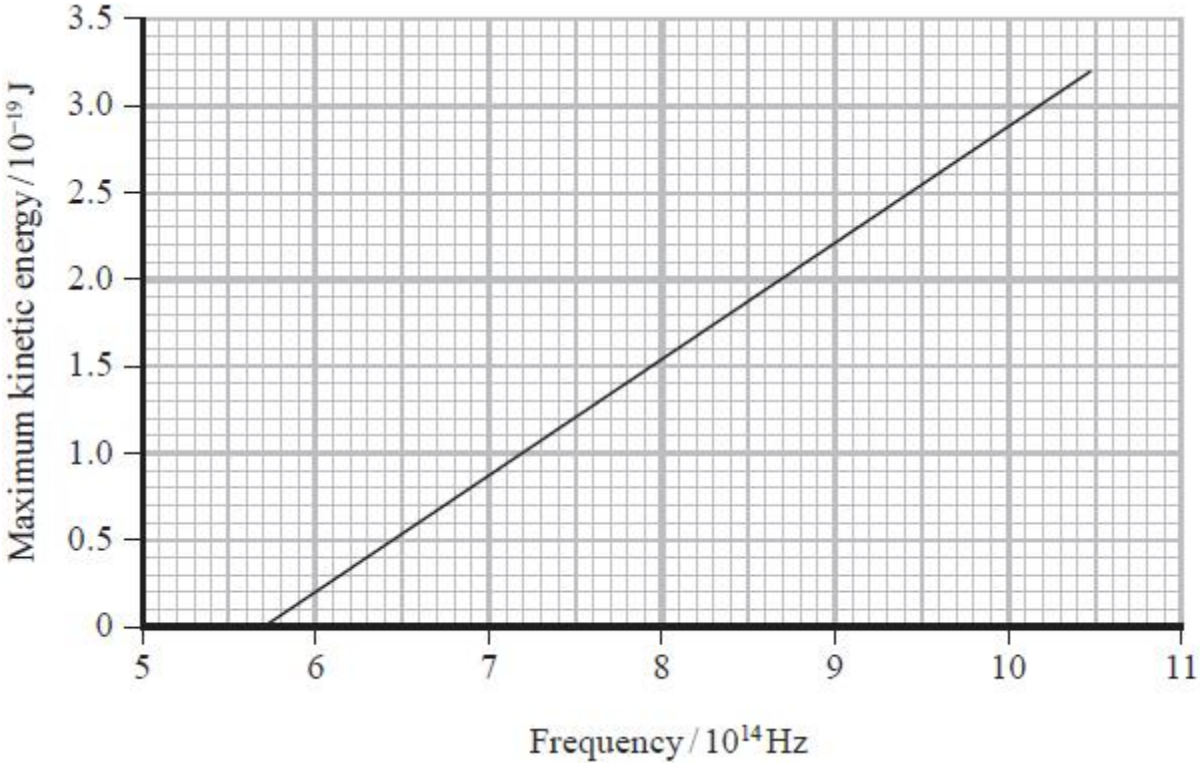
Q2.

In 1905 Einstein published his equation for the photoelectric effect.

In 1916 Millikan demonstrated that the maximum kinetic energy of photoelectrons is consistent with Einstein's equation.

Millikan used his data to obtain a value of the Planck constant.

The following graph of maximum kinetic energy of photoelectrons against frequency was produced from his data for the photoelectric effect using lithium.



Millikan suggested that the uncertainty from his results for lithium was as little as 1%.

Determine whether the value of the Planck constant obtained from this graph is within 1% of the value stated on the data sheet for this examination paper.

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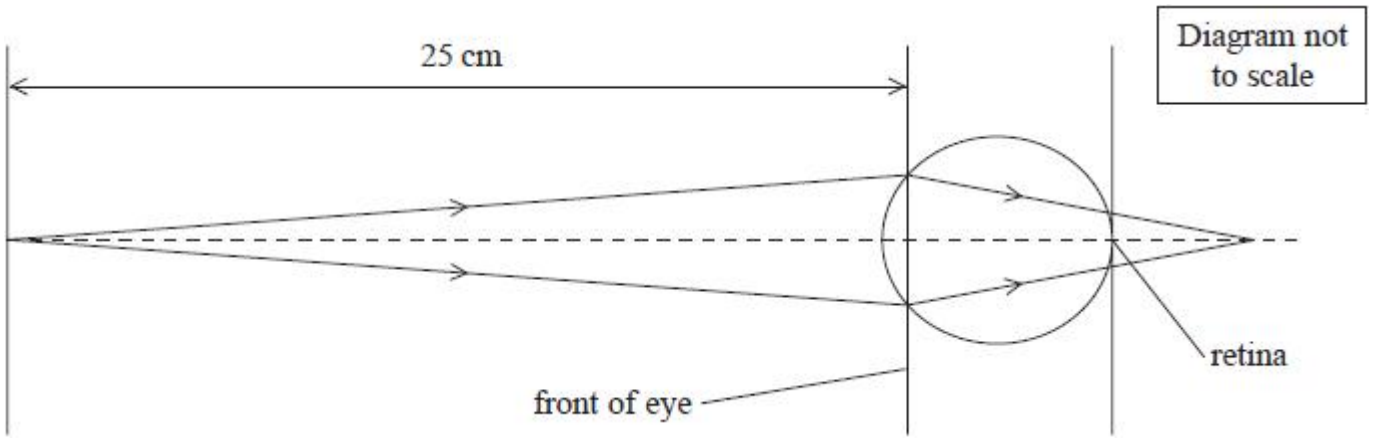
(Total for question = 3 marks)

Q3.

Converging and diverging lenses may be used in glasses to correct problems with eyesight.

A person who is long-sighted cannot clearly see objects that are close to the eye.

Rays of light from an object 25 cm in front of the eye would converge to a point behind the retina as shown in the diagram.



This may be corrected by using an additional converging lens.

State how an additional converging lens would enable the light rays from an object 25 cm in front of the eye to converge at a point on the retina.

(1)

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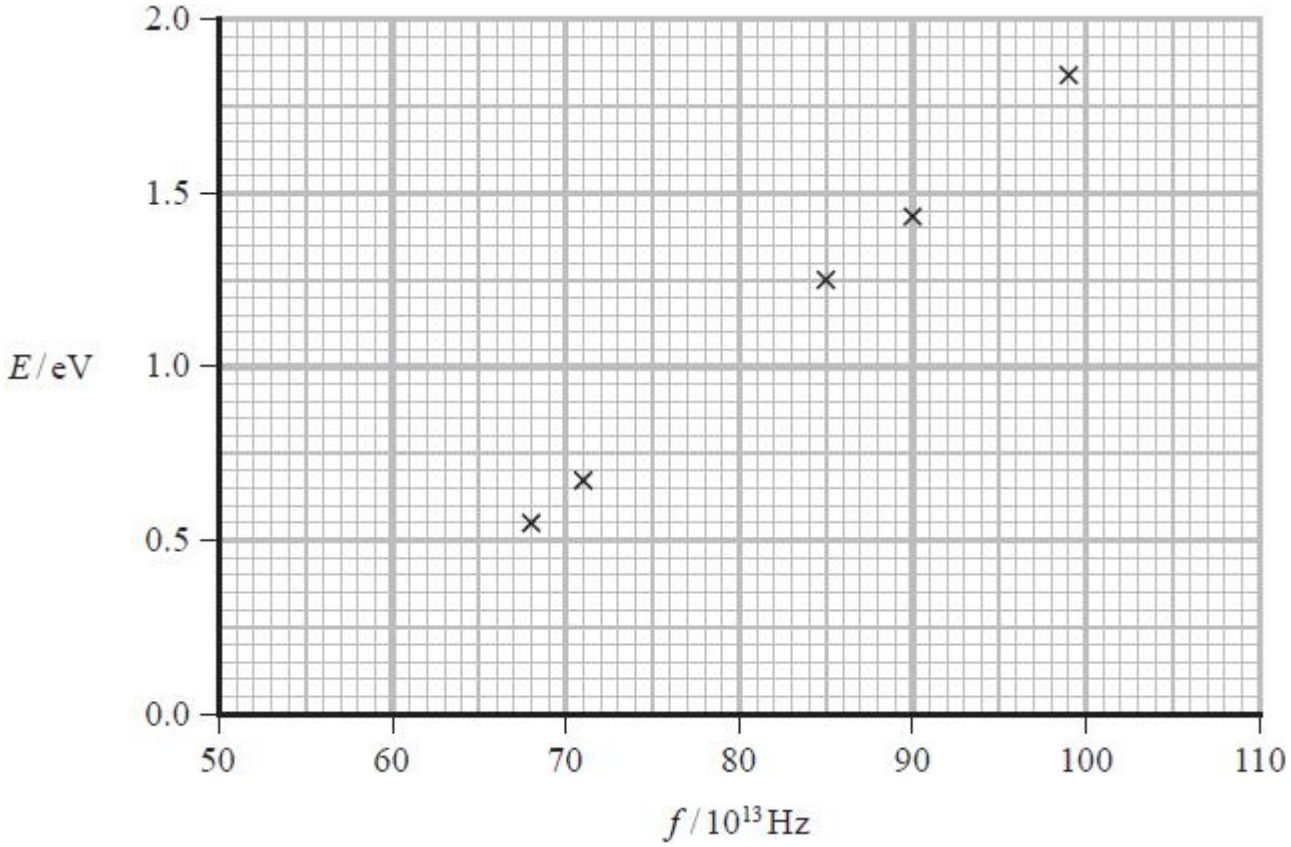
(Total for question = 1 mark)

Q4.

In an investigation of the photoelectric effect, electromagnetic radiation of frequency *f* was directed onto a metal plate. The maximum kinetic energy *E* of the photoelectrons emitted from the metal plate was determined. The procedure was repeated for a range of frequencies.

The graph shows how *E* depended upon *f*.



Determine a value for the Planck constant, *h*, in J s.

(4)

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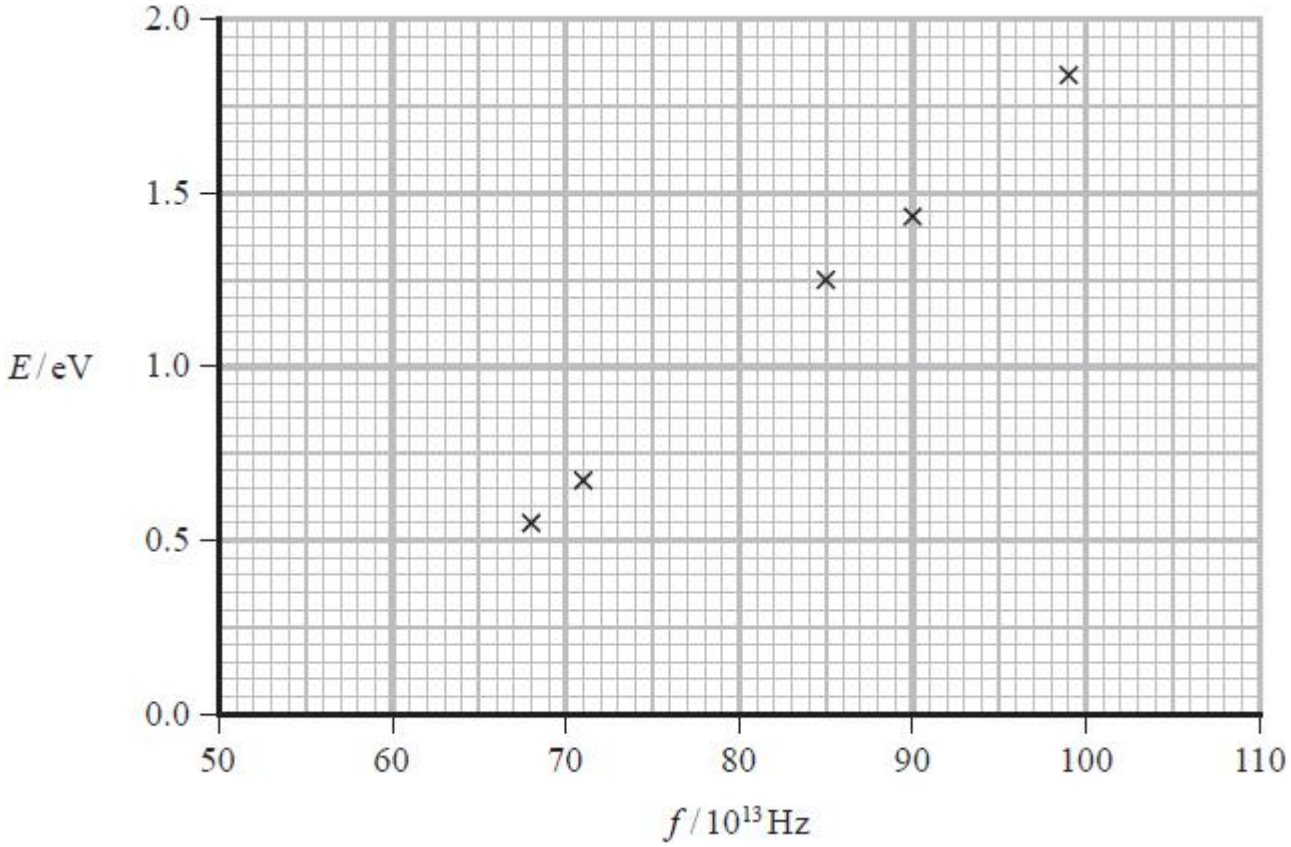
h = ... J s

(Total for question = 4 marks)

Q5.

In an investigation of the photoelectric effect, electromagnetic radiation of frequency *f* was directed onto a metal plate. The maximum kinetic energy *E* of the photoelectrons emitted from the metal plate was determined. The procedure was repeated for a range of frequencies.

The graph shows how *E* depended upon *f*.



The table gives data for different metal surfaces.

Metal surface	Work function / eV
Caesium	2.0
Calcium	2.9
Magnesium	3.7

Deduce which metal was being used in the investigation.

(3)

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(Total for question = 3 marks)

Q6.

Two students are carrying out an investigation to determine a value for the speed of sound in air.

They stand 80 m from a building. One student hits two pieces of wood together to make a loud sound and a short time later an echo is heard. The other student uses a stopwatch to measure the time interval *t* between the two pieces of wood being hit and the echo being heard. The procedure is repeated. The students also measure the air temperature.

(a) Explain how a sound wave travels through air.

(2)

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(b) The students repeat the investigation on a different day. The results are shown in the table.

	temperature / °C	t_1 / s	t_2 / s	t_3 / s	mean t / s
Day 1	12	0.51	0.43	–	0.47
Day 2	18	0.44	0.69	0.48	0.46

(i) Deduce why the students thought it necessary to make a third measurement on day 2.

(1)

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(ii) Calculate the percentage uncertainty in the mean value of time on day 1.

(2)

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Percentage uncertainty = ...

(iii) Calculate the difference in the value for the speed of sound between day 1 and day 2 obtained from these results.

(2)

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Difference in speed = ...

(iv) The students state that the difference in the speed of sound between day 1 and day 2 is due to the change in air temperature.

Explain whether the results obtained are sufficient for this statement to be made.

(2)

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(Total for question = 9 marks)