

Name of the Student: _____

Max. Marks : 27 Marks

Time : 27 Minutes

Q1.

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 a device known as a monochromator to ensure that a single wavelength of light was used to illuminate the surface of the lithium.

A monochromator separates wavelengths using a diffraction grating.

Calculate the angle at which a diffraction grating would produce the most intense line at a single wavelength of 6.1×10^{-7} m.

number of lines per mm for grating = 600 mm^{-1}

(3)

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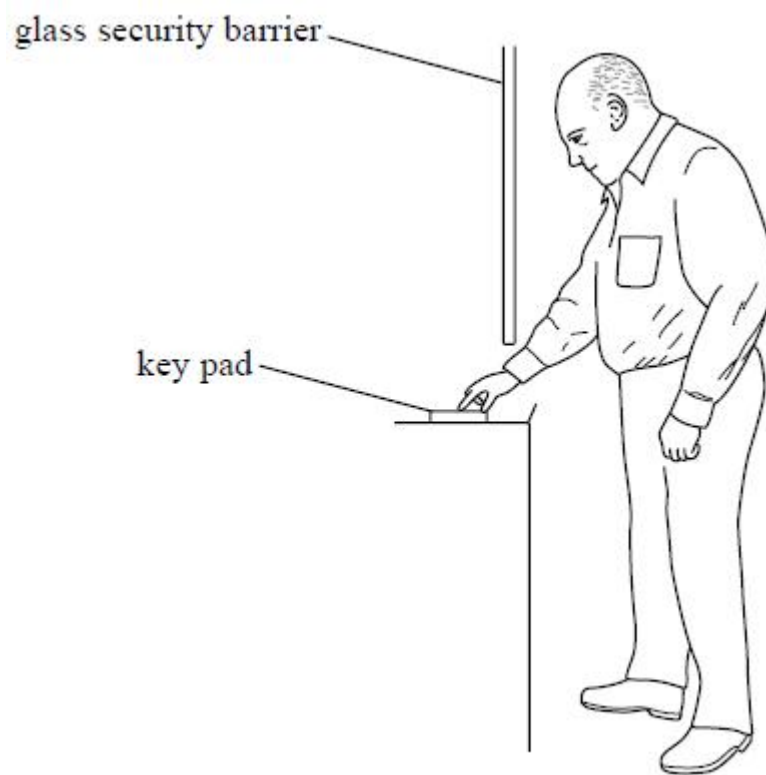
Angle = ...

(Total for question = 3 marks)

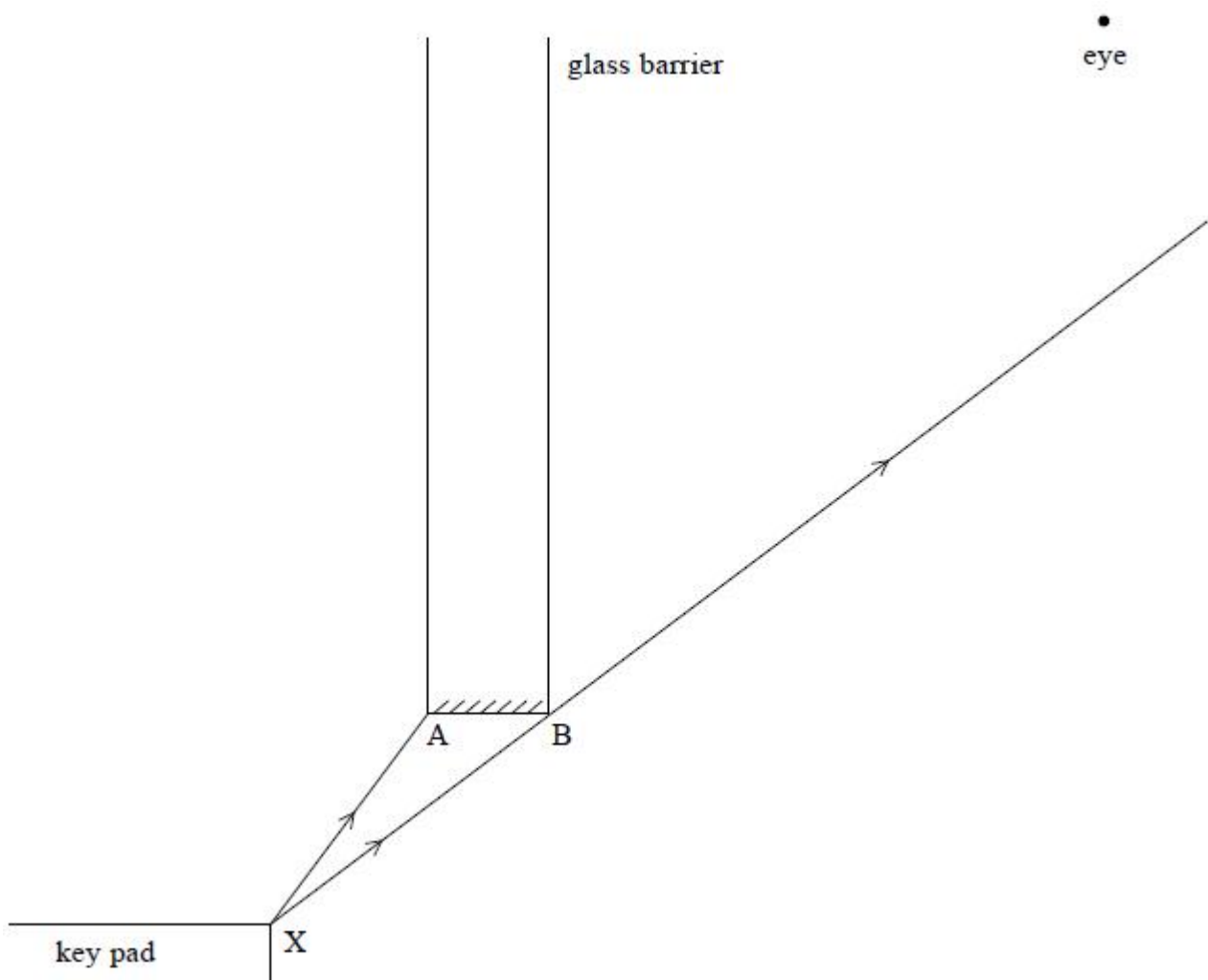
Q2.

A motorist pays for petrol at a filling station using a bank card for which a personal identification number must be entered on a key pad.

There is a thick sheet of glass between the cashier and the motorist, with a gap at the bottom to give access to the key pad.



When standing as shown in the diagram, refraction of light through the glass means that the motorist is unable to see the key pad without moving his head to see under the glass.



The diagram shows rays from the key pad. The light travelling initially along the path XA, which then passes through the glass, does not reach the motorist's eye. Assume no light passes through the surface AB.

- (i) Measure the angle of incidence for the ray travelling along XA and calculate the angle of refraction in the glass.
refractive index of glass = 1.5

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- (ii) Add to the diagram to show that light travelling initially along the path XA does not reach the eye of the motorist.

(1)

(Total for question = 4 marks)

Q3.

In 1864, William Huggins and William Miller used dark lines in the spectrum of the Sun to identify elements in the Sun's atmosphere.

* Explain how gases in the Sun's atmosphere cause dark lines in the spectrum corresponding to different elements.

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(Total for question = 6 marks)

Q4.

Helium was first discovered because of dark lines observed in the continuous spectrum of light from the Sun. The lines were caused by a few specific frequencies of light in the spectrum being present at very much lower intensity than the rest.

Scientists deduced that this was due to an unknown element in the Sun's atmosphere.

(a) Explain how helium in the Sun's atmosphere caused this set of dark lines.

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(b) The diagram shows some of the energy levels for an atom of another element.

$n = 5$ ————— -0.38 eV

$n = 4$ ————— -0.55 eV

$n = 3$ ————— -0.85 eV

$n = 2$ ————— -1.51 eV

$n = 1$ ————— -3.41 eV

(i) Determine which energy levels are associated with photons of frequency $4.6 \times 10^{14} \text{ Hz}$.

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(ii) Suggest why the energy levels all have a negative value.

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(c) Lines such as those described in (a) can be used to determine the motion of stars relative to the Earth.
Suggest how these lines may be used to determine the motion of stars.

(3)

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(Total for question = 14 marks)