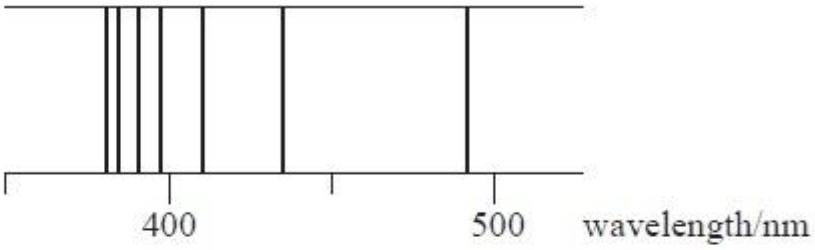
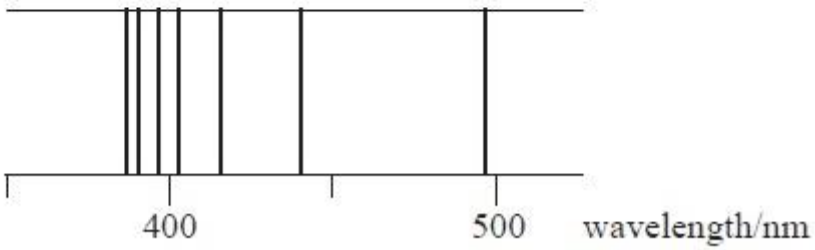
**Name of the Student**:_____
**Max. Marks : 17 Marks** **Time : 17 Minutes**

**Q1.**
The diagram shows part of the hydrogen line spectra obtained for radiation emitted from hydrogen in the laboratory and received from hydrogen in a distant galaxy.



Laboratory Spectrum



Distant Galaxy Spectrum

The lines in the distant galaxy spectrum are all shifted in wavelength compared to the lines in the laboratory spectrum.

State why the lines are shifted and what we can conclude about this distant galaxy.

**(2)**

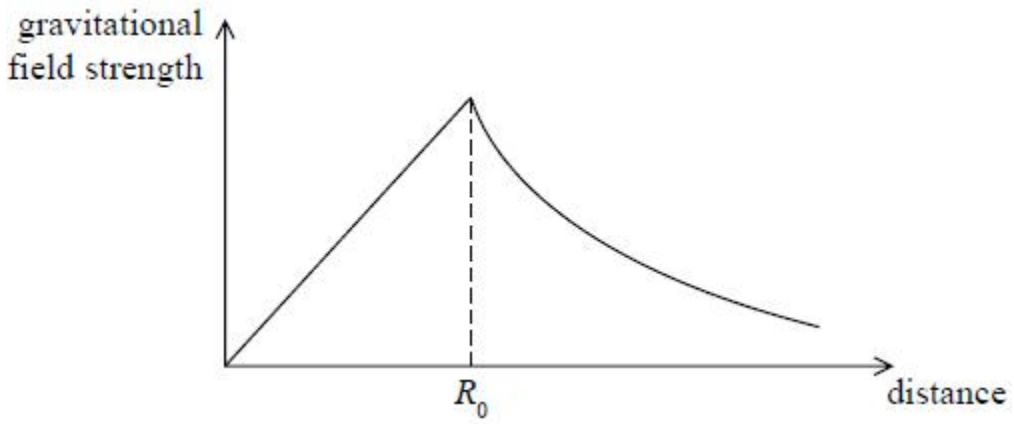
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**(Total for Question = 2 marks)**

**Q2.**

The graph shows the variation of the gravitational field strength with distance from the centre of the Earth. $R_0$ is the radius of the Earth.

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A scientist suggests the following:

> "If a tunnel were made through the centre of the Earth, an object dropped at one end would accelerate downwards until it reached the centre. It would then decrease in speed until it reached the other end of the tunnel with a speed of zero. The object would then return the other way, undergoing simple harmonic motion."

Using the graph between 0 and $R_0$, determine whether simple harmonic motion would occur.

**(4)**

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**(Total for question = 4 marks)**

**Q3.**

According to astronomers in Denmark and Australia a common type of active galactic nucleus (AGN) could be used as an accurate "standard candle" for measuring cosmic distances. The technique has been used to measure distances corresponding to redshifts significantly larger than was previously possible.

(a) (i) State what is meant by a standard candle.

**(1)**

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(ii) Explain how a standard candle is used to measure cosmic distances.

**(2)**

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(b) (i) State what is meant by redshift.

**(1)**

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(ii) Calculate the distance to a galaxy with a redshift $z = 0.12$

$H_0 = 2.1 \times 10^{-18}\ s^{-1}$

**(2)**

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Distance to galaxy = .....

*(c) Discuss how astronomers were led to propose the existence of dark matter and the consequences of its existence for the ultimate fate of the universe.

**(3)**

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(d) Explain why the observable universe has a finite size.

**(2)**

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**(Total for Question = 11 marks)**

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