GCSE

4781/03-A

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SCIENCE B

UNIT 1: Space, Energy and Life

Resource Folder (Pre-Release Article)

For use with:

GCSE Science B (UNIT 1) **Section B** of the Foundation Tier

GCSE Science B (UNIT 1) **Section A** of the Higher Tier

4781
03A001

Pre-Release Article

Evolution of the structure and composition of the universe

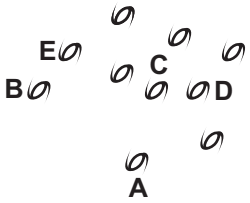
The universe is believed to have started about 13.5 thousand million years ago.

Theories about the origin of the universe have changed over time. The Steady-State theory proposed by Fred Hoyle in 1948 was widely accepted for many years. New evidence supports the Big Bang theory.

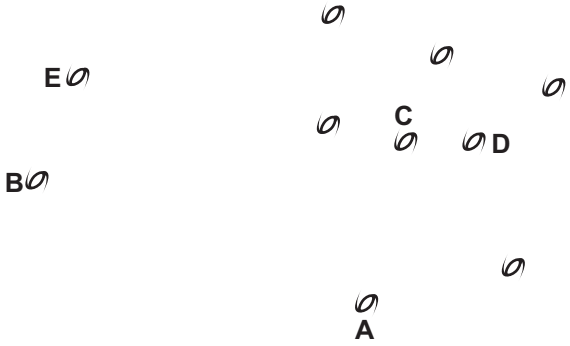
The drawings below show the same group of galaxies at two different times during the history of the universe.

Diagram 1

Early Universe



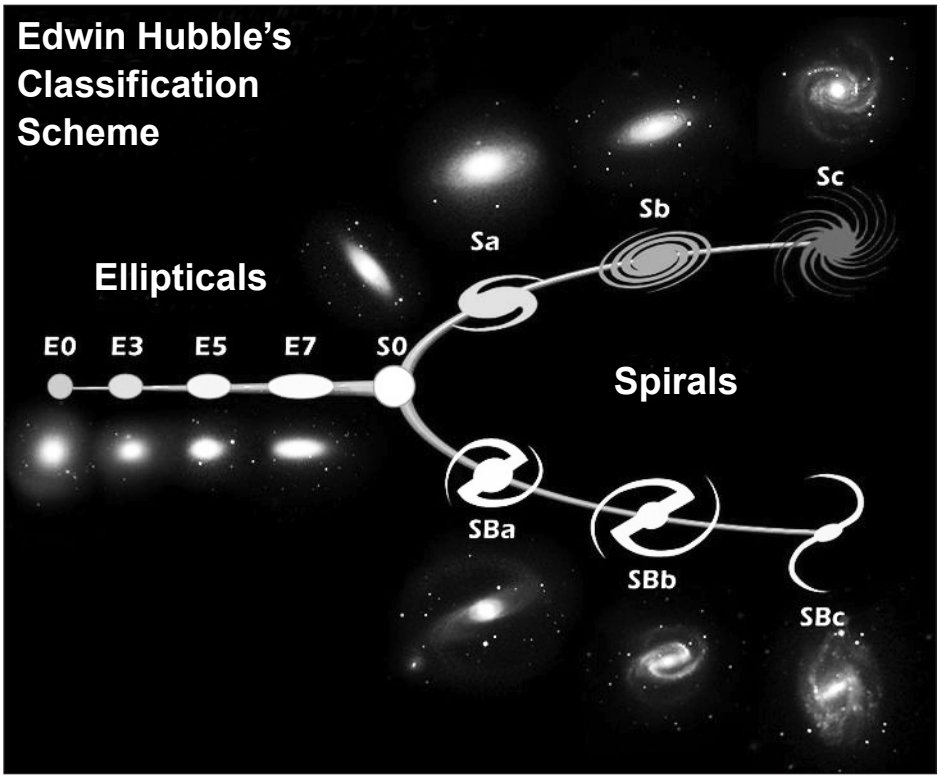
Universe at a later time



Classifying galaxies

Edwin Hubble proposed a method of classifying galaxies. The classes of galaxies are shown in **Diagram 2**.

Diagram 2



Turn over.

Table 1 gives the type of galaxy for different symbols used in classifying galaxies.

Table 1

Class of galaxy	Type of galaxy
E	elliptical
S0	lenticular
S	spiral
SB	barred spiral
a	tight arms & large bulge
b	intermediate arms
c	open arms & small bulge
Irr	irregular

Types of galaxies

Spiral galaxies are made up of a flattened disk containing spiral arms, a bulge at its centre, and a halo. Spiral galaxies have a variety of shapes and are classified according to the size of the bulge and tightness and appearance of the arms. The spiral arms, which wrap around the bulge, contain numerous young blue stars and lots of gas and dust. Stars in the bulge tend to be older and redder. Yellow stars like our Sun are found throughout the disk of a spiral galaxy. These galaxies rotate.

Barred spiral galaxies are spiral galaxies that have a bar running across the centre of the galaxy.

Elliptical galaxies do not have a disk or arms. Instead, they have a smooth, ball-shaped appearance. Elliptical galaxies contain old stars, and possess little gas or dust. They are classified by the shape of the ball. The stars in elliptical galaxies do not revolve around the centre in an organized way.

Irregular galaxies are galaxies that are neither spiral nor elliptical. They tend to be smaller objects that are without definite shape. They have newer stars mixed with lots of gas and dust in the interstellar space. These galaxies often have active regions of star formation. Sometimes the irregular shape of these galaxies results from interactions or collisions between galaxies.

The speed of galaxies

In 1921, astronomer Edwin Hubble measured the speeds of galaxies at different distances from Earth. The table shows similar data for recently measured galaxies.

Table 2

Galaxy	Distance from Earth (Mpc)	Speed (km/s)
NGC-5357	0.45	200
NGC-3627	0.9	650
NGC-5236	0.9	500
NGC-4151	1.7	960
NGC-4472	2.0	850
NGC-4486	2.0	800
NGC-4649	2.0	1090
NGC-1832	31.0	2000
NGC-6217	49.0	1260
NGC-7469	65.0	4470
NGC-5548	67.0	5270

The distances are given in megaparsecs (Mpc).

One megaparsec equals 3.26 million light years.

The speed of light is 300 000 km/s.

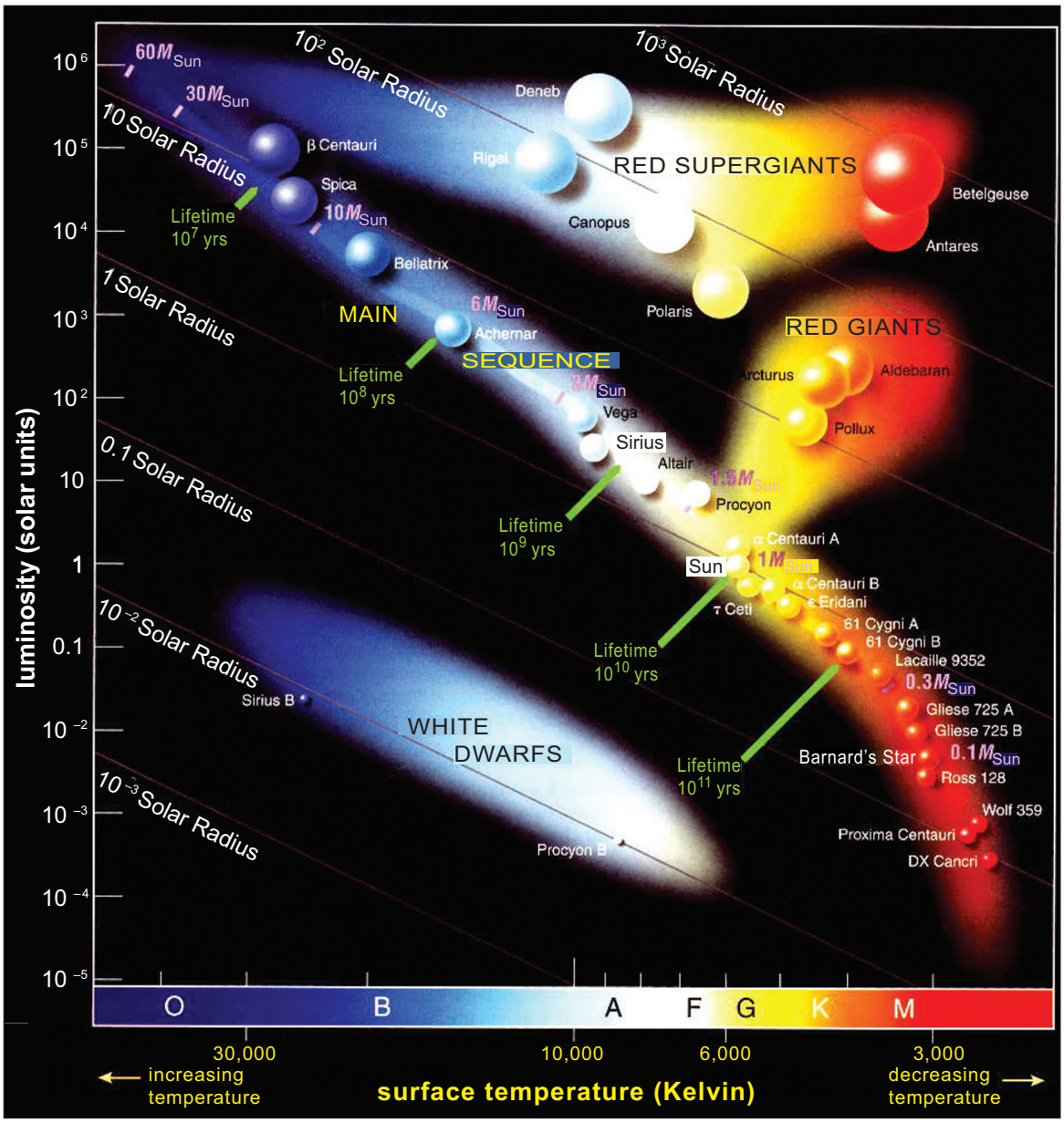
Hubble's Constant can be determined by plotting this data on a graph and finding the gradient of the best fit line that goes through the origin.

The contents of galaxies

Each galaxy contains billions of stars in different stages of their lives. The H-R (Hertzsprung-Russell) diagram (**Diagram 3**) shows stars at these different stages. The sequence of a star through the regions of the H-R diagram depends on their size.

The **H-R diagram** is a scatter graph of stars showing the relationship between the stars' luminosities and their colour classifications (O, B, A, F, G, K & M) which depends upon the surface temperature.

Diagram 3



Adapted Sources:

Diagram 1

http://amazing-space.stsci.edu/resources/explorations.glazies-galore/index.html

Diagram 2

http://en.wikipedia.org/wiki/Galaxy_morphological_classification

Table 2

http://spacemath.gsfc.nasa.gov

Diagram 3

http://zebu.uoregon.edu/~imamura/122/lecture-5/lecture-5.html

Examiner only

Answer **all** *questions in the spaces provided.*

Use the information in the separate Resource Folder to answer the following questions.

1. Use **Diagram 1** to answer the following questions.

(a) Describe how the diagram shows the universe has changed over time. [1]

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(b) Explain why the diagram does not support the Steady-State theory of the universe. [2]

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(c) Imagine **C** is our galaxy, the Milky Way. Compare how the distances of galaxies **A** and **D** from the Milky Way have changed from the early universe to some time later. [2]

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(d) Arrange galaxies **A**, **B**, **D** and **E**, in order of speed of travel away from **C** from fastest to slowest. [1]

Fastest .... *Slowest*

6

Examiner only

2. Use the information in **Diagram 2**, **the text** and **Table 1** to answer the following questions.

(a) Describe how the properties of galaxies change from left to right along the Hubble Classification Scheme. [6 QWC]

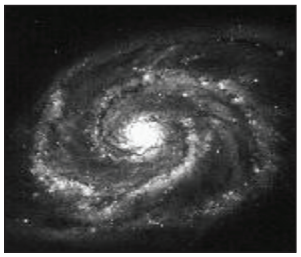
Turn over.

Examiner only

(b) Write down the class of each galaxy shown in the diagrams below. [3]

The first one has been done for you.

Class E0



Class .....

Class.....

Class .....

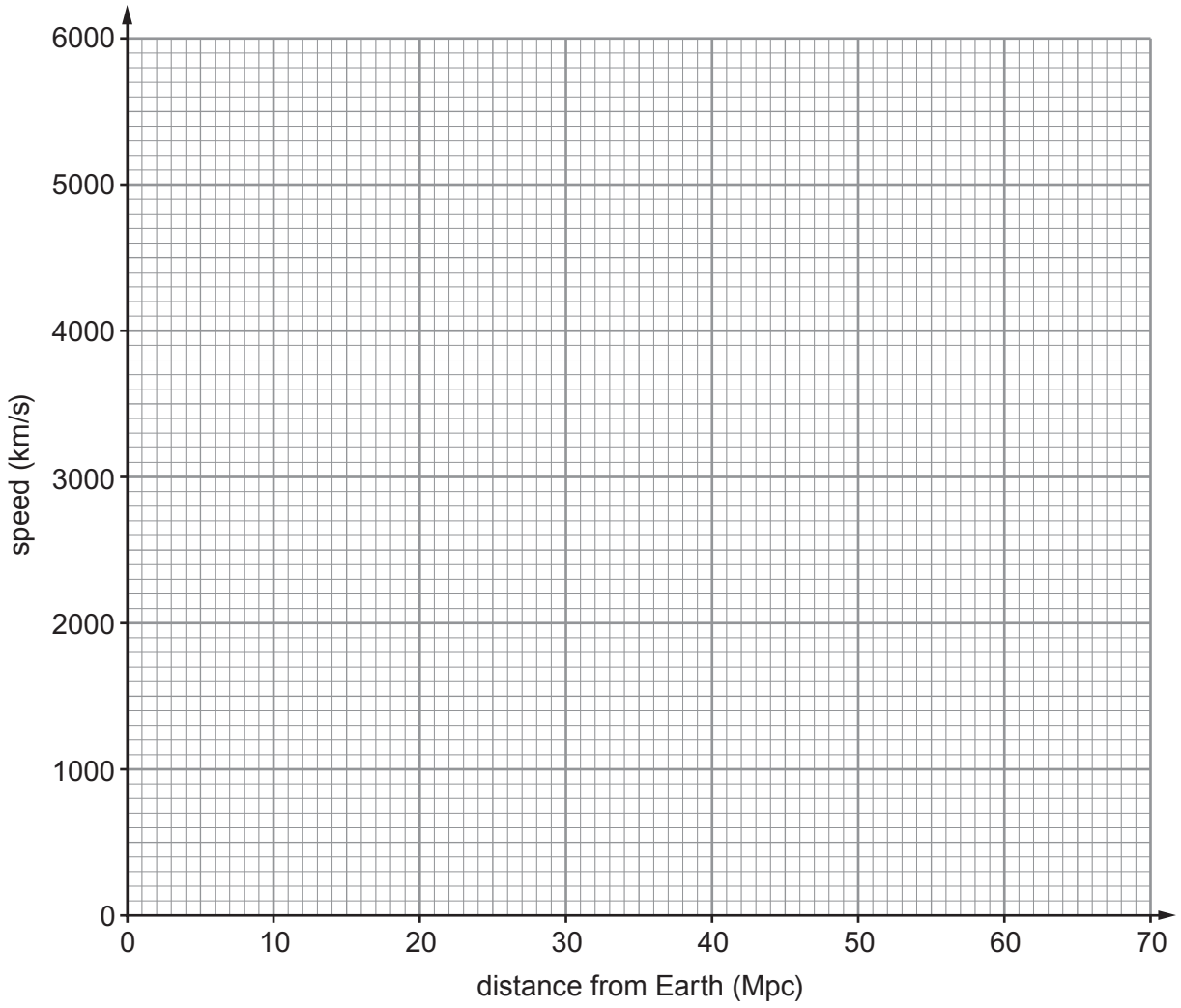
9

Examiner only

3. *(a)* Use the data in **Table 2** to plot a graph on the grid below.

Use **only** the data for the six galaxies from NGC-4486 to NGC-5548.

Add a straight line of best fit that goes through the origin. [3]



(b) Use your graph to find a value for the Hubble constant. [3]

Hubble constant = ... km/s/Mpc

6

Turn over.

Examiner only

4. Refer to **Diagram 3** to answer this question.

Describe how the surface temperature of our Sun will change as it becomes a red giant similar to Aldebaran and then a white dwarf similar to Sirius B. You should include data in your answer. [3]

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3

END OF PAPER

GCSE MARKING SCHEME

SCIENCE B

SUMMER 2015

Question		Marking point	Marks
1.	(a)	The galaxies have moved apart / universe has expanded	1
	(b)	Steady state says universe would look the same at any time in its history (1) **but** this is not the case in the diagram (1) *Second mark is awarded for a second statement linked to the first.*	2
	(c)	Both are further away (1) and A has moved more (1)	2
	(d)	B-E-A-D	1

Question	Marking point	Marks
2. (a)	**Indicative content** • The first set of galaxies are elliptical. They do not have spirals. • From E0 to E7 their shape changes from round to more oval. • Next are the lenticular galaxies which have a central bulge but no arms. • The spiral galaxies (S) and barred spiral galaxies (SB) appear next. • SB galaxies have a bar across their centres from which the arms appear. • Sa and SBa galaxies have a large central bulge and tight arms / Sc and SBc have a smaller bulge and open arms. **5-6 marks** The candidate constructs an articulate, integrated account correctly linking relevant points such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling, punctuation and grammar. **3-4 marks** The candidate constructs an account correctly linking some relevant points such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar. **1-2 marks** The candidate makes some relevant points such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar. **0 marks** The candidate does not make any attempt or give a relevant answer worthy of credit.	6
(b)	Sb/Sc, E3 - 5, SBb	3

Question		Marking point	Marks
3.	(i)	Plotting all correct $^{+}$/- half square tolerance (2), five correct (1) Straight line of best fit (1) (must go through origin)	3
	(ii)	Evidence of use of graph to provide values from both axes (1) correct substitution (1) value for Hubble Constant between 50 – 80 km/s/Mpc (1)	3

Question	Marking point	Marks
4.	Current T = 5000 – 6000 K (1) Decreases (as it becomes a red giant) to T = 3500 – 4500 K (1) Increase (as it becomes a white dwarf) T = 20000 - 30000 K (1) 1 mark only if correct sequence (decrease, increase) without data given	3