Topic 8 Space

Name: _____

Class: _____

Date: _____

Time:	**38 minutes**
Marks:	**38 marks**
Comments:	

Q1. In 1929, the astronomer Edwin Hubble observed that the light from galaxies moving away from the Earth had longer wavelengths than expected.

(a)   What name is given to this effect?

....

....

(1)

(b)   From his observations, Hubble was able to calculate the speed of a galaxy and the distance of the galaxy from the Earth.

Figure 1 shows the results of Hubble's calculations.

Figure 1
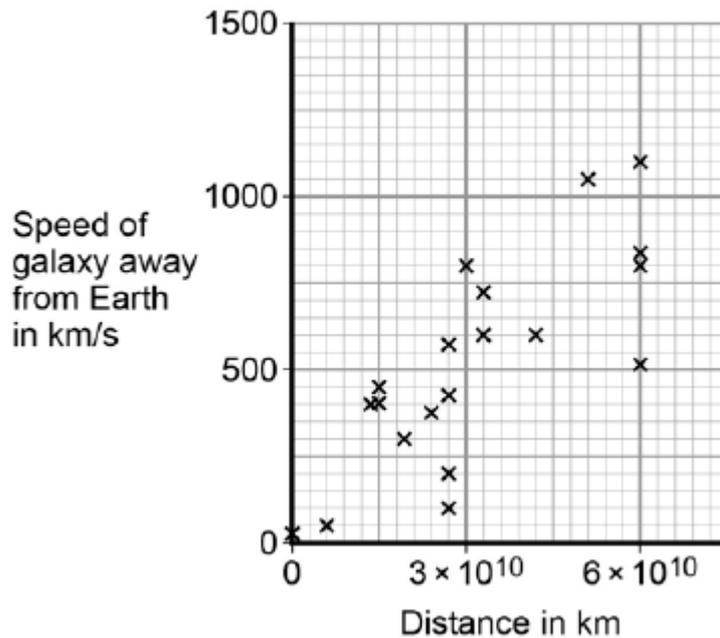
What relationship between the speed of a galaxy and the distance is suggested by Hubble's results?

....

....

(1)

The observations made by Hubble support the idea that the Universe is expanding. This means that galaxies are continually moving away from each other and from the Earth.

Figure 2 shows a student using a balloon to model the idea of an expanding Universe.

Some dots, which represent galaxies, were marked on the balloon. The balloon was then inflated.

Figure 2
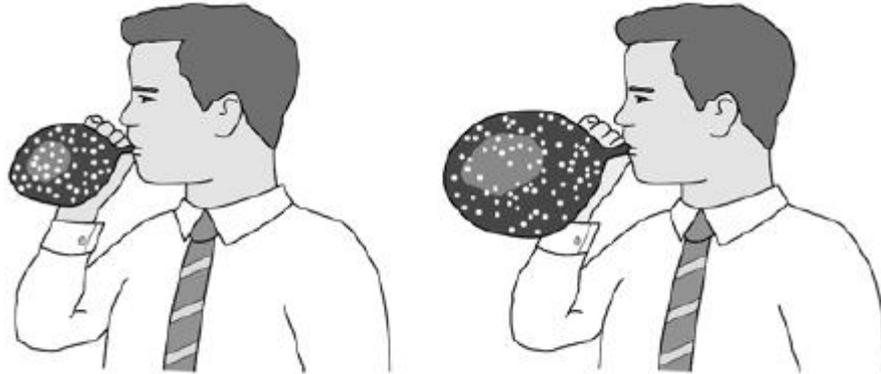
(c)   Give **one** strength and **one** weakness of this model in representing the idea of an expanding Universe.

Strength ....

....

Weakness ....

....

(2)

In the 1950s there were two main theories to explain how the Universe began.

| Theory 1 | The Universe has always existed, it is continually expanding. New galaxies are formed as older galaxies die out. |

| Theory 2 | The Universe began from a very small region that was extremely hot and dense. The Universe has been expanding ever since. |

(d)   In what way do the observations made by Hubble support both Theory 1 and Theory 2?

....

....

....

(e)   Most scientists now believe that Theory 2 is correct. Suggest what is likely to have caused scientists to start thinking Theory 1 is wrong.

....

....

....

(1)
(Total 6 marks)

Q2. Scientists can use the visible light spectrum from distant stars to determine whether the stars are moving.

The visible light spectrum from stars includes dark lines at specific wavelengths.

(a)   The diagram shows the visible light spectrum from the Sun and from four other stars, **A**, **B**, **C** and **D**.
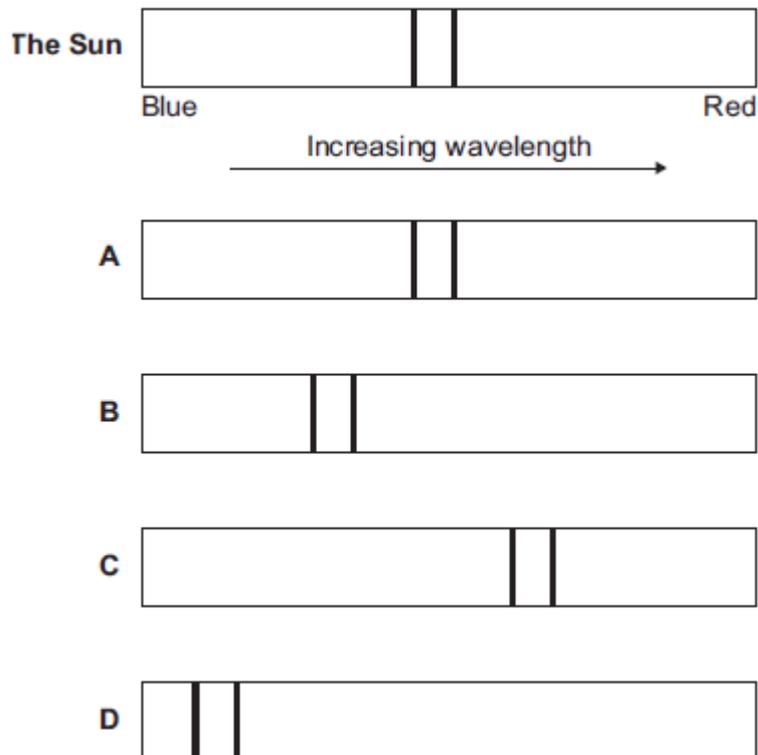
(i)   Which star, **A**, **B**, **C** or **D**, is moving away from the Earth?

(ii) How does the speed of star **B** compare with the speed of star **D**?

Tick (✓) **one** box.

	Tick (✓)
The speed of star **B** is greater than the speed of star **D**.	
The speed of star **B** is less than the speed of star **D**.	
The speed of star **B** is the same as the speed of star **D**.	

(1)

(b) A radio wave is emitted by a star.
The radio wave has a wavelength of 1500 m and a frequency of 200 000 Hz.

Calculate the speed of this radio wave.

Choose the correct unit from the list below.

m   m / s   m / s²

....

....

....

Speed = ... unit ....

(3)
(Total 5 marks)

Q3. Man-made satellites can orbit the Earth, as shown in the figure below.

Not to scale
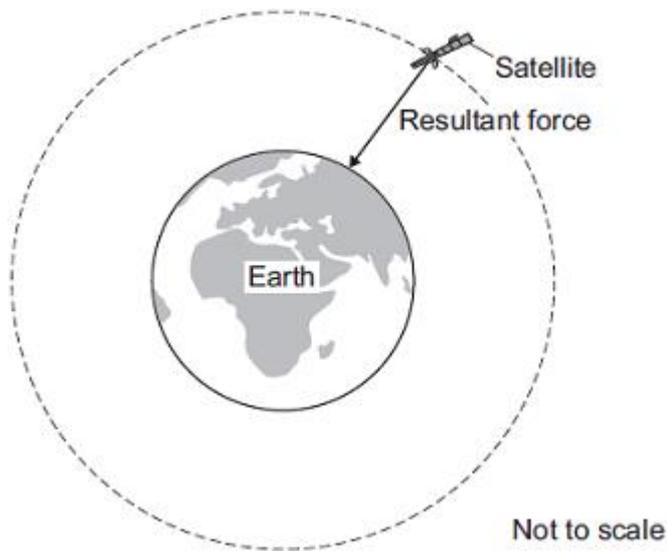
The satellite experiences a resultant force directed towards the centre of the orbit.

The resultant force is called the centripetal force

(a) What provides the centripetal force on the satellite?

....

(1)

(b) State **two** factors that determine the size of the centripetal force on the satellite.

1 ....

2 ....

(2)

(c) The table below gives data for five different satellites orbiting the Earth.

Satellite	Average height above Earth's surface in kilometres	Time taken to orbit Earth once in minutes	Mass of satellite in kilograms
A	370	93	419 000
B	697	99	280
C	827	103	630
D	5 900	228	400
E	35 800	1440	2 030

(i)   State the relationship, if any, between the height of the satellite above the
        Earth's surface and the time taken for the satellite to orbit the Earth once.

        ....

        ....

                                                                                                            (1)

(ii)   State the relationship, if any, between the time taken for the satellite to orbit
        the Earth once and the satellite's mass.

        ....

        ....

                                                                                                            (1)

(d)   Over 300 years ago, the famous scientist Isaac Newton proposed, with a 'thought
        experiment', the idea of satellites.

        Newton suggested that if an object was fired at the right speed from the top of a high
        mountain, it would circle the Earth.

        Why did many people accept Isaac Newton's idea as being possible?

        Tick (✓) **one** box.

        Isaac Newton was a respected scientist who had made new discoveries before. ☐

        Isaac Newton went to university. ☐

        It was a new idea that nobody else had thought of before. ☐

                                                                                                            (1)
                                                                                            (Total 6 marks)

Q4.   The 'big bang' theory is one theory explaining the origin of the Universe.

(a)   The graphs **X**, **Y** and **Z**, show how the size of the Universe may have changed with
        time.
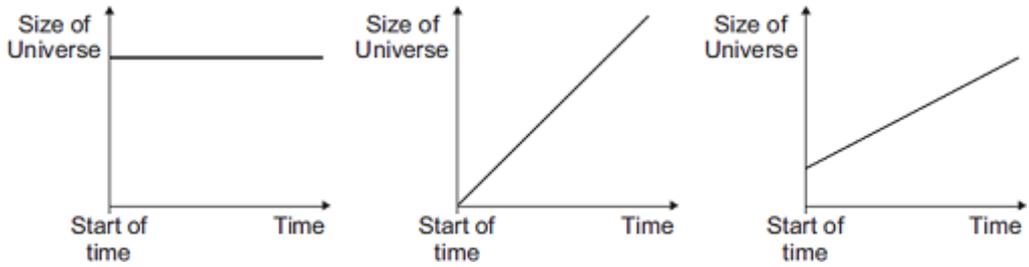
Which graph would the 'big bang' theory suggest is correct?

Write your answer, **X**, **Y** or **Z**, in the box.

Explain the reason for your answer.

....

....

....

....

(3)

(b)   In 1948, an alternative to the 'big bang' theory, called the 'steady state' theory, was developed.
The 'steady state' theory suggested that the Universe, although expanding, has always existed without a beginning in time.

(i)   Complete the following sentence by drawing a ring around the correct line in the box.

The measurement of red-shift in the light from distant galaxies provides evidence

to support

| only the 'big bang' theory. |
| only the 'steady state' theory. |
| both the 'big bang' and 'steady state' theories. |

(1)

(ii)   In 1965, scientists rejected the 'steady state' theory in favour of the 'big bang' theory.

Suggest what might cause scientists to stop supporting one theory and to start supporting an alternative theory.

....

....

....

(1)
(Total 5 marks)

Q5. Read this statement from a website.

> Immediately after the 'big bang', at the start of the Universe, there were only atoms of the element hydrogen (H).
>
> Now there are over one hundred elements.
> Scientists think that all the elements on Earth are also present throughout the Universe.

(a)   Explain how atoms of the element (He) are formed in a star.

....

....

....

....

(2)

(b)   Explain how atoms of very heavy elements, such as gold (Au), were formed.

....

....

....

....

(2)

(c)   Scientists have only examined a tiny fraction of the Universe.

What is the basis for scientists thinking that the elements found on Earth are present throughout the Universe?

....

....

(1)
(Total 5 marks)

Q6. Optical telescopes may be used to observe galaxies. Some optical telescopes are on the Earth and some are on satellites in space.

Scientists have observed that the wavelengths of the light from galaxies moving away from the Earth are longer than expected. This observation is called red-shift.

(i)   What does the size of the red-shift tell the scientists about the distance a galaxy is from the Earth?

....

....

(1)

(ii)   Complete the following passage.

Red-shift provides evidence to support the 'big bang' theory. The 'big bang' theory is

one of the ways of explaining the .... of the Universe.

(1)
(Total 2 marks)

Q7. Galaxies emit all types of electromagnetic wave.

(a)   (i)   Which type of electromagnetic wave has the shortest wavelength?

....

(1)

(ii) State **one** difference between an ultraviolet wave and a visible light wave.

....

....

(1)

(b) Electromagnetic waves travel through space at a speed of 3.0×10^8 m/s.

The radio waves emitted from a distant galaxy have a wavelength of 25 metres.

Calculate the frequency of the radio waves emitted from the galaxy and give the unit.

....

....

....

Frequency = ...

(3)

(c) Scientists use a radio telescope to measure the wavelength of the radio waves emitted from the galaxy in part (b) as the waves reach the Earth. The scientists measure the wavelength as 25.2 metres. The effect causing this observed increase in wavelength is called red-shift.

(i) The waves emitted from most galaxies show red-shift.

What does red-shift tell scientists about the direction most galaxies are moving?

....

....

(1)

(ii) The size of the red-shift is **not** the same for all galaxies.

What information can scientists find out about a galaxy when they measure the size of the red-shift the galaxy produces?

....

....

....

....

(2)

(iii)   What does the observation of red-shift suggest is happening to the Universe?

....

....

(1)
(Total 9 marks)

M1.(a)   red–shift

1

(b)   the further away from the Earth, the faster a galaxy is moving

1

(c)   **strength** as the balloon expands the dots get further apart, representing the galaxies moving apart

1

weakness dots are only on the surface of the balloon, galaxies are throughout the universe **or** there is a limit to how far the balloon can expand

1

(d)   both theories suggest that the Universe is expanding

1

(e)   new evidence / observations that cannot be explained by Theory 1
accept specific example of new evidence ie CMBR

1

[6]

M2.(a)   (i)   C

1

(ii)   The speed of star **B** is less than the speed of star **D**.

1

(b)   300 000 000
*allow **1** mark for correct substitution ie 200 000 × 1500
provided no subsequent step shown*

2

m / s
allow unit correctly indicated in list if not written in answer space

1

[5]

M3. (a) gravitational attraction (between the satellite and the Earth)

> *allow gravity*
> *allow weight of the satellite*

1

(b) any **two** from:
- mass of satellite
- speed / velocity (of satellite)
- radius of orbit / circle

> *allow height above the Earth*
> *radius / height alone is insufficient*

2

(c) (i) increasing the height (above the Earth's surface) increases the time (for one orbit)

> *allow a positive correlation*
> *allow as one gets bigger, the other gets bigger, or vice versa*
> *ignore they are directly proportional*

1

(ii) there is no relationship / correlation

1

(d) Isaac Newton was a respected scientist who had made new discoveries before

1

[6]

M4. (a) **Y**

> *accept cannot be **X** as size is increasing*

1

shows Universe expanding

> *this scores if **Y** or **Z** is chosen*
> *accept exploding outwards*

1

from a (very small) point

> *this only scores if **Y** is chosen*
> *accept from zero (size)*
> *answers in terms of planets*
> *negate the last two mark points*

1

(b)　(i)　both the 'big bang' and 'steady state' theories

1

(ii)　(new) evidence that supports / disproves a theory
　　　　accept proves for supports
or
(new) evidence not supported by current theory
　　　　accept there may be more evidence supporting one (theory)
　　　　than the other (theory)
　　　　accept new evidence specific to this question eg
　　　　measurement of CBR
　　　　or
　　　　some types of star only found in distant parts of Universe
　　　　(steady state suggests should be same throughout Universe)

1

[5]

M5.(a)　fusion
　　　　　*do **not** credit any response which looks like 'fission'*

1

of hydrogen / H (atoms)
　　　　credit only if 1ˢᵗ mark point scores

1

(b)　fusion of other / lighter atoms / elements
　　　　reference to big bang nullifies both marks

1

during supernova / explosion of star(s)

1

(c)　the (available) evidence: supports this idea**or**does not contradict this idea**or**can be extrapolated to this idea**or**(electromagnetic) spectrum from other stars is similar to sun

1

[5]

M6. (i) bigger the red-shift, further the galaxy is from the Earth

accept red-shift and distance are directly proportional

accept there is a positive correlation

1

(ii) origin / start / beginning / creation

accept expansion

1

[2]

M7.(a) (i) gamma

accept correct symbol

1

(ii) any **one** from:

• (ultraviolet has a) higher frequency

ultraviolet cannot be seen is insufficient

• (ultraviolet has a) greater energy

• (ultraviolet has a) shorter wavelength

ignore ultraviolet causes cancer etc

1

(b) 1.2×10^7 / 12 000 000

*allow **1** mark for correct substitution, ie $3 \times 10^8 = f \times 25$*

2

hertz / Hz / kHz / MHz

*do **not** accept hz **or** HZ*

*answers 12 000 kHz **or** 12 MHz gain **3** marks*

for full credit the numerical answer and unit must be consistent

1

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(c) (i) away (from each other)
accept away (from the Earth)
accept receding

1

(ii) distance (from the Earth)
accept how far away (it is)

1

speed galaxy is moving

1

(iii) (Universe is) expanding

1

[9]