Name: _____

Class: _____

Date: _____

Space Physics part 2 AQA Triple Physics

Time: **77 minutes**

Marks: **73 marks**

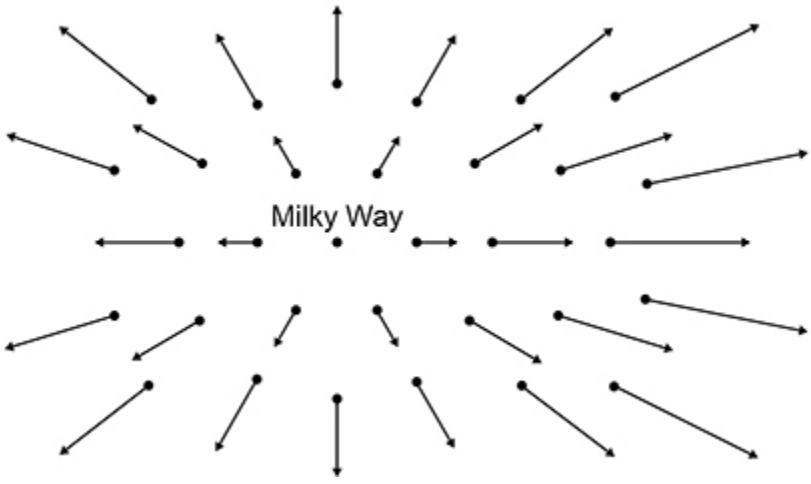
Comments:

1. Galaxies contain billions of stars.

(a) Compare the formation and life cycles of stars with a similar mass to the Sun to stars with a much greater mass than the Sun.

(6)

The points on diagram below represent galaxies that are moving away from the Milky Way.



Each arrow represents the velocity of the galaxy relative to the Milky Way.

(b) Light from all galaxies represented in diagram above is red-shifted.

Describe what is meant by red-shift.

_____

_____

_____

_____

(2)

(c) Explain how above diagram provides evidence for the Big Bang theory.

_____

_____

_____

_____

(2)

(d) Sometimes scientists have to change theories about the universe.

Give the reason why.

_____

_____

(1)

(Total 11 marks)

2. The Sun is the closest star to the Earth.

(a) A 2.5 kg mass would have a weight of 750 N at the surface of the Sun.

Calculate the gravitational field strength at the surface of the Sun.

Use the equation:

$$\text{gravitational field strength} = \frac{\text{weight}}{\text{mass}}$$

_____

_____

_____

_____

Gravitational field strength = _____ N/kg

(2)

(b) Gravity is a non-contact force.

Which of the following is also a non-contact force?

Tick (✓) **one** box.

Air resistance	☐
Electrostatic	☐
Friction	☐
Tension	☐

(1)

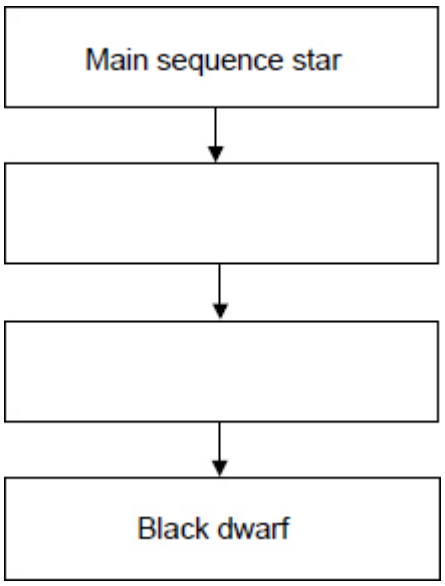
(c) All stars have a life cycle.

The figure below shows part of the life cycle of a star that becomes a black dwarf.

Complete the figure below.

Choose answers from the box.

	Black hole	**Neutron star**
Red giant	**Supernova**	**White dwarf**



(2)

The table below gives the mass of three stars compared to the mass of the Sun.

Star	Mass compared to the mass of the Sun
X	× 25.0
Y	× 15.0
Z	× 0.9

(d) Which letter represents the star most likely to become a black dwarf?

Give a reason for your answer.

Tick (✓) **one** box.

X ☐ **Y** ☐ **Z** ☐

Reason _____

_____

_____

(2)

(e) In which stage of the life cycle of a star are elements heavier than iron produced?

Tick (✓) **one** box.

Nebula ☐

Protostar ☐

Supernova ☐

(1)

(Total 8 marks)

3. A main sequence star in a distant galaxy is the same size and mass as the Sun.

(a) Explain why the star is stable while it is in the main sequence stage of its life cycle.

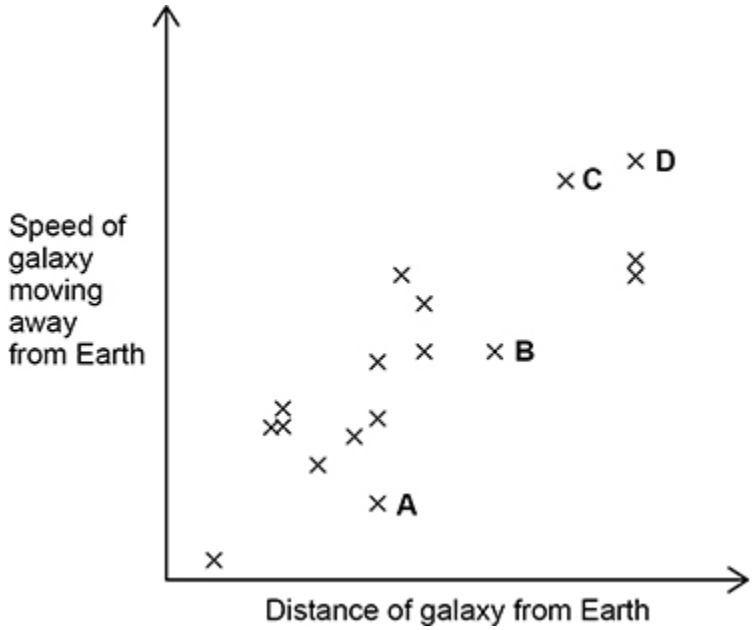
(2)

(b) Describe what will happen to the star between the main sequence stage and the end of the star's life cycle.

You should include the names of the stages in the life cycle of the star.

(3)

(c) The figure below shows how the speed of galaxies moving away from Earth varies with the distance of the galaxies from Earth.



Which galaxy would show the smallest observed change in the wavelength of visible light?

Give a reason for your answer.

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Reason _____

_____

(2)

(Total 7 marks)

4. Our solar system includes the Sun, planets and moons.

(a) Complete the sentence.

Choose the answer from the box.

Andromeda	**Milky Way**	**Pinwheel**	**Whirlpool**

Our solar system is part of the _____ galaxy.

(1)

(b) Planets orbit the Sun.

What force causes planets to orbit the Sun?

_____

(1)

The table below shows data about five planets.

Planet	**Mean distance from the Sun in millions of kilometres**	**Mean surface temperature in °C**
Earth	150	+22
Mars	228	–48
Jupiter	778	**X**
Saturn	1430	–178
Uranus	2870	–200

(c) How does the mean surface temperature of the planets in the table change as the mean distance from the Sun increases?

_____

_____

(1)

(d) Predict the mean surface temperature of Jupiter (**X**) in the table above.

Mean surface temperature of Jupiter = _____ °C

(1)

(e) Five of the planets in the solar system are given in the table above.

How many other planets are there in the solar system?

Tick (✓) **one** box.

Two ☐

Three ☐

Four ☐

Five ☐

(1)

(f) Our Moon is a natural satellite.

Why is the Moon classified as a satellite?

Tick (✓) **one** box.

It has no atmosphere. ☐

It has no gravitational field. ☐

It is too small to be a planet. ☐

It orbits a planet. ☐

(1)

(g) How are planets and moons similar?

Tick (✓) **two** boxes.

Their mass is about the same. ☐

Their orbits are circular. ☐

Their surfaces are the same colour. ☐

They are similar in diameter. ☐

They do not emit visible light. ☐

(2)

(h) The diameter of the Earth is 13 000 km.

The diameter of the Sun is 110 times greater than the diameter of the Earth.

Calculate the diameter of the Sun.

_____

_____

Diameter of the Sun = _____ km

(2)

(Total 10 marks)

5. (a) Complete the sentences.

The Sun is a stable star. This is because the forces pulling inwards caused by _____ are in equilibrium with the forces pushing outwards caused by the energy released by nuclear _____.

(2)

(b) Write down the equation that links distance travelled (*s*), speed (*v*) and time (*t*).

_____

(1)

(c) The mean distance between the Sun and the Earth is 1.5×10^{11} m.

Light travels at a speed of 3.0×10^{8} m/s.

Calculate the time taken for light from the Sun to reach the Earth.

Time = _____ s

(3)

(d) Some stars are much more massive than the Sun.

Describe the life cycle of stars much more massive than the Sun, including the formation of new elements.

(6)

(e) Stars emit radiation with a range of wavelengths.

Which property of a star does the range of wavelengths depend on?

Tick (✓) **one** box.

Density	☐
Mass	☐
Temperature	☐
Volume	☐

(1)

(Total 13 marks)

6. Most galaxies are moving away from the Earth. Scientists can determine the speed of a galaxy by observing the light from the galaxy.

(a) Complete the sentence.

Choose the answer from the box.

frequency	**speed**	**wavelength**

When scientists observe the light from distant galaxies, they observe an increase in the _____ of light from those galaxies.

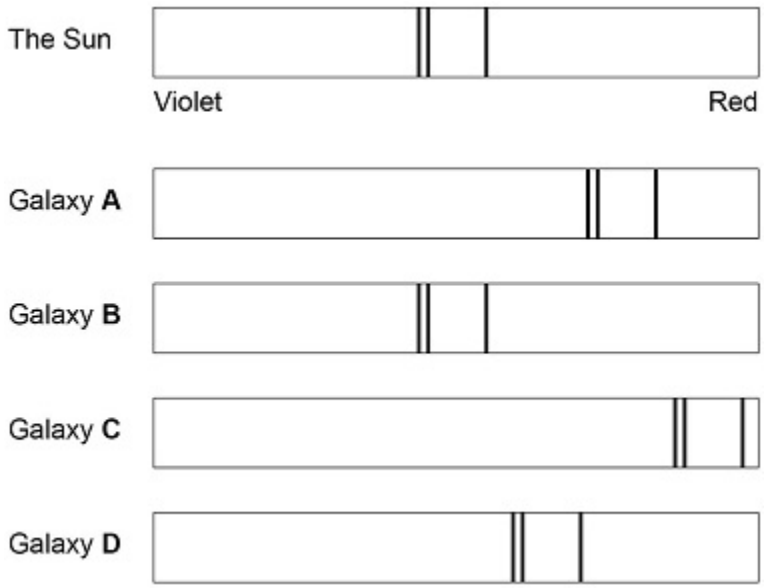
(1)

The light spectra from stars and galaxies include dark lines.

The lines have the same pattern.

Figure 1 shows the light spectrum from the Sun and from four galaxies.

Figure 1



(b) Which galaxy is moving the fastest away from the Earth?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(c) Which galaxy is the furthest away from the Earth?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(d) The Big Bang theory is one way to explain the origin of the universe.

How does the Big Bang theory describe the universe when it began?

Tick (✓) **one** box.

Very big and very dense ☐

Very big and extremely hot ☐

Very dense and extremely hot ☐

Very small and extremely cold ☐

(1)

(e) Which statement about the Big Bang theory is correct?

Tick (✓) **one** box.

Scientists have proved that the theory is correct. ☐

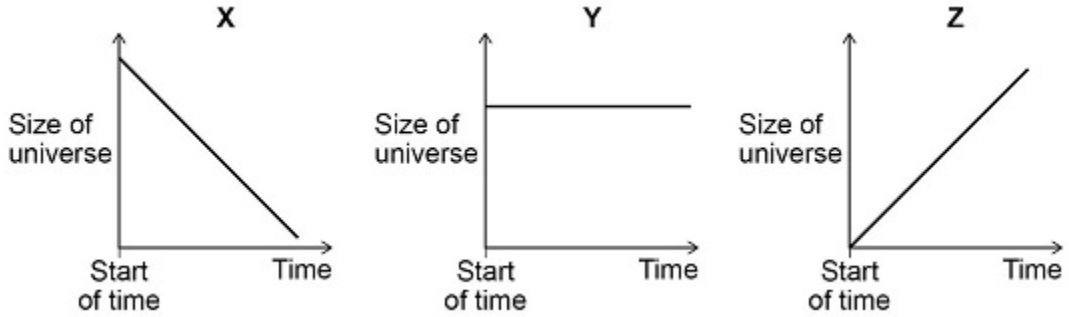
Scientific evidence supports the theory. ☐

There is no other way to explain the origin of the universe. ☐

(1)

(f) **Figure 2** shows three ways that the size of the universe may have changed with time.

Figure 2



Which graph would the Big Bang theory suggest is correct?

Tick (✓) **one** box.

X ☐ **Y** ☐ **Z** ☐

Give a reason for your answer.

_____

_____

(2)

(Total 7 marks)

7. (a) The light from distant galaxies shows red-shift.

Complete the sentence.

The term red-shift describes the observed increase

in the _____ of the light from a distant galaxy.

(1)

(b) The Big Bang theory is one model used to explain the origin of the universe.

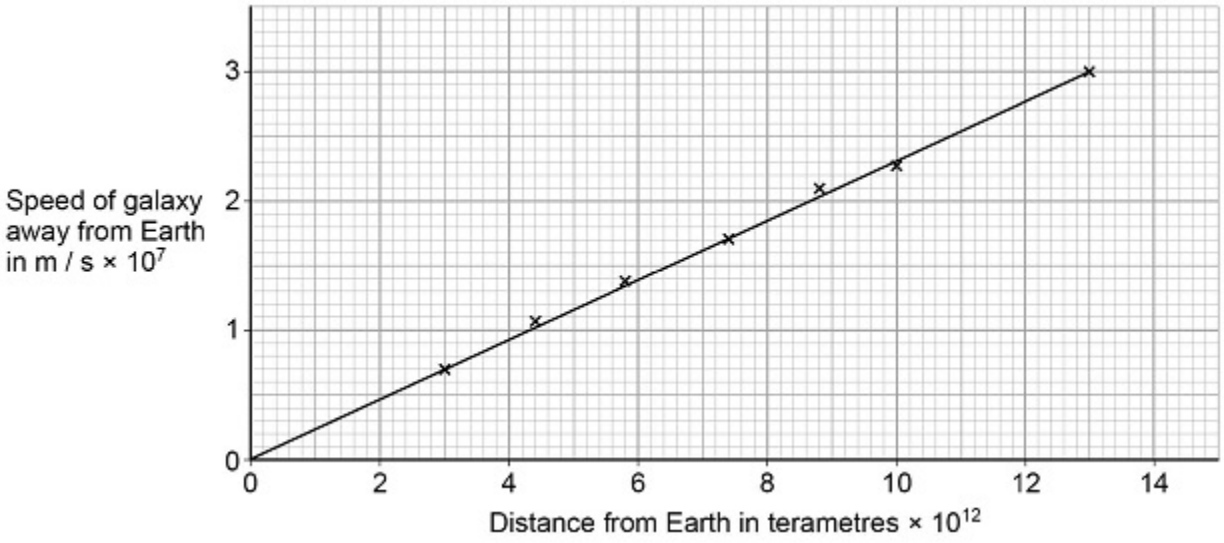
How does the Big Bang theory describe the universe when it began?

_____

_____

(1)

The figure below shows data scientists have calculated from measurements of red-shift.



(c) Describe the relationship between the speed of a galaxy and the distance the galaxy is from the Earth.

_____

_____

(1)

(d) Which of the following is the same as 6 x 10^{12} terametres?

Tick (✓) **one** box.

6×10^{15} m ☐

6×10^{18} m ☐

6×10^{21} m ☐

6×10^{24} m ☐

(1)

(e) Explain how the data in the figure above supports the suggestion that the universe began from a very small region.

_____

_____

_____

_____

_____

(2)

(f) The Big Bang theory suggested that gravity would slow the rate at which galaxies move away from the Earth.

New observations suggest that distant galaxies are moving away from the Earth at an increasingly fast rate.

What do the new observations suggest is happening to the universe?

_____

_____

(1)

(g) New observations and data that do not fit existing theories should undergo peer review.

Give **one** reason why peer review is an important process.

_____

_____

_____

(1)

(h) The Andromeda galaxy is moving towards the Earth.

Describe how the wavelength and frequency of the light from Andromeda seem to have changed when viewed from the Earth.

_____

_____

_____

_____

(2)

(Total 10 marks)

8. (a) The Sun is a star.

Which galaxy is the Sun in?

Tick **one** box.

Cartwheel ☐

Milky Way ☐

Starburst ☐

Tadpole ☐

(1)

(b) Light takes 500 seconds to travel from the Sun to the Earth.

Light travels at 300 000 kilometres per second.

Calculate the distance between the Sun and the Earth.

Use the equation:

distance = speed × time

_____

_____

_____

_____

Distance = _____ kilometres

(2)

The table below gives information about some of the planets in our solar system.

The planets are in order of increasing distance from the Sun.

Planet	Time to orbit the Sun in years
Mercury	0.2
Venus	0.6
Earth	1.0
Mars	
Jupiter	12.0

(c) There are some planets in our solar system missing from the table above.

How many planets are missing?

_____

(1)

(d) Estimate how many years it takes Mars to orbit the Sun.

_____ years

(1)

(e) Calculate how many times Venus will orbit the Sun in 9 years.

_____

_____

_____

_____

In 9 years, Venus will orbit the Sun _____ times.

(2)

(Total 7 marks)

1.

(a) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.

4–6

Level 1: Relevant features are identified and differences noted.

1–3

No relevant content

0

Indicative content

all stars:

- form in a cloud of gas and dust (nebula) by gravity – mostly hydrogen
- forms a protostar
- fusion begins
- fusion of small nuclei into larger nuclei (hydrogen into helium)
- main sequence star – stable period where gravitational forces (inwards) balance forces (outwards) due to fusion processes

comparisons:

- stars about the same size as the Sun expand to become a red giant, stars much bigger than the Sun expand to become a red super giant
- stars about the same size as the Sun contract (and temperature increases) to become a white dwarf, stars much bigger than the Sun explode in a supernova
- stars about the same size as the Sun (cool to) become a black dwarf, stars much bigger than the Sun become either a neutron star or black hole

(b) the (observed) increase in wavelength (of light from galaxies)

ignore light waves are stretched

1

as galaxies move away from us

1

(c) the furthest galaxies are moving away (from the Milky Way) the fastest

1

(which suggests that) at some time all galaxies / matter started at the same point

1

(d) there are new observations / evidence that does not fit into current theory / model

allow specific examples of new observations / theories such as dark matter or dark energy

1

[11]

2. (a) $g = \frac{750}{2.5}$

1

g = 300.0 (N/kg)

1

(b) electrostatic

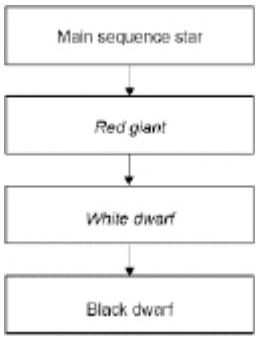
1

(c) red giant

this order only

1

white dwarf



1

(d) Z

reason only scores if Z chosen

1

only stars about the same/smaller size/mass as the Sun become Black dwarfs

allow converse

1

(e) supernova

1

[8]

3. (a) gravitational force inwards and forces as a result of fusion reactions outwards

allow fusion energy for fusion reactions outwards

allow radiation pressure for fusion reactions outwards

1

are in equilibrium / balanced

dependant on scoring 1st mark point

*allow for **1** mark forces are in equilibrium*

1

(b) (the star will) expand to become a red giant

*the answers must be in the correct sequence to score all **3** marks*

1

(the star will) collapse to become a white dwarf

allowed outer layers ejected for collapsed

1

(the star will) cool to become a black dwarf

*if no other marks score, allow red giant, white dwarf, black dwarf in the correct order for **1** mark*

1

(c) **A**

1

it is (moving away from Earth) the slowest
or
it is the closest (to the Earth)

reason only scores if A is chosen

1

[7]

4. (a) Milky Way

1

(b) gravitational (force)

allow gravity

1

(c) it decreases

1

(d) answer between -60 and -160 (degrees Celsius)

1

(e) Three

1

(f) It orbits a planet.

1

(g) Their orbits are circular.

1

They do not emit visible light.

1

(h) d = 13 000 × 110

1

d = 1 430 000 (km)

allow 1.4(3) × 10^6

allow a rounded answer (e.g. 1 400 000)

1

[10]

5. (a) (force of) gravity

*do **not** allow weight*

1

fusion

1

(b) distance = speed × time

allow a correct re-arrangement

or

s = vt

*do **not** allow d = st*

1

(c) $1.5 \times 10^{11} = 3.0 \times 10^8 \times t$

1

$$t = \frac{1.5 \times 10^{11}}{3.0 \times 10^8}$$

1

t = 500 (s)

1

(d) **Level 3**: Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.

5–6

Level 2: Scientifically relevant facts, events or processes are identified and their relevance is clear. The account is not fully accurate.

3–4

Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.

1–2

No relevant content

0

Indicative content:

- fusion (processes in stars) produce new elements
- cloud of gas / hydrogen **and** dust **OR** nebula
- pulled together by gravity
- causing increasing temperature (to start the fusion process)
- (to become a) protostar
- hydrogen nuclei fuse to form helium nuclei
- and the star becomes main sequence
- hydrogen begins to run out
- helium nuclei fuse to make heavier elements
- up to iron
- the star expands (to become a)
- red super giant
- (the star collapses rapidly) and explodes
- called a supernova
- creating elements heavier than iron
- and distributing them throughout the universe
- leaving behind a neutron star
- or a black hole.

(e) Temperature

1

[13]

6. (a) wavelength

allow a correct answer indicated in the box provided the answer space is blank

1

(b) C

1

(c) C

1

(d) Very dense and extremely hot

1

(e) Scientific evidence supports the theory

1

(f) Z

1

any **one** from
- (only one) shows the universe is expanding
- (only one) shows the universe began (very) small

only scores if Z is chosen

1

[7]

7. (a) wavelength

this answer only

1

(b) (extremely) hot and dense

ignore very small

1

(c) (directly) proportional

allow a correct description of direct proportionality
ignore positive correlation

1

(d) 6×10^{24}

1

(e) the furthest galaxies are moving the fastest

1

(this suggests) the universe is expanding (from a very small region)

1

(f) expanding at (an ever) greater rate

allow expanding faster

1

(g) any **one** from:
- detects false claims

  allow provides credibility
- detects inaccurate data

  allow detects mistakes
- detects bias

  allow removes bias
- verifies new data

  allow checks validity
- provides a consensus (of opinion)

  ignore shows data is accurate
  ignore proves a theory

1

(h) wavelength (seems to have) decreased

1

frequency (seems to have) increased

1

[10]

8. (a) Milky Way

1

(b) distance = 300 000 × 500

1

d = 150 000 000 (km)

1

*an answer of 150 000 000 scores **2** marks*

(c) 3

1

(d) accept any number greater than 1.0 and less than 12.0

1

(e) $\frac{9}{0.6}$

1

15

1

*an answer of 15 scores **2** marks*

[7]