**All questions are for separate science students only**

**1.** 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.

_____

_____

_____

_____

_____

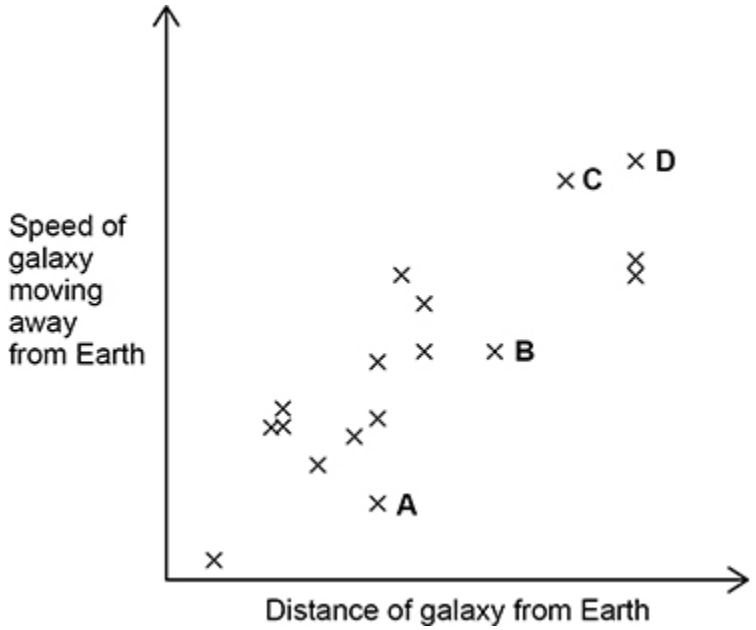
_____

_____

_____

**(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)**

**2.** (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.

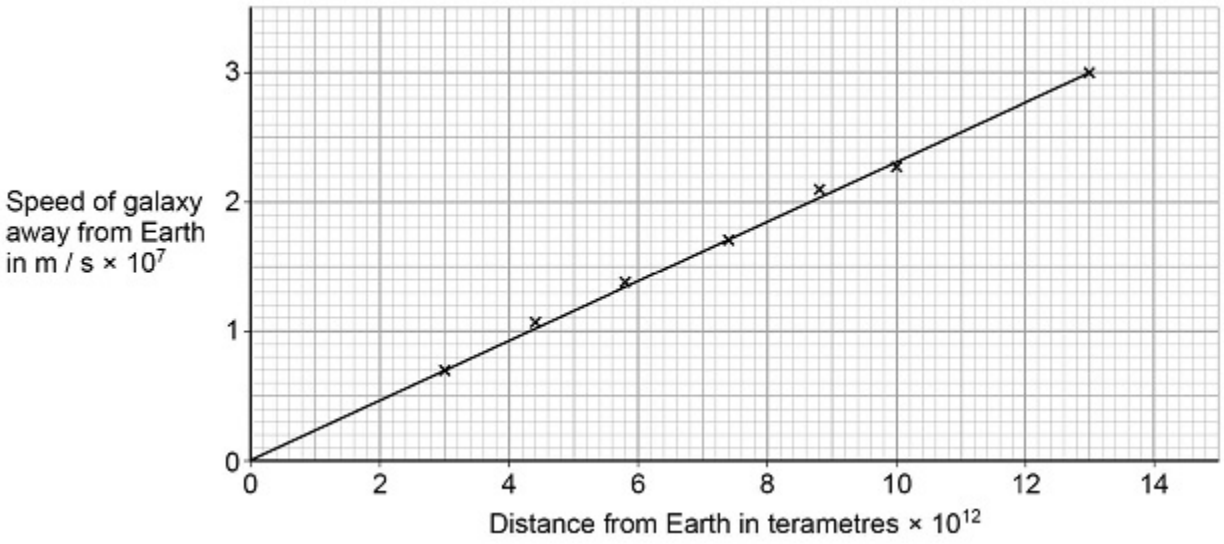
How does the Big Bang theory describe the universe when it began?

_____

_____

**(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 $6 \times 10^{12}$ terametres?

Tick (✓) **one** box.

$6 \times 10^{15}$ m ☐

$6 \times 10^{18}$ m ☐

$6 \times 10^{21}$ m ☐

$6 \times 10^{24}$ m ☐

(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.

_____

_____

_____

_____

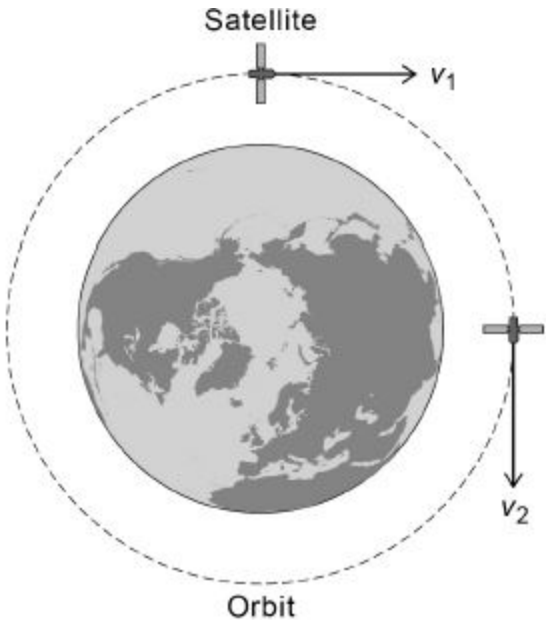
**(2)**

**(Total 10 marks)**

**3.** A satellite is in a circular orbit around the Earth.

**Figure 1** shows the velocity of the satellite at two different positions in the orbit.

**Figure 1**

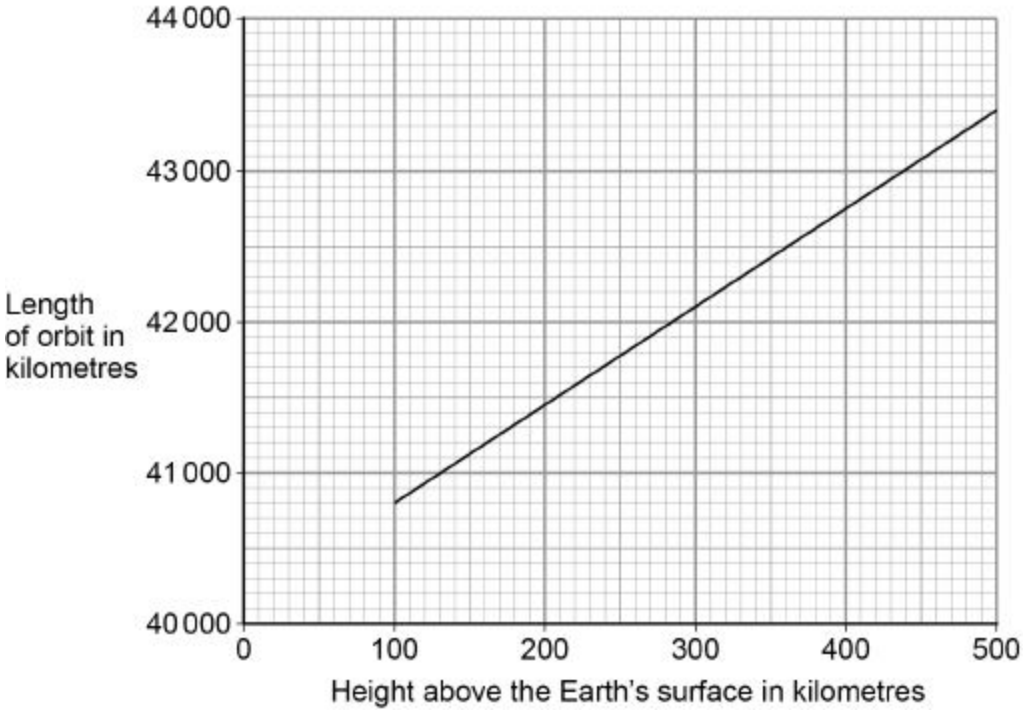



(a) Explain why the velocity of the satellite changes as it orbits the Earth.

**(3)**

(b) **Figure 2** shows how the length of a satellite orbit depends on the height of the satellite above the Earth's surface.

**Figure 2**




A satellite orbits 300 km above the Earth's surface at a speed of 7.73 km/s.

Calculate how many complete orbits of the Earth the satellite will make in 24 hours.

Number of complete orbits = _____

**(5)**

In 1772, an astronomer called J Bode developed an equation to predict the orbital radii of the planets around the Sun.

The table shows Bode's predicted orbital radii and the actual orbital radii for the planets that were known in 1772.

| **Planet** | **Predicted orbital radius in millions of kilometres** | **Actual orbital radius in millions of kilometres** |
|---|---|---|
| Mercury | 60 | 58 |
| Venus | 105 | 108 |
| Earth | 150 | 150 |
| Mars | 240 | 228 |
| Jupiter | 780 | 778 |
| Saturn | 1500 | 1430 |

(c) The predicted data can be considered to be accurate.

Give the reason why.

_____

_____

**(1)**

(d) J Bode used his equation to predict the existence of a planet with an orbital radius of 2940 million kilometres.

The planet Uranus was discovered in 1781.

Uranus has an orbital radius of 2875 million kilometres.

Explain why the discovery of Uranus was important.

_____

_____

_____

_____

**(2)**

**(Total 11 marks)**

**4.** (a) Which one of the following types of electromagnetic wave has the highest frequency?

Tick **one** box.

Gamma rays ☐

Infrared ☐

Microwaves ☐

Ultraviolet ☐

**(1)**

(b) What makes microwaves suitable for sending communications to a satellite in space?

_____

_____

**(1)**

(c) Scientists have detected short bursts of radio waves emitted from a distant galaxy.

The scientists think that the radio waves may have been emitted from a neutron star.

What event leads to a neutron star forming?

_____

_____

**(1)**

(d) Some of the radio waves from the distant galaxy have a frequency of 1.2 gigahertz (GHz).

Which of the following is the same as 1.2 GHz?

Tick **one** box.

$1.2 \times 10^3$ Hz ☐

$1.2 \times 10^6$ Hz ☐

$1.2 \times 10^9$ Hz ☐

$1.2 \times 10^{12}$ Hz ☐

**(1)**

(e) Radio waves travel through space at a speed of $3.0 \times 10^8$ m/s

Calculate the wavelength of the 1.2 GHz radio waves emitted from the distant galaxy.

_____

_____

_____

_____

_____

Wavelength = _____ m

**(3)**

(f) When radio waves are absorbed by an aerial they may create an alternating current in an electrical circuit.

If an alternating current is created what frequency would it have?

_____

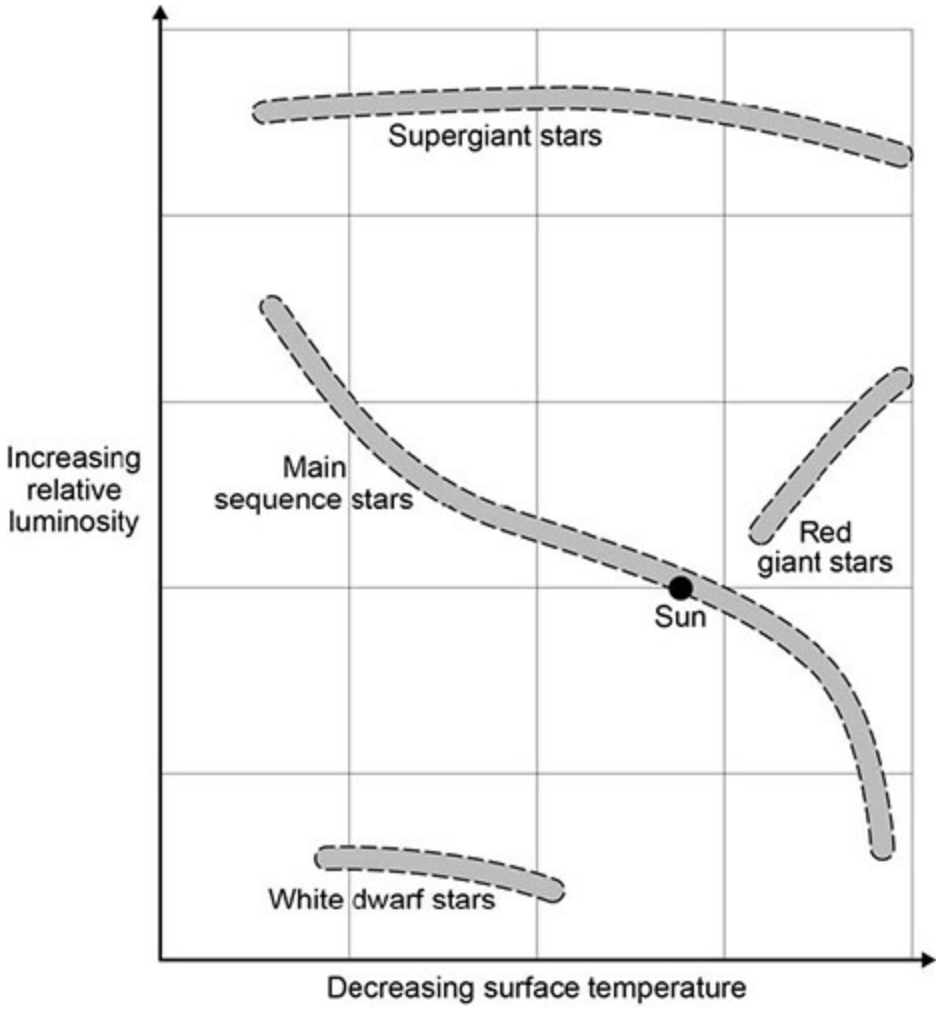
_____

**(1)**

The diagram shows four groups of stars.

The surface temperature and relative luminosity determine which group a star is in.

A star with a relative luminosity of 1 emits the same amount of energy every second as the Sun.




(g) The Sun is in the group of main sequence stars. These stars are stable.

Explain why a star remains stable.

_____

_____

_____

_____

**(2)**

(h) At different points in their lifecycle stars change from one group to another.

Describe what will happen to the Sun between it leaving the main sequence group and becoming a white dwarf.

Use information from the diagram.

**(4)**

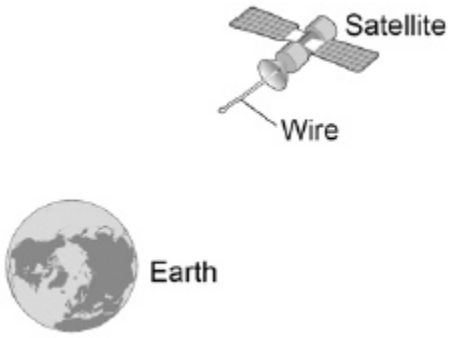
**(Total 8 marks)**

**5.** Scientists have used a satellite system to investigate the idea of generating electricity in space.

As the system orbited the Earth a 20 km copper wire was reeled out.

Before the wire snapped a current of 1 amp was induced in the wire.

**Figure 1**




(a) What provides the force needed to keep a satellite in orbit around the Earth?

**(1)**

(b) Explain how a current is induced in the wire.

_____

_____

_____

_____

_____

_____

_____

_____

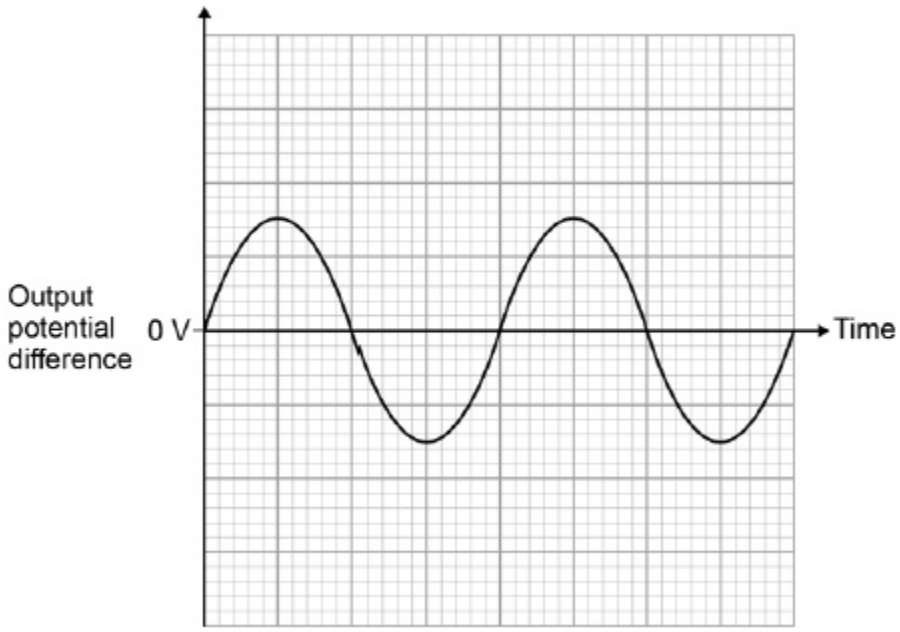
**(3)**

An alternator is connected to a data logger.

The data logger is connected to a computer.

**Figure 2** shows how the output potential difference of the alternator varies with time.

**Figure 2**




(c) The coil inside the alternator now rotates at twice the frequency.

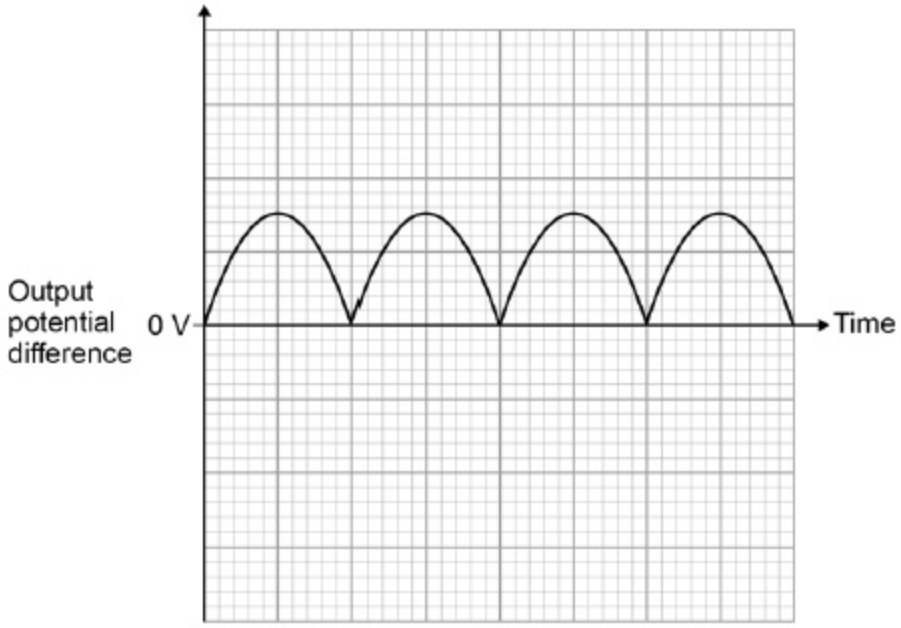
Draw on **Figure 2** to show how the output potential difference varies with time at this new frequency.

**(2)**

Another type of generator is now connected to the data logger and computer.

**Figure 3** shows how the output potential difference varies with time for this generator.

**Figure 3**




(d) What name is given to this second type of generator?

_____

**(1)**

(e) Look at **Figure 2** and **Figure 3**.

Give one difference between the outputs from the two types of generator.

_____

_____

_____

**(1)**

(f) The charger used to charge the battery inside a laptop computer contains a small transformer.

The charger plugs into the mains electricity supply.

mains electricity supply = 230 V

number of turns on the primary coil of the transformer = 690

number of turns on the secondary coil of the transformer = 57

Calculate the potential difference applied by the charger across the battery inside the computer.

Potential difference = _____ V

**(3)**

**(Total 11 marks)**