

PHYSICS



EXAM QUESTION PACK

P8.3 BEYOND EARTH

SCORE

/118

PERCENTAGE

%

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Gateway Physics A (9-1)

Beyond Earth

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	
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Centre number						Candidate number				
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INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **118**.
- The total number of marks may take into account some 'either/or' question choices.

1 The Sun was formed from a cloud of dust and gas.

Which force brought together the particles of the cloud?

- A electrostatic
- B frictional
- C gravitational
- D magnetic

Your answer

[1]

2 Which of these is evidence for an expanding universe?

- A Light from galaxies is red shifted.
- B Nuclear fusion occurs in stars.
- C Many stars have orbiting planets.
- D Stars were formed from dust and gas.

Your answer

[1]

3(a) Rockets carry satellites into space.

These satellites are kept in orbit around a planet by a force.

What is the name of this force?

-----[1]

(b) Write down the name of the Earth's natural satellite.

-----[1]

(c) A rocket carrying a vehicle called the Mars Rover was sent to Mars.



The Mars Rover has a mass of 185 kg.

The gravitational field strength (g) on Mars is 3.75 N/kg.

Calculate the weight of the Rover vehicle on Mars.

Show your working and give your answer to 3 significant figures.

State the unit for weight.

answer: _____ unit _____ [5]

(d) Why did the Mars Rover weigh more on Earth than on Mars?

----- [1]

4 How was the Sun formed?

- A From dust and gas pushed together by gravity leading to a fission reaction.
- B From dust and gas pulled together by gravity leading to a fusion reaction.
- C From dust and gas pushed together by gravity leading to a fusion reaction.
- D From dust and gas pulled together by gravity leading to a fission reaction.

Your answer

[1]

6 State **two** features of a satellite in a **polar orbit**?

Suggest a use for a satellite in a polar orbit.

----- [3]

7 Asteroids orbit the Sun.

What are asteroids and how have some asteroids damaged the Earth in the past?

----- [2]

8(a) Artificial satellites, such as TV Satellites, can be used for communication.

They are put into orbit around the Earth.

TV satellites are in a high orbit above the equator **and** move around the Earth once every 24 hours.

Explain how this orbit is an **advantage** for satellite TV.

----- [2]

(b) Some weather forecasting satellites have lower orbits than TV satellites.

How does this **lower** orbit affect the time they take to move around the Earth?

----- [1]

(c) Satellites are taken into space by manned and unmanned rockets.

Rocket flight and space travel can be risky. However, the use of satellites can bring benefits.

Write about the risks and benefits of putting satellites into space.

----- [3]

9 Rockets carry satellites into space.

(i) These satellites are kept in orbit around a planet by a force.

What is the name of this force?

----- [1]

(ii) Write down the name of a natural satellite and describe how it is different from an artificial satellite.

----- [2]

- (i) A rocket is in a stable orbit.

To keep the rocket in this orbit its speed needs to stay at 8000 m/s.

Suggest, by using ideas about gravitational and centripetal forces, why this speed needs to be maintained to keep it in this stable orbit.

[3]

- (ii) The rocket re-enters the Earth's atmosphere safely.

In the final part of the descent its speed reduces steadily from 2000 m/s to 120 m/s just before touchdown. This takes place over a distance of 5×10^5 m.

Calculate the average **deceleration** over this distance.

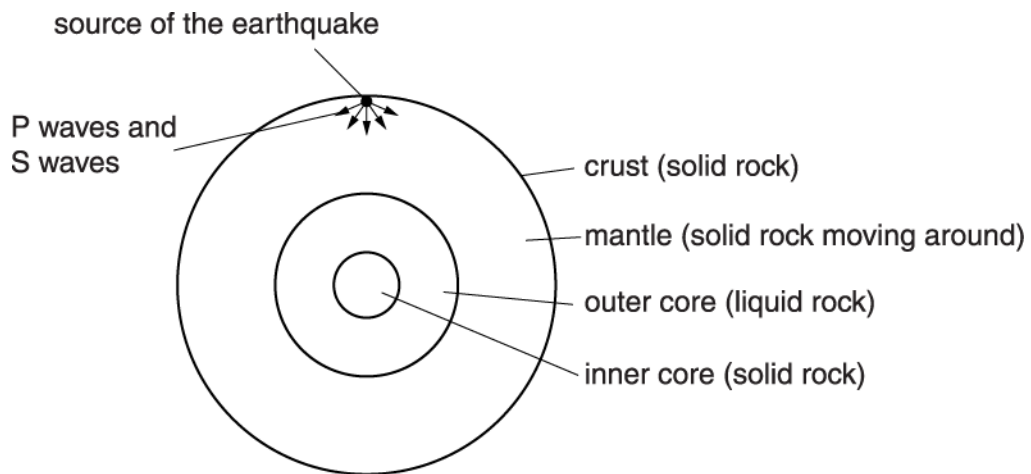
answer _____ m/s^2

[3]

11(a) Look at the diagram of the Earth.

An earthquake produces P waves and S waves.

Look at the diagram. It shows the initial directions of the P waves and S waves.



P waves and S waves are detected by seismometers on the Earth's surface.

Each type of wave from the earthquake is detected at different times by seismometers.

Which type of wave is received first?

Explain your answer.

----- [1]

(b) Scientists take measurements of P waves and S waves using seismometers.

After an earthquake, scientists can work out the exact position of the earthquake, using these measurements.

Suggest how they do this.

----- [2]

(c) S waves do not travel through the Earth's inner core.

Explain why.

----- [1]

12 Rockets carry satellites into space.

These satellites can have different types of orbit around the Earth.

One type is a low polar orbit.

Another type is a geostationary orbit, which has an orbital period of 24 hours.

Describe and explain the differences in orbits, periods and speeds between geostationary orbits and low polar orbits.



The quality of written communication will be assessed in your answer to this question.

----- [6]

Complete the crossword.

Across

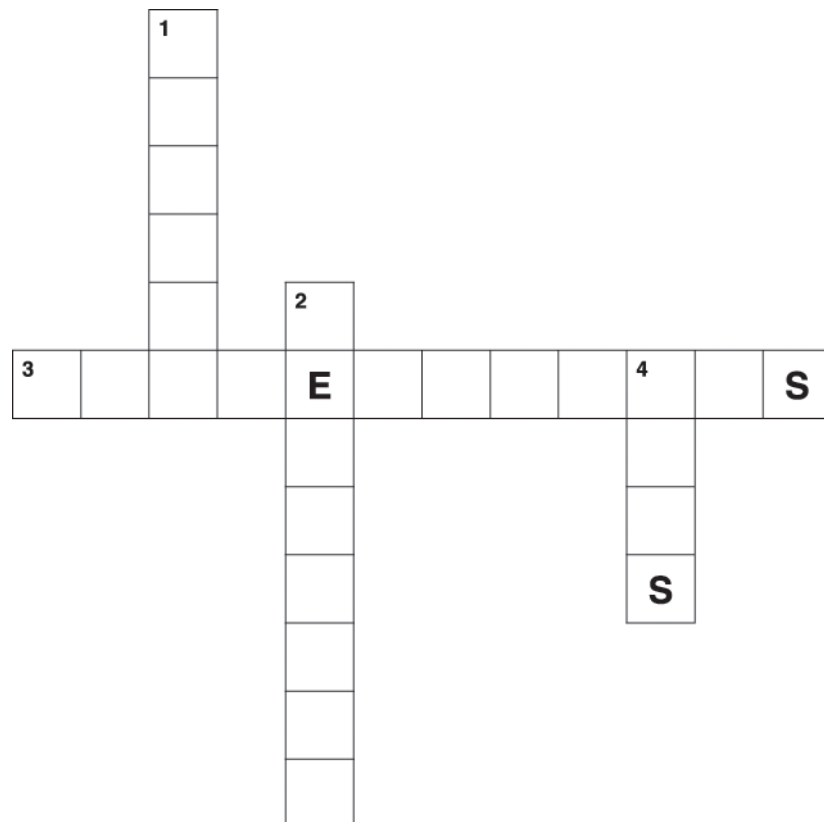
3 In stars, fusion happens at extremely high _ _ _ _ **e** _ _ _ _ _ **s**.

Down

1 Nuclei of hydrogen isotopes undergo fusion to form _ _ _ _ _ nuclei.

2 Scientists stop nuclear fission reactions going out of control in a reactor by absorbing some of the _ **e** _ _ _ _ _.

4 Scientists stop nuclear reactions going out of control by placing metal _ _ _ **s** in the reactor.



[2]

14(a) In 2011 there was a major earthquake in Japan. This was followed by a devastating tsunami.

Scientists did not predict the earthquake accurately.

Immediately after the earthquake they did predict the tsunami.

Explain why the tsunami was predictable.

----- [1]

(b) Scientists are getting better at making predictions.

Suggest what scientists could do to improve their monitoring of earthquakes.

----- [1]

15(a) Our understanding of the Solar System has developed over centuries.

Astronomer	Dates	
Ptolemy	87 to 150 AD	He believed the Earth was the centre of the Universe.
Copernicus	1473 to 1543 AD	He believed the Sun was the centre of the Solar System.
Galileo	1564 to 1642 AD	He showed that Copernicus' model was right and that Ptolemy's was wrong.

(i) What did Copernicus do to develop his theory?

----- [1]

(ii) How was Galileo able to support Copernicus' theory?

----- [1]

(iii) Why were Copernicus' and Galileo's ideas **controversial** at the time?

----- [1]

(b) The Big Bang Theory, developed in 1949, states that the Universe began with an 'explosion'.

This made the Universe expand.

What can we conclude about the movement of galaxies from the Big Bang Theory?

----- [2]

(c) The Big Bang Theory has been accepted by many scientists.

The theory might be changed by future scientists.

Explain why.

----- [1]

16 Scientists study space.

They collect evidence to help develop theories.

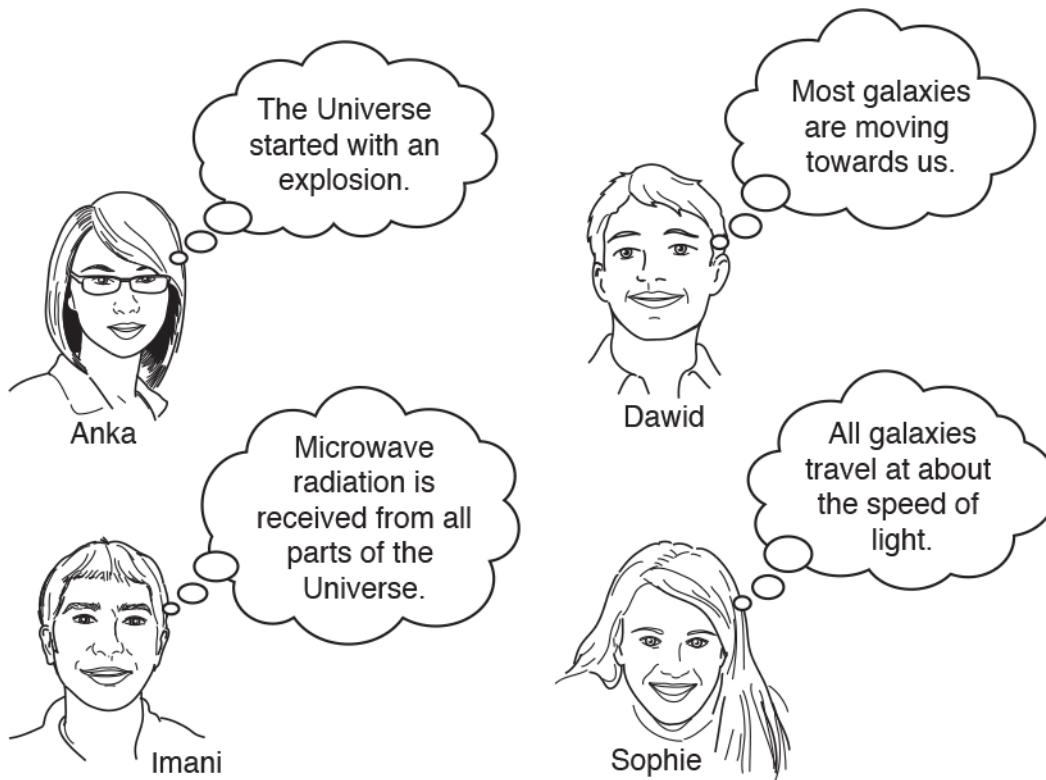
The **Big Bang** is a well-known theory.

What is the Big Bang theory?

----- [1]

17 Four students discuss ideas about the origin of the Universe.

Look at their ideas.



Only two students have correct ideas about the origin of the Universe.

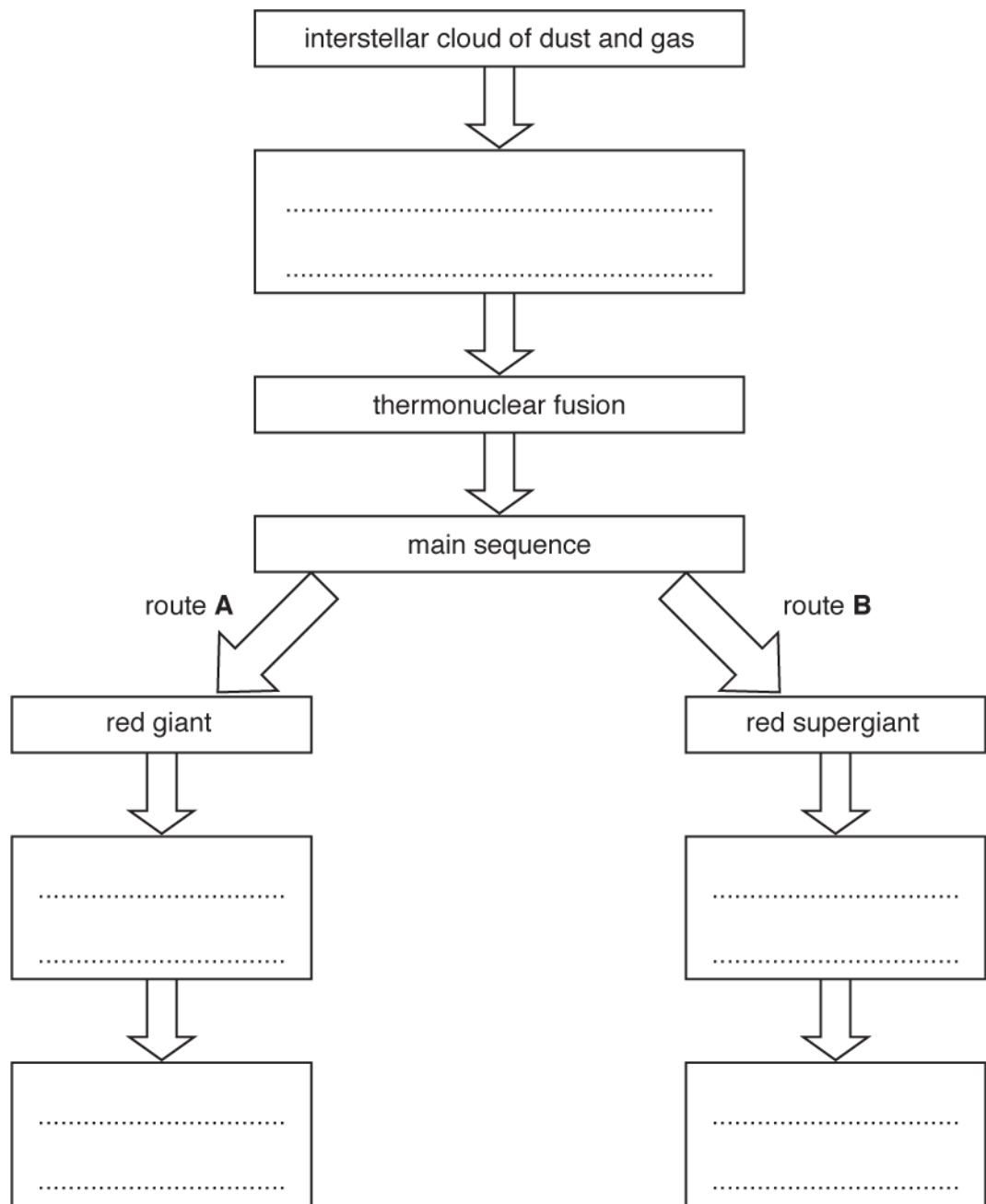
(i) Which **two** students have correct ideas about the origin of the Universe?

----- and ----- [2]

(ii) For one of the **incorrect** ideas, write the correct information.

----- [1]

Look at their flow chart.



(i) Their flow chart is incomplete.

Fill in the **five** missing parts of the life-cycle of a star.

Write your answers in the boxes on the flow chart.

-----[3]

(ii) Explain what determines whether a star follows route **A** or route **B** after the main sequence.

-----[1]

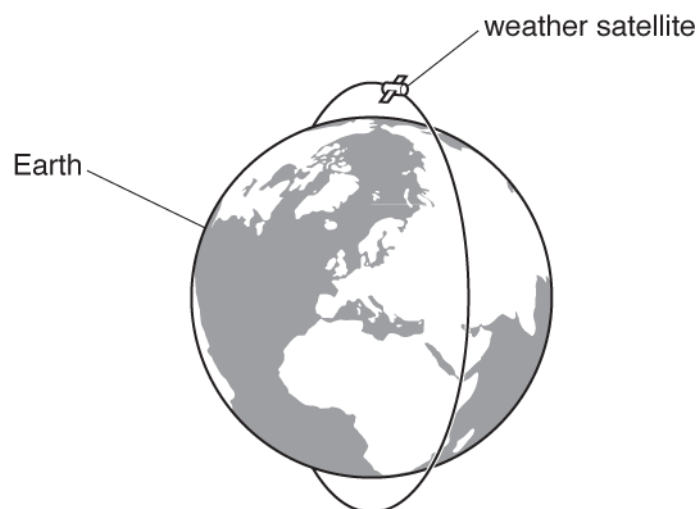
19(a) Satellites orbit larger objects in space.

The Moon is a natural satellite of the Earth. It has a circular orbit.

Explain why the Moon remains in orbit around the Earth.

-----[2]

(b) Artificial satellites are used for weather forecasting.

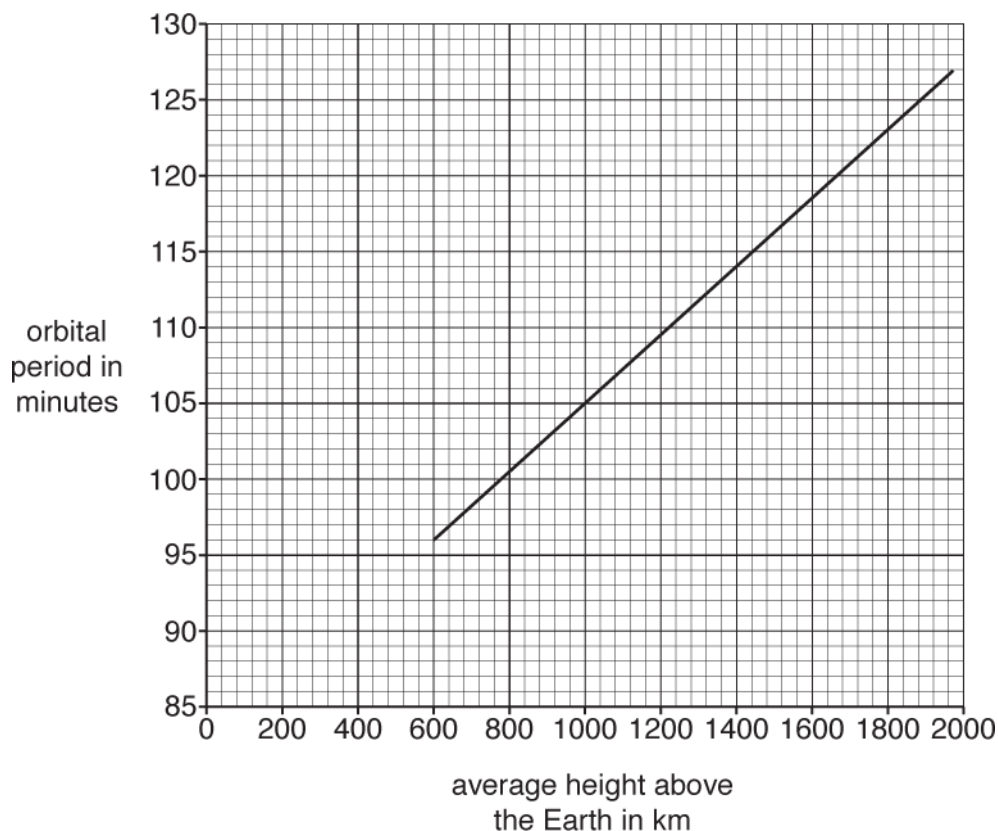


Write down one **other** use of artificial satellites.

-----[1]

(c) Weather forecasting satellites are in a low orbit.

The average height of a satellite above the Earth is linked to its orbital period.



(i) A scientist suggests that doubling the height above the Earth from 1000 km to 2000 km will double the time period.

Is he correct?

Use calculations in your answer.

[2]

(ii) Write down one **advantage** of a low orbit for weather satellites.

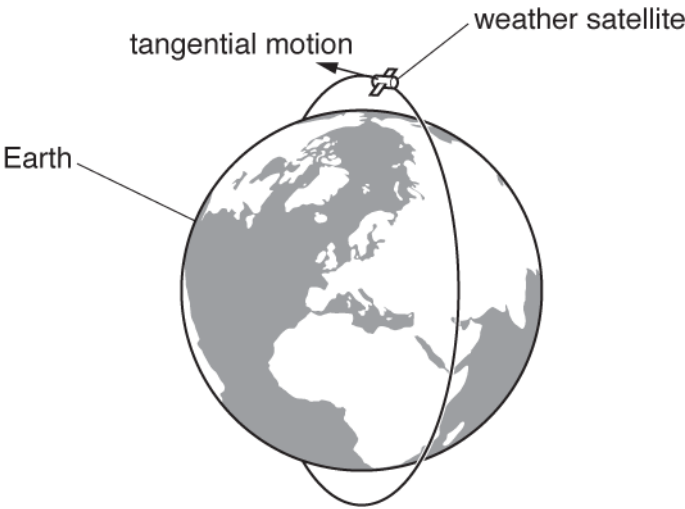
[1]

20(a) Satellites are objects that orbit larger objects in space.

Artificial satellites constantly accelerate towards the Earth.

Their tangential motion keeps them moving around the Earth.

Look at the diagram.

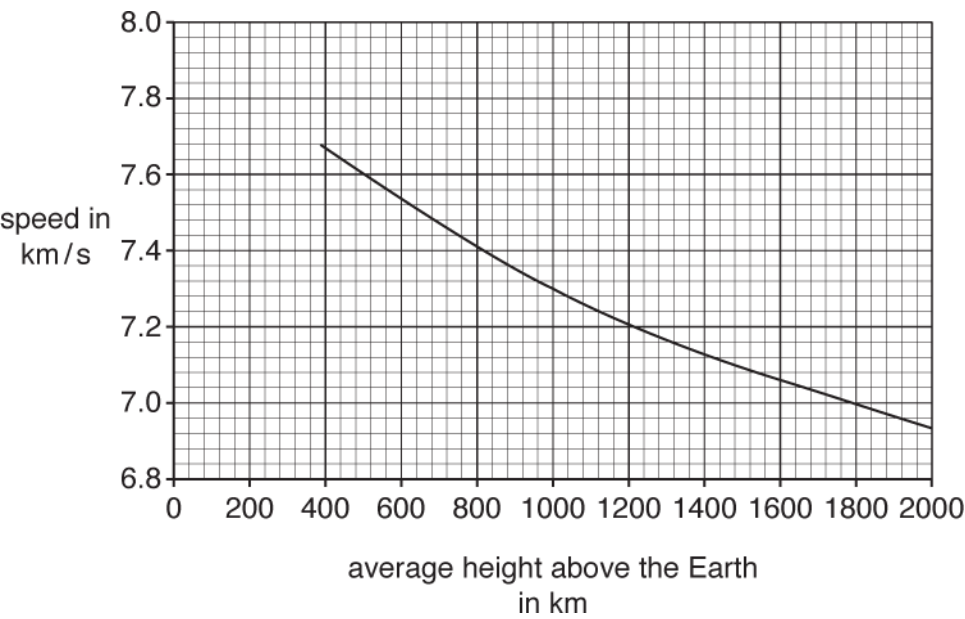


Explain what will happen if the tangential motion is too fast or too slow.

[2]

(b) Weather forecasting satellites are in a Low Earth Orbit (LEO).

The average height of a satellite above the Earth is linked to its speed.



(i) This artificial satellite is in orbit at an average height of 200 km above the Earth.

Use the graph to estimate its speed.

Speed _____ km/s [1]

(ii) Explain why artificial satellites have different speeds.

----- [2]

(iii) Write down one **advantage** of a Low Earth Orbit (LEO) weather satellite.

----- [1]

21 A planet moves in a circular orbit around its star.

Which statement is correct?

- A The planet travels at changing speed and changing velocity.
- B The planet travels at changing speed but constant velocity.
- C The planet travels at constant speed and velocity.
- D The planet travels at constant speed but changing velocity.

Your answer

[1]

22 An artificial satellite is kept in its low polar orbit by a gravity force from a planet.

The satellite is moved to a higher orbit above the planet.

Which statement is correct about the satellite in this higher orbit?

- A The force of gravity is greater and its speed decreases.
- B The force of gravity is greater and its speed increases.
- C The force of gravity is less and its speed decreases.
- D The force of gravity is less and its speed increases.

Your answer

[1]

23 Which row A, B, C or D, describes what has happened to light that has undergone red shift?

	Wavelength	Frequency
A	Decreases	Decreases
B	Decreases	Increases
C	Increases	Decreases
D	Increases	Increases

Your answer

[1]

24 Which statement is **correct** about geostationary satellites?

- A They are above the equator and they orbit the Earth in about 90 minutes at a high orbit.
- B They are above the equator and they orbit the Earth in 24 hours at a high orbit.
- C They are above the equator and they orbit the Earth in 24 hours at a low orbit.
- D They are above the poles and they orbit the Earth in 24 hours at a low orbit.

Your answer

[1]

25 The table contains statements about red-shift and galaxies.

Which row in the table is correct?

	Statement 1	Statement 2
A	All galaxies move apart at the same speed.	They show both red-shift and blue-shift.
B	Distant galaxies show more red-shift.	The distant galaxies are moving apart faster than nearby ones.
C	Distant galaxies show more red-shift.	The distant galaxies are moving apart slower than nearby ones.
D	There are no galaxies that show blue-shift.	All galaxies are moving away from each other.

Your answer

[1]

26 All bodies emit electromagnetic radiation.

Body R is at a higher temperature than body S.

Which statement is correct?

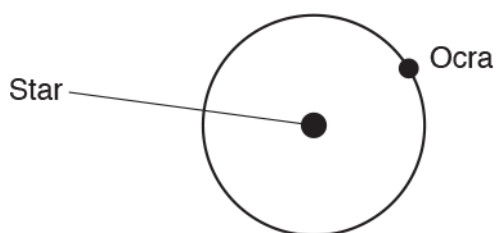
- A R emits radiation with a mean higher frequency.
- B R emits radiation with a mean longer wavelength.
- C S emits radiation with a higher intensity.
- D S emits radiation with a mean shorter wavelength.

Your answer

☐

[1]

27 Planet Ocra is in a circular orbit around a star.



Which statement is correct?

- A The acceleration of Ocra is zero.
- B The speed of Ocra is changing.
- C The velocity of Ocra is changing.
- D The velocity of Ocra is zero.

Your answer

☐

[1]

28 Nuclear **fusion** is a reaction that happens in stars. This equation for fusion is incomplete.



(i) What else is produced in this reaction?

[1]

(ii) Stars are formed from dust and gas.

What causes the dust and gas to undergo fusion?

[1]

29 An artificial satellite orbits the Earth in a circular path.

The satellite is moved further away from Earth to another orbit.

Which row in the table is correct?

	Force of gravity	Speed in orbit	Time period
A	decreases	decreases	decreases
B	decreases	decreases	increases
C	decreases	increases	increases
D	increases	increases	increases

Your answer

[1]

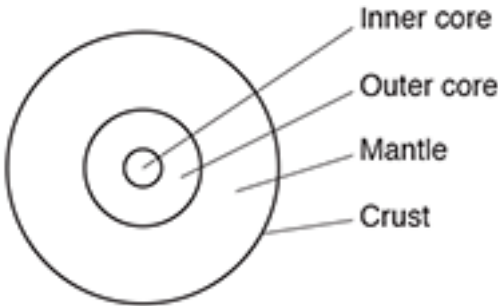


Fig. 22.1

Table 22.1 gives some data about seismic waves and the Earth.

	Density (g / cm ³)	P wave speed (km / s)	S wave speed (km / s)
Top of crust	2.2	5.55	3.25
Top of mantle	3.4	7.97	4.55
Top of outer core	9.9	8.10	-
Bottom of outer core	12.2	10.30	-

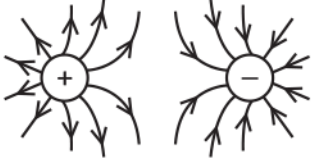
Table 22.1

Describe what information the data in Table 22.1 gives about the structure of the Earth.

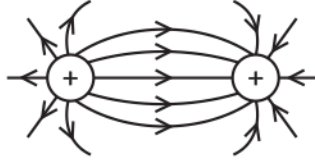
In your answer you should explain any trends in the data in Table 22.1.

31 Look at the field line diagrams for positive and negative charges.

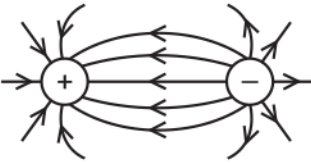
A



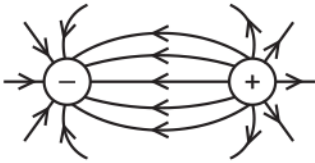
B



C



D



Which field line diagram is correct?

Your answer

[1]

32(a) A student looks at two identical metal spoons, **A** and **B**.

Spoon **A** was placed in hot water at 70 °C.

Spoon **B** is at 20 °C.

Which spoon emits the most radiation?

Tick (✓) **one** box.

Spoon **A** ☐

Spoon **B** ☐

Explain your answer.

[1]

(b) Explain why both spoons look identical to the student, even though they are at different temperatures.

[1]



(i) Explain why this is nuclear fusion.

----- [1]

(ii) It is difficult for nuclear fusion reactions to occur on Earth.

Explain why nuclear fusion reactions occur in the Sun.

----- [2]

(iii) What will happen to our Sun when it runs out of hydrogen?

----- [1]

34 Use the words from the list to complete the sentences about the Universe.

You may use each word once, more than once, or not at all.

Big-Bang Contracting CMBR Expanding

LDR Red giant Red shift Solar system

The is a model of how the universe began.

Light from distant galaxies has a longer wavelength when it reaches Earth than when it was emitted.

This is called

Distant galaxies are moving away faster so the universe is

[3]

35 Which statement about geostationary satellites is correct?

- A They appear to be in a fixed position relative to a point on the Earth.
- B They are in a polar orbit.
- C They are positioned 400 km above the Earth's surface.
- D They take 2 hours to orbit the Earth.

Your answer

☐

[1]

36 The average temperature on the Earth has increased over the last century.

Which statement explains why?

- A Radiation absorbed by the Earth has decreased.
- B Radiation absorbed is less than radiation emitted.
- C Radiation absorbed is greater than radiation emitted.
- D Radiation emitted by the Earth has increased.

Your answer

☐

[1]

37 Which statement about a star that explodes into a supernova is correct?

- A The star has more mass than the sun.
- B The star is older than the sun.
- C The star will become a white dwarf.
- D The star's core expands.

Your answer

☐

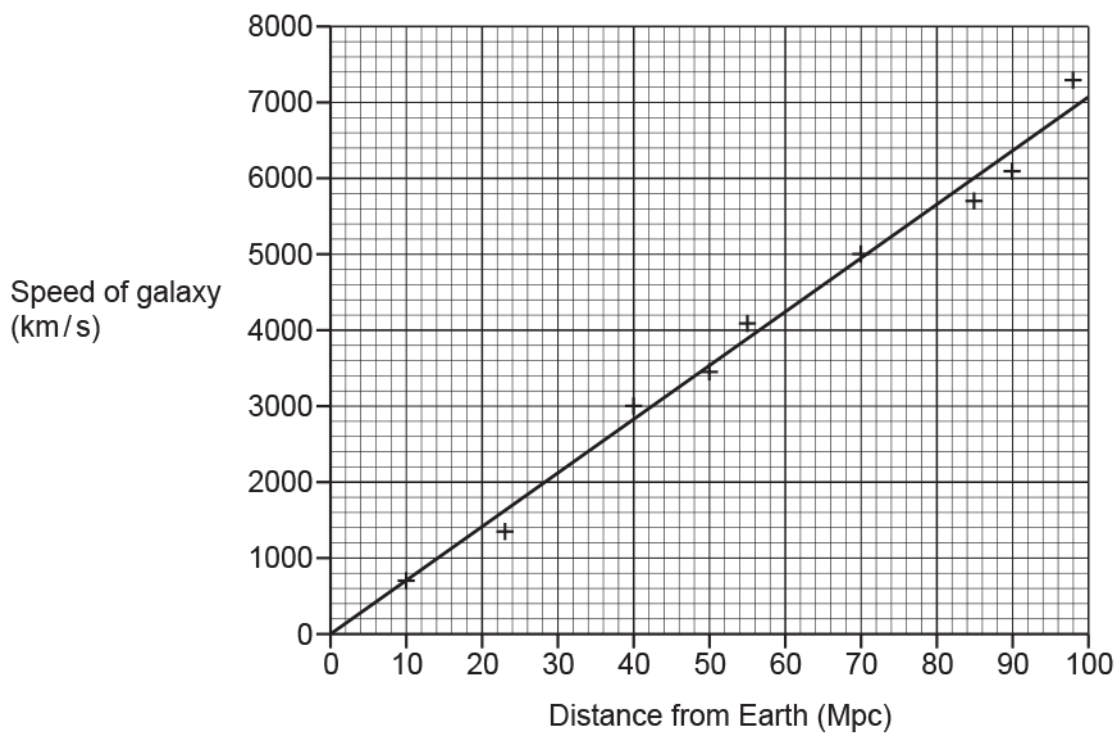
[1]

38(a) Edwin Hubble discovered that all distant galaxies were moving away from the Earth.

Explain how he could tell that all distant galaxies were moving away from the Earth.

[2]

(b) This graph shows how the speed of a galaxy changes with distance from the Earth.



(i) Use data from the graph to show that the speed of the galaxy is proportional to the distance from the Earth.

[2]

(ii) Explain how data from the graph provides evidence for the Big-Bang.

[1]

(c) Before Edwin Hubble could publish his results, his work was peer reviewed.

Suggest why peer review is important.

----- [1]

(d) The parsec (pc) is a unit used for measuring large distances in the Universe.

(i) A galaxy is at a distance of 82 Mpc from the Earth.

Use the graph to determine the speed of this galaxy.

Give your answer in metres per second (m / s).

Speed = ... m / s [2]

(ii) Calculate the time it takes for the galaxy to travel 2.53×10^{24} m.

Use your answer to (i) to help you.

Time = ... s [3]

39 Which statement about nuclear **fusion** is correct?

- A Energy is released because mass is converted to energy.
- B Helium is converted into hydrogen.
- C It is the main way in which nuclear power generates electricity.
- D It is the splitting of a heavy nucleus into smaller nuclei.

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			Total	1	
2			A	1	
			Total	1	
3	a		Gravitational / centripetal (force) (1)	1	ALLOW 'gravity' (1) Ignore 'weight force'
	b		Moon (1)	1	
	c		Recall weight = mass $\times$ gravitational field strength (1) Substitute: 185×3.75 (1) 694 to 3 sig.figs (2) N (1)	5	ALLOW 693.75 (1) but no marks for significant figures
	d		'g' is greater on Earth than Mars / weight is bigger as 'g' is greater on Earth (1)	1	
			Total	8	
4			B	1	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5			* Please refer to point 10 of the marking instructions of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Interpretation of the diagram and how it provides evidence for an expanding universe and the Big Bang model <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Description of red shift AND recognition of what the red shift diagram indicates relating to the Big Bang model <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Simple description of the Big Bang model OR redshift <i>The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.</i> 0 marks <i>No response or no response worthy of credit.</i>	6	AO3.2b: Analyse the diagram to conclude how it provides evidence for an expanding universe and the Big Bang model • The further away a galaxy is the more red shifted it is indicating an expanding universe • If galaxies are moving away then the universe must be expanding • If whole universe is expanding then it must have started from a certain point – the singular point where the Big Bang occurred • More distant galaxies are more red shifted than stars that are closer • Distant galaxies show the lines moving towards the red end of the spectrum • Dark bands are moving towards the red end of the spectrum AO1.1: Description of evidence linking red shift to the Big Bang model • Red shift is caused by a change in frequency / wavelength of light • Description of the changes in frequency and wavelength of light from distant galaxies • Red shift shows galaxies moving away.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6			Any two features from: Polar orbit travels over both poles (1) Travels faster than a geostationary satellite (1) Multiple orbits in a day (1) Lower orbit than geostationary satellites(1) Any one use from: Mapping / weather / surveillance (1)	3	
			Total	3	
7			made of rock [1] have caused craters / dust / fires / species extinction / named species [1]	2	ignore ice / metal / dust ignore collided with Earth Examiner's Comments Approximately half of the candidates knew that asteroids were made of rock and caused craters when they hit the earth. Other correct effects were fires and species extinction.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8	a		any 2 from (idea that) satellite has a wide coverage [1] (idea that) satellite always in same (relative) position [1] (idea that) satellite receivers (on the house) don't need to be moved to follow satellite / AW [1]	2	Examiner's Comments Very few could describe the advantages of satellites in geostationary orbit for TV signals
	b		less time [1]	1	allow faster [1] allow any time less than 24 hours Examiner's Comments Most stated that low polar satellites were faster or took less time to orbit
	c		Risks any one or two from: Loss of life / need oxygen or food or water or heat / high cost / large energy input needed / failed launch / fall back to Earth / difficult to repair / risk of collision [1] Benefits and uses - any one or two from: Spying / communication / scientific research / GPS / imaging of Space / [1]	3	Maximum two marks from each section allow higher level answers ignore Satellite TV ignore weather forecasts Examiner's Comments Most could state at least one benefit (usually spying or space exploration) or one risk (usually collision) of putting satellites into space. Most commonly fullmarks were not gained due to a repetition of uses already given earlier in the question
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9		i	gravity (1)	1	allow centripetal force allow gravitational force / gravitational pull ignore centrifugal ignore gravitational potential energy / GPE Examiner's Comments Almost all stated gravity correctly.
		ii	Moon / other correctly named moon (of another planet) (1) (natural satellite) not put into space by man / not controlled by man / cannot be adjusted by man / not made by man / made of rock / not made of just metal / ora (1)	2	allow named planet as a satellite of the Sun e.g. Jupiter is a satellite of the Sun allow moon is (much) larger / artificial satellite is (much) smaller ignore references to uses of artificial satellites Examiner's Comments Most candidates gained at least one mark ? usually for identifying the Moon and/or that it was not man-made. A misconception by a minority of candidates was that a stationary satellite is an example of a natural satellite.
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10		i	lower speed (than 8000 m/s) then: –centripetal / gravitational force too high (to stay in this orbit) [1] –rocket may fall / move or spiral to Earth [1] higher speed (than 8000 m/s) then: –centripetal / gravitational force too low (to stay in this orbit) [1] –rocket may move away from Earth / spiral out of orbit [1] (idea of) higher stable orbits experience lower gravitational force or lower speed / ORA [1]	3	Eg. rocket may fall as centripetal / gravitational force is too big [2] Eg. rocket may move away as centripetal / gravitational force is too small [2] allow any idea that correct speed needed to allow correct angle of re-entry to avoid overheating [1] <u>Examiner's Comments</u> This was an intentionally challenging question, which required both confidence in the physics and some skill in its communication. Few referred correctly in terms of the forces. The idea that lower speeds would cause the satellite to spiral to Earth was reasonably common. Less common was the idea that at higher speeds the satellites would spiral into space.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	(+/-) 4 (m/s²) scores [3] but if answer is incorrect then: (+/-) $\frac{(120^2 - 2000^2)}{2 \times 5 \times 10^5}$ [2] Or if no other marks scored then evidence of correct substitution into $v^2 = u^2 + 2as$ or evidence of rearranged formula: $\frac{v^2 - u^2}{2s}$ [1]	3	allow 3.99 / 3.9856 (m/s²) [3] <u>Examiner's Comments</u> The calculation of deceleration was challenging but it discriminated well with about a quarter gaining full marks.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a		P wave (no mark) because they are faster [1]	1	Allow primary / pressure / longitudinal wave Ignore 'powerful / stronger' S wave ...etc scores [0] <u>Examiner's Comments</u> This question was about p and s waves and it was better answered than equivalent questions in the past. Most knew that p (or primary) waves were received first due to their higher speed.
	b		can measure lag time / time between waves [1] idea that distance is determined by lag time [1] but difference in time can be used to calculate the distance from earthquake [2] determine wave direction / direction that the wave(s) have come from / AW [1] idea of triangulating the results [1] compare results from different sites [1]	2	maximum 2 marks find time taken by waves [1] E.g. readings taken from different points on Earth [1] <u>Examiner's Comments</u> This question was about p and s waves and it was better answered than equivalent questions in the past. In tracing earthquakes many referred to the idea of using the wave directions to predict the source. Some referred to measuring the times and a few to the idea of triangulating the results.

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	c		(can't get through because) outer core is liquid [1]	1	Ignore S-waves can't get through liquid Eg. S-waves can't get through liquid inner core scores [0] <u>Examiner's Comments</u> This question was about p and s waves and it was better answered than equivalent questions in the past. There were some good answers here that described the waves as being unable to get through the liquid outer core. This idea was better answered than in past papers.
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance															
12			[Level 3] Answers must give a comparison and an explanation of at least two ideas with reference to gravitational / centripetal force. (See summary chart) Quality of written communication does not impede communication of the science at this level. (5–6 marks) [Level 2] Answers must give a comparison and a description of at least two ideas. Quality of written communication partly impedes communication of the science at this level. (3–4 marks) [Level 1] Answers are limited to one simple description OR a description of an appropriate use of a satellite. Quality of written communication impedes communication of the science at this level. (1–2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to A*. allow reverse arguments for geostationary orbits throughout. Indicative scientific points may include at level 3: • higher gravitational force and lower altitude for polar orbit • higher gravitational force and higher speed or acceleration for polar orbit • higher gravitational force and shorter period for polar orbit Indicative scientific points may include at level 2: • lower altitudes for polar orbit • higher speeds for polar orbit • shorter period for polar orbit • polar orbit over poles and geostationary orbit over equator Indicative scientific points may include at level 1: • short(er) time period for polar orbit • geostationary orbits around equator • Correct use for a relevant satellite (eg polar – military, mapping, navigation, weather, etc. Geostationary –navigation, communication, weather etc.) Use the L1, L2, L3 annotations in Scoris; do not use ticks. <table><tr><td>ideas</td><td>geostationary</td><td>polar</td></tr><tr><td>orbit description</td><td>equator</td><td>Go over poles</td></tr><tr><td>period</td><td>longer</td><td>shorter</td></tr><tr><td>speed</td><td>lower</td><td>higher</td></tr><tr><td>gravitational force</td><td>lower</td><td>higher</td></tr></table> At level 3 accept higher level answer in terms of acceleration Examiner's Comments This was a 6 mark question on artificial	ideas	geostationary	polar	orbit description	equator	Go over poles	period	longer	shorter	speed	lower	higher	gravitational force	lower	higher
ideas	geostationary	polar																		
orbit description	equator	Go over poles																		
period	longer	shorter																		
speed	lower	higher																		
gravitational force	lower	higher																		

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					satellites targeted up to grade A*. There were many level 2 answers (3 or 4 marks) that correctly compared the orbital periods, speeds and heights. Level 3 answers were obviously less common and this discriminated well at A and A*. For this they had to relate the orbits to the relative force of gravity.
			Total	6	
13			h e l i u n t e m p e r a t u r e s u t r o n s o d s	2	answers in crossword take precedent but if crossword blank allow answers next to the clues 0 or 1 correct = 0 marks 2 or 3 correct = 1 mark 4 correct = 2 marks Examiner's Comments Most gave two or three correct answers in the crossword [1]. One common error was 'reactant' (instead of neutrons).
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
14	a		idea that tsunamis are caused by earthquakes / AW (1)	1	allow (pressure) sensors in oceans can detect tsunamis allow visual confirmation of tsunami (eg water recedes) allow correct description eg plates move and cause tsunami eg earth movement disturbed water and made tsunami eg earthquake happens under water ignore merely rising sea levels Examiner's Comments The idea that earthquakes cause tsunamis or that the earthquake happened under the sea, together with the idea of equipment, better positioning of 'sensors' or constant monitoring in the second part, usually secured both marks.
	b		idea of more data gathered / AW or better able to process (more) data now / AW or better (more sensitive) equipment / better technology or idea of better positioning of monitors or constant or more frequent monitoring (1)	1	ignore idea of data sharing allow description eg use more sensors or put sensors in areas known to produce earthquakes / AW Examiner's Comments A significant number thought that historical data could be used to predict the next event.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a	i	(improved) astronomical observation (of planets) (1) mathematical explanation or physical model used (1) reviewing previous theories or made use of previous observations / AW (1)	1	Ignore telescopes Examiner's Comments About 40% or so stated that he used models [1] or astronomical observations [1]. Many merely repeated information in the table.
		ii	(He) used a (better) telescope (1) (He) invented / developed a telescope / AW (1) (He) observed moons around Jupiter (1) (He) observed that not all bodies orbited Earth (1)	1	Examiner's Comments Again less than half of candidates got this right. Those that did usually referred to an improved telescope being used or invented.
		iii	contradicted religious views / AW (1)	1	Examiner's Comments Just over half knew that the influence of the Church was responsible here.
	b		galaxies move away / show red-shift / AW (1) Distant galaxies move faster (than closer galaxies) (1) BUT distant galaxies move away quicker / AW (2)	2	ignore background microwave radiation ignore planets / merely stars moving away ignore universe expanding Examiner's Comments This question about the Big Bang theory uncovered the usual misconceptions about it. Frequent ideas seen were that galaxies / stars / planets / moon were expanding. Many though (50%) knew that galaxies were moving apart [1] and some (only about 10%) went on to say that the outer ones moved faster than the inner ones [1].
	c		Only current evidence explained (1) Further research done / new evidence may be found in future (1) Technological advances (1)	1	eg new data (will be found) (1) Examiner's Comments This was mostly correct.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16			explosion / start of universe (from a point) / expansion / AW [1]	1	NOT just 'creation of the Earth' NOT just 'creation of life' BUT 'an explosion created the Earth and the Universe' / AW scores [1] NOT colliding rocks / matter Examiner's Comments Many knew that The Big Bang was an explosion which created the Universe [1]. Some thought it just created the Earth or the Earth and moon system [0]. Some thought that it was when rocks collided [0].
			Total	1	
17		i	Anka (1) Imani (1)	2	either order
		ii	any one from: most galaxies are moving away from us (1) few galaxies are moving towards us (1) further galaxies travel faster (1) closer galaxies travel slower than further galaxies (1)	1	Allow Galaxies travel at different speeds / AW (1) Not all galaxies travel at the speed of light (1)
			Total	3	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
18		i	TOP BOX: (Gravitational) collapse / (dust and gas) pulled together / proto-star (1) LEFT BOXES: (planetary) nebula and then white dwarf OR (planetary) nebula and then black dwarf OR white dwarf and then black dwarf (1) RIGHT BOXES: supernova and then neutron star / black hole (1)	3	NOT Proton star in correct order and both required for (1) mark in correct order and both required for (1) mark If middle box is a neutral answer then award this mark if answer is correct in lowest box. Eg. LHS: middle box – it explodes and sheds its outer layer Bottom box – white dwarf then black dwarf (1)
		ii	(Difference in) mass / weight (1)	1	Allow (differences in) the number of (hydrogen) nuclei (1) Ignore references to size / large and small stars
			Total	4	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19	a		(force of) gravity (1) attracts the Moon to the Earth (1)	2	allow idea of centripetal force (1)
	b		any one from communications (1) military use (1) scientific research (1) GPS (1) imaging the Earth (1)	1	ignore weather forecast allow examples e.g. (satellite) TV (1) allow Satnav (1)
	c	i	1000km takes 105 minutes and 2000km takes 127–128 minutes (1) not double / use of values to show not double/ 23 difference (1)	2	
		ii	any one from scan whole surface of the Earth / can 'see' much of the surface of the Earth / can 'see' the weather patterns (of the Earth) (1) orbit the Earth many times a day / can 'see' changes in weather patterns / can be used to forecast future weather / can see the changes more quickly(1) idea of a more detailed image (due to proximity to the Earth) (1)	1	ignore more accurate allow clearer image (1)
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20	a		Any two from: If too fast - - Satellite goes deeper into space (1) (centripetal / gravitational) force is too small to maintain orbit (at this speed) (1) If too slow - - Satellite goes towards Earth / atmosphere (1) - Hits Earth (1) (centripetal / gravitational) force is too high to maintain this orbit (at this speed) (1)	2	If no mark awarded - general unspecified answer of 'just leaves orbit' for (1) Eg. Too fast crashes to Earth scores (1)
	b	i	7.8 – 7.9 (1)	1	Allow numbers that can be rounded to these values. Eg. 7.78 (1)
		ii	any two from In a high(er) orbital path - less gravitational / centripetal force / ORA (1) In a higher (er) orbital path - low(er) speed / ORA (1) (sensible reference to) inverse square law (1)	2	Ignore references to the function of the satellite Allow geostationary for higher orbit Allow polar for lower orbit If no other marks scored then different heights / forces give different speeds [1]

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	any one from • higher resolution / detailed images • Scans whole surface of Earth (over a period of time)	1	Eg. more detailed weather maps / photos (1) Eg. 'can cover more area' (1) Ignore references to merely updates of / changes in weather BUT more frequent weather forecasts scores (1)
			Total	6	
21			D ✓	1 (AO1.1)	
			Total	1	
22			C ✓	1 (AO2.1)	<u>Examiner's Comments</u>  Most candidates demonstrated a good knowledge about the orbits of artificial satellites at different heights (P8.3f and P8.3g). Most other candidates correctly identified that the force of gravity would be less when the satellite is moved to a higher orbit, but also predicted that the speed would increase (distractor D).
			Total	1	
23			C ✓	1 (AO1.1)	
			Total	1	
24			B ✓	1 (AO 2.1)	<u>Examiner's Comments</u> This question assessed P8.3e and was answered correctly by around 40% of candidates. All three distractors were chosen with equal frequency.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
25			B ✓	1 (AO 1.1)	<u>Examiner's Comments</u> Candidates were mainly able to apply their knowledge to link correctly the amount of red-shift to the movement of galaxies.
			Total	1	
26			A ✓	1 (AO 1.1)	
			Total	1	
27			C ✓	1 (AO 1.1)	<u>Examiner's Comments</u> This question assessed candidates' knowledge of how the force of gravity can change the velocity of a planet but its speed stays the same. Most candidates correctly chose option C.
			Total	1	
28		i	Neutron(s) ✓	1 (AO 1.1)	IGNORE gamma <u>Examiner's Comments</u> About two thirds of the candidates did not know that neutrons were also produced in a fusion reaction. Common misconceptions included water, carbon dioxide and protons.
		ii	Any one from: Gravity ✓ (very) high temperatures ✓ high pressure ✓	1 (AO 1.1)	ALLOW (high) gravitational field strength ALLOW hot (temperatures) / lots of heat IGNORE just heat <u>Examiner's Comments</u> The majority of candidates answered this correctly.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
29			B ✓	1 (AO 2.1)	<u>Examiner's Comments</u> A number of candidates struggled with this question about satellite orbits. A common error was option C as candidates incorrectly thought that the speed of the satellite in orbit would increase as it is moved further from Earth.
			Total	1	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
30	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description of the structure of the Earth AND Detailed explanation of the trends in Table 22.1. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Description of the structure of the Earth. AND Explanation of the trends in Table 22.1. OR Detailed description of the structure of the Earth. OR Detailed explanation of the trends in Table 22.1. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) A basic description of the structure of the Earth. OR A basic description of the trends in Table 22.1. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6 (AO 2×3.1a) (AO 2×3.2a) (AO 2×2.1)	AO3.1a Analyse information and ideas to interpret some basic trends in data • density increases as depth increases • speed (of P/S waves) increases as density increases • speed (of P/S waves) increases as depth increases AO2.1 Apply knowledge and understanding of scientific ideas to explain trends in the data • Earth contains layers • velocity changes at a boundary • as density changes at a boundary • particles more tightly packed • P is longitudinal, S is transverse AO3.2a Analyse information and ideas to make judgements about the structure of the Earth • core has highest density • core has highest speed for P waves • S waves do not travel through the core • so the outer core is a liquid • pressure highest in core / $P = \rho gh$ • pressure and so density increase with depth • large change in density between mantle and outer core <u>Examiner's Comments</u> This was the Level of Response question, targeted up to Grade 9, and assessed AO2 and AO3. There was a wide range of marks achieved and the question discriminated well. Very few candidates did not achieve any credit. The majority of candidates were able to describe some basic trends in the table for density and speed of P and S waves. More detailed responses also included a description of the structure of the Earth for Level 2.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					Many excellent responses from the more able candidates at Level 3 included: • trends in the data identified and explained • linking facts about P and S waves to an explanation of why the outer core is liquid. Poor quality of communication, including contradictions or the same facts repeated a number of times, prevented some candidates from achieving a higher mark. Exemplar 2 Describe what information the data in Table 22.1 gives about the structure of the Earth. In your answer you should explain any trends in the data in Table 22.1. P waves are longitudinal and travel through both solid and liquids but S waves are transverse and only travel through solids. There is no data for the wave speed of S waves through the top of the outer core and the bottom so the core must be made of liquid, however both waves can travel through the crust and the mantle as there is data for it so there must be made of solid. The density of the layers of the earth decreases down the table so the density of the earth must decrease from the surface of the crust to the centre of the inner core. The speed of both P waves and S waves increase down the table as well. P waves travel faster in more 22 material as the particles are closer together so they carry the wave to each other faster. The data therefore backs up that the density of the earth increases towards the centre. This response achieved Level 3, 6 marks. The candidates included a detailed description of the structure of the Earth, including ideas about density and the liquid outer core. There is also a detailed explanation of the trends shown in the table.
			Total	6	
31			D ✓	1 (AO1.1)	Examiner's Comments This was generally well answered. Candidates who did not gain the correct answer often chose C indicating that the direction of the electric field was not fully understood.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
32	a		spoon A AND (More radiation emitted) at higher temperature / hotter objects (emit more radiation) / spoon A is hotter / AW / OR A✓	1 (AO1.1)	ALLOW spoon A is heated (more) <u>Examiner's Comments</u> Many candidates correctly ticked Spoon A but did not explain their answer correctly. It was expected that they would state that objects at higher temperatures would emit more radiation.
	b		Any one from: Eye can only detect visible light / eye cannot detect IR ✓	1 (AO1.1)	ALLOW see for detect ALLOW spoon is not hot enough for a change in colour AW <u>Examiner's Comments</u> The common incorrect answer to this question was to refer to the spoons not melting rather than stating that infrared radiation cannot be detected by the eye.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
33		i	Nuclei join (in fusion) ✓	1 (AO 1.1)	ALLOW fuse / combine <u>Examiner's Comments</u> There were many vague answers in terms of hydrogen reacting to produce large amounts of energy. Ideally candidates should understand that fusion is where nuclei join together.
		ii	Any two from: High temperature ✓ High pressure ✓ Large gravitational forces (due to large mass) ✓	2 (AO 2×2.1)	IGNORE heat <u>Examiner's Comments</u> Examiners were keen that correct physics terms were used. Answers such as a lot of heat were not credited. Some candidates did mention very high temperatures. Other acceptable answers included high pressure and large gravitational forces. There needed to be some idea of size, e.g. high, large Often only one comment was made when the mark bracket was [2] which indicates two points need to be made.
		iii	The sun will expand / become a red giant / (ultimately) become a white dwarf ✓	1 (AO 1.1)	ALLOW fusion of helium / heavier elements <u>Examiner's Comments</u> The question required candidates to state what would happen when the sun ran out of hydrogen. Many candidates state what would happen to the sun eventually.
			Total	4	
34			Big Bang ✓ Red shift ✓ Expanding ✓	3 (AO3 × 1.1)	
			Total	3	
35			A ✓	1 (AO1.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
36			C ✓	1 (AO1.1)	
			Total	1	
37			A ✓	1 (AO1.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
38	a		(All galaxies) showed <u>red-shift</u> ✓ (Hubble measured the) wavelength/frequency of <u>light</u> (from the galaxy) ✓	2 (AO2 × 1.1)	ALLOW (all galaxies) showed <u>light</u> with a longer wavelength/lower frequency for 2 marks
	b	i	Readings of speed taken for two different values of distance ✓ Working to show that the factor increase in speed is the same as distance ✓	2 (AO2 × 3.1a)	ALLOW +/- ½ a small square ALLOW a statement for the second mark e.g. as the distance doubles so does the speed. <u>Example:</u> At 20 Mpc, speed = 1400 km/s At 40 Mpc, speed = 2800 km/s $40/20 = 2 = 2800/1400$ ALLOW 1 mark maximum for it is a (straight) line of best fit through the origin (therefore it is proportional)
		ii	Any one from: The more distant galaxies are travelling faster ✓ The evidence suggests the universe is expanding ✓ The universe was smaller in the past ✓	1 (AO1.1)	ALLOW galaxies are moving away from each other
	c		To ensure results are reproducible / check the work is of high enough quality / claims are not false / for new theories to be accepted / to develop theories / AW ✓	1 (AO1.1)	ALLOW check validity / for mistakes/anomalies / AW ALLOW check that it's not biased / AW
	d	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5 800 000 (m/s) award 2 marks (Reads off speed from graph =) 5800 (km/s) ✓ Speed = $5800 \times 1000 = 5\,800\,000$ (m/s) ✓	2 (AO2.2) (AO1.2)	ALLOW 5.8×10^6 (m/s) ALLOW ecf for their speed from graph x 1000

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4.36×10^{17} (s) award 3 marks time = distance / speed ✓ (time =) $2.53 \times 10^{24} / 5\,800\,000$ ✓ (time =) 4.36×10^{17} (s) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW ecf from (i) ALLOW 4.4×10^{17} (s) ALLOW equation in any form
			Total	11	
39			A ✓	1 (AO1.1)	
			Total	1	