Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Space physics

Time allowed: 1 hour 20 minutes

Subject code **0625**

Physics

Questions from Paper 3 and Paper 4

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.

Total marks

/ 82

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.

Information

- This paper has 10 questions worth 82 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1 Fig. 11.1 represents the Solar System. The Sun and five of the eight planets are labelled.

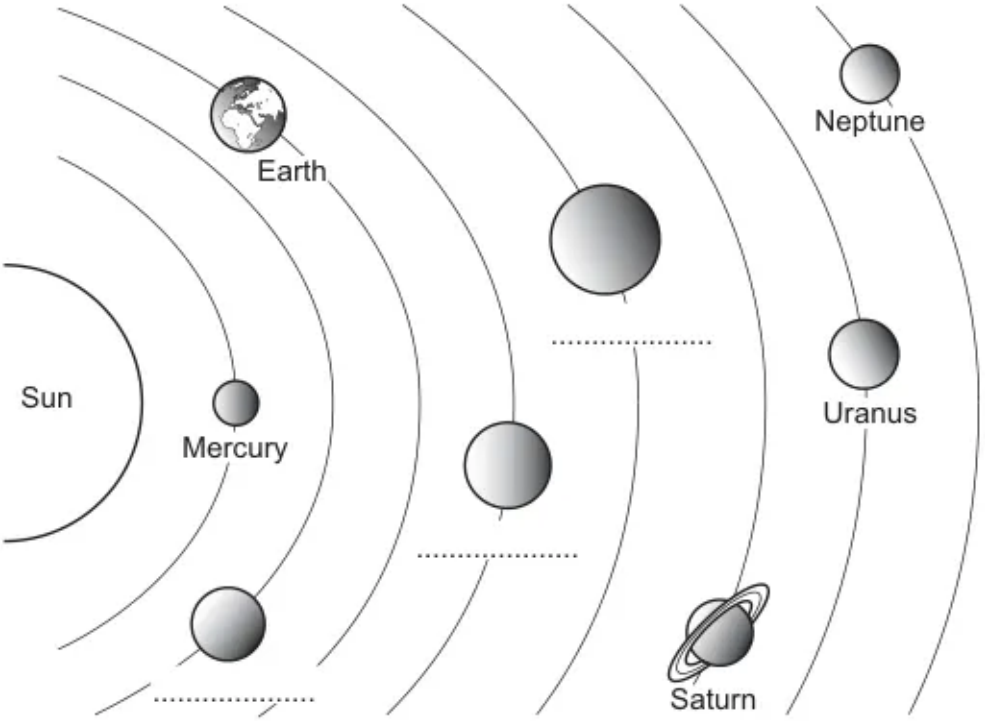


Fig. 11.1 (not to scale)

(a) Complete the **three** missing labels on Fig. 11.1 by writing the name of each planet on its dotted line. [2]

(b) **(i)** The Sun consists mainly of two elements.

Name the **two** elements.

..... and ..... [2]

(ii) The Sun radiates energy mainly in three regions of the electromagnetic spectrum. Ultraviolet is one of the three regions.

State the name of **one** of the other two regions.

..... [1]

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(c) **(i)** Scientists use the Big Bang Theory to explain the way the Universe began.

State **one** piece of evidence that supports the Big Bang Theory.

.....

..... [1]

(ii) Scientists use the accretion model to explain the formation of the Solar System.

Complete the following sentences about the accretion model.

In space, there are clouds of dust and ..... .

The material spins around and moves closer together due to the force of ..... .

This forms an accretion ..... .

[3]

[Total: 9]

Stars and the Universe Click for more variations

1(a)	Venus Mars Jupiter **all** 3 in correct position – 2 marks 1 or 2 in correct position **OR** **all** 3 named – 1 mark	**B2**
1(b)(i)	hydrogen	**B1**
	helium	**B1**
1(b)(ii)	visible light **OR** infrared	**B1**
1(c)(i)	redshift	**B1**
1(c)(ii)	gas(es)	**B1**
	gravity	**B1**
	disc	**B1**

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2 Fig. 10.1 represents part of the Solar System.

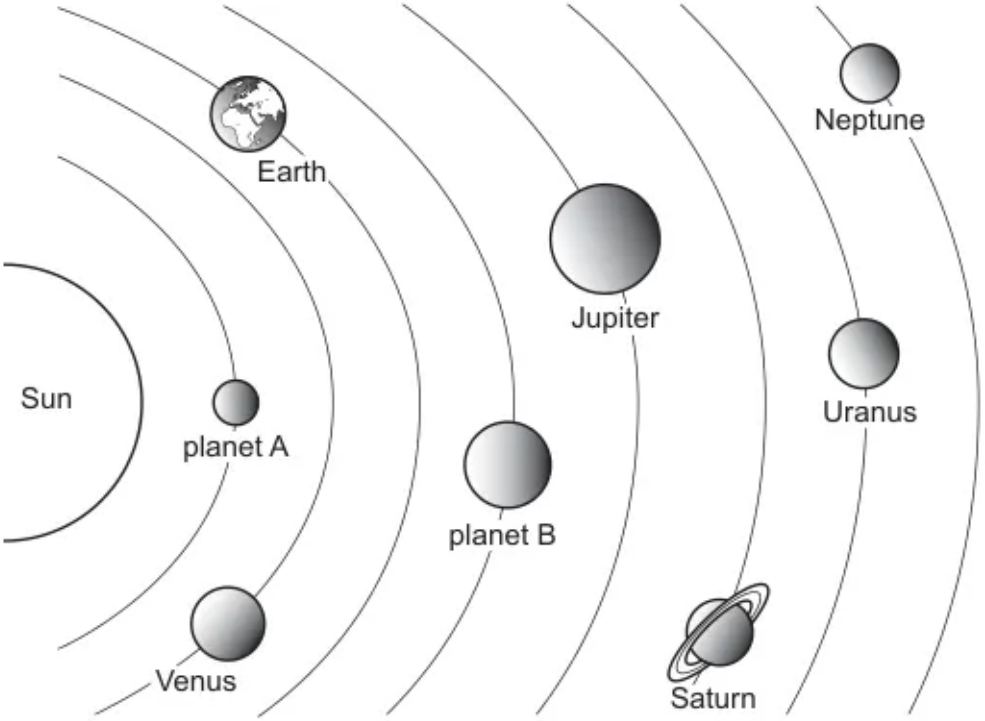


Fig. 10.1 (not to scale)

(a) (i) State the name of planet A and the name of planet B.

planet A .....

planet B .....
[2]

(ii) On Fig. 10.1, draw an X to represent a moon of Jupiter. Draw a line to show how this moon moves. [1]

(iii) State **two** ways in which the four planets nearest to the Sun are different from the four planets furthest away from the Sun.

1 .....

2 .....
[2]

(iv) Complete the following sentences:

The galaxy that includes the Solar System is called the ..... .

The ..... includes billions of galaxies.
[2]

(b) The distance between the Sun and the Earth is 1.5×10^{11} m.
The speed of an electromagnetic wave is 3.0×10^{8} m/s.

Calculate the time taken for an electromagnetic wave to travel from the Sun to the Earth.

time taken = ... s [3]

[Total: 10]

Earth and the Solar System Click for more variations

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2(a)(i)	Mercury (nearest to Sun)	**B1**
	Mars (between Earth and Jupiter)	**B1**
2(a)(ii)	(circular / oval) path round Jupiter	**B1**
2(a)(iii)	rocky **OR** furthest planets are gaseous owtte	**B1**
	small(er) **OR** furthest planets large(r)	**B1**
2(a)(iv)	(the) Milky Way	**B1**
	(the) Universe	**B1**
2(b)	(time =) distance ÷ speed in any form	**C1**
	$1.5 \times 10^{11} \div 3.0 \times 10^{8}$	**C1**
	500 (s)	**A1**

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3 Table 11.1 shows some information about two of the planets in the Solar System.

Table 11.1

name of planet	mass of planet / kg	distance from the Sun / km	time for one rotation on its axis / hours
Venus	4.87×10^{24}	108.2×10^{6}	5832
Earth	5.97×10^{24}	149.6×10^{6}	24

(a) (i) Venus is a similar size to the Earth.

State why the gravitational field strength at the surface of the Earth is greater than the gravitational field strength at the surface of Venus.

..... [1]

(ii) Calculate the time, in Earth days, for **one** day on Venus.

time = ... Earth days [3]

(iii) Calculate the time taken for light to travel from the Sun to Venus. The speed of light is 3.0×10^{8} m / s.

time taken = ... s [4]

(b) The star nearest to the Sun is about 4.25 light-years from the Sun.

Explain what is meant by one light-year.

.....

..... [2]

[Total: 10]

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3(a)(i)	Earth has greater mass ORA	**B1**
3(a)(ii)	243 (Earth days)	**A3**
	5832 ÷ 24	(C2)
	idea that one rotation on its axis equals one day	(C1)
3(a)(iii)	360 (s)	**A4**
	$108.2 \times 10^9 \div 3.0 \times 10^8$	(C3)
	speed = distance ÷ time **OR** (t =) $s \div v$	(C1)
	conversion 1 km = 1000 m	(C1)
3(b)	distance	**M1**
	travelled (in space) by light in one year owtte	**A1**

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4 Table 9.1 gives information about three planets in the Solar System.

Table 9.1

planet	mass / 10^{24} kg	average distance from Sun / 10^{6} km	orbital period / days	gravitational field strength at surface / N/kg
Earth	5.97	149.6	365.2	9.8
Jupiter	1898	778.6	4331	23.1
X	4.87	108.2	224.7	8.9

(a) State the name of planet X.

..... [1]

(b) Describe the relationship shown in Table 9.1 between the mass of a planet and the gravitational field strength at its surface.

.....

..... [1]

(c) Explain why 'distance from Sun' in Table 9.1 is an average value.

.....

..... [1]

(d) Show that the average orbital speed of the Earth is approximately 30 km / s.

[3]

[Total: 6]

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4(a)	Venus	**B1**
4(b)	The larger the mass (of the planet), the larger the gravitational field strength (at the surface)	**B1**
4(c)	orbit of planets is elliptical / is not circular owtte	**B1**
4(d)	correct conversion of T into seconds i.e. $365.2 \times (24 \times 60 \times 60)$ **OR** 3.2×10^7	**B1**
	$(v =) \{2\pi r\} / T$	**B1**
	$2\pi \times 149.6 \times 10^6 / 365.2 \times 24 \times 60 \times 60$	**B1**

5 **(a)** Sketch a diagram to show the orbital path of a comet around the Sun.

Mark the position of the Sun on your diagram using an S.

[2]

(b) Draw a cross on your diagram to show where the comet is travelling with the slowest speed. Label the cross **L**. [1]

(c) Explain why the speed of a comet changes as it travels around its orbit.

Use the conservation of energy in your explanation.

.....

.....

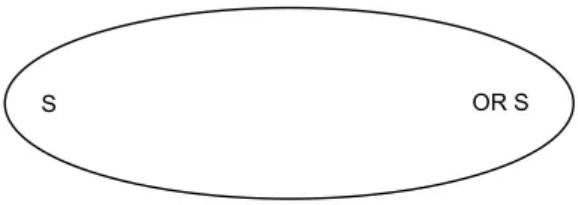
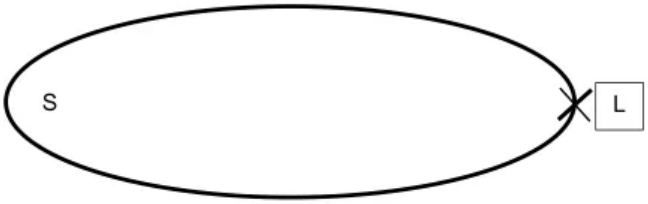
.....

..... [3]

[Total: 6]

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5(a)		
	elliptical shape drawn	**B1**
	S at a focus of the ellipse by eye	**B1**
5(b)		
	L furthest away from their S / Sun	**B1**
5(c)	total energy = gravitational (potential) energy + kinetic energy	**B1**
	(energy stored as) GPE decreases and (energy stored as) KE increases closer to the Sun	**B1**
	when the comet has more kinetic energy it has a greater speed	**B1**

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6 **(a)** **(i)** **1.** State what is represented in space physics by the symbol H_0.

..... [1]

2. Write down the equation that defines H_0 in terms of the speed that a far galaxy is moving away from the Earth and its distance from the Earth.

..... [1]

(ii) The numerical value of H_0 is 2.2×10^{-18}. State the unit of H_0.

..... [1]

(iii) Use this value of H_0 to determine an estimate for the age of the Universe in seconds.

age of the Universe = ... s [2]

(b) State when cosmic microwave background radiation (CMBR) was formed and where we detect it coming from.

.....

.....

.....

..... [2]

[Total: 7]

Stars and the Universe Click for more variations

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6(a)(i)	1 Hubble constant	**B1**
	2 $H_0 = v / d$	**B1**
6(a)(ii)	per second **OR** s^{-1} **OR** 1 / s	**B1**
6(a)(iii)	4.5×10^{17} (s)	**A2**
	$d / v = 1 / H_0$ **OR** (age of Universe =) $1 / H_0$ **OR** (age of Universe =) d / v **OR** (age of Universe =) $1 / 2.2 \times 10^{-18}$	C1
6(b)	shortly after the Universe was formed **OR** shortly after the Big Bang	**B1**
	all points in space	**B1**

7 The Milky Way is the galaxy in which the Solar System is located.

(a) State what a galaxy is.

.....

..... [1]

(b) The Milky Way has a diameter that is approximately equal to 100 000 light-years.

Determine this distance in kilometres (km).

distance = ... km [2]

(c) Astronomers determine the speed and distance from the Earth of a far galaxy that is moving away from the Earth.

(i) State **one** observation that allows the speed at which a galaxy is moving away to be determined.

.....

..... [1]

(ii) State **one** different observation that is used to determine the distance to a far galaxy.

.....

..... [1]

(iii) State how the speeds of galaxies and their distances from the Earth are related.

.....

..... [1]

(iv) The best estimate for the Hubble constant H_0 is 2.2×10^{-18} per second.

Use this value to calculate an estimate for the age of the Universe.

age of the Universe = ... s [2]

[Total: 8]

Stars and the Universe Click for more variations

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7(a)	group / collection of (billions of) stars	**B1**
7(b)	9.5×10^{17} (km)	**A2**
	(1 light-year =) 9.5×10^{15} (m) **OR** (1 light-year =) $3 \times 10^{8} \times 365 \times 24 \times 3600$	C1
7(c)(i)	increase in wavelength (of light from far galaxy) **OR** (amount of) redshift	**B1**
7(c)(ii)	brightness of a supernova	**B1**
7(c)(iii)	(their) speeds are (directly) proportional to distances (from Earth) **OR** $H_0 = v / d$	**B1**
7(c)(iv)	4.5×10^{17} (s)	**A2**
	(age of Universe =) $1 / H_0$ **OR** $1 / (2.2 \times 10^{-18})$	C1

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8 **(a)** State the equation that defines the average orbital speed v of a planet. State the meaning of any symbols you use.

.....

..... [2]

(b) Suggest why countries that are a significant distance from the Equator experience significant temperature variation throughout the year.

.....

.....

..... [1]

(c) Fill in the gaps in the paragraph about a star much more massive than the Sun.

The stage that follows the stable state in the life cycle of the star is the

..... stage.

It then explodes as a supernova to form a ..... , this leaves behind a

..... or a ..... .

[4]

(d) A galaxy is moving away from the Earth with a speed of 33 000 km / s.
The value of the Hubble constant is 2.2×10^{-18} per second.

Calculate the distance from the galaxy to the Earth. Give your answer in light-years.

distance = ... light-years [2]

[Total: 9]

Stars and the Universe Click for more variations

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8(a)	$v = 2\pi r / T$	**B1**
	r = (average) radius of the orbit **AND** T = (orbital) period	**B1**
8(b)	rays from Sun strike the country at different angles through the year **OR** rays from Sun strike the country for different number of hours per day through the year	**B1**
8(c)	(first space:) red supergiant	**B1**
	(second space:) nebula	**B1**
	(3rd and 4th spaces:) neutron star	**B1**
	black hole	**B1**
8(d)	1.6×10^9 (light-years)	**A2**
	$H_0 = v / d$ **OR** (d =) v / H_0 **OR** (d =) $[33\,000 \times 10^3] / [2.2 \times 10^{-18} \times 9.5 \times 10^{15}]$	C1

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9 **(a)** **(i)** State the name of **one** planet that has an orbit further away from the Sun than Venus.

..... [1]

(ii) State the name of **one** planet that has an orbit closer to the Sun than Venus.

..... [1]

(b) Venus has an average radius of orbit of 1.1×10^{11} m and an orbital period of 220 Earth days. Calculate the average orbital speed of Venus. Give your answer in m/s.

average orbital speed = ... m/s [3]

(c) State the relationship between the orbital speeds of the planets and their distances from the Sun.

.....

..... [1]

(d) Comets are balls of ice and dust. Some comets orbit the Sun.

State how the speed of a comet changes as it orbits the Sun.
Explain your answer using ideas about the conservation of energy.

You may include a labelled diagram in your answer.

.....

.....

..... [3]

[Total: 9]

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Earth and the Solar System Click for more variations

9(a)(i)	Earth / Mars / Jupiter / Saturn / Uranus / Neptune	**B1**
9(a)(ii)	Mercury	**B1**
9(b)	3.6×10^4 (m / s)	**A3**
	(T =) $220 \times 24 \times 60 \times 60$ **OR** (T =) 1.9×10^7 (s)	C1
	(v =) $\frac{2\pi r}{T}$ **OR** (v =) $\frac{2\pi \times 1.1 \times 10^{11}}{220 \times 24 \times 60 \times 60}$	C1
9(c)	The further away from the Sun the slower the orbital speed / ORA	**B1**
9(d)	1 *any **one** from:* • comet has an elliptical orbit • speed of comet is faster when it closer to the Sun • speed of comet is slower when it is further away from the Sun	**B1**
	2 *any **one** from:* • (conservation of energy requires that) transfers between kinetic and gravitational stores (as comet changes speed) • total energy remains constant • energy cannot be created or destroyed	**B1**
	3 as radius of orbit decreases, gravitational energy decreases and kinetic energy increases ORA	**B1**

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10 **(a)** Define a light-year in words.

..... [1]

(b) It takes light 490 s to travel from the Sun to the Earth.

Calculate the distance from the Sun to the Earth.

distance = ... [2]

(c) Fig. 10.1 is a scatter graph showing how the speed of galaxies moving away from the Earth varies with their distances from the Earth.

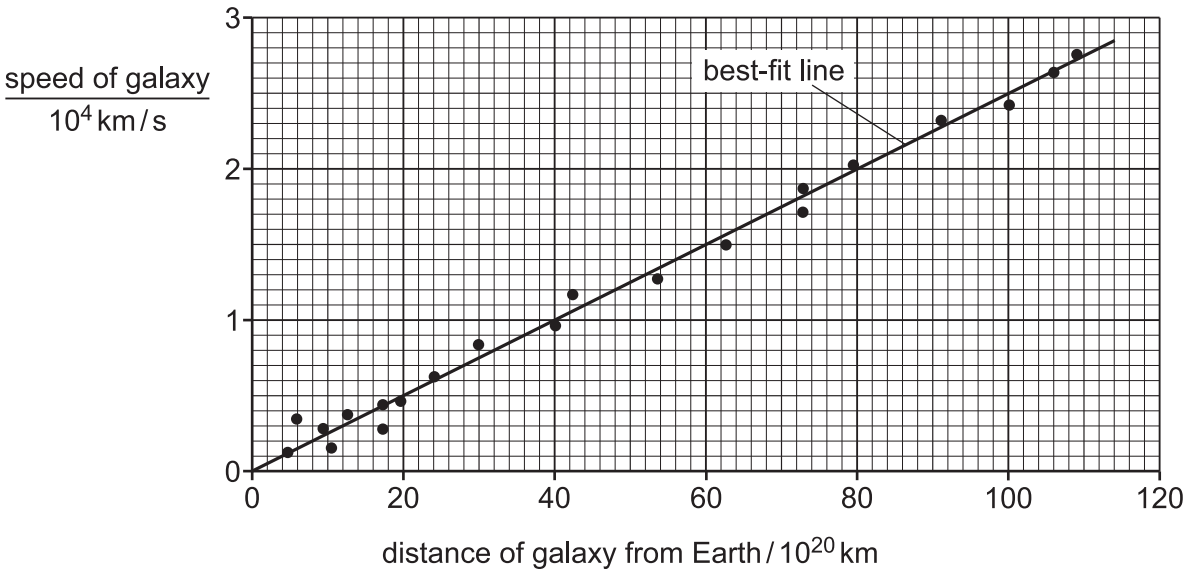


Fig. 10.1

A scientist draws a best-fit line on the scatter graph.

Use this best-fit line to determine a value for the Hubble constant.

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Hubble constant = ... [3]

(d) The speed of a receding galaxy can be estimated using redshift.

Describe what is meant by redshift.

.....

.....

.....

..... [2]

[Total: 8]

Stars and the Universe Click for more variations

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10(a)	distance travelled (in the vacuum of space) by light in one year	**B1**
10(b)	1.5×10^{11} m	**A2**
	9.5×10^{15} (m) **OR** (c =) $3(.0) \times 10^{8}$ (m / s) **OR** $3(.0) \times 10^{N} \times 490$	C1
10(c)	2.5×10^{-18} per second	**A3**
	(Hubble's constant =) gradient **OR** (H_0 =) $v \div d$	C1
	$2.5 \times 10^{4}(-0) \div \{100 \times 10^{20}(-0)\}$	C1
10(d)	electromagnetic radiation / light from (distant) galaxies	**B1**
	(observed) increase in wavelength (compared to wavelength measured on the Earth)	**B1**

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