K15E Space Physics: Depth and Practice

AQA AQA KS3 Science - Space Physics · Calculator allowed · about 90 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 State what keeps the Moon moving around the Earth instead of travelling off in a straight line.

(1)

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2 Complete the sentence. A planet's orbit around the Sun is caused by the Sun's _____ acting on the planet.

(2)

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3 Which of these correctly describes the shape of most planetary orbits in our Solar System? Options: A) Circular B) Elliptical C) Helix D) Parabolic

- [ ] A) Circular
- [ ] B) Elliptical
- [ ] C) Helix
- [ ] D) Parabolic

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4 A small model satellite is launched into a circular low Earth orbit at a height where the orbital speed is 7800 m/s. The satellite has a mass of 50 kg.

(a) Calculate the satellite's momentum in kg m/s. **(2)**

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(b) State how the momentum would change if the satellite's mass were doubled but speed stayed the same. **(1)**

5 Describe one piece of evidence that supports the idea that Earth orbits the Sun rather than the Sun orbiting the Earth. Give the evidence and explain how that evidence supports the heliocentric model.

(3)

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6 A student times a model rocket from launch until it reaches its highest point. The student repeats the launch three times and records the times to the highest point as 6.2 s, 6.5 s and 6.4 s.

(a) Calculate the mean time to the highest point. **(2)**

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(b) Suggest one change the student could make to improve the repeatability of the times. Explain how this change would help. **(2)**

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7 State the name for the region around a planet where its gravity is the dominant influence on satellites and objects.

(1)

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8 A newly discovered small asteroid orbits the Sun at an average distance of 1.2 astronomical units (AU). Using Earth as reference, where 1 AU = 150 000 000 km, calculate the asteroid's average orbital radius in kilometres. Give your answer in standard units (km).

(3)

9 Describe why we see phases of the Moon (for example new moon, first quarter, full moon).

(2)

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10 You want to plan a classroom practical to model how gravity acts on different masses. You have small wooden blocks of different masses, a metre rule and a clamp stand. Describe a simple method to compare how gravity acts on different masses and state one safety point. (Assume students work in pairs.)

(4)

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11 A simple graph shows the brightness of a star measured by a student each night over 10 nights. The brightness in arbitrary units is: 4.8, 4.9, 5.0, 4.7, 4.7, 4.8, 5.1, 5.0, 4.9, 4.8. The student thinks there is variation beyond measurement error.

(a) Calculate the mean brightness to two decimal places. **(2)**

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(b) Suggest one reason, other than real change in the star, why the measurements might vary and one way to reduce this source of error in future observations. **(2)**

12 Extended response (6 marks). A school must decide whether to invest time in training pupils to use a small telescope to observe planets or to buy a simple electronic light sensor to monitor variable stars. Evaluate both approaches and give a justified recommendation on which would be better for the school science club. You should consider factors such as cost, skills developed, data quality, accessibility and how the activity supports learning about space.

(6)

Mark scheme · K15E Space Physics: Depth and Practice

Question 1

- **B1** Earth's gravity pulls the Moon so it stays in orbit (cao)
- Answer: **Earth's gravity pulls the Moon and keeps it in orbit around the Earth.**

Question 2

- **M1** one correct word given
- **A1** gravity cao
- Answer: **gravity**

Question 3

- **B1** B cao
- Answer: **B) Elliptical**

Question 4

- (a) **M1** use p = m v with m = 50 and v = 7800
- (a) **A1** 390000 cao
- (a) Answer: **390000 kg m/s**
- (b) **B1** momentum would double or state new momentum 780000 kg m/s
- (b) Answer: **The momentum would double to 780000 kg m/s.**

Question 5

- **M1** state a correct piece of evidence eg stellar parallax, phases of Venus, or retrograde motion explained by relative movement
- **A1** explain how that evidence shows Earth moves around the Sun (eg parallax shows viewpoint change over a year)
- **A1** link to heliocentric model conclusion (eg therefore Earth orbits the Sun not vice versa)
- Answer: **Stellar parallax: nearby stars shift position over a year as Earth moves, showing our viewpoint changes; this supports the heliocentric model that Earth orbits the Sun.**

Question 6

- (a) **M1** sum values and divide by 3
- (a) **A1** 6.37 s cao
- (a) Answer: **6.37 s**
- (b) **M1** suggest a valid improvement such as use an electronic timer or video analysis, keep launch angle and fuel constant, or use identical rockets
- (b) **A1** explain how it improves repeatability (eg electronic timer reduces human reaction time variation)
- (b) Answer: **Use an electronic timer or video analysis to measure the time to the highest point; this reduces variation from human reaction times and improves repeatability.**

Question 7

- **B1** Hill sphere or sphere of influence cao
- Answer: **Hill sphere (also called the sphere of influence).**

Question 8

- **M1** substitute 1.2 x 150000000
- **A1** 180000000 km cao
- **B1** correct unit km given
- Answer: **180000000 km**

Question 9

- **M1** state that phases are due to changing portion of illuminated side visible from Earth as Moon orbits Earth
- **A1** mention relative positions of Sun, Earth and Moon causing different amounts of reflected sunlight seen (eg full Moon when Earth between Sun and Moon)
- Answer: **Phases occur because the Moon orbits Earth and we see different amounts of the side lit by the Sun; at full Moon we see the lit side, at new Moon the lit side faces away from Earth.**

Question 10

- **M1** describe using the metre rule and clamp to hang or attach blocks and measure a quantity such as extension or force reading with spring balance (simple comparative method)
- **M1** state compare two or more masses while keeping method the same (eg same attachment point and same drop height if timing fall)
- **A1** explain how result shows gravity acts equally on all mass in sense of acceleration or shows heavier mass gives larger weight (eg larger force reading)
- **B1** state a safety point such as ensure clamp stand is secure and blocks cannot fall on feet, wear safety goggles if dropping objects, or clear floor area
- Answer: **Hang blocks from a fixed clamp stand at the same attachment point and measure the downward force or effect for each mass; keep method identical for fair comparison. Ensure the clamp stand is secure and the area below is clear so blocks cannot hit anyone.**

Question 11

- (a) **M1** sum values and divide by 10
- (a) **A1** 4.87 cao
- (a) Answer: **4.87**
- (b) **M1** give a plausible source of variation such as atmospheric conditions, instrument calibration, or observer technique (eg clouds, seeing)
- (b) **A1** give a method to reduce it such as observe on clearer nights, use same calibrated instrument, average more measurements, or use electronic detector
- (b) Answer: **Atmospheric conditions such as thin clouds can change measured brightness; reduce this by observing on clear nights or using the same calibrated electronic detector and averaging more readings.**

Question 12

- **Level 3** (5-6): A balanced evaluation comparing both options with clear reasoned judgement. Discusses cost, skills, data quality, accessibility and learning outcomes and gives a justified recommendation with supporting points.
- **Level 2** (3-4): Some comparison of the two options and includes a simple judgement. Mentions at least two relevant factors with some explanation.
- **Level 1** (0-2): Limited or descriptive response. May list advantages or disadvantages of one option with little or no evaluation or justification.
- **Indicative content:**
  - Telescope option: develops observational and practical skills, good for direct engagement and learning about planetary appearance and motion, relatively low instrument cost but needs training and clear skies, data are qualitative or low-precision for science projects.
  - Light sensor option: gives quantitative data suitable for analysis of variable stars, higher initial cost for sensor and interface, more inclusive as can be used indoors and in poor weather, supports data handling and scientific investigation skills.
  - Comparison points: cost vs data quality, skills taught (visual observing and optics vs electronics and data analysis), accessibility (weather dependence), long-term educational value.
  - Recommendation should weigh the school's priorities: for hands-on observing and engagement choose telescope; for reliable data collection and curriculum links to data analysis choose light sensor. A justified recommendation might be to buy a light sensor for reliable science projects and use occasional telescope nights for engagement.