3.5 Space Physics: Test Pack

Calculator allowed · about 45 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Name the main star at the centre of our Solar System.

(1)

2 State one hazard to spacecraft from micrometeorites and suggest one engineering method to reduce the hazard.

(2)

3 Describe how telescopes that operate outside Earth's atmosphere (space telescopes) give better images than similar telescopes on the ground. Give three effects of the atmosphere and their consequences.

(4)

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4 An experiment measures the brightness of a light source at different distances to test the inverse square law. The student places a light sensor at distances 0.5 m, 1.0 m and 2.0 m and obtains readings proportional to brightness: 400, 100, 25 (arbitrary units). Analyse whether the results support the inverse square law for brightness.

(3)

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5 A student times how long it takes a beam of light to travel from Earth to a nearby star 4 light years away. Explain why this is not practical for an experiment and give the actual time in seconds a light beam takes to travel 4 light years. Use speed of light = 3.00×10^8 m/s and 1 light year = 9.46×10^{15} m.

(a) Why is timing this in a classroom not practical? **(1)**

(b) Calculate the time in seconds for light to travel 4 light years. Give your answer to 2 significant figures. **(2)**

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6 A comet moves rapidly past the Sun and its icy surface turns directly into gas, forming a tail. Name this change of state and explain in one sentence what happens to the particles.

(3)

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7 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)

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

(2)

9 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)**

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

10 Which list correctly orders these three objects from smallest to largest?

- ☐ A) Moon, Earth, Sun
- ☐ B) Sun, Earth, Moon
- ☐ C) Earth, Moon, Sun
- ☐ D) Moon, Sun, Earth

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11 The Earth experiences a cycle of day and night.

(a) State the reason the Earth experiences a cycle of day and night. **(1)**

(b) Explain why one side of the Earth has day while the other side has night at the same time. **(1)**

12 Geostationary satellites are used for television and communication signals.

(a) State two features of a geostationary satellite's orbit. **(2)**

(b) Explain why geostationary satellites are useful for TV and communication signals. **(2)**

13 A satellite is in a circular geostationary orbit around the Earth, at a radius of 4.22×10^7 m, travelling at a speed of 3070 m/s. Equations you may need: circumference = 2 x π x radius; speed = distance / time. Take π = 3.14.

(a) Calculate the circumference of the satellite's orbit. **(2)**

(b) Show that the time for one orbit is approximately 24 hours. **(3)**

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Mark scheme · 3.5 Space Physics: Test Pack

Question 1

Sun cao **B1**

Answer: **Sun**

Question 2

hazard e.g. puncture, damage to instruments, short circuit, oe **B1**

method e.g. shielding like Whipple shield, redundant systems, protective layers, oe **B1**

Answer: **Hazard: puncture or damage to instruments. Method: use protective shielding such as a Whipple shield to absorb impacts.**

Question 3

atmospheric turbulence causes twinkling/blur, reducing sharpness **B1**

atmospheric absorption blocks some wavelengths (UV, X-ray, infrared), so space telescopes can detect these wavelengths **B1**

scattering by air and dust reduces contrast, space avoids this **B1**

overall: space telescopes give sharper, clearer images and access to more wavelengths, oe **B1**

Answer: **Earth's atmosphere causes turbulence that blurs images and scatters light, and it absorbs some wavelengths; space telescopes avoid turbulence and absorption so they give sharper images and can see wavelengths blocked by the atmosphere.**

Question 4

recognise that brightness is proportional to $1/\text{distance}^2$ and check ratios: 0.5 to 1 to 2 gives factors $(1/0.5^2)$: $(1/1^2):(1/2^2)$ = 4:1:0.25 so expected relative brightness 4:1:0.25 **M1**

compare measured values 400:100:25 which simplify to 4:1:0.25 showing good agreement **M1**

conclude that results support inverse square law with brief reason, oe **A1**

Answer: **Measured values 400:100:25 simplify to 4:1:0.25 which matches the expected 4:1:0.25 from an inverse square relationship, so the results support the inverse square law for brightness.**

Question 5

(a) because light travel time is many years so it cannot be measured in a classroom or human timescale **B1**

(a) Answer: **Because light takes years to travel that distance so it is far longer than a classroom experiment can run.**

(b) time = distance / speed = $4 \times 9.46 \times 10^{15} / 3.00 \times 10^8$ **M1**

(b) 1.3e8 s cao **A1**

(b) Answer: **1.3e8 s**

Question 6

sublimation or sublimating cao **B1**

particles gain energy, break free from solid structure and move apart as gas **M1**

clear sentence linking particle behaviour to change of state, oe **A1**

Answer: **Sublimation. The particles gain energy, escape the solid structure and move apart as a gas forming the tail.**

Question 7

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) **M1**

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) **A1**

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 **B1**

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 8

one correct word given **M1**

gravity cao **A1**

Answer: **gravity**

Question 9

(a) sum values and divide by 3 **M1**

(a) 6.37 s cao **A1**

(a) Answer: **6.37 s**

(b) suggest a valid improvement such as use an electronic timer or video analysis, keep launch angle and fuel constant, or use identical rockets **M1**

(b) explain how it improves repeatability (eg electronic timer reduces human reaction time variation) **A1**

(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 10

A cao **B1**

Answer: **A**

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Question 11

(a) the Earth rotates (spins) on its axis, once approximately every 24 hours (oe) **B1**

(a) Answer: **The Earth rotates on its axis once approximately every 24 hours.**

(b) the side facing the Sun is lit up (day), and the side facing away from the Sun is in darkness (night) (ft from part a) **B1**

(b) Answer: **The side facing the Sun has day, and the side facing away from the Sun has night.**

Question 12

(a) it orbits directly above the equator (oe) **B1**

(a) it has an orbital period of 24 hours, the same as the Earth's rotation, so it stays above the same point on the Earth's surface (oe) **B1**

(a) Answer: **It orbits directly above the equator, with a 24 hour orbital period matching the Earth's rotation, so it stays above the same point on the surface.**

(b) the satellite always remains above the same point on the Earth (ft from part a) (oe) **B1**

(b) so a receiving dish on the ground can be fixed in one direction, pointing permanently at the satellite, without needing to track its movement (oe) **B1**

(b) Answer: **Because the satellite stays above the same point on Earth, a receiving dish can be fixed in one direction, pointing at the satellite, without needing to track it.**

Question 13

(a) correct substitution: circumference = 2 x 3.14 x 4.22 x 10^7 **M1**

(a) awrt 2.65 x 10^8 m **A1**

(a) Answer: **2.65 x 10^8 m**

(b) correct substitution: time = 2.65 x 10^8 / 3070 (ft from part a) **M1**

(b) awrt 8.6 x 10^4 s (86000 to 86400 s) **A1**

(b) converts to hours (divides by 3600) to show approximately 24 hours cso **A1**

(b) Answer: **Approximately 8.63 x 10^4 s, which is about 24 hours.**

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