International Astronomy and Astrophysics Competition

Final Round 2019

Important: Read all the information on this page carefully!

- Please read all questions carefully!
- This exam consists of 40 multiple-choice questions.
- To every question, there are four possible answers: A, B, C and D.
- Only one of the four answers is correct!
- Every correct answer gives you one point.
- There are no negative points for wrong answers.
- You have strictly 60 minutes to solve as many problems as possible.
- Write your answers on the *Your-Answers-page* only (see next page)!
- After the 60 minutes, return the exam (including all question pages) back to your teacher.
- **You are allowed to...**
  - use a pencil/pen for writing.
  - use extra blank papers for personal notes.
- **You are not allowed to...**
  - work more than 60 minutes on this exam.
  - use electronic devices (e.g. internet, calculators).
  - use any source of information (e.g. notes, books).
  - receive help from your supervisor or other students.
  - take this exam, your answers, or the questions with you (after the exam).
- **Cheating Policy:** In addition to the presence and supervision of your teacher during the examination we have various additional methods to detect cheating: This includes methods to detect time violations as well as to detect the usage of tools (e.g. internet, textbooks) for cheating.
  Cheating will result in immediate disqualification!

Good luck!

Your Answers

Name:

Please write your answers on this page!

No. 1	**No. 2**	**No. 3**	**No. 4**	**No. 5**	**No. 6**	**No. 7**	**No. 8**	**No. 9**	**No. 10**
No. 11	**No. 12**	**No. 13**	**No. 14**	**No. 15**	**No. 16**	**No. 17**	**No. 18**	**No. 19**	**No. 20**
No. 21	**No. 22**	**No. 23**	**No. 24**	**No. 25**	**No. 26**	**No. 27**	**No. 28**	**No. 29**	**No. 30**
No. 31	**No. 32**	**No. 33**	**No. 34**	**No. 35**	**No. 36**	**No. 37**	**No. 38**	**No. 39**	**No. 40**

Please write A, B, C or D into the boxes to give your answers.

Question 1 : Most people us C°(degree Celsius) to measure everyday temperatures. Astronomers prefer to use K (Kelvin) to measure temperatures. Approximately how many Kelvin are 25 C°?

(A) 200 Kelvin (B) 250 Kelvin (C) 300 Kelvin (D) 350 Kelvin

Question 2 : Mars might be a place for future human explorations. However, humans can not breathe on the surface of Mars because the atmosphere consists mostly of ...

(A) Nitrogen (B) Argon (C) Methane (D) CO_2

Question 3 : The two moons of Mars are called ...

(A) Tritos and Desmos (B) Tritos and Deimos

(C) Phobos and Tritos (D) Phobos and Deimos

Question 4 : On which planet in our solar system can you find the *Great Red Spot*?

(A) Venus (B) Mars (C) Jupiter (D) Saturn

Question 5 : The axis of the Earth is tilted at an angle of approximately ... relative to the orbital plane around the Sun.

(A) 20.3 degrees (B) 21.4 degrees (C) 22.7 degrees (D) 23.5 degrees

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Question 6 : The Pleiades is an open star cluster that plays a role in many ancient stories and is well-known for containing ... bright stars.

(A) 5 (B) 7 (C) 9 (D) 12

Question 7 : Previous IAAC rounds featured Proxima/Alpha Centauri as closes star(system) to the Earth. Which one is the second closest star(system)?

(A) Wolf 359 (B) Sirius (C) 61 Cygni (D) Barnard's Star

Question 8 : The visible part of the electromagnetic spectrum is between ...

(A) 240 to 680 nm. (B) 360 to 620 nm. (C) 380 to 740 nm. (D) 420 to 810 nm.

Question 9 : The constellation ... is a bright W-shaped constellation in the northern sky.

(A) Centaurus (B) Cygnus (C) Cassiopeia (D) Cepheus

Question 10 : What is the so-called *bolometric luminosity* in astronomy?

(A) The luminosity, integrated over vertically polarized wavelengths.

(B) The luminosity, integrated over horizontally wavelengths.

(C) The luminosity, integrated over visible wavelengths.

(D) The luminosity, integrated over all wavelengths.

Question 11 : The *second cosmic velocity* (or *escape velocity*) is the speed required by an object to escape the gravitational field of a celestial body with mass M and radius R. Which formula correctly calculates this velocity? (G: gravitational constant)

(A) $v = \sqrt{\frac{GM}{R}}$ (B) $v = 2\sqrt{\frac{GM}{R}}$ (C) $v = \sqrt{\frac{2GM}{R}}$ (D) $v = \sqrt{\frac{GM}{2R}}$

Question 12 : The International Space Station (ISS) circles the Earth approximately 410 km above the ground. Find the best estimate for the orbital speed of the ISS:

(A) 19,000 km/h (B) 21,000 km/h (C) 28,000 km/h (D) 32,000 km/h

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Question 13 : Find the best approximation for the surface temperature of the Sun:

(A) 6000 K (B) 7000 K (C) 9000 K (D) 13000 K

Question 14 : The four big moons of Jupiter are Callisto, Europa, Ganymede, and Io. Which one of them has the smallest distance to Jupiter?

(A) Callisto (B) Europa (C) Ganymede (D) Io

Question 15 : The name of the black hole in the center of our Milky Way is ...

(A) Altair A* (B) Alsephina A* (C) Fomalhaut A* (D) Sagittarius A*

Question 16 : Approximately how far away is the Andromeda Galaxy?

(A) 1.7 million light years (B) 2.1 million light years

(C) 2.5 million light years (D) 3.2 million light years

Question 17 : When was the telescope invented by Galileo?

(A) 1409 (B) 1509 (C) 1609 (D) 1709

Question 18 : The astronomical unit parsec (pc) plays a crucial role in astronomy. One parsec is equal to about 3.26 light-years. How is one parsec defined in astronomy?

(A) Distance at which one astronomical unit measures one arcsecond from Earth.

(B) Orbital distance of the solar system around the center of the Milky Way in one year.

(C) Effective distance of the solar wind (i.e. the radius of the heliosphere).

(D) Historical distance to the brightest star Sirius.

Question 19 : The picture below shows a very famous nebula: What is the name of this nebula?

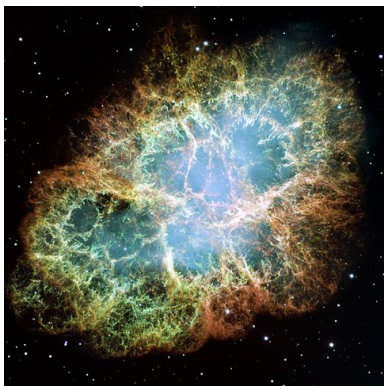

Figure 1: Nebula. Credit: NASA

(A) Crab Nebula (B) Orion Nebula (C) Ring Nebula (D) Carina Nebula

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Question 20 : The star Betelgeuse is one of the brightest stars in the night sky with remarkable red color. In which constellation is Betelgeuse located?

(A) Cassiopeia (B) Cygnus (C) Ursa Major (D) Orion

Question 21 : What does the astronomical term *ecliptic* describe?

(A) The path of the Sun in the sky throughout a year.

(B) The axial tilt of the Earth throughout a year.

(C) The movement of the stars due to Earth's rotation.

(D) The central line through the axis of rotation.

Question 22 : Approximately how long does it take Pluto to orbit the Sun once?

(A) 150 years (B) 200 years (C) 250 years (D) 300 years

Question 23 : Sunspots are black regions that temporarily appear on the Sun. Their number highly increases every ... years. This period is also called the *solar cycle*.

(A) 9 (B) 11 (C) 13 (D) 15

Question 24 : The *Large Magellanic Cloud* is ...

(A) a dwarf galaxy orbiting the Milky Way.

(B) the closest planetary nebula to the Earth.

(C) a bright star cluster discovered by Magellan.

(D) the outer arm of the Milky Way named after Magellan.

Question 25 : The Milky Way is part of a giant supercluster with a diameter of 160 Mpc. What is the name of this supercluster?

(A) Virgo (B) Laniakea (C) Sculptor (D) Boötes

Question 26 : Why are *Cepheid* stars relevant for astronomers?

(A) To measure interstellar mass. (B) To measure galactic distances.

(C) To measure galactic energy-density. (D) To measure interstellar density.

Question 27 : What type of radiation causes a black hole to evaporate over time?

(A) Schwarzschild radiation (B) Planck radiation

(C) Kolmogorov radiation (D) Hawking radiation

Question 28 : In astronomy, the concept of *black bodies* is very important to better calculate the radiation of stars. Which one is the correct definition of a *black body*?

(A) An idealized physical object that reflects all electromagnetic radiation.

(B) An idealized physical object that absorbs all electromagnetic radiation.

(C) An idealized physical object that reflects all polarized radiation.

(D) An idealized physical object that absorbs all polarized radiation.

Question 29 : One astronomical unit (AU) is equal to approximately ...

(A) 130 million km (B) 150 million km (C) 170 million km (D) 190 million km

Question 30 : Radio telescopes are crucial for astronomical observations. Which one of these well-known radio telescopes has the largest parabolic antenna?

(A) Green Bank Telescope (B) Arecibo Telescope

(C) Yevpatoria RT-70 Telescope (D) Effelsberg Telescope

Question 31 : Which one of these constellations is not located along the Milky Way in the sky?

(A) Perseus (B) Cygnus (C) Scorpius (D) Leo

Question 32 : A comet's tail points in the following direction:

(A) away from the Sun (B) towards the Sun

(C) in the direction of movement (D) against the direction of movement

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Question 33 : As the life of a star progresses, heavy elements are produced. The elements form layers around the star in this order (starting from the outer layer):

(A) H $\rightarrow$ He $\rightarrow$ Li $\rightarrow$ N $\rightarrow$ O $\rightarrow$ Si $\rightarrow$ Fe (B) H $\rightarrow$ He $\rightarrow$ C $\rightarrow$ O $\rightarrow$ Ne $\rightarrow$ Si $\rightarrow$ Fe

(C) H $\rightarrow$ He $\rightarrow$ Li $\rightarrow$ O $\rightarrow$ Ne $\rightarrow$ Si $\rightarrow$ Fe (D) H $\rightarrow$ He $\rightarrow$ C $\rightarrow$ N $\rightarrow$ O $\rightarrow$ Si $\rightarrow$ Fe

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Question 34 : The so-called *dark energy* is a model to explain ...

(A) the radiation of black holes.

(B) the mass distribution of galaxies.

(C) the acceleration of the universe.

(D) the microwave background of the universe.

Question 35 : As a star collapses at the end of its life, the *triple-alpha* reaction takes place. Which one of these equations describes this reaction correctly?

(A) ${}^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{6}_{3}\mathrm{Li} + \gamma$

(B) ${}^{4}_{2}\mathrm{He} + {}^{4}_{2}\mathrm{He} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{12}_{6}\mathrm{C} + \gamma$

(C) ${}^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} + {}^{4}_{2}\mathrm{He} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{12}_{6}\mathrm{C} + \gamma$

(D) ${}^{2}_{1}\mathrm{H} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{6}_{3}\mathrm{Li} + \gamma$

Question 36 : Besides large astronomical objects, astrophysicists are also interested in small particles from space. Which one of these particles has the weakest interactions with other particles?

(A) μ Muons (B) Antiparticles (C) ν Neutrinos (D) π Pions

Question 37 : The term *Schwarzschild radius* usually describes properties of ...

(A) red dwarfs. (B) pulsars. (C) black holes. (D) galaxies.

Question 38 : What is the correct numerical value and unit of the Boltzmann constant?

(A) $1.38 \times 10^{-21}\ m^3 \cdot kg \cdot s^{-2} \cdot K^{-1}$ (B) $1.38 \times 10^{-22}\ m^2 \cdot kg \cdot s^{-3} \cdot K^{-1}$

(C) $1.38 \times 10^{-23}\ m^2 \cdot kg \cdot s^{-2} \cdot K^{-1}$ (D) $1.38 \times 10^{-24}\ m^2 \cdot kg \cdot s^{-2} \cdot K^{-2}$

Question 39 : What is true for a type-Ia ("type one-a") supernova?

(A) This type occurs in binary systems.

(B) This type occurs often in young galaxies.

(C) This type produces gamma-ray bursts.

(D) This type produces high amounts of X-rays.

Question 40 : The famous *Drake equation* attempts to answer the following question:

(A) Will the Sun become a black hole? (B) Is the universe infinitely large?

(C) How old is the visible universe? (D) Are we alone in the universe?
