Introductory Astronomy   **NAME:**

Homework 26: The Discovery of Galaxies: Homeworks and solutions are posted on the course web site. Homeworks are **NOT** handed in and **NOT** marked. But many homework problems ($\sim$ 50–70 %) will turn up on tests.

Answer Table   # Name:

	a	b	c	d	e			a	b	c	d	e
1.	O	O	O	O	O		37.	O	O	O	O	O
2.	O	O	O	O	O		38.	O	O	O	O	O
3.	O	O	O	O	O		39.	O	O	O	O	O
4.	O	O	O	O	O		40.	O	O	O	O	O
5.	O	O	O	O	O		41.	O	O	O	O	O
6.	O	O	O	O	O		42.	O	O	O	O	O
7.	O	O	O	O	O		43.	O	O	O	O	O
8.	O	O	O	O	O		44.	O	O	O	O	O
9.	O	O	O	O	O		45.	O	O	O	O	O
10.	O	O	O	O	O		46.	O	O	O	O	O
11.	O	O	O	O	O		47.	O	O	O	O	O
12.	O	O	O	O	O		48.	O	O	O	O	O
13.	O	O	O	O	O		49.	O	O	O	O	O
14.	O	O	O	O	O		50.	O	O	O	O	O
15.	O	O	O	O	O		51.	O	O	O	O	O
16.	O	O	O	O	O		52.	O	O	O	O	O
17.	O	O	O	O	O		53.	O	O	O	O	O
18.	O	O	O	O	O		54.	O	O	O	O	O
19.	O	O	O	O	O		55.	O	O	O	O	O
20.	O	O	O	O	O		56.	O	O	O	O	O
21.	O	O	O	O	O		57.	O	O	O	O	O
22.	O	O	O	O	O		58.	O	O	O	O	O
23.	O	O	O	O	O		59.	O	O	O	O	O
24.	O	O	O	O	O		60.	O	O	O	O	O
25.	O	O	O	O	O		61.	O	O	O	O	O
26.	O	O	O	O	O		62.	O	O	O	O	O
27.	O	O	O	O	O		63.	O	O	O	O	O
28.	O	O	O	O	O		64.	O	O	O	O	O
29.	O	O	O	O	O		65.	O	O	O	O	O
30.	O	O	O	O	O		66.	O	O	O	O	O
31.	O	O	O	O	O		67.	O	O	O	O	O
32.	O	O	O	O	O		68.	O	O	O	O	O
33.	O	O	O	O	O		69.	O	O	O	O	O
34.	O	O	O	O	O		70.	O	O	O	O	O
35.	O	O	O	O	O		71.	O	O	O	O	O
36.	O	O	O	O	O		72.	O	O	O	O	O

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001 qmult 00007 1 4 1 easy deducto-memory: reading done 2
1. Did you complete reading the intro astro web lecture before the **SECOND DAY** on which the lecture was lectured on in class?

    a) YYYessss!   b) Jawohl!   c) Da!   d) Sí, sí.   e) OMG no!

SUGGESTED ANSWER: (a),(b),(c),(d)

Wrong answers:
  e) As Lurch would say AAAARGH.

Redaction: Jeffery, 2008jan01

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044 qmult 00100 1 4 4 easy deducto-memory: galaxy defined
    Extra keywords: CK-370
2. "Let's play *Jeopardy*! For $100, the answer is: They are large, gravitationally-bound systems of stars that range from dwarf versions that are kiloparsec in size scale to the large ones that are tens of kiloparsecs or even a couple hundred kiloparsecs in size scale."

What are _____, Alex?

    a) binaries   b) open clusters   c) globular clusters   d) galaxies   e) universes

SUGGESTED ANSWER: (d) See FK-582.

Wrong answers:
  a) Now does this sound likely?

Redaction: Jeffery, 2001jan01

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044 qmult 00110 1 1 3 easy memory: Irregular galaxies
3. Galaxies come in five main types: ellipticals, lenticular, unbarred spirals, barred spirals, and:

    a) globulars.   b) regulars.   c) irregulars.   d) Cepheids.   e) Vermeers.

SUGGESTED ANSWER: (c)

Wrong answers:
  a) These are a kind of star cluster.
  d) These are luminous variable stars used as distance indicators.
  e) These are paintings by Vermeer. Very pricy.

Redaction: Jeffery, 2001jan01

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044 qmult 00200 1 4 4 easy deducto-memory: traditional Milky Way
    Extra keywords: CK-370
4. "Let's play *Jeopardy*! For $100, the answer is: In the celestial-sphere picture of the sky, this object is luminous band on celestial sphere that straddles a great circle that is at an angle of about $60°$ to the celestial equator."

What is the _____, Alex?

    a) Zodiac   b) celestial axis   c) ecliptic   d) Milky Way   e) Andromeda Nebula

SUGGESTED ANSWER: (d) See CM-366 for the angle of the Milky Way band on the celestial sphere.

Wrong answers:
  a) The Zodiac constellations straddle the ecliptic.

Redaction: Jeffery, 2001jan01

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044 qmult 00210 2 1 2 moderate memory: center of Milky Way
5. The center of the Milky Way is in:

    a) Orion.   b) Sagittarius.   c) Virgo.   d) Cassiopeia.   e) Norma.

SUGGESTED ANSWER: (b)

Wrong answers:
  e) Norma is a small constellation in the southern celestial sphere. No one knows the Norma myth.

Redaction: Jeffery, 2001jan01

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044 qmult 00320 1 4 5 easy deducto memory: Milky Way structure speculators

6. The first three persons to speculate about the structure of the Milky Way in context of Newtonian physics in the 18th century seem to have been:

  a) Larry, Curly, and Moe.   b) Voltaire, Talleyrand, and Robespierre.   c) Ben Franklin, Thomas Jefferson, and George Washington.   d) Thomas Wright, Goethe, and Frederick the Great.   e) Thomas Wright, Immanuel Kant, and J. H. Lambert.

SUGGESTED ANSWER: (e)

Wrong answers:
  a) I don't think so.
  c) Ben Franklin is plausible. He was a considerable scientist with broad interests.
  d) Goethe also had broad interests and dabbled in science.

Redaction: Jeffery, 2001jan01

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044 qmult 00330 1 4 4 easy deducto-memory: Herschel maps the Milky Way

7. "Let's play *Jeopardy*! For $100, the answer is: He/she attempted to map the Milky Way using star counts (or star gauges)."

Who is _____, Alex?

  a) Nicolaus Copernicus (1473–1543)   b) Galileo Galilei (1564–1642)   c) Isaac Newton (1642/3–1727)   d) William Herschel (1738–1822)   e) Caroline Lucretia Herschel (1750–1848).

SUGGESTED ANSWER: (d)

  Caroline Lucretia probably helped out.

Wrong answers:
  c) Newton was born 1642dec25 on the Julian calendar used in England all of this life. This 1643jan04 on the modern Gregorian calendar that was used in most of the rest of Europe at that time.
  e) She was probably nearby making coffee or something. Actually, she helped her brother a lot.

Redaction: Jeffery, 2001jan01

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044 qmult 00350 1 4 3 easy deducto-memory: Shapley and Milky Way

8. "Let's play *Jeopardy*! For $100, the answer is: He/she obtained a roughly correct size estimate for the Milky Way and was the first to roughly correctly locate the center of the Milky Way using Cepheid variable stars in globular clusters in the halo of the Milky Way."

Who is _____, Alex?

  a) Henrietta Swan Leavitt (1868–1921).   b) Heber Curtis (1872–1942).   c) Harlow Shapley (1885–1972).   d) Edwin Hubble (1889–1953).   e) Stephen Hawking (1942–).

SUGGESTED ANSWER: (c)

Wrong answers:
  a) She was the discoverer of the period-luminosity relation for Cepheid variable stars (No-488) while working at Harvard College Observatory. Distance determinations by Hubble using this relation established the extragalactic nature of the galaxies.

Redaction: Jeffery, 2001jan01

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044 qmult 00400 1 4 4 easy deducto-memory: nebulae

Extra keywords: CK-366,370

9. Clouds in space or, historically, those objects regarded as cloud-like are called:

   a) shapleys.   b) stars.   c) galaxies.   d) nebulae.   e) curtises.

SUGGESTED ANSWER: (d)

Wrong answers:
  e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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044 qmult 00460 1 4 2 easy deducto-memory: Rosse discovers spirals
   Extra keywords: CK-366, super-easy deduction question

10. The spiral nature of some nebulae was discovered using visual astronomy and the largest telescope of its time: the 183-cm diameter Leviathan of Parsontown located at Birr Castle, Parsontown, Ireland. Because the spiral nebula are rather faint, it takes are large telescope to make out the spiral arms visually. With long-exposure photography it is relatively easy to discover spirals. But visual astronomy beat the recently invented photography by some years in this case: the discovery was made in 1845 April by the builder of the Leviathan:

    a) Caroline Lucretia Herschel (1750–1848). b) the Earl of Rosse (1800-1867).   c) Henrietta Swan Leavitt (1868–1921).   d) Harlow Shapley (1885–1972).   e) Edwin Hubble (1889–1953).

SUGGESTED ANSWER: (b)

Wrong answers:
  a) Yes, 95-year old Caroline Herschel still going strong in Ireland ...

Redaction: Jeffery, 2001jan01

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044 qmult 00500 1 1 4 easy memory: Shapley-Curtis debate
   Extra keywords: CK-370

11. On 1920 April 26, a debate about the nature of the spiral nebulae was held at a meeting of the National Academy of Sciences in Washington, D.C. The debaters both made sound points in the printed presentations that they later made if not on the day of. This debate is called the Great Debate or the:

    a) Einstein-de Sitter debate.   b) Rosse-Hubble debate.   c) Shapley-Hubble debate.
    d) Shapley-Curtis debate.   e) Kant-Einstein debate.

SUGGESTED ANSWER: (d) Curtis is generally considered to have won on actual points on the day of since Shapley was aiming at impressing people who could hire him to be director of the Harvard College Observatory than on winning the debate. Curtis also won historically: he argued the spiral nebulae were other galaxies and he was right. See Hoskin, M. A. 1976, *Journal for the History of Astronomy,* vii, 169.

Wrong answers:
  e) It might have been interesting to have Immanuel Kant (1724–1804) square of with Albert Einstein (1879–1955).

Redaction: Jeffery, 2001jan01

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044 qmult 00600 1 1 4 easy memory: Hubble proves galaxies exist
   Extra keywords: CK-370-2

12. Using Cepheid variable stars as distance indicators and the inverse square law for electromagnetic radiation flux, this famous astronomer was able to prove that M31 (the Andromeda spiral nebulae) was a giant star system (i.e., a galaxy) outside of the Milky Way. His/her name is:

    a) Caroline Lucretia Herschel (1750–1848). b) Henrietta Swan Leavitt (1868–1921).   e) Harlow Shapley (1885–1972).   d) Edwin Hubble (1889–1953).   e) Knut Lundmark (1889–1958).

SUGGESTED ANSWER: (d)

Wrong answers:

a) Caroline Herschel was a noted comet and nebula discoverer in her own right (No-399), but is most noted as helpmeet (eek!) to her brother William Herschel (1738–1822), the foremost observational astronomer of his time (No-398).
b) She was the discoverer of the period-luminosity relation for Cepheid variable stars (No-488) while working at Harvard College Observatory. Distance determinations by Hubble using this relation established the extragalactic nature of the galaxies.
c) Shapley was the first person to achieve a good estimate for the size of the Galaxy and the location of its center using Cepheid variables (No-493, 497).
e) Lundmark deduced some kind of law connecting distances and velocities of galaxies in 1925, but my source fails to say what it was (No-523).

Redaction: Jeffery, 2001jan01

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044 qmult 00610 1 4 2 easy memory: Hubble and the 100-inch
13. Edwin Hubble (1889–1953) was able to prove the extragalactic nature of the spiral nebulae because, among other things, he had available the world's:

a) largest telescope of our day.   b) largest telescope of his day.   c) smallest telescope of his day.   d) smallest telescope of our day.   e) largest telescope of Newton's day.

SUGGESTED ANSWER: (b)

Wrong answers:
a) The Hooker 100-inch (2.54 m) telescope is a significant, but not large, telescope by modern standards.
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01