Core Science 221: Section 1 EXAM 2

HAND IN ONLY THE ANSWER TABLE WITH YOUR NAME ON THE FRONT AND BACK **NAME:**

2009 October 29 Thursday

Instructions: There are 74 multiple choice questions each worth 1 mark for a total of 74 marks altogether. Choose the **BEST** answer, completion, etc., and darken fully the appropriate circle on the table provided on the next page. Read all responses carefully. **NOTE** that intricately-worded questions and responses won't depend on easily-missed or hidden keywords: keywords in such cases are bold-faced capitalized.

This is a **CLOSED-BOOK** exam. **NO** cheat sheets allowed. Calculators are permitted.

This a 75 minute test. Hand in only answer table. Remember your name (and write it down on the answer table too).

Answer Table

Name:

	a	b	c	d	e		a	b	c	d	e
1.	O	O	O	O	O	38.	O	O	O	O	O
2.	O	O	O	O	O	39.	O	O	O	O	O
3.	O	O	O	O	O	40.	O	O	O	O	O
4.	O	O	O	O	O	41.	O	O	O	O	O
5.	O	O	O	O	O	42.	O	O	O	O	O
6.	O	O	O	O	O	43.	O	O	O	O	O
7.	O	O	O	O	O	44.	O	O	O	O	O
8.	O	O	O	O	O	45.	O	O	O	O	O
9.	O	O	O	O	O	46.	O	O	O	O	O
10.	O	O	O	O	O	47.	O	O	O	O	O
11.	O	O	O	O	O	48.	O	O	O	O	O
12.	O	O	O	O	O	49.	O	O	O	O	O
13.	O	O	O	O	O	50.	O	O	O	O	O
14.	O	O	O	O	O	51.	O	O	O	O	O
15.	O	O	O	O	O	52.	O	O	O	O	O
16.	O	O	O	O	O	53.	O	O	O	O	O
17.	O	O	O	O	O	54.	O	O	O	O	O
18.	O	O	O	O	O	55.	O	O	O	O	O
19.	O	O	O	O	O	56.	O	O	O	O	O
20.	O	O	O	O	O	57.	O	O	O	O	O
21.	O	O	O	O	O	58.	O	O	O	O	O
22.	O	O	O	O	O	59.	O	O	O	O	O
23.	O	O	O	O	O	60.	O	O	O	O	O
24.	O	O	O	O	O	61.	O	O	O	O	O
25.	O	O	O	O	O	62.	O	O	O	O	O
26.	O	O	O	O	O	63.	O	O	O	O	O
27.	O	O	O	O	O	64.	O	O	O	O	O
28.	O	O	O	O	O	65.	O	O	O	O	O
29.	O	O	O	O	O	66.	O	O	O	O	O
30.	O	O	O	O	O	67.	O	O	O	O	O
31.	O	O	O	O	O	68.	O	O	O	O	O
32.	O	O	O	O	O	69.	O	O	O	O	O
33.	O	O	O	O	O	70.	O	O	O	O	O
34.	O	O	O	O	O	71.	O	O	O	O	O
35.	O	O	O	O	O	72.	O	O	O	O	O
36.	O	O	O	O	O	73.	O	O	O	O	O
37.	O	O	O	O	O	74.	O	O	O	O	O

---

001 qmult 00112 1 1 2 easy memory: energy defined 2

1. A useful, but very limited, definition of energy is:

   a) Energy is everything.
   b) Energy is the quantified capacity for change.
   c) Energy is the magnitude of momentum.
   d) Energy is force.
   e) Energy is a vector.

   SUGGESTED ANSWER: (b)

   Wrong answers:
   a) This is just a useful aphorism, not a definition.

   Redaction: Jeffery, 2008jan01

---

001 qmult 00130 1 1 2 easy memory: SI unit of energy

2. The standard metric system or SI unit of energy,

   which has the special name of joule (J)
   and that rhymes with drool
   and that honors James Joule (1818–1889)
   which rhymes with bowel
   and that starts with b . . .,

   is a derived unit whose formula is:

   a) $\mathrm{kg\,m/s^2}$. b) $\mathrm{kg\,m^2/s^2}$. c) $\mathrm{kg\,m/s}$. d) $\mathrm{m/s^2}$. e) $\mathrm{m/s}$.

   SUGGESTED ANSWER: (b)

   Wrong answers:
   a) This is the newton (N), the unit of force.
   c) This is the unit of momentum which has no special name or symbol.
   d) This is the unit of acceleration which has no special name or symbol.
   e) This is the unit of velocity which has no special name or symbol.

   Redaction: Jeffery, 2008jan01

---

001 qmult 00140 1 4 4 easy deducto-memory: kinetic energy defined

Extra keywords: EPS

3. "Let's play *Jeopardy*! For \$100, the answer is: The energy of motion with formula $KE = (1/2)mv^2$, where m is the object's mass and v is the object's speed."

   What is _____, Alex?

   a) joule b) force c) momentum d) kinetic energy e) potential energy

   SUGGESTED ANSWER: (d)

   Wrong answers:
   a) As Lurch would say AAAARGH.

   Redaction: Jeffery, 2008jan01

---

001 qmult 00144 1 1 4 easy memory: velocity from KE

4. An object has mass m and kinetic energy KE. What is its speed?

   a) $v = \sqrt{\dfrac{vKE}{m}}$. b) $v = \sqrt{\dfrac{2vKE}{m}}$. c) $v = \sqrt{\dfrac{2m}{KE}}$. d) $v = \sqrt{\dfrac{2KE}{m}}$.
   e) $v = \sqrt{\dfrac{KE}{m}}$.

   SUGGESTED ANSWER: (d)

   Wrong answers:
   a) Oh, c'mon.

Redaction: Jeffery, 2008jan01

---

001 qmult 00150 1 5 5 easy deducto-memory: vector has mag. and direction

Extra keywords: EPS

5. A vector is a physical quantity with:

   a) no direction. b) no magnitude. c) three directions. d) three and half directions. e) a magnitude and a direction.

SUGGESTED ANSWER: (e)

The statement is not intended to be a definition, but merely give two of a vector's defining traits.

Wrong answers:

a) Exactly wrong.

Redaction: Jeffery, 2008jan01

---

001 qmult 00210 1 4 5 easy deducto-memory: conservation of energy 2

Extra keywords: EPS

6. "Let's play *Jeopardy*! For $100, the answer is: Zero."

   What is _____, Alex?

   a) less than b) the conservation of energy c) 3 d) energy e) the change in total energy of a closed system

SUGGESTED ANSWER: (e)

Wrong answers:

a) Tempting.

Redaction: Jeffery, 2008jan01

---

001 qmult 00220 1 4 2 easy deducto-memory: Noether's theorem

Extra keywords: EPS

7. "Let's play *Jeopardy*! For $100, the answer is: A theoretical proof of the conservation of energy."

   What is _____, Alex?

   a) Pythagoras's theorem b) Noether's theorem c) Birkhoff's theorem d) Newton's corollary e) Noether's conjecture

SUGGESTED ANSWER: (b)

Wrong answers:

a) Oh, c'mon.
c) This is an actual theorem in general relativity.
d) He had some corollaries, but not for this.
e) A conjecture is not a proof.

Redaction: Jeffery, 2008jan01

---

001 qmult 00310 1 5 3 easy deducto memory: energy analysis

8. One of the great boons of using the energy concept in the prediction of the behaviors of systems is that it (i.e., the energy concept) often gives you limited, but very useful information:

   a) with impossible difficulty. b) never. c) easily. d) with zero probability. e) not.

SUGGESTED ANSWER: (c)

Wrong answers:

a) A nonsense answer.

Redaction: Jeffery, 2008jan01

---

001 qmult 00320 1 4 2 easy deducto-memory: energy limits

Extra keywords: EPS

9. "Let's play *Jeopardy*! For $100, the answer is: This feature of an isolated physical system sets a limit to the amount of change that system can undergo."

   What is _____, Alex?

   a) nothing b) the total energy c) something d) the total kinetic energy
   e) the total potential energy

   SUGGESTED ANSWER: (b)

   Wrong answers:
   a) As Lurch would say AAAARGH.

   Redaction: Jeffery, 2008jan01

---

001 qmult 00400 1 1 1 easy memory: Aristotle and energy

10. The word energy was apparently coined by:

    a) Aristotle (384–322 BCE). b) Gottfried Wilhelm von Leibniz (1646–1716).
    c) Thomas Young (1773–1829). d) Emmy Noether (1882–1935).
    e) Richard Feynman (1918–1988).

    SUGGESTED ANSWER: (a)

    Wrong answers:
    b) He coined *vis viva* or at least used the word early on. *Vis viva* is nearly our modern kinetic energy. There is a factor of 1/2 missing in the formula.
    c) He changed the name of *vis viva* to energy and thereby gave energy a scientific meaning. His energy is nearly our modern kinetic energy. There is a factor of 1/2 missing in the formula.

    Redaction: Jeffery, 2008jan01

---

001 qmult 00600 1 4 3 easy deducto-memory: Einstein and special relativity

Extra keywords: EPS

11. "Let's play *Jeopardy*! For $100, the answer is: He was the discoverer of special relativity."

    Who was _____, Alex?

    a) Isaac Newton (1643–1727) b) James Clerk Maxwell (1831–1879)
    c) Albert Einstein (1879–1955) d) Erwin Schrödinger (1887–1961)
    e) Louis de Broglie (1892–1987)

    SUGGESTED ANSWER: (c)

    Wrong answers:
    b) Maxwell was such a brilliant person that if he had lived longer, one wonders if he wouldn't have anticipated Einstein. Making Maxwell's theory of electromagnetism (taken as exact) consistent with the principle of relativity was one of the things that led Einstein to special relativity.

    Redaction: Jeffery, 2008jan01

---

001 qmult 00610 1 1 3 easy memory: light speed

Extra keywords: EPS

12. According to special relativity, the vacuum speed of light is (with some qualifications we needn't go into):

    a) dependent on the observer. b) 3 m/s. c) the highest possible physical speed. d) the lowest possible physical speed. e) negligible.

    SUGGESTED ANSWER: (c)

    Wrong answers:
    a) Wrong.

    Redaction: Jeffery, 2008jan01

---

001 qmult 00620 1 4 5 easy deducto-memory: E=mc**2

Extra keywords: EPS

13. "Let's play *Jeopardy*! For $100, the answer is: It is the mass-energy equivalence equation or the Einstein equation."

    What is _____, Alex?

    a) $E = \frac{1}{2}mv^2$ b) $E = mv$ c) $E = mc^4$ d) $E = mc^3$ e) $E = mc^2$

    SUGGESTED ANSWER: (e)

    Wrong answers:
    a) As Lurch would say AAAARGH.

    Redaction: Jeffery, 2008jan01

---

001 qmult 00640 1 3 2 easy math: E=mc**2 calculation

14. What is the energy equivalent in joules of 1 kg? Recall the vacuum speed of light is approximetely 3.00×10^8 m/s.

    a) 9×10^8 J. b) 9×10^{16} J. c) 3×10^{16} J. d) 3×10^8 J. e) 1.

    SUGGESTED ANSWER: (b)

    Behold:

    $$E = mc^2 = 1 \times (3 \times 10^8)^2 = 9 \times 10^{16} \text{ J} .$$

    Wrong answers:
    d) Bad guess.

    Redaction: Jeffery, 2008jan01

---

002 qmult 00100 1 4 4 easy deducto-memory: force in everyday speech

Extra keywords: EPS

15. "Let's play *Jeopardy*! For $100, the answer is: A push or a pull in everyday speech."

    What is a/an _____, Alex?

    a) acceleration b) velocity c) momentum d) force e) angular momentum

    SUGGESTED ANSWER: (d)

    Wrong answers:
    a) As Lurch would say AAAARGH.

    Redaction: Jeffery, 2008jan01

---

002 qmult 00120 1 1 1 easy memory: short- and long-range forces

Extra keywords: EPS

16. Forces in physics can be categorized in various ways. One way is as:

    a) short- and long-range forces. b) right and wrong forces. c) good and evil forces.
    d) short and tall forces. e) avant-garde and reactionary forces.

    SUGGESTED ANSWER: (a)

    Wrong answers:
    b) Forces among physicists can be categorized this way.
    c) This way too.

    Redaction: Jeffery, 2008jan01

---

002 qmult 00130 1 4 2 easy deducto-memory: field force

17. "Let's play *Jeopardy*! For $100, the answer is: It is a force caused by a field: it can also be called a body force, but that expression seems to be somewhat pass/'e nowadays. A field is a thing that permeates all space at least within some region and has a well defined value at each point. To cause a force, a field must be a vector field. This means at each point in space it has magnitude and direction. If a force

is caused by a field it is usually considered a long-range force since such forces between bodies don't require the bodies to be touching in a macroscopic sense. Actually at the microscopic level all forces are caused by fields."

What is a _____, Alex?

a) contact force b) field force c) branching force d) truth force e) back force

SUGGESTED ANSWER: (b)

Wrong answers:
a) Exactly wrong.

Redaction: Jeffery, 2008jan01

---

002 qmult 00140 1 1 3 easy memory: contact force

18. A short-range force is usually one that requires the interacting bodies to be touching in a macroscopic sense. Such forces nowadays are usually called:

a) truth forces. b) branching forces. c) contact forces. d) back forces.
e) forth forces.

SUGGESTED ANSWER: (c)

Wrong answers:
a) A nonsense answer.

Redaction: Jeffery, 2008jan01

---

002 qmult 00150 1 4 2 easy deducto-memory: unit of force
Extra keywords: EPS

19. "Let's play *Jeopardy*! For $100, the answer is: It is the standard SI unit of force."

What is the _____, Alex?

a) pound lb b) newton (N) c) joule (J) d) watt (W) e) kilowatt-hour (kWh)

SUGGESTED ANSWER: (b)

Wrong answers:
e) As Lurch would say AAAARGH.

Redaction: Jeffery, 2008jan01

---

002 qmult 00200 1 4 5 easy deducto-memory: work in everyday speech
Extra keywords: EPS

20. "Let's play *Jeopardy*! For $100, the answer is: Expending energy and moving things around and getting things done."

What is _____, Alex?

a) resting b) force c) common sense d) staring out the window e) work

SUGGESTED ANSWER: (e)

Wrong answers:
a) As Lurch would say AAAARGH.

Redaction: Jeffery, 2008jan01

---

002 qmult 00210 1 4 1 easy deducto-memory: work formula
Extra keywords: EPS

21. "Let's play *Jeopardy*! For $100, the answer is: The formula

$$W = Fd \ ,$$

where d is displacement moved for a body and F is the component along the direction of motion of a constant force acting on the body.

What is the _____, Alex?

a) work formula b) kinetic energy formula c) potential energy formula
d) energy formula e) rest formula

SUGGESTED ANSWER: (a)

Wrong answers:
e) As Lurch would say AAAARGH.

Redaction: Jeffery, 2008jan01

---

002 qmult 00220 1 1 3 easy memory: work unit, the joule
Extra keywords: EPS

22. The derived standard SI unit of work is the:

a) pound (lb). b) newton (N). c) joule (J). d) watt (W). e) kilowatt-hour (kWh).

SUGGESTED ANSWER: (c)

Wrong answers:
b) That's the SI unit of force.
e) This is actuall a non-SI unit of energy. The electric company bills you for energy using this unit—for no good reason—they could use megajoules which would make a lot more sense.

Redaction: Jeffery, 2008jan01

---

002 qmult 00230 1 3 2 easy math: work calculation
Extra keywords: EPS

23. You have pushed an object of in straight line for 10 m with 10 N of force aligned with the direction of motion. The work you have done on the object is:

a) 10 J. b) 100 J. c) 20 J. d) 13 J. e) none of the above.

SUGGESTED ANSWER: (b)

Wrong answers:
a) Sort of a so-so guess

Redaction: Jeffery, 2008jan01

---

002 qmult 00240 1 1 1 easy memory: work-kinetic-energy theorem

24. The work-kinetic-energy theorem is:

a) $\Delta KE = W$. b) $\Delta KE = \frac{1}{2}W$. c) $\Delta KE = \frac{1}{3}W$. d) $\Delta KE = \frac{1}{W}$.
e) $\Delta KE = \frac{1}{2W}$.

SUGGESTED ANSWER: (a)

Wrong answers:
d) Not dimensionally correct.

Redaction: Jeffery, 2008jan01

---

002 qmult 00250 1 1 2 easy memory: change in kinetic energy
Extra keywords: EPS

25. The work done (W) by a net force on an object equals:

a) the object's total kinetic energy of the body (KE). b) the object's change in kinetic energy of the body (ΔKE). c) 1 joule. d) joules. e) the heat absorbed by the body (ΔQ).

SUGGESTED ANSWER: (b)

The statement is actually just the work-kinetic-energy theorem in words. As an equation, this theorem is

$$\Delta KE = W \ .$$

To be exactly correctly the kinetic energy is object's center-of-mass kinetic energy.

Wrong answers:
a) This is only true if the body started from rest.

Redaction: Jeffery, 2008jan01

---

002 qmult 00260 1 1 4 easy math: work-KE calculation
Extra keywords: EPS

26. A body starts from **REST** and is acted on by a single force. The total work done on the body is 100 J. The body's mass is 1 kg. Approximately what is the body's final speed?

a) 100 m/s. b) 200 m/s. c) 1 m/s. d) 14 m/s. e) 4000 m/s.

SUGGESTED ANSWER: (d)

Well the change in kinetic energy is the net work done on body by all forces:

$$\Delta KE = W_{\text{net}} \ .$$

In this case the body, starts from rest, and so the change in the kinetic energy is the total kinetic energy given by

$$KE = \frac{1}{2}mv^2 \ ,$$

where m is the body's mass and v is the body's speed. So we have

$$\frac{1}{2}mv^2 = KE = \Delta KE = W_{\text{net}} \ .$$

Thus

$$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2W_{\text{net}}}{m}} = \sqrt{200} \approx 14 \,\text{m/s} \ .$$

Wrong answers:
b) Forgot to take the square root.

Redaction: Jeffery, 2008jan01

---

002 qmult 00270 2 3 1 moderate math: work and waste heat
Extra keywords: EPP

27. You pushed a piano along its path of motion on a level surface with 500 N (i.e., about 112 lb) of force for 100 m. At the end of that haul, the piano is at **REST**. How much work did you do on the piano and where did the energy go that you expended?

a) 5×10^4 J. It went into waste heat.
b) 1.12×10^4 J. It went into the gravitational potential energy of the piano.
c) 500 J. It went into waste heat.
d) 100 J. It went into the gravitational potential energy of the piano.
e) 5×10^4 J. It went into the kinetic energy of the piano.

SUGGESTED ANSWER: (a)

Behold:

$$W = Fd = 500 \times 100 = 5^4 \,\text{J} \ .$$

Wrong answers:
b) Use newtons not pounds in an SI calculation.

Redaction: Jeffery, 2008jan01

---

002 qmult 00300 1 4 5 easy deducto-memory: force of gravity
Extra keywords: EPS

28. "Let's play *Jeopardy*! For $100, the answer is: The force of gravity near the Earth's surface."

What is _____, Alex?

a) $F = mgy$ b) $KE = \frac{1}{2}mv^2$ c) $W = Fd$ d) $F = \frac{m}{g}$ e) $F = mg$

SUGGESTED ANSWER: (e)

Wrong answers:
a) The right hand side is the expression for the gravitational potential energy near the Earth's surface with reference to some set $y = 0$ point.

Redaction: Jeffery, 2008jan01

---

002 qmult 00320 1 4 2 easy deducto-memory: PE formula
Extra keywords: EPS

29. "Let's play *Jeopardy*! For $100, the answer is: It is the formula for the change in gravitational potential energy near the Earth's surface."

What is _____, Alex?

a) $KE = \frac{1}{2}mv^2$ b) $\Delta PE = mg\Delta y$ c) $F = mg$ d) $F = mgy$ e) $W = Fd$

SUGGESTED ANSWER: (b)

Wrong answers:
a) This is the kinetic energy formula.

Redaction: Jeffery, 2008jan01

---

002 qmult 00330 1 4 3 easy deducto-memory: PE zero-point
Extra keywords: EPS

30. "Let's play *Jeopardy*! For $100, the answer is: This form of energy has no physically determined zero-level or zero-point. The zero-level is chosen for mental or calculational convenience in any particular physical system."

What is _____, Alex?

a) kinetic energy b) thermal energy c) potential energy d) red-hot energy
e) cinematic energy

SUGGESTED ANSWER: (c)

Wrong answers:
e) A useful metaphor.

Redaction: Jeffery, 2008jan01

---

002 qmult 00340 1 1 4 easy memory: cell phone trajectory
Extra keywords: EPS

31. In a moment of euphoria, you toss your cell phone straight up in the air—sort of like Mary Richards in the *Mary Tyler Moore Show* (1970–1977)—except, not having a cell phone, it was her hat. Take the starting point where it leaves your hand as the zero level for gravitational potential energy (PE). For the cell phone, the initial energy just after release was all _____; the top-of-the-trajectory energy was all _____; the final energy just before you catch it at the same height you released it was all _____.

a) KE; KE; PE b) KE; KE; KE c) PE; KE; PE d) KE; PE; KE
e) PE; KE; KE

SUGGESTED ANSWER: (d)

Wrong answers:
c) Exactly wrong.

Redaction: Jeffery, 2008jan01

---

002 qmult 00350 2 3 2 moderate math: hill-climb energy and power
Extra keywords: EPS

32. You have a mass of 70 kg and have just hiked up 400 m in elevation in 30 minutes. Approximately what is the total energy you have put into your gravitational potential energy in your climb. Approximately what was your average power output to gravitational potential energy? Your total power output was more because some energy went into keeping your body going and some ultimately into _____. Recall $g = 9.8\,\mathrm{m/s^2}$.

a) 2.8×10^5 J; 2.8×10^5 W; waste heat b) 2.8×10^5 J; 150 W; waste heat c) 2.8×10^4 J; 150 W; waste heat d) 2.8×10^5 J; 10^4 W; electrical potential energy e) 2.8×10^4 J; 10^4 W; chemical energy

SUGGESTED ANSWER: (b)

Behold:

$$\Delta PE = mg\Delta y \approx 70 \times 10 \times 400 = 2.8 \times 10^5\,\mathrm{J}$$

and

$$P \approx \frac{2.8 \times 10^5\,\mathrm{J}}{1800\,\mathrm{s}} \approx 1.5 \times 10^2 = 150\,\mathrm{W}\ .$$

A typical human basal metabolic rate (a lowest-activity power rate for a animal) is of order 80 W (Smil 2006, p. 59). A typical healthy human can output 10 times this for some time (maybe of order an hour or so depending on fitness level???: Smil, 2006, p. 61). So the your power output for gravitational PE is not obviously strongly demanding. But the overall power required is probably well above 150 W. A lot of energy has to go into waste heat due to frictional resistance of the body. And remember in most real hikes, one travels much farther horizontally than vertically and one has to do all kinds of energy-demanding zigzagging and motion adjusting. I suspect—from the sound of it alone—that only very fit people would have found such a trek untiring even with an easy path. But I don't really know. I'd appreciate it if anyone with hiking savvy would clue me in.

Wrong answers:
c) You neglected to convert minutes to seconds.

Redaction: Jeffery, 2008jan01

---

003 qmult 00110 1 3 4 easy math: hundred million billion in sci. not.
Extra keywords: physci

33. Write a hundred million billion miles in scientific notation.

a) 10^2 mi. b) 10^6 mi. c) 10^9 mi. d) 10^{17} mi. e) 10^{-9} mi.

SUGGESTED ANSWER: (d)

As Andy Rooney says (or used to say), don't you just hate it when newspapers use expressions like hundred million billion miles. We all know scientific notation or should nowadays.

Behold:

$$10^2 \times 10^6 \times 10^9 = 10^{17}\ .$$

Wrong answers:
e) Seems unlikely.

Redaction: Jeffery, 2001jan01

---

003 qmult 00122 1 3 1 easy math: sci-not. multiplication
Extra keywords: EPS

34. What is $3.0 \times 10^7 \times 4.0 \times 10^4$?

a) 1.2×10^{12}. b) 1.2×10^{11}. c) 1.2×10^4. d) 1.2×10^3. e) 12×10^4.

SUGGESTED ANSWER: (a)

Behold:

$$3.0 \times 10^7 \times 4.0 \times 10^4 = 12 \times 10^{7+4} = 12 \times 10^{11} = 1.2 \times 10^{12}\ .$$

Wrong answers:
a) You may have forgotten to move the decimal place over.

Redaction: Jeffery, 2008jan01

---

003 qmult 00132 1 3 4 easy math: sci-not. division

Extra keywords: EPS

35. What is $(9.0 \times 10^{7})/(2.0 \times 10^{21})$?

    a) 1.8×10^{29}. b) 1.8×10^{-13}. c) 4.5×10^{-13}. d) 4.5×10^{-14}. e) 1.8×10^{-14}.

    SUGGESTED ANSWER: (d)

    Wrong answers:
    a) You have multiplied and not divided.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00220 1 4 1 easy deducto-memory: megajoule

Extra keywords: EPS

36. "Let's play *Jeopardy*! For $100, the answer is: A megajoule."

    What is _____, Alex?

    a) 10^{6} J b) 10^{-6} J c) 10^{3} J d) 10^{9} J e) 10^{24} J

    SUGGESTED ANSWER: (a)

    Wrong answers:
    b) This is a microjoule.
    c) This is a kilojoule.
    d) This is a gigajoule.
    d) This is a yotajoule.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00230 1 4 5 easy deducto-memory: decimeter scale

Extra keywords: EPS guinea pig

37. "Let's play *Jeopardy*! For $100, the answer is: It is a creature whose size scale is of order a decimeter."

    What is a/an _____, Alex?

    a) human b) wolf c) blue whale d) E. coli bacterium e) guinea pig

    SUGGESTED ANSWER: (e)

    Wrong answers:
    c) These guys have lengths up to about 30 m. I originally had the Etruscan shrew here. But Etruscan shrews are a third or more of decimeter and guinea pigs are 2 to 2.5 decimeters. So the question had arguably two right answers since both animals were of order a decimeter though at the opposite ends of the order of scale.
    d) These guys are of order micron scale.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00240 2 5 3 moderate deducto-memory: 1000 food calories

Extra keywords: EPS

38. The food calorie is a weird unit. **1 FOOD CALORIE** is actually 1000 calories or 1 kcal. Now **1000 FOOD CALORIES** is about:

    a) 4 J. b) 4 kJ. c) 4 MJ. d) 4 ZJ. e) 4 YJ.

    SUGGESTED ANSWER: (c)

    Wrong answers:
    a) Really small. Just think lifting a 1 kg mass 1 meter takes about 10 J to put into gravitational potential energy and a 1000 food calories is about half of what sedentary person needes in a day. Even a very sedentary person does a lot more lifting than 1 kg by 1 m.
    c) A yotajoule is 10^{24} J. World total commercial energy usage for a year is only of order 0.0005 YJ.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00320 1 5 3 easy deducto-memory: horsepower
Extra keywords: EPS

39. What is 1 electrical horsepower in SI units? **HINT:** Think about light bulb power or small household electrical motor power.

    a) 746 cW. b) 7.46 W. c) 746 W. d) 746 MW. e) 746 GW.

    SUGGESTED ANSWER: (c)

    Wrong answers:
    a) This is 7.46 W. Small household appliances need more than this and you think a horse can only to that much. My electrical pencil sharpner uses 240 W. I suspect it isn't very efficient and a lot of energy goes into waste heat. The world is waiting for the super-efficient electrical pencil sharpner.
    d) This enough power for about 7×10^6 100-W bulbs. If a horse could do this, our energy problems would be solved. Of course, the horses might take over and feed us oats in feed bags and make us wear baggies in the city streets.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00332 1 1 2 easy memory: power per capita

40. Circa 2009, the world commercial power per capita is about:

    a) 1 watts/capita. b) 2000 watts/capita. c) 2000 joules/capita. d) 12000 joules/capita. e) 16×10^{12} watts/capita.

    SUGGESTED ANSWER: (b)

    Wrong answers:
    a) 16×10^{12} W is about total power

    Redaction: Jeffery, 2008jan01

---

001 qmult 00334 1 1 3 easy memory: world population

41. Circa 2009, world population is about:

    a) 550 million. b) 3.5 billion. c) 6.8 billion. d) 9.1 billion. e) 16 billion.

    SUGGESTED ANSWER: (c)

    Wrong answers:
    b) When I was young.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00410 1 1 3 easy memory: biosphere energy
Extra keywords: EPS from the Sun.

42. The overwhelmingly dominant source of energy for the biosphere (entire world of living things on Earth which somewhat patchily envelops the Earth in a thin sheath) is:

    a) geothermal power. b) nuclear power stations. c) solar power. d) thermal power stations. e) horse power.

    SUGGESTED ANSWER: (c)

    Wrong answers:
    a) There are some biota in the vicinity of hydrothermal vents (black smokers) in the deep sea that rely heavily on geothermal energy. But at least some of these biota depend on solar energy indirectly. See Wikipedia: Hydrothermal vent.
    e) Oh, c'mon.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00420 1 1 1 easy memory: visible light

43. Visible light is:

    a) only a small part of the electromagnetic spectrum.

b) not in the electromagnetic spectrum.
c) is the inverse of the electromagnetic spectrum.
d) is not electromagnetic radiation.
e) only green in color.

SUGGESTED ANSWER: (a)

Wrong answers:
e) Tis the Irish answer.

Redaction: Jeffery, 2008jan01

---

003 qmult 00422 1 1 4 easy memory: Sun power
44. The Sun's luminosity (or power output) is:

a) 1 MW. b) 16×10^{12} W. c) 16 TW. d) 3.846×10^{26} W. e) 10^{43} W.

SUGGESTED ANSWER: (d)

Wrong answers:
b) World commercial power generation.
e) About the luminosity of the brighest supernovae.

Redaction: Jeffery, 2008jan01

---

003 qmult 00424 1 1 3 easy memory: solar spectrum peak
45. The Sun's emitted spectrum of electromagnetic radiation peaks in the:

a) X-ray. b) ultraviolet. c) visible. d) infrared. e) radio.

SUGGESTED ANSWER: (c)

Wrong answers:
a) In the deep interior it has an X-ray spectrum.

Redaction: Jeffery, 2008jan01

---

003 qmult 00432 1 1 1 easy memory: dryland biomass energy density
46. The power production averaged over time for dryland biomass has a maximum value of about:

a) 1 W/m^2. b) 150 W/m^2. c) 1366 W/m^2. d) 1 MW/m^2. e) 16 TW/m^2.

SUGGESTED ANSWER: (a)

Wrong answers:
a) If this were true biofuels would be closer to being a possible major energy source.

Redaction: Jeffery, 2008jan01

---

003 qmult 00440 1 4 5 easy deducto-memory: solar/commercial power ratio
Extra keywords: EPS
47. "Let's play *Jeopardy*! For $100, the answer is: Approximately the ratio of total solar power reaching the Earth's surface to total world commercial power circa year 2009."

What is _____, Alex?

a) 0.5 b) 2 c) 6 d) 550 e) 5500

SUGGESTED ANSWER: (e) See Smil (2006, p.27).

Wrong answers:
a) As Lurch would say AAAARGH.

Redaction: Jeffery, 2008jan01

---

003 qmult 00510 1 4 2 easy deducto-memory: basal metabolic rate
Extra keywords: EPS

48. "Let's play *Jeopardy*! For $100, the answer is: The rate of energy expended (i.e., power expended) by an animal in a state of complete rest, several hours after the last feeding (about 12 hours for humans) and in a comfortable temperature setting."

    What is _____, Alex?

    a) metabolic rate (MR) b) basal metabolic rate (BMR) c) metabolic scope (MS) d) barometric metabolic rate (BMR) e) Basil Rathbone rate (BRR)

    SUGGESTED ANSWER: (e)

    Wrong answers:
    e) Basil Rathbone (1892–1967) will always be the film Sherlock Holmes. But actually Jeremy Brett (1933-1995) was the real Sherlock Holmes.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00522 1 1 5 easy memory: sedentary human energy per day in MJs

49. A typical sedentary human being needs about 2000 food calories per day. This is about:

    a) 1000 W. b) 1 kilojoules per day. c) 8 kilojoules per day. d) 1 megajoules per day. e) 8 megajoules per day.

    SUGGESTED ANSWER: (e)

    Wrong answers:
    a) A factor of 10 too large.

    Redaction: Jeffery, 2008jan01

---

003 qmult 00530 2 5 4 mod. deducto memory: metabolic scope

Extra keywords: EPS

50. What animal has the largest sustained metabolic scope?

    a) Etruscan shrews. b) Guinea pigs. c) Humans.
    d) Canids (i.e., wolves, Cairn terriers, etc.). e) Felids.

    SUGGESTED ANSWER: (d)

    I wish my source (Smil 2006, p. 47, 61) would specify how long sustained is? But I would guess hours for truly fit specimens in their primes.

    Wrong answers:
    c) We are only number 2.
    e) C'mon, does Fluffy look like she has any metabolic scope at all?

    Redaction: Jeffery, 2008jan01

---

003 qmult 00550 2 4 2 mod-memory: ethanol energy content

Extra keywords: EPS

51. "Let's play *Jeopardy*! For $100, the answer is: It is approximately the energy content of ethanol (commonly called alcohol in alcoholic beveridges)."

    What is _____, Alex?

    a) 3 joules/hectogram b) 3 megajoules/hectogram c) 3 gigajoules/hectogram
    d) 3 zetajoules/hectogram e) 3 yotajoules/hectogram

    SUGGESTED ANSWER: (b)

    The students should remember that humans need of order 8–16 MJ/day and this sets a scale for the energy content of typical servings. A standard US alcolohic drink contains of order 13 grams of ethanol. So if one could metabolize all the ethanol energy one would need at least about 3 hectograms or 23 standard drinks a day to sustain oneself energywise if not otherwise. The author is not sure how much of the quoted energy content of ethanol (Smil 2006, p. 58) is metabolizable. But this discussion reminds of W.C. Fields: "During one of my treks through Afghanistan, we lost our corkscrew. We were compelled to live on food and water for several days."

Wrong answers:
e) A yotajoule is 10^{24} J. World total commercial energy usage for a year is only of order 0.0005 YJ. Strong drink indeed.

Redaction: Jeffery, 2008jan01

---

003 qmult 00610 1 4 5 easy deducto-memory: R/P ratio 2
Extra keywords: EPS

52. "Let's play *Jeopardy*! For $100, the answer is: If the values of the ratio calculation are accurate and the denominator a true constant, then it is the time until a resource reserve is exhausted."

What is the _____, Alex?

a) BMR b) PR factor c) P/R ratio d) fairy tale e) R/P ratio

SUGGESTED ANSWER: (e)

Wrong answers:
b) Sometimes.
d) All too often, I'm afraid.

Redaction: Jeffery, 2008jan01

---

003 qmult 00630 3 3 4 tough math: R/P for oil hypothesis
Extra keywords: EPS For the EPS students this is tough.

53. As of year 2009, the estimated reserve of oil (petroleum) is/was about 1300 Gbl (a Gbl is a gigabarrel). The annual rate of oil consumption (circa 2008) in the U.S. is/was about 7.1 Gbl/year. The U.S.'s population is about 1/20 of the world population. If all countries consumed oil per capita at the U.S.'s per capita rate, what approximately would be the current estimated world R/P ratio for oil? Is it at all likely, that all countries can consume oil per capita at the U.S.'s per capita rate?

a) 1300 years. Yes. b) 31 years. No. c) 1 week. Yes. d) 9 years. No.
e) 43 years. Yes.

SUGGESTED ANSWER: (d)

For world production oil production, see:

`http://en.wikipedia.org/wiki/World_oil_production` .

For world proved oil reserves, see:

`http://www.eia.doe.gov/emeu/international/reserves.html` .

For the US oil consumption, see:

`http://tonto.eia.doe.gov/dnav/pet/pet_cons_psup_dc_nus_mbbl_a.htm` .

Well if all countries consumed as much per capita as U.S., then the world consumption rate for oil would be about 20 times the U.S.'s or 140 Gbl/year. I then follows that

$$R/P = \frac{1300}{140} \approx 9 \,\text{years} \; .$$

Even if there were twice as much oil reserve as there is, the R/P ratio would only be about 18 years. I think long before per capita oil consumption of the world could get anywhere near as much as that of the U.S., the world oil reserve would be well on its way to exhaustion and the average per capita consumption rate of the world would have to start falling rather than rising.

Wrong answers:
a) We'd have nothing to worry about—except global warming.

Redaction: Jeffery, 2008jan01

---

004 qmult 00110 1 1 3 easy memory: thermodynamics defined 2
Extra keywords: EPS

54. The brief description of this thing is the science of heat energy and temperature. The thing is:

a) thermostatics. b) thermosonics. c) thermodynamics. d) thermometrics.
e) thermostrics.

SUGGESTED ANSWER: (c)

Wrong answers:
d) The study of antique thermometers maybe.
e) The study of antique thermoses maybe.

Redaction: Jeffery, 2008jan01

---

004 qmult 00200 1 1 4 easy memory: thermodynamic variables
Extra keywords: EPS

55. They are macroscopic observables that are functions of the thermodynamic state of matter. Observable means that the quantity can be measured by means in which we have complete theoretical confidence. After all we do not measure, for example, temperature directly, but rather, for example, the volume of alcohol in an alcohol thermometer. To be deeply philosophical for a moment, we only observe our sense perceptions directly and everything else depends on our theoretical understanding of what we perceive. In the jargon of the philosophy of science, observations are theory laden. Nevertheless, by custom we say we observe things where we have complete confidence in the theory of those things. Where our theoretical confidence is less than complete, we sometimes talk model-dependent results or indirect observations. To end this digression, the observables we were talking about are sometimes called state functions, but the author prefers:

a) quantum mechanical observables. b) factors. c) global factors.
d) thermodynamic variables. e) thermodynamic temperatures.

SUGGESTED ANSWER: (d)

In macroscopic classical physics, one uses about dynamic variables, and so using thermodynamical variables gives a more consistent terminology.

Wrong answers:
e) It might be argued that there is more than one kind of temperature depending on the context of the discussion. But there are other thermodynamic variables that are not temperature. In any case, one never (to my knowledge) the redundant locution thermodynamic temperature. The main meaning of temperature is the temperature of thermodynamics. Qualification is only needed for other uses of temperature which do exist in special cases or metaphorically.

Redaction: Jeffery, 2008jan01

---

004 qmult 00320 1 4 2 easy deducto-memory: kelvin/absolute temperature
Extra keywords: physci

56. "Let's play *Jeopardy*! For $100, the answer is: This temperature scale is considered to be the absolute temperature scale and its zero-point is absolute zero."

What is the _____ scale, Alex?

a) Fahrenheit b) Kelvin c) Celsius d) thermometer e) Hobbes

SUGGESTED ANSWER: (b)

Wrong answers:
a) Contact force: no way.

Redaction: Jeffery, 2001jan01

---

004 qmult 00340 1 1 1 easy memory: 273.15 K conversion to Celsius
Extra keywords: EPS

57. The temperature 273.15 K on the Celsius scale is

a) 0°C. b) 273.15°C. c) 100°C. d) −273.15°C. e) 200°C.

SUGGESTED ANSWER: (a)

Wrong answers:
c) This is 373.15 K.

Redaction: Jeffery, 2008jan01

---

004 qmult 00520 1 4 5 easy deducto-memory: 3 forms of heat transfer 2

Extra keywords: physci

58. The three most commonly known forms of heat tranfer are:

a) conduction, convection, hyperventilation. b) conduction, contrition, contemplation.
c) conduction, neutrinos, gravitational radiation. d) crenelation, navigation, mutation.
e) conduction, convection, radiative transfer.

SUGGESTED ANSWER: (e)

Wrong answers:

c) Neutrinos are important in supernova explosions and gravitational radiation in tight binary star systems and probably elsewhere. But they are not mostly commonly known forms of heat transfer.

Redaction: Jeffery, 2001jan01

---

004 qmult 00550 1 4 4 easy deducto-memory: thermodynamic equilibrium

Extra keywords: EPS

59. "Let's play *Jeopardy*! For $100, the answer is: It is a state of a system of unchanging thermodynamic behavior at the macroscopic level: i.e. pressure, temperature, density, phase, and entropy are unchanging. Entropy is in fact at the maximum allowed by the nature and the available internal energy. At the microscopic level, there is continual change going on. But the atoms and molecules have a distribution of behavior, but the distribution itself is unchanging, and in particular the average behavior is unchanging. The state is a timeless state that could be called at dead state since life (as we know it) cannot exist in this state when it is fully enforced."

What is _____, Alex?

a) hydrostatic equilibrium b) mimimum entropy c) heat flow
d) thermodynamic equilibrium e) ennui

SUGGESTED ANSWER: (d)

Wrong answers:

e) Well that too.

Redaction: Jeffery, 2008jan01

---

004 qmult 00600 1 5 1 easy thinking: zeroth law of thermodynamics

Extra keywords: EPS

60. If two bodies are in thermodynamic equilibrium with a third body, they are in thermodyamic equilibrium with each other. By being in thermodyamic equilibrium, we mean that if put in thermal contact where heat flows can occur, no macroscopic heat flows will occur and no thermodynamic variables will change. The first statement is the:

a) zeroth law of thermodynamics. b) first law of thermodynamics.
c) second law of thermodynamics. d) third law of thermodynamics.
e) fourth law of thermodynamics.

SUGGESTED ANSWER: (a)

Wrong answers:

e) Historically this was true.

Redaction: Jeffery, 2008jan01

---

004 qmult 00700 1 4 2 easy deducto-memory: 1st law of thermodynamics

Extra keywords: EPS

61. "Let's play *Jeopardy*! For $100, the answer is: It is the 1st law of thermodynamics (in less than most general form), as expressed as formula."

What is _____, Alex?

a) $W = Q + \Delta E$ b) $\Delta E = Q - W$ c) $E = \frac{1}{2}mv^2$ d) $E = mv^2$ e) $E = mc^2$

SUGGESTED ANSWER: (b)

Wrong answers:
c) This the kinetic energy formula.
d) This the not the kinetic energy formula though Thomas Young (1773–1829) thought so once.

Redaction: Jeffery, 2008jan01

---

004 qmult 00810 1 1 3 easy memory: gas pressure
Extra keywords: EPS

62. Gas pressure is caused by the _____ of atoms and/or molecules.

a) cohesion b) suction c) collisions d) chemical bonds e) neutrons

SUGGESTED ANSWER: (c)

Wrong answers:
d) Arguable true of solids and liquids.

Redaction: Jeffery, 2008jan01

---

004 qmult 00840 2 1 5 moderate memory: aerodynamic lift
Extra keywords: EPS

63. Aerodynamic lift is an non-static-air air pressure effect with two main identifiable components:

a) a wing and a prayer. b) entropy and reaction lift. c) entropy and temperature.
d) reaction lift and Carnot lift. e) reaction lift and Bernoulli lift.

SUGGESTED ANSWER: (e)

Wrong answers:
a) Well no. Well maybe.

Redaction: Jeffery, 2008jan01

---

004 qmult 00842 1 5 5 easy easy thinking: paper and lift
Extra keywords: Not fair so some students with disabilities.

64. Take this quiz and . . .—no, no not that. Take this quiz—or some single sheet of paper if you arn't in a quiz *mise en scène*—in your fingers with your fingers on either side of one of narrow ends. Hold this end just **BELOW** your lips and blow a strong gust.

a) Nothing happens, because you've blown too hard.
b) Nothing happens, because you've blown too softly and you've never succeeded in blowing up a balloon in your life.
c) You spit.
d) The instructions are unintelligible.
e) The paper rises because you've created a high-speed, low-pressure zone above the paper. Below the paper is normal pressure. The pressure force inequality will push the paper upward against the force of gravity. The overall effect is the Bernoulli lift which is part of aerodynamic lift by which airplanes fly. Of course, if you put the paper above your lips and blow the paper rises too. This time it is the reaction lift which is the other part of aerodynamic lift. The blown air is deflected down by the paper, but for every force there is an equal and opposite force and so the air pushes up on the paper too.

SUGGESTED ANSWER: (e)

The experiment should work and the answer obeys the longest-answer-is-right rule. How can anyone miss. Well actually everyone already knows this trick as actual experience shows: oh well, chagrined agained.

The trick is an example of Bernoulli lift. Moving air above the paper is at lower pressure than stationary air below the paper as the Bernoulli equation suggests. (We derived the Bernoulli equation for incompressible fluids, but Bernoulli-like behavior for compressible fluids is to be

expected.) The situation is actually pretty complex: the low pressure zone above the paper causes the high pressure below the paper to push the paper up. But the low pressure zone also causes air above the low pressure zone to lose pressure support and fall down, but I guess the downfalling air gets entrained by the blowing air. Oh, well someone probably knows exactly what everything is doing.

Wrong answers:
a) This seems to be distinctly wrong.
b) This could well be true.
c) It's been known to happen. Best not to aim at anyone.
d) Well I tried my best, but, as we say in science, one picture is worth 10^3 words.

Redaction: Jeffery, 2001jan01

---

004 qmult 00870 1 5 5 easy thinking: 2001: A Space Odyssey
Extra keywords: physci

65. In *2001: A Space Odyssey*, astronaut David Bowman finds himself trapped without his helmet in a space pod. The computer Hal has locked the direct pod-to-space-ship airlock. Bowman decides to "breathe vacuum"—to go sans helmet through space to an outside airlock—and then deal with Hal. Why doesn't Bowman explode due to his internal body pressure in the nearly zero pressure of space?

a) He is too quick to explode.
b) He holds his breath.
c) Hal has not anticipated Bowman's maneuver or at least has no contingency plan.
d) Sheer plot requirement.
e) Most of the body's internal pressure is supplied by nearly incompressible (and therefore nearly non-expandable) fluid and solid: these parts won't explode under decompression. The solid and liquid parts are strong enough it seems to keep the air in the body cavities contained. One **HOLDS** one's breath and one hopes one's eardrums don't rupture.

SUGGESTED ANSWER: (e)

I used to just hope Arthur C. Clarke (1917–2008) and Stanley Kubrick (1928–1999) were right about this. Clarke was a diver as well as a space guru: so supposedly he knows all about it. But Bowman can't stay out too long because some nasty bubbles must form in his blood, or so I seem to recall. Apparently, the situation is more dangerous if you try to return to ordinary air pressure with your lungs full of high pressure air: see Halliday & Resnick, p. 526. Even about a 1 psi difference between between lungs and body is dangerous then—say when a diver surfaces without exhaling.

I think the resolution of the two cases is this. In the space case, the whole membrane (skin) of the body resists decompression from normal air pressure (about 15 psi) to nearly zero pressure, and thus the lung-body pressure difference stays tolerable. In the diver case, the body, blood and tissue, can relax from a slightly higher-than-air-pressure state to an air-pressure state quickly: the body is designed to hold itself at air pressure. But if the diver doesn't exhale an intolerable pressure difference between lungs and body develops. Maybe I'm talking through my hat.

Wikipedia (Wikipedia: 2007nov23: human adaptation to space) confirm that a human may be able to survive about 30 seconds in vacuum, but perhaps be conscious for only 15 seconds. So Bowman had to be quick, but 15 seconds can be a long time if all you need to is pass through an airlock.

Wrong answers:
a) Oh, c'mon.
b) True, but not an answer.
c) True, but not an answer.
d) The screenwriters could have got him out of that pod some other way.

Redaction: Jeffery, 2001jan01

---

004 qmult 00902 1 1 4 easy memory: Clausius and entropy 2

66. Rudolf Clausius (1822–1888):

a) discovered temperature. b) proved the existence of density.
c) was wrong about heat engines. d) introduced the concept of entropy.
e) wrote the famous memoir *I, Clausius*.

SUGGESTED ANSWER: (d)

Wrong answers:
a) A nonsense answer.

Fortran-95 Code

Redaction: Jeffery, 2008jan01

---

004 qmult 00910 1 1 3 easy memory: entropy defined
Extra keywords: EPS

67. The thermodynamic variable entropy is a quantitative measure of:

a) order. b) microscopic order. c) microscopic disorder. d) macroscopic disorder.
e) temperature.

SUGGESTED ANSWER: (c)

Wrong answers:
d) I think macroscopic disorder can be qualitatively described by a qualitative generalized entropy. Others may not think this a useful idea.

Redaction: Jeffery, 2008jan01

---

004 qmult 00920 1 4 5 easy deducto-memory: cause of entropy
Extra keywords: EPS

68. "Let's play *Jeopardy*! For $100, the answer is: They are the cause of increasing disorder."

What are _____, Alex?

a) Rambo or Rambolizing processes b) rambling or rambilizing processes
c) rotational or rotationalizing processes d) rational or rationalizing processes
e) random or randomizing processes

SUGGESTED ANSWER: (e)

Wrong answers:
a) Just a nod to Sylvester Stallone (1946–).

Redaction: Jeffery, 2008jan01

---

004 qmult 01000 1 4 3 easy deducto-memory: 2nd law of thermodynamics stated
Extra keywords: EPS

69. "Let's play *Jeopardy*! For $100, the answer is: The entropy of a thermodynamically closed (or isolated) system never decreases. Random processes if present will in fact drive a closed system to the state of maximum entropy allowed by the system's nature and available internal energy."

What is _____, Alex?

a) zeroth law of thermodynamics b) first law of thermodynamics
c) second law of thermodynamics d) third law of thermodynamics
e) fourth law of thermodynamics

SUGGESTED ANSWER: (c)

Wrong answers:
a) As Lurch would say AAAARGH.

Redaction: Jeffery, 2008jan01

---

004 qmult 01210 1 4 4 easy deducto-memory: 3 main phases
Extra keywords: EPS

70. "Let's play *Jeopardy*! For $100, the answer is: Solid, liquid, gas."

What are _____, Alex?

a) the three laws of thermodynamics b) the last three real substances c) the chemical categories d) the three main phases of matter e) the three least important phases of matter

SUGGESTED ANSWER: (d)

Wrong answers:
e) As Lurch would say AAAARRRGHHH!

Redaction: Jeffery, 2008jan01

---

004 qmult 01310 1 1 5 easy memory: phase change, temperature
Extra keywords: EPS pressure

71. Bulk phase changes (i.e., not just changes at the surfaces of samples) for pure substances happen at definite temperatures which are:

a) all above 273.15 K. b) all below 273.15 K. c) all below 273.15 K and independent of pressure. d) independent of pressure. e) dependent on pressure in general.

SUGGESTED ANSWER: (e)

Wrong answers:
d) Exactly wrong.

Redaction: Jeffery, 2008jan01

---

004 qmult 01340 2 1 3 moderate memory: dry ice
Extra keywords: EPS

72. A common substance that has no liquid phase at ordinary air pressure is carbon dioxide (CO_2). The solid phase is commonly called:

a) impossible green. b) sublimium. c) dry ice. d) marsh gas. e) Irish dirt.

SUGGESTED ANSWER: (c)

Wrong answers:
d) A gaseous decomposition product of organic matter which is mostly methane.

Redaction: Jeffery, 2008jan01

---

004 qmult 01360 1 4 5 easy deducto-memory: water cycle
Extra keywords: EPS

73. "Let's play *Jeopardy*! For $100, the answer is: It is the movement of water through the Earth's atmosphere and on its land and water surfaces and subsurfaces. An outline of the process is as follows. Solar energy evaporates liquid water from the water surfaces and causes convection and vertical and horizontal movement in the atmosphere of water vapor. The vapor precipitates out as rain or snow or hail. Usuually as a liquid water flows downhill then and at least some of it reaches the oceans. There are also large amounts of water in the form of ice some of which is also flowing slowly downhill. The whole process is also called the hydrological cycle."

What is the _____, Alex?

a) heat engine cycle b) bicycle c) ice cycle d) last real cycle e) water cycle

SUGGESTED ANSWER: (e)

Wrong answers:
a) Well the water cycle is in some respects like heat engine. In fact, one could call it a natural heat engine.

Redaction: Jeffery, 2008jan01

---

001 qmult 01000 1 5 5 easy thinking: energy riddle: Frodo
Extra keywords: The Riddler Strikes Again III

74. The Riddler strikes again:

I am always only me,

but never the same,
sometimes I'm just—well—PE,
and where is the shame,
the change artist triumphs again—
and I'm like money—but I don't inflate—
paid—and on the due of the date,
from light unto dark, hot unto cold,
as Joule, my prophet, has foretold,
but all riddle games—and so it goes—
must end—so speak it—as in Frodo's.

a) Hamlet.
b) The Sun.
c) The Tao.
d) Poetry—no, wait, aaaAAAHHHhhh . . .
e) Energy.

SUGGESTED ANSWER: (e)

A super easy thinking question. This is the joke question. But it's all true. Yes, I know, it was Bilbo in the riddle game—the Muse herself told me to write Frodo.

Wrong answers:
a) C'mon, it can't be Hamlet.
d) All too likely.

Redaction: Jeffery, 2001jan08