Physical Science 126: 1st Exam NAME:
2005 February 11 Friday

Instructions: There are 57 multiple choice questions each worth 1 mark for a total of 57 marks altogether. Choose the **BEST** answer, completion, etc., and darken fully the appropriate circle on the table provided below. Read all responses carefully. **NOTE** long detailed responses won't depend on hidden keywords: keywords in such responses are bold-faced capitalized.

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

This an 75 minute test. Just hand in your answer table. Remember your name (and write it down on the exam too).

Answer Table

Name:

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

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000 qmult 00100 1 1 4 easy memory: scientific method

Extra keywords: physci KB-24-1 but much altered

1. The scientific method can be schematically described as:

   a) an inward spiral of theorizing and experiment/observation. b) an integrative process. c) a reductive process. d) a cycle of theorizing and experiment/observation. e) a pointless pursuit.

   SUGGESTED ANSWER: (d)

   Wrong answers:
   b) Say what?
   c) Say what?
   e) As Lurch would say: "Aaaarh."

   Redaction: Jeffery, 2001jan01

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000 qmult 00200 1 4 3 easy deducto-memory: physics defined

Extra keywords: physci

2. Physics can be briefly defined as the science of:

   a) human relations. b) sports and leisure. c) matter and motion. d) matter and rest. e) light.

   SUGGESTED ANSWER: (c)

   Wrong answers:
   b) As Lurch would say: "Aaaarh."
   e) Light is only part of physics. Matter and motion is more descriptive, but not totally descriptive.

   Redaction: Jeffery, 2001jan01

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000 qmult 00210 1 4 4 easy deducto-memory: fundamental in physics

Extra keywords: physci

3. "Let's play *Jeopardy*! For $100, the answer is: 'Just so' in physics."

   What is _____, Alex?

   a) a story by Rudyard Kipling b) essential c) eternal d) fundamental e) infernal

   SUGGESTED ANSWER: (d)

   Wrong answers:
   a) There were several *Just So Stories*.

   Redaction: Jeffery, 2001jan01

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000 qmult 00300 1 1 2 easy memory: physical science

Extra keywords: physci

4. A physical science can be defined as:

a) an art form. b) a science that depends strongly on physics. c) a science that does not depend on physics at all. d) a science that is identical with fundamental physics. e) a pointless pursuit.

SUGGESTED ANSWER: (b)

Wrong answers:
d) No.
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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001 qmult 00100 1 4 2 easy deducto-memory: scientific notation defined
Extra keywords: physci

5. "Let's play *Jeopardy*! For $100, the answer is: It is a notation in which one expresses a number by a prefix number (usually in the range 1 to 10, but not including 10) multiplied explicitly by 10 to the appropriate power."

What is _____, Alex?

a) British notation b) scientific notation c) metric notation d) tensy notation e) Irish notation

SUGGESTED ANSWER: (b)

Wrong answers:
e) Tis yourself that does not know that scientific notation was invented by St. Patrick who, alas, was actually British.

Redaction: Jeffery, 2001jan01

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

6. 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 would say, don't you just hate it when newspapers use expressions like hundred million billion miles. We all know scientific notation or should nowadays. $10^2 \times 10^6 \times 10^9 = 10^{17}$.

Wrong answers:
e) Seems unlikely.

Redaction: Jeffery, 2001jan01

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001 qmult 00210 1 4 5 easy deducto-memory: units needed
Extra keywords: physci

7. "Let's play *Jeopardy*! For $100, the answer is: For any measurements of quantities one needs these conventionally agreed upon things."

What are _____, Alex?

a) unities b) dualities c) duplicities d) quantons e) units

SUGGESTED ANSWER: (e)

Wrong answers:
d) I think this is a pretty good alternative to units.

Redaction: Jeffery, 2001jan01

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001 qmult 00220 1 1 3 easy memory: metric units
Extra keywords: physci

8. The modern standard set of units for science, most engineering, and much of everyday life (except in the 2nd largest country in North America) is the International System of Units (Système International d'Unités or SI) which is often called the:

a) British system. b) Mesopotamian system. c) metric system. d) Paraguayan system. e) rational system.

SUGGESTED ANSWER: (c)

Wrong answers:
a) More or less exactly wrong.
b) In timekeeping and angular measurement we still use a lot of the sexagesimal system of the ancient Mesopotamians.
e) Sounds reasonable.

Redaction: Jeffery, 2001jan01

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001 qmult 00410 1 1 1 easy memory: metric kilo and centi
Extra keywords: physci

9. In the metric system, the prefixes kilo and centi indicate, respectively, multiplication by:

a) 1000 and 0.01. b) 0.01 and 1000. c) 1000 and 100. d) 60 and 0.01. e) π and e.

SUGGESTED ANSWER: (a)

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

Redaction: Jeffery, 2001jan01

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001 qmult 00500 1 1 1 easy memory: conversion in general
Extra keywords: physci

10. In conversions, one can just treat units as variables whose values are never specified. One can do algebra with them and cancel them. One also knows a set of equalities relating units, and so can write down factors of unity or conversion factors. For example, $1000\,\mathrm{m} = 1\,\mathrm{km}$, and so a factor of unity (or conversion factor) is

$$\left(\frac{1000\,\mathrm{m}}{1\,\mathrm{km}}\right) .$$

This factor would be used to convert an amount in kilometers to meters by:

a) multiplication. b) division. c) addition. d) subtraction. e) squaring.

SUGGESTED ANSWER: (a)

Wrong answers:
b) An amount in meters could be converted to kilometers by division.
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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001 qmult 00520 1 4 1 easy deducto-memory: kilogram to grams
Extra keywords: physci

11. A kilogram is:

a) 1000 grams. b) 1×10^{-3} grams. c) 3.1416 grams. d) 2 grams. e) 0 grams.

SUGGESTED ANSWER: (a)

Wrong answers:
b) kilograms just sound bigger than grams. Even before this course, everyone should know this is wrong.
c) Not π grams.
d) C'mon, metric is a decimal system.
e) A nonsense answer.

Redaction: Jeffery, 2001jan01

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001 qmult 00550 2 4 4 moderate deducto-memory: 10 m/s to mph
Extra keywords: physci

12. A human (a very speedy human) can run 10 m/s. What is this speed in miles per hour (mph)? **HINT:** You do not need to do any explicit calculation (although that will work too), just think about everyday reality. Can you outrun a car? Yes/no/maybe?

a) 100 mph. b) 1 mph. c) 11.2 km/s. d) 22.37 mph. e) 22.37 miles.

SUGGESTED ANSWER: (d) Note:

$$10 \times \frac{1./1609.}{1/3600} = 22.3741455 \text{ mph} .$$

Wrong answers:
a) Not even Donovan Bailey. (A long ago Canadian sprint hero. Not the one who used steroids.)
b) Your kid sibling could do this.
c) Wrong units. Also this is the escape speed from the surface of the Earth (Fr-454). Humans arn't constantly just about launching themselves into orbit.

e) Wrong units.

Redaction: Jeffery, 2001jan01

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001 qmult 00560 1 3 4 easy math: seconds in a day

Extra keywords: physci

13. Exactly how many seconds are there in a day? How many seconds are there in a day to order of magnitude? **HINT:** Order of magnitude means rounded off to the nearest power of 10: e.g., 2.2 rounds off to $10^0 = 1$ and 991 rounds off to 10^3.

a) 86400 s and 10^4 s. b) 1440 s and 10^4 s. c) 1440 s and 10^5 s. d) 86400 s and 10^5 s. e) $\pi \times 10^7$ s.

SUGGESTED ANSWER: (d)

Wrong answers:

e) This curiously enough is the number of seconds in a year (Julian or tropical) to better than 0.5This is a simple coincidence, but its a useful mnemonic.

Redaction: Jeffery, 2001jan01

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002 qmult 00100 1 2 1 moderate memory: kinematics definition

Extra keywords: physci

14. Kinematics is:

a) the description of motion. b) the techniques of the cinema. c) dynamics by another name. d) the study of the causes of motion in terms of physical quantities, most prominently force and mass. e) the rate of change of acceleration with time.

SUGGESTED ANSWER: (a)

Wrong answers:

b) Cinematics? Both kinematics and cinema derive from the Greek word kinema meaning motion. I think the trouble is that the Romans used c for the k sound, but in medieval times, the c became soft in medieval Latin. A great improvement in most cases. Circe is sounds better than Kirke to me.

c) Nah, nah. Dynamics is (d)

d) This is dynamics.

e) The rate of change of acceleration doesn't have a common name although I vaguely recall from first year physics course that it may have been called jerk. Yes/no?

Redaction: Jeffery, 2001jan01

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002 qmult 00200 1 3 3 easy math: d=vt calculation

Extra keywords: physci

15. You move at speed 3 m/s. How far do you go in 9 s?

a) 3 m. b) 9 m. c) 27 m. d) 1/3 m. e) 0 m.

SUGGESTED ANSWER: (c)

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

Redaction: Jeffery, 2001jan01

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002 qmult 00220 1 1 3 easy math: travel time from distance/speed: Knoxville
Extra keywords: physci

16. You have just traveled the back roads from Knoxville to Nashville. Your average speed was 60 mph, but you occasionally hit an instantaneous speed of 130 mph. (Could be you're hauling white lightning.) Your odometer travel distance is 250 miles. How long have you been on the road?

a) 1/4 hours. b) 10 hours. c) 4.17 hours. d) 6 hours. e) about 2 hours.

SUGGESTED ANSWER: (c) The students have to be clear on how you get a time from a distance and speed: distance/speed. The question is a remnant of my hillbilly days in Tennessee. Actually, the only time I drank white lightning in Tennessee it was imported from Romania by friends. Alas the great days of Thunder Road are mostly over.

Wrong answers:

Redaction: Jeffery, 2001jan01

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002 qmult 00250 1 1 3 easy memory: lightning and thunder
Extra keywords: physci KB-60-5

17. The speed of sound in air (at 1 atm pressure and 20°C) is 343 m/s. A lightning flash occurs 1.5 km away. How long until you hear thunder?

a) 228.7 s. b) 0.0044 s. c) 4.4 s. d) 515 s. e) 1.5 s.

SUGGESTED ANSWER: (c) Remember this is time-to-exhaustion question where the solution is always amount/rate assuming a constant rate. Behold:

$$t = \frac{\text{distance}}{\text{sound speed}} = \frac{1500}{343} = 4.37318 \approx 4.4\,\text{s} \ ,$$

where 4.4 s is to the correct number of significant figures actually. HRW-400 gives the sound speed.

Fortran Code

```
* code
      print*
      vsound=343.   ! in m/s at 1 atm and 20 C
      dd=1.5e+3     ! distance in meters
      tt=dd/vsound
      print*,'Time until you hear thunder is
     &       ',tt,' seconds.' ! 4.37318
```

Wrong answers:
e) All things are wrong.

Redaction: Jeffery, 2001jan01

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002 qmult 00300 1 1 2 easy memory: acceleration and speed
Extra keywords: physci

18. If an object's speed changes, the object:

a) stops. b) accelerates. c) starts. d) goes forward. e) hesitates.

SUGGESTED ANSWER: (b)

Wrong answers:
a) Not necessarily.
e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

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002 qmult 00320 2 5 5 moderate thinking: acceleration and instantaneous acc.
Extra keywords: physci

19. At time zero you are moving at 10 m/s in the positive y-direction. At 10 s, you are moving at 15 m/s in the positive y-direction. What is your average acceleration over the 10 s? What is your instantaneous acceleration at the 5 s point?

a) The average acceleration and the 5 s instantaneous acceleration are both 0.5 m/s^2 in the **POSITIVE** y-direction.
b) The average acceleration and the 5 s instantaneous acceleration are both 0.5 m/s^2 in the **NEGATIVE** y-direction.
c) The average acceleration is 0.5 m/s^2 in the **NEGATIVE** y-direction. There is **NOT** enough information to determine the 5 s instantaneous acceleration.
d) The average acceleration and the 5 s instantaneous accelerations are both 5 m/s^2 in the **NEGATIVE** y-direction.
e) The average acceleration is 0.5 m/s^2 in the **POSITIVE** y-direction. There is **NOT** enough information to determine the 5 s instantaneous acceleration.

SUGGESTED ANSWER: (e) The average acceleration can be found, but the velocity may have changed in any fashion in between the two time limits. So the acceleration at the 5 s point cannot be determined.

Wrong answers:
a) You havn't answered the second question.

Redaction: Jeffery, 2001jan01

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002 qmult 00420 1 1 3 easy memory: free fall independent of mass: Galileo
Extra keywords: physci

20. It is reported that Galileo (circa 1590) dropped balls of different mass at the same time from the top of the Leaning Tower of Pisa in order to demonstrate that:

a) the heavier ball hit the ground first by a large margin.

b) the lighter ball hit the ground first by a large margin.
c) both balls hit the ground at more or less the same time.
d) the balls would levitate toward the Moon.
e) the Leaning Tower was leaning.

SUGGESTED ANSWER: (c) This is an easy observation question. The Tower story was ahistorically embellished, but probably something of the sort did occur. It was likely a public demonstration not a real experiment. Of course, the balls wouldn't hit at exactly the same time and the hardcore Aristotelians likely pointed to this as the significant fact verifying Aristotle. The point of the ideal Galileo (if not exactly the Galileo of history though maybe him too) was that this slight discrepancy didn't matter. You imagined going to the ideal limit in which frictional forces and release time errors vanished and in that limit the balls would fall in exactly the same time. No mathematical theory can be verified to infinite accuracy. It can only be verified to within experimental error. If the that error can be made small, then the theory is very adequate and could become widely accepted. This reasoning was an important conceptual leap in the development of science—of course, it didn't happen all at once—millennia were involved—but Galileo's career exemplified it.

Wrong answers:
a) Air resistance does tend to cause denser bodies to fall faster, but the effect is small for reasonably dense bodies over not so large distances

Redaction: Jeffery, 2001jan01

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002 qmult 00430 1 3 2 easy math: ball thrown down
Extra keywords: physci KB-60-17

21. A ball is thrown downward at 12 m/s. What is its **SPEED** 2.0 s later assuming no air resistance?

a) 20 m/s. b) 32 m/s. c) 22 m/s. d) −2 m/s. e) 12 m/s.

SUGGESTED ANSWER: (b) Behold

$$v = v_0 + gt = 12 + 9.8 \times 2 = 31.6 \approx 32 \text{ m/s} ,$$

where 32 m/s is to the correct number of significant figures.

Wrong answers:
e) All things are wrong.

Redaction: Jeffery, 2001jan01

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002 qmult 00440 2 3 4 moderate math: kinematic equations: arrow flight 1
Extra keywords: physci

22. A tall archer with her longbow shoots an arrow straight up at 100 m/s. The arrow rises, slows, holds for an instant, and then descends picking up speed. The rise time, neglecting air resistance, is:

a) 100 s. b) 100.2 s. c) 9.8 s. d) 10.2 s. e) 980 s.

SUGGESTED ANSWER: (d) Use the kinematic equation

$$v = v_0^2 + at$$

with $v = 0$ for the time when the arrow reaches, the highest point, $v_0 = 100\,\mathrm{m/s}$ for the initial speed, and $a = -g = -9.8\,\mathrm{m/s^2}$ for the acceleration. We then have

$$0 = 100 - 9.8 \times t$$

which has solution $t \approx 10.2\,\mathrm{s}$.

I was thinking of Geena Davis for the tall the archer apropos of nothing at all: she was an Olympic hopeful for 2004.

Wrong answers:
a) Bad guess.

Redaction: Jeffery, 2001jan01

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002 qmult 00530 1 2 3 easy deduction: human terminal velocity
Extra keywords: physci

23. What is approximately the terminal velocity of a human in air? **HINT:** You don't have to know the answer; you can deduce it.

a) 10 km/hr. b) 1 km/hr. c) 200 km/hr. d) 0.1 km/hr. e) 3×10^5 km/s.

SUGGESTED ANSWER: (c) The students have to be clear that 1 mph is very roughly about 2 kilometers per hour. They have to realize that you don't hit the ground very hard at 10 km/hr. This is just a bit faster than ordinary walking speed.

Wrong answers:
a) This is a hard, but not deadly, hitting speed.
b) This is isn't even hard.
d) This is soft.
e) This is the speed of light. Students have to at least recognize this is faster than anything they see fall.

Redaction: Jeffery, 2001jan01

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003 qmult 00110 1 4 5 easy deducto-memory: vector defined
Extra keywords: physci

24. "Let's play *Jeopardy*! For $100, the answer is: It is a quantity with both a magnitude and a direction."

What is a/an _____, Alex?

a) director b) aviator c) bisector d) scalar e) vector

SUGGESTED ANSWER: (e)

Wrong answers:

d) Exactly wrong.

Redaction: Jeffery, 2001jan01

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003 qmult 00130 1 1 1 easy memory: identify a non-vector
Extra keywords: physci KB-56-1

25. Which of the following quantities is not a vector?

a) mass b) force c) acceleration d) velocity e) displacement

SUGGESTED ANSWER: (a)

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

Redaction: Jeffery, 2001jan01

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003 qmult 00200 1 4 3 easy deducto-memory: displacement defined
Extra keywords: physci

26. "Let's play *Jeopardy*! For $100, the answer is: This vector is specified by giving the direction and a straight-line distance in that direction."

What is _____, Alex?

a) velocity b) acceleration c) displacement d) force e) distance

SUGGESTED ANSWER: (c)

Wrong answers:
e) This is not a vector.

Redaction: Jeffery, 2001jan01

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003 qmult 00220 1 1 4 easy memory: definition of acceleration
Extra keywords: physci

27. Acceleration is:

a) speed.
b) velocity.
c) the rate of change of velocity with time. It is a **SCALAR**.
d) the rate of change of velocity with time. It is a **VECTOR**.
e) the rate of change of displacement with time. It is a **VECTOR**.

SUGGESTED ANSWER: (d)

Wrong answers:
c) There is a scalar meaning of acceleration, but that isn't rate of change of velocity and it isn't the first meaning.

Redaction: Jeffery, 2001jan01

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003 qmult 00300 1 1 5 easy memory: walk and elevator displacement
Extra keywords: physci KB-60-9

28. A man walks 40 m to an elevator and then rises 70 m. What approximately is his displacement from the starting point?

a) 8 m. b) 110 m. c) 30 m. d) 6500 m. e) 80 m.

SUGGESTED ANSWER: (e) Behold

$$d = \sqrt{70^2 + 40^2} = \sqrt{4900 + 1600} = \sqrt{6500} \approx 80\,\text{m} ,$$

where we have used the Pythagorean theorem.

Wrong answers:
b) This is the distance he has traveled.
d) Forgot to take the square root.

Redaction: Jeffery, 2001jan01

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003 qmult 00400 1 3 2 easy math: ground speed of an airplane
Extra keywords: physci KB-57-23

29. An airplane has an air speed of 250 km/hr and is flying in a wind of 70 km/hr. The ground speed of the airplane must be somewhere in the range:

a) 250–320 km/hr. b) 180–320 km/hr. c) 180–250 km/hr. d) 240–260 km/hr. e) 70–250 km/hr.

SUGGESTED ANSWER: (b) The two velocities must add vectorially. The actual value depends on the relative orientation of the velocities. But the minimum value is if the wind is a headwind and the maximum is if it is a tailwind.

Wrong answers:
d) I don't know why anyone would choose this answer.

Redaction: Jeffery, 2001jan01

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003 qmult 00520 1 1 3 easy memory: vector uniform circular motion
Extra keywords: physci

30. You are going in a circle at a constant speed (i.e., a uniform speed). Is your **VELOCITY** ever changing?

a) No, the speed is constant.
b) Yes, it is constantly changing since the motion is in a **STRAIGHT LINE**.
c) Yes, it is constantly changing since the motion is in a **CIRCLE** and direction is constantly changing.
d) No, the velocity is constant.
e) Yes, on **EVERY OTHER LEFT** bend.

SUGGESTED ANSWER: (c) Going in a circle at a constant speed is usually called uniform circular motion in physics-astronomy jargon. Although your speed is constant, you are accelerating at every moment. Actually, the acceleration vector points toward the center, and so your acceleration is constantly changing too although not in magnitude.

Wrong answers:
a) Speed is constant, but velocity is still changing.
b) Circles are not straight lines.
d) Direction is changing constantly: velocity is not constant.
e) A nonsense answer. You may be continuously bending left or right, but there is no separate bends and even if you argue that there, you would have to argue that you accelerated on every "left" bend.

Redaction: Jeffery, 2001jan01

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004 qmult 00500 2 3 1 moderate math: ground speed from Pyth. theorem
Extra keywords: physci

31. Air velocity is 40 mi/hr due north. Wind velocity is 30 mi/hr due west. What is the magnitude of ground velocity (i.e., the ground speed)?

a) 50 mi/hr. b) -50 mi/hr. c) 40 mi/hr. d) 30 mi/hr.
e) 2500 mi/hr.

SUGGESTED ANSWER: (a) This question was a natural for my pilot students at Middle Tennessee State University. The magnitude of the ground velocity can be found by the Pythagorean theorem in this case because the two velocity vectors to be added are at right angles to each other. Deduction should also give the answer. But more formally:

$$\vec{v}_{\text{air}} = (0, 40) \qquad \text{and} \qquad \vec{v}_{\text{wind}} = (30, 0)$$

Thus

$$\vec{v}_{\text{ground}} = (30, 40) \qquad \text{and} \qquad v_{\text{ground}} = \sqrt{30^2 + 40^2} = 50\,\text{mi/hr}\ .$$

Wrong answers:
b) Magnitude or speed is never negative.
c) No the ground speed is higher than the air speed in this case.
d) No the ground speed is higher than the wind speed in this case.
e) You forgot to take the square root. But no subsonic-aircraft-wind combination can have this speed.

Redaction: Jeffery, 2001jan01

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004 qmult 01000 1 4 3 easy deducto-memory: centripetal acceleration defined
Extra keywords: physci

32. "Let's play *Jeopardy*! For $100, the answer is: It is the acceleration in situation of uniform circular motion."

What is _____, Alex?

a) net acceleration b) centrifugal (center-fleeing) acceleration
c) centripetal (center-pointing) acceleration d) deceleration e) zero

SUGGESTED ANSWER: (c)

Wrong answers:

e) The magnitude of the velocity is unchanging, but the direction changes continually. Hence there is an acceleration.

Redaction: Jeffery, 2001jan01

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004 qmult 01010 1 5 3 easy thinking: centripetal acceleration formula

Extra keywords: physci

33. From dimensional analysis (i.e., by checking for correct units) one identifies the formula for centripetal acceleration to be:

a) $a_{\text{cen}} = v^2 r$. b) $a_{\text{cen}} = v^2 r^2$. c) $a_{\text{cen}} = v^2/r$. d) $a_{\text{cen}} = vr$. e) $a_{\text{cen}} = vr^2$.

SUGGESTED ANSWER: (c)

Wrong answers:

a) Wrong units.

Redaction: Jeffery, 2001jan01

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005 qmult 00300 1 5 1 easy thinking: acceleration and third law

Extra keywords: also physci KB-59-15

34. If Newton's 3rd law is true, why then does anything accelerate at all?

a) The equal and opposite forces **DO NOT** have to be on the same body.
b) The equal and opposite forces **DO** have to be on the same body.
c) Nothing moves at all as Parmenides argued in the 5th century BC. Motion is but seeming. Anyway Parmenides seems to have been a pretty smart guy since he's credited with the spherical Earth theory and the discovery that the Moon shines by reflected light.
d) Acceleration has nothing do with forces.
e) Forces have nothing do with acceleration.

SUGGESTED ANSWER: (a) I've provided some leading answers.

Wrong answers:

b) Straight nonsense, since it leads to the opposite conclusion.
c) Parmenides was not really saying that nothing moves at all. He was just arguing from certain premises which he did not necessarily affirm. Actually it is hard to quite know for sure about the big P, since his own words only survive in fragments from his poem in which he lets the unnamed goddess speak for him in oracular manner. Shortly after Parmenides, natural philosophers gave up on poetry and the two have seldom overlapped since. Omar Khayyam (if he really was a poet) and Chaucer (really more of popularizer of science than a practitioner) are possible cases. See D. Furley, "The Greek Cosmologists", p. 36 ff, esp. 41.

Redaction: Jeffery, 2001jan01

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005 qmult 00400 1 3 3 easy math: person's weight

Extra keywords: physci

35. If you have a mass of 60 kg and $g = 9.8\,\mathrm{m/s^2}$, you weigh about:

    a) 10 N. b) 60 N. c) 600 N. d) 500 N. e) 20 N.

    SUGGESTED ANSWER: (c) Actually you need to remember the gravitational force is the cause of weight. In this case

    $$F_g = 60 \times g \approx 6000\,\mathrm{N}\ .$$

    Wrong answers:

    Redaction: Jeffery, 2001jan01

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005 qmult 00910 1 4 4 easy deducto-memory: mass and weight

Extra keywords: physci KB-13

36. "Let's play *Jeopardy*! For $100, the answer is: they are, respectively, the resistance of a body to acceleration and the force of gravity on a body."

    What are _____ and _____, Alex?

    a) acceleration; normal force b) mass; normal force c) force; weight
    d) mass; weight e) gravity; momentum

    SUGGESTED ANSWER: (d)

    Wrong answers:

    b) The normal force can be equal to weight if the normal force cancels gravity as it frequently does.

    Redaction: Jeffery, 2001jan01

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005 qmult 01020 1 1 1 mod. thinking: reaction forces of a book

Extra keywords: physci

37. A book sits at rest on a table. The reaction force that follows from Newton's 3rd law to the gravitational force of the Earth on the book is the:

    a) gravitational force of the book on the Earth.
    b) normal (i.e., perpendicular upward) force of the table on the book.
    c) table friction force on the book.
    d) book friction force on the table.
    e) book normal force on the table.

    SUGGESTED ANSWER: (a) This question actually raises an issue that can easily get all snarled up. In order to calculate the acceleration of body, one finds all the forces on the body and does not concern oneself with the forces the body itself exerts which are going to be the reaction forces from the body's perspective. Thus the table normal force acts on the book and Earth's gravity acts on the book. The respective reaction forces are the normal force of the book on the Earth and the book's gravitational force on the Earth. Note the normal force on the Earth is a contact force that acts directly on the table and causes all kinds of internal

table and ground pressure force adjustments. The book's gravitational force is spread out over the whole Earth, but since the Earth is squishy, it can respond in a sqishy way. But the overall response of the Earth to the book's gravity is pretty minute because of the Earth's huge inertial mass.

Wrong answers:
b) The reaction force must be force the book exerts.

Redaction: Jeffery, 2001jan01

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005 qmult 01230 1 3 5 easy math: F=ma to find a brick's mass
Extra keywords: physci KB-60-23

38. A 50 N net force gives a brick an acceleration of 5 m/s. What net force is need to give it an acceleration of 10 m/s?

a) 50 N. b) 5 N. c) 10 N. d) 200 N. e) 100 N.

SUGGESTED ANSWER: (e) The brick's mass is invariant one assumes. Thus, by $F_{\text{net}} = ma$, the acceleration is proportional to the net force. If the acceleration is double, so must the force be. Incidentally, the mass of the brick is 10 kg.

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

Redaction: Jeffery, 2001jan01

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005 qmult 01240 2 5 4 moderate thinking: diving woman
Extra keywords: physci KB-60-27

39. What is the approximate mass of a 500 N woman? What is gravitational force that Earth exerts on her. After she jumps **UPWARD** from a diving board, what is her acceleration in the absence of air resistance?

a) About 50 kg, 500 N, and 9.8 m/s^2 downward once she starts moving downward, but **ZERO** before that.
b) About 50 kg, 50 N, and 9.8 m/s^2 downward once she starts moving downward, but **ZERO** before that.
c) About 50 kg, 50 N, and 9.8 m/s^2 downward at **ALL** times.
d) About 50 kg, 500 N, and 9.8 m/s^2 downward at **ALL** times.
e) None of these questions can be answered with the given information.

SUGGESTED ANSWER: (d) Remember that weight near the Earth's surface is mg where m is mass and $g = 9.8\,\text{m/s}^2$ is the acceleration due to gravity constant. Now 500 N obviously describes the woman's weight: thus her mass is this value divide by about 10. Her weight is the gravitational force that Earth exerts on her. Once she's left the board the only force on her is gravity and she must accelerate downward at 9.8 m/s^2 no matter what direction she is moving in.

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

Redaction: Jeffery, 2001jan01

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005 qmult 01320 2 5 1 moderate thinking: elevator acceleration of woman
Extra keywords: physci KB-61-31

40. A woman who has a mass of 50 kg is in an elevator that is accelerating downward at $2\,\mathrm{m/s^2}$. What is the force the floor exerts on her? What is the force she exerts on the floor?

a) 390 N upward; 390 N downward.
b) 390 N downward; 390 N upward.
c) 490 N downward; 490 N upward.
d) 490 N upward; 490 N downward.
e) 100 N upward; 100 N downward.

SUGGESTED ANSWER: (a) The proper way to formulate this problem is to apply Newton's 2nd law to the woman:

$$F_g + F_{\text{normal}} = -mg + F_{\text{normal}} = ma \ ,$$

and now solve for F_{normal}:

$$F_{\text{normal}} = m(a+g) = 50 \times (-2 + 9.8) = 390\,\text{N} \ .$$

The normal force is the force the floor exerts on the woman: it is 390 N upward. By the 3rd law, the woman exerts 390 N downward on the floor.

Wrong answers:
e) All things are wrong.

Redaction: Jeffery, 2001jan01

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006 qmult 00320 1 1 3 easy memory: friction to heat
Extra keywords: physci related to KB-94-9 but not really that

41. The friction between sliding surfaces tends to change macroscopic kinetic energy into:

a) potential energy.
b) rest mass energy.
c) thermal or heat energy.
d) magnetic energy.
e) nothing.

SUGGESTED ANSWER: (c)

Wrong answers:
e) This violates conservation of energy.

Redaction: Jeffery, 2001jan01

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006 qmult 00800 1 1 3 easy memory: centripetal acceleration in UCM
Extra keywords: physci

42. In uniform circular motion, the acceleration has:

a) a constant magnitude and always points **OUTWARD** from the center of motion.
b) a constant magnitude and always points **ALONG** the circular path (i.e., tangent to the circular path).
c) a constant magnitude and always points **INWARD** to the center of motion.

d) a zero value.
e) a nonconstant magnitude, but a constant direction.

SUGGESTED ANSWER: (c) The magnitude of the acceleration is a constant, but its direction is continually changing so that it always points toward the center.

Wrong answers:
d) I've lived in vain.

Redaction: Jeffery, 2001jan01

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006 qmult 00910 1 1 5 easy memory: centripetal force
Extra keywords: physci KB-57-13

43. For a body to move in a circle at a uniform speed in an inertial frame it is **NECESSARY** to supply a/an _____ force.

a) centrifugal b) inertial c) gravitational d) tension e) centripetal

SUGGESTED ANSWER: (e) Many forces can act as a centripetal force. Thus it is not necessarily any particular kind of force. But it must be a force that points to the center: i.e., a centripetal force.

Wrong answers:
a) The centrifugal force is not a real force though it sure seems that way. It is the tendency of bodies to move in a straight line. In a rotating frame this tendency tends to throw you out of the frame unless some force (i.e., a centripetal force) keeps you rotating with the frame.

Redaction: Jeffery, 2001jan01

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006 qmult 01100 2 3 2 moderate math: centripetal force yo-yo string
Extra keywords: physci KB-61-35

44. A yo-yo of 200 g and string length 80 cm is swirled around by holding the end of the string in the absence of gravity and air resistance. The string will break if tension force exceeds 10 N. About how fast can the yo-yo be swung without breaking the string?

a) 3.2 m/s. b) 6.3 m/s. c) 80 m/s. d) 200 m/s. e) 10 m/s.

SUGGESTED ANSWER: (b) Recall

$$F = m\frac{v^2}{r}$$

is the centripetal force law. Now F increases with v and so the breaking force occurs when v exceeds the upper bound the tension force. Thus, one just solves for the v which gives the bound force:

$$v = \sqrt{\frac{rF}{m}} = \sqrt{\frac{0.8 \times 10}{0.2}} = \sqrt{40} \approx 6.3\,\text{m/s}\ .$$

Wrong answers:

a) It looks like you have just taken the square root of 10.

Redaction: Jeffery, 2001jan01

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007 qmult 00010 1 4 5 easy deducto-memory: partial energy definition

Extra keywords: physci KB-66

45. "Let's play *Jeopardy*! For $100, the answer is: It has been described as that property of something that enables that something to do work."

What is _____, Alex?

a) inevitability b) noise c) tension d) gravity e) energy

SUGGESTED ANSWER: (e)

Wrong answers:

a) This answer just confounds me: I'm not prepared to accept it.

Redaction: Jeffery, 2001jan01

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007 qmult 00020 1 1 1 easy memory: energy conservation

Extra keywords: physci KB-72

46. The total energy of a closed system (i.e., a system which nothing enters or leaves) is:

a) conserved. b) annihilated. c) created. d) combusted. e) eviscerated.

SUGGESTED ANSWER: (a) This is the principle of conservation of energy. Is the universe as a whole a closed system? Is energy conserved in the universe as a whole?

Wrong answers:

e) Now does this seem likely?

Redaction: Jeffery, 2001jan01

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007 qmult 00030 2 1 1 moderate memory: energy necessity and sufficiency

Extra keywords: physci

47. Having enough energy for a given job or transformation that requires a certain amount of energy is _____, but **NOT** _____ for the job or transformation.

a) necessary; sufficient b) sufficient; necessary c) inevitable; necessarily so d) harmonious; ceremonious e) forbidden; a given

SUGGESTED ANSWER: (a) Given the wrong answers, I think this answer must inevitably and necessarily be the best.

Wrong answers:

b) The question says the job needs a certain amount of energy; thus having enough is necessary.

c) You don't have enough energy inevitably: the "not necessarily so" part is right.
e) "Not necessarily so."

Redaction: Jeffery, 2001jan01

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007 qmult 00050 1 1 1 easy memory: unit of energy, the joule
Extra keywords: physci
48. The SI unit of energy and of work is the:

a) joule (J). b) newton (N). c) kelvin (K). d) bassingthorp (B). e) trufflehunter (T).

SUGGESTED ANSWER: (a) Here's a versicle from the poem016.tex file:

The unit of energy is the joule
and this rhymes with drool,
but it should rhyme with bowel
to be correct for James Joule.

Wrong answers:
e) Trufflehunter was a character in the Narnia stories by C.S. Lewis: can't stand them any more myself.

Redaction: Jeffery, 2001jan01

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007 qmult 00200 1 1 3 easy memory: definition kinetic energy
Extra keywords: physci
49. Kinetic energy is:

a) the energy of position with formula KE= mgy. b) the energy of motion with formula KE= mgy. c) the energy of motion with formula KE= $(1/2)mv^2$. d) the energy of position with formula KE= $(1/2)mv^2$. e) heat energy.

SUGGESTED ANSWER: (c) There are plenty of clues.

Wrong answers:
a) The mgy is the potential energy of gravity near the Earth's surface.
e) Heat energy can be microscopic kinetic energy, but there are other forms of heat energy. When we just say kinetic energy, we are usually thinking of macroscopic kinetic energy.

Redaction: Jeffery, 2001jan01

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007 qmult 00220 2 5 4 moderate math: friction killing KE
Extra keywords: physci KB-95-9
50. A moving object has initial $KE = 100\,\mathrm{J}$ and is subjected to a friction force of 2 N and no other forces. How far does the object go before coming to a stop?

a) 100 m. b) 2 m. c) 1000 m. d) 50 m. e) 0 m.

SUGGESTED ANSWER: (d) Well in this case $W = Fd = \Delta KE$: i.e., work done equal changes in kinetic energy: F is the force and d is the distance it acts over. Thus

$$d = \frac{\Delta KE}{F} = \frac{-100}{-2} = 50\,\text{m} .$$

Wrong answers:
e) Not a good guess.

Redaction: Jeffery, 2001jan01

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007 qmult 00300 1 1 1 easy memory: definition power
Extra keywords: physci
51. Work per unit time or energy transformed per unit time is:

a) power. b) might. c) oomph. d) strength. e) pay.

SUGGESTED ANSWER: (a)

Wrong answers:
e) Not the best answer in this context.

Redaction: Jeffery, 2001jan01

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007 qmult 00302 1 5 3 easy thinking: sunlight power
Extra keywords: physci KB-99-17
52. If you could capture it all for useful work, the energy sunlight delivers to a square meter of ground would run several ordinary light bulbs. The power delivered by the Sun to a square meter of ground is of order:

a) 1 W. b) 10 W. c) 1000 W. d) 10^6 W. e) 1 MW.

SUGGESTED ANSWER: (c) The solar constant is the solar flux above the atmosphere: it is about 1370 W. At the ground I believe the Sun delivers about 700 W: this probably for a beam coming perpendicularly through the atmosphere, but I'm not sure.

Wrong answers:
a) C'mon, ordinary light bulbs require tens to hundreds of watts.
e) A megawatt is the same as 10^6 W.

Redaction: Jeffery, 2001jan01

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007 qmult 00400 1 3 1 easy math: work lifting ostrich
Extra keywords: physci KB-93-21
53. The work done on a 30 kg ostrich lifting it to a height of 30 m without acceleration is about:

a) 9000 J. b) 900 J. c) 300 J. d) 3 J. e) 4500 J.

SUGGESTED ANSWER: (a) Behold:

$$W = Fd = mgd \approx 30 \times 10 \times 30 = 9000\,\text{J} .$$

If there is no acceleration, then the upward force must just cancel gravity, and thus have magnitude mg.

I think that in practice, lifting an ostrich might take more work than this.

Wrong answers:

b) Maybe you forgot to multiply by g.

Redaction: Jeffery, 2001jan01

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008 qmult 00100 1 1 2 easy memory: potential energy definition

Extra keywords: physci

54. Potential energy is:

a) the energy of position: it exists for nonconservative forces.
b) the energy of position: it exists for conservative forces.
c) the energy of motion: its formula is PE= $(1/2)mv^2$.
d) the energy of position: its formula is PE= $(1/2)mv^2$.
e) heat energy.

SUGGESTED ANSWER: (b) There are plenty of clues.

Wrong answers:

e) Nah.

Redaction: Jeffery, 2001jan01

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008 qmult 00130 2 5 2 moderate thinking: mountain climber power output

Extra keywords: physci KB-95-7

55. A 100 kg mountain climber climbs 4000 m in 10 hours. What is his power output going into gravitational potential energy? What is his total power output?

a) 3.92×10^6 W and 3.92×10^6 W.
b) The power going into gravitational potential energy is 109 W. His total power output cannot be accurately calculated since a lot of power must go into waste heat due to frictional forces and also his body constantly radiates heat. All one can easily say is that 109 W is a **LOWER BOUND** on the total power output.
c) The power going into gravitational potential energy is 3.92×10^6 W. His total power output cannot be accurately calculated since a lot of power must go into waste heat due to frictional forces and also his body constantly radiates heat. All one can easily say is that 3.92×10^6 W is a **LOWER BOUND** on the total power output.
d) The power going into gravitational potential energy is 3.92×10^6 W. His total power output cannot be accurately calculated since a lot of power must go into waste heat due to frictional forces and also his body constantly radiates heat. All one can easily say is that 3.92×10^6 W is an **UPPER BOUND** on the total power output.
e) The power going into gravitational potential energy is 109 W. His total power output cannot be accurately calculated since a lot of power must go into waste heat due to frictional forces and also his body constantly radiates heat. All one can easily say is that 109 W is an **UPPER BOUND** on the total power output.

SUGGESTED ANSWER: (b)

Fortran Code

```
          print*
          xmass=100.
          gg=9.8
          hh=4.e+3
          tt=3600.*10.
          energy=xmass*gg*hh
          power=xmass*gg*hh/tt
          print*,'energy,power'
          print*,energy,power
    *             3920000.        108.8889
```

Wrong answers:
e) All things are wrong.

Redaction: Jeffery, 2001jan01

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008 qmult 00500 1 3 5 easy math: dog drops brick energy conserved
Extra keywords: physci

56. A brick has mass 1 kg. A dog (from a joke that some day I'll tell you) drops the brick (which it was holding in its mouth) 1 m. What is the kinetic energy of the brick just before it hits the ground? **HINT:** The calculator is superfluous.

    a) 9.8 watts. b) 9.8 gems. c) 9.8 newtons. d) 9.8 jowls. e) 9.8 joules.

    SUGGESTED ANSWER: (e) The potential energy at 1 meter of a 1 kilogram brick is 9.8 joules. If it drops 1 meter its potential energy becomes zero and its kinetic energy 9.8 joules by the conservation of mechanical energy.

    Wrong answers:
    d) James Prescott Joule (1818–1889) British physicist and brewer proved that mechanical, heat, and chemical energies were all different forms of the same thing within experimental uncertainty. He was one of the last of the great gentleman scientists. He actually pronounced his name jowl (rhymes with bowel), but in the interests of euphony we usually pronounce the unit named after him jool (rhymes with drool).

    Redaction: Jeffery, 2001jan01

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014 qmult 00304 1 1 1 easy memory: gravity law for two spheres
Extra keywords: physci

57. Given two spherically symmetric objects, the force of gravity between them _____ if their separation is doubled and _____ if one object's mass is doubled.

    a) decreases by 1/4; is doubled b) decreases by 1/2; is doubled c) is doubled; decreases by 1/2 d) decreases by 1/4; increases by 4 e) stays the same; stays the same

SUGGESTED ANSWER: (a)

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

Redaction: Jeffery, 2001jan01

Equation Sheet for Physical Sciences Courses

The equations are mnemonic. Students are expected to understand how to interpret and use them. Usually, non-vector forms have been presented: i.e., forms suitable for one-dimensional calculations.

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1 Geometry

$$C_{\text{cir}} = 2\pi r \qquad A_{\text{cir}} = \pi r^2 \qquad A_{\text{sph}} = 4\pi r^2 \qquad V_{\text{sph}} = \frac{4}{3}\pi r^3$$

$$c^2 = a^2 + b^2 \quad \text{Pyth.Thm.}$$

---

2 Kinematics

$$d = vt \qquad v_{\text{ave}} = \frac{d_{\text{final}} - d_{\text{initial}}}{t} \qquad v = at \qquad a_{\text{ave}} = \frac{v_{\text{final}} - v_{\text{initial}}}{t}$$

$$\text{Amount} = \text{Constant Rate} \times \text{time} \qquad \text{time} = \frac{\text{Amount}}{\text{Constant Rate}} \qquad a_{\text{centripetal}} = \frac{v^2}{r}$$

---

3 Dynamics

$$F_{\text{net}} = ma \qquad 1\,\text{N} \approx 0.225\,\text{lb} \qquad F_{\text{centripetal}} = \frac{mv^2}{r} \qquad p = mv$$

---

4 Gravity

$$F = \frac{Gm_1m_2}{r^2} \qquad F_g = mg \qquad v_{\text{circular}} = \sqrt{\frac{GM}{r}} \qquad v_{\text{escape}} = \sqrt{\frac{2GM}{r}}$$

$$G = 6.6742 \times 10^{-11}\,\text{MKS units (circa 2002)}$$

$$g = 9.80\,\text{m/s}^2 \quad (\text{latitude range } \sim 9.78030\text{–}9.8322\,\text{m/s}^2\ [\text{CAC-72}])$$

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5 Energy and Work

$$W = Fd \qquad 1\,\text{J} = 1\,\text{N}\cdot\text{m} \qquad P = \frac{W}{t} \qquad KE = \frac{1}{2}mv^2 \qquad PE_{\text{gravity}} = mgy$$

$$c = 2.99792458 \times 10^8\,\text{m/s} \approx 2.998 \times 10^8\,\text{m/s} \approx 3 \times 10^8\,\text{m/s}$$

$$E = mc^2 \qquad E_{\text{rest}} = m_{\text{rest}}c^2 \qquad \Delta t_{\text{proper}} = \Delta t\sqrt{1 - (v/c)^2}$$