Exam 1 (February 23, 2011)

Please read the problems carefully and answer them in the space provided. Write on the back of the page, if necessary. Show your work where requested in order to be considered for partial credit. In problems where you are requested to show your work, no credit will be given unless your work is shown.

Problem 1 (6 pts, no need to show work, circle best answer):

A "psychic" tells you that "Tonight, while you are sleeping, everything will double in size." This statement is

if you consider other quantities ... density for example

a) A scientific prediction that is certainly false.
b) A scientific prediction that is probably false because the experimental evidence will probably disprove it..
c) A nonscientific statement because it is based completely on guess-work.
d) A nonscientific statement because no experiment can check it to determine whether it is true or false.

if you consider lengths only

Problem 2 (6 pts, no need to show work, circle best answer):

According to Newtonian physics, an object with no forces acting on it must

a) fall.
b) eventually come to rest.
c) be at rest.
d) either be at rest or have constant velocity.
e) be accelerated, with an unchanging acceleration.

Problem 3 (6 pts, no need to show work, circle best answer):

Mary passes Mike from behind while bicycling. As she passes him,

a) the two have the same speeds but different velocities.
b) The two have different speeds but the same velocities.
c) The two have different speeds and velocities.
d) The two have the same speeds and the same velocities.

Problem 4 (6 pts, no need to show work, circle best answer):

A telecommunications satellite moves at a steady speed of 25,000 kilometers/hour in a circular orbit about the Earth. Is it accelerated?

a) Yes, because its speed is changing.
b) Yes, because its direction of motion is changing.
c) No, because its speed is unchanging.
d) No, because its direction of motion is unchanging.
e) No, because, with its height fixed, it is not falling toward Earth.

Scores
1. ___/6
2. ___/6
3. ___/6
4. ___/6
5. ___/6
6. ___/30
7. ___/5
8. ___/5
9. ___/10
10. ___/10
11. ___/10

_____

Total ___/100

Problem 5 (6 pts, no need to show work, circle best answer):

Blackbody radiation is

a) Electromagnetic radiation that is reflected from an object.
b) Electromagnetic radiation emitted by an object due to its temperature.
c) Electromagnetic radiation that passes through an object (leading it to appear black).
d) Electromagnetic radiation that is emitted by an object but not visible to the human eye.

Problem 6 (30 pts, no need to show work):

In the blank to the left of each statement, write "True" or "False" for statements that are true or false, respectively.

False ___ Blue light travels faster than red light in a vacuum.

True ___ Blue light with a wavelength of 4.7×10^{-7} meters has a higher frequency than red light (with a wavelength of 7×10^{-7} meters).

False ___ A car that hits a mosquito exerts more force on the mosquito than the mosquito exerts on the car.

True ___ The way in which waves add together is known as interference.

False ___ The way in which waves spread out after passing through a small opening is known as refraction.

False ___ The gravitational force between two objects depends linearly on the net electric charge of each object.

True ___ The force exerted on your feet by the floor when you stand is equal to your weight.

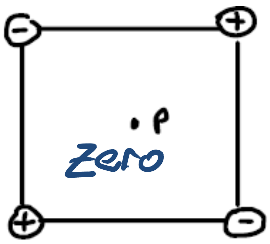
False ___ The force exerted on your feet by the floor when you stand is equal to your mass.

False ___ Two events at different spatial locations which happen at the same time in one reference frame will necessarily happen at the same time in all other reference frames.

True ___ The photoelectric effect can be understood by assuming light comes in little packets of energy.

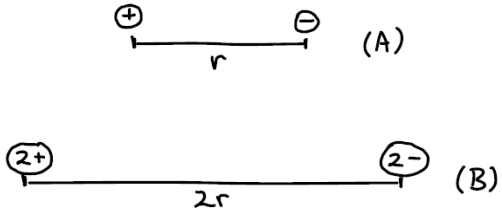
Problem 7 (5 pts, no need to show work):

Consider the situation sketched below. Four electric charges of equal magnitude are placed at the four corners of a square. The charges are arranged so that like-sign charges occupy opposite corners of the square as shown. Indicate on the drawing the direction of the electric field at point p in the center of the square. If there is no electric field at that point, write "zero" by point p.



Problem 8 (5 pts, no need to show work):

Consider the two situation, (A) and (B) sketched below. How does the magnitude of the force between the electric charges in case (A) compare to the magnitude of the force between the electric charges in case (B)?



IT is the same

$\frac{kq_1q_2}{d^2} \rightarrow \frac{k2q_1 2q_2}{(2d)^2}$

Problem 9 (10 pts, no need to show work):

Briefly defend (your choice of) the following statement(s):

The concept of intelligent design is (is not) a scientific theory.

I will defend "The concept of ID is NOT a scientific theory".
If you defend "is a scientific theory" grading will depend on how well you make the argument.

"The concept of ID is NOT a scientific theory."

Intelligent design is the idea that the physical constants of nature and the many characteristics of life are so very unusual and "fine-tuned" that it must mean the design is purposeful and springs from a form of higher intelligence. This is NOT scientific because there is no way to falsify the hypothesis.

Problem 10 (10 pts, no need to show work):

Briefly suggest/describe a scientific experiment aimed at supporting/falsifying the ideas espoused by astrologers.

This might be somewhat difficult because astrological predictions tend to be rather fuzzy. But, in general, astrologers predict behavior based on the position of the stars at birth. One could study the behavior/characteristics of a large sample of people and show there is no significant difference shown among samples segregated by astrological sign.

Problem 11 (10 pts, no need to show work):

Briefly discuss what might lead to a "computational multiverse."

A society has advanced computing resources and develops Artificial intelligence. Members of this society simulate a universe with intelligent beings that develop simulated universes with intelligent beings in the simulation that develop simulated ... and so forth.

Some potentially useful formulas

$F = \frac{G m_1 m_2}{r^2}$ (m_1 and m_2 in kg, r in meters) $\rightarrow G = 6.7 \times 10^{-11}$

$F = \frac{k q_1 q_2}{r^2}$ (q_1, q_2 in Coulombs, r in meters) $\rightarrow k = 9 \times 10^9$ in both cases, Force comes out in Newtons

$F = ma$

(distance) = (speed)(time)

$v = \frac{\Delta x}{\Delta t}$

$a = \frac{\Delta v}{\Delta t}$

work = force x distance

Momentum = $p = mv$

$\Delta x' = \gamma \Delta x$, length longest in proper frame

$\Delta t' = \gamma \Delta t$, time shortest in proper frame

$\gamma = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}$

1 Joule = 1.6×10^{-19} eV

speed of sound = 330 M/s

$c = 3 \times 10^8$ M/s

$v = \lambda \nu$

$\nu = \frac{1}{T}$ (T = period)

gravitational force at Earth's surface

$F = mg$ where

$g = \frac{G M_E}{R_E^2} = 9.8$ M/s^2