PHYSICS 6 Practice Final Exam (2003) SOLUTIONS

I. 1e ; 2c; 3a; 4b; 5c; 6b; 7c; 8d; 9e; 10d

II. a) distance = v(horiz) t

so t = d/v(horiz) = 200 Km/ 1 (Km/s) = **200 sec**

b) reach max ht in half the total time or 100 sec

c) max ht = ½ g t^2 = $0.5\times9.8(m/s^2) \times (100\ s)^2$ = 4.9×10^4m =49 Km

d) Consider the clock on the ground at the time of impact. It reads 200 sec. According to the rocket, that clock is moving and runs slow. The corresponding rocket clock will read $t \times \gamma = t \div \sqrt{(1-v^2/c^2)} = 200 \div \sqrt{(1-(0.8)^2)}$ = 200/0.6 =330 sec

e) distance measured by the rocket is contracted

= d/ γ = 200 Km $\times$ 0.6 = 120 Km

III. a) E_n = -13.6 eV / n^2 so E_3 = - 13.6/9 eV and E_1 = -13.6 eV

Then E(photon) = -13.6 $\times$ (1/9 – 1) = 12.1 eV

b) E(photon) = h f , so f = E(photon)/h = 12.1eV/4.1x10^{-15} eV·s =

2.95×10^{15} s^{-1}

c) 1 Watt=1 J/s. To get 1 Joule of photon energy note that

1 Joule=$(1/1.6\times10^{-19})$eV = 6.25×10^{18} eV

Then have number of photons is

6.25×10^{18}eV/(12.1 eV/photon) = 5.17×10^{18} photons per sec.

IV. a) Dow went up 27 times in 53 days, or prob=27/53=0.509 to go up in one day.

b) Up, up, up is one combination out of 8 possibilities in 3 days, so
if up and down had same probability the result would be
prob=$(1/2)^3$=1/8
BUT they have different probabilities so prob $(0.509)^3$=0.13 = 13%
(This is the same as using the formula n!/((n-k)!k!) $p^k(1-p)^{n-k}$ with n=3, k=3.)

c) To go up only once in 3 days there are 3 combs in 8 possibilities, so again, if up and down were equal probabilities the result would be 3/8.
But with different probabilities for up and down
prob=3 $\times$ $(0.509)^1 \times (0.491)^2$ = 0.37 = 37%
(Note that 1-0.509=0.491 is the prob of Dow on a single day not going up or prob to go down.)
(This is the same as using the formula n!/((n-k)!k!) $p^k(1-p)^{n-k}$ with n=3, k=1.)

V. a) 500 MegaWatt=5.0×10^8 Watt = 5.0×10^8 J/s

In 1 year E=5.0×10^8 (J/s) $\times$ 3.2×10^7s = 1.6×10^{16}J

b) 1.6×10^{16}J / 1.6×10^{-13} (J/MeV) = 1.0×10^{29} MeV

c) The fission reactions need to produce that amount of electrical energy, but because of 20% efficiency the reactions actually need to provide 1/0.20 = 5 times more energy or 5.0×10^{29} MeV. Then need

5.0×10^{29} MeV / (200 MeV/reaction) = 2.5×10^{27} reactions

d) 2/3 of reactions form Pu239 or 1.7×10^{27} Pu nuclei formed.

That is $1.7\times10^{27}/6.0\times10^{23}$ = 2.8×10^3 moles

0.239 Kg in one mole, so $0.239\times2.8\times10^3$=670Kg of Pu239.

e) Activity=$(0.69/T_{1/2})$ N

$T_{1/2}$=2.44×10^4yr $\times$ 3.2×10^7s/yr=7.8×10^{11}s

So Activity=$(0.69/7.8\times10^{11}s) \times 1.7\times10^{27}$ decaying Pu nuclei

= 1.5×10^{15}(decay/sec)/(3.7×10^{10}decay/sec/Ci)

= 4.1×10^4 Ci (that is a huge activity)