PHONE:____________________

SAFETY QUESTIONNAIRE FOR CERTIFICATION OF X-RAY DIFFRACTION USERS

NAME ______________________ DEPARTMENT ______________ DATE ________

This questionnaire is based on the 1982 Stanford University Radiation Protection Manual. Please complete and bring to the Health Physics Office on Oak Road room 41 for correction and certification. Please direct any questions to Health Physics by calling Sorcha Dennison ext. 3-4723.

True/False

1. ___Units of exposure, absorbed dose, and dose equivalent are R,rad, and rem, respectively.

2. ___Under identical conditions (mA and kV) a copper target would produce a higher intensity X-ray beam than a tungsten target (use Lindell formula).

3. ___Stanford requires all users of X-ray diffraction machines to wear film badges and finger ring dosimeters.

4. ___The average dose equivalent received by personnel in the San Francisco Bay Area from natural background is about 100 mrems per year and from medical exposures is also about 100 mrem per year.

5. ___The average dose equivalents received by inhabitants of the U.S. for one year for the following categories are as follows:

   from natural background is about 82 mrem per year
   from medical exposures is about 92 mrem per year
   from nuclear weapons fallout is about 5 mrem per year
   from nuclear energy use is less than 1 mrem per year
   from TVs and such is about 0.5 mrem/year
   from air travel (cosmic radiation) is about 0.5 mrem per year

6. ___On balance the GM (GSM1) survey meter is the best instrument for surveying for small radiation leaks from XRD machines.

7. ___Below 6 keV photon energy even the thin windows of the "G-M"survey meter and the Ion-chamber instruments severely attenuate the readings so they cannot be regarded as being reliable.

8. ___A cataract can be caused by an absorbed dose of as low as 225 rads.

9. ___At a distance of 4 feet from a radiation source, a meter reading of 10 mR/hour was observed. At 8 feet neglecting air attentuation and scattering the meter will read 2.5 mR/hour.

10.___You may bypass an interlock to complete an experiment.

11.___The lead shielding around an XRD machine may be removed or re-arranged at any time.

12.___Should you notice an unsafe condition or operation you are required to notify the Project Director and Health Physics.

13.___Only those procedures specified by the manufacturer should be used, unless an alternate has been approved by Health Physics.

14.___State and Federal regulations require that each person working with sources of ionizing radiation be familiar with the hazards to which they may be exposed.

15.___Stanford requires that the leakage radiation at the edge of all XRD machine tables as measured with an "GM" detector be less than 0.2 mR/hour.

16.___An authorized user wishes to leave a running XRD machine unattended for awhile in an empty room.. This wish can be fulfilled if all of the following conditions are met: (1) a survey is made and the leakage radiation is found to be <0.2 mR/Hr. (2) an entry of its use is made in the log book, and (3) the room is locked.

Fill-in

17. Estimate the exposure rate given the following values of the parameters: (1) 30 kV; (2) 30 mA; (3) copper target Z=29; (4) distance 20 cm.
Answer: _______________ R/sec.

18. At a distance of 6 feet from the radiation source, and exposure rate of 120 mR/hour was measured. Neglecting scattering and air attenuation find the exposure rate at 12 feet.
Answer:________________ mR/hour.

19. A ionization chamber has an effective end face area of 60 sq. cm. If an incident X-ray beam has an effective area of 10 sq. cm. and reads an exposure rate of 10 mR/hour what is the true rate?
Answer:________________ mR/hour.

Multiple Choice: Check the best single answer with a check mark

20. Scattered radiation from a sample set up in an XRD unit:

a changes with sample angle

b must be checked with a survey meter after any changes
c may require shielding
d all of the above

21. Given the density of air as 0.0012 gram/cubic cm the correction factor for the attenuation (I_o/I) of 10-keV photons in air over a 2-meter path is about which one of the following values:

(See Appendix D-1-b)

a 1.005
b 1.8
c 3.3
d 10
e 100

22. The minimum legal age for a radiation worker is:

a 16 years
b 18 years
c 21 years
d 25 years

23. The "G-M" counter has the following deficiencies for measuring X-radiation:

a its response is strongly energy dependent
b it is subject to counting-rate loss
c it may jam or become paralyzed
d its calibration at low energy is generally unknown
e it has all of the above disadvantages

24. A mass energy absorption coefficient is useful for calculating:

a shielding thickness
b absorbed dose
c attenuation of photon energy
d leakage radiation
e the best X-ray target

25. The temporary loss of hair growth by exposure to X-radiation is regarded as:

a no problem
b an irreversible effect
c a conditional reversible effect
d a reversible effect
e none of the above

26. A small amount of radiation exposure from work related activities or from medical x-rays is:

a dangerous
b helpful
c unnecessary
d justifiable if accompanied by a reasonable benefit
e something to be avoided at all costs

27. An hypothetical exposure to a finger lasts one second to an X-ray beam 2 cm from the source (50 kV, 20 mA, W target). The exposure is estimated from the Lindell formula to be __________R.

Which one of the following effects is most likely to occur as a result of the exposure?

a a hole through the finger
b a reddening of the skin
c need for amputation of the finger
d a wound which would not heal
e no effect

28. A correction is required for finite X-ray beam size when the beam is:

a smaller than the instrument
b larger than the instrument
c the same size as the instrument
d of very low energy
e uniform over the instrument

29. Examples of a quantity is <u>distance</u>. The corresponding unit could be <u>mile</u>. Indicate which one of the following items is a unit.

a exposure rate
b absorbed dose
c dose equivalent
d flux density
e rad

30. Pigmentation of the skin after exposure to X-radiation is a sign of:

a a reversible change
b cancer
c erythema
d loss of production of sebum
e a conditional reversible change

31. An erythema can be produced by an X-ray exposure of as low as:

a 5 R
b 50 R

c 100 R
d 500 R
e 1000 R

32. Check the most correct statement. The transmissivity of an X-ray beam through an absorber:

a is exp(-u.x) where u is the linear attenuation coefficient (1/cm) and x is the thickness of the absorber in cm
b is the fraction of the photons left in the beam
c is useful to calculate in the evaluation of shielding
d is exp(-u/rho.x.rho) where u/rho is the mass attenuation (sq cm/gram) and x.rho is the thickness (gram/sq cm)
e all of the above

33. Stanford requires that your film badge and finger rings be returned for processing:

a weekly
b monthly
c quarterly
d semiannually

34. Choose the most correct statement:

a a "G-M" counter comes closer to measuring photon flux density (photons/cm2-sec) than it does in measuring exposure rate (mR/hour).
b an ionization chamber calibrated with a Cs137 source (662 keV) has the same calibration constant for measuring exposure rates at an energy of 40 keV.
c the small size of a "G-M" counter is an advantage over an ionization chamber in looking for small radiation leaks
d all of the above

35. The quality factor (QF) for X-rays is usually:

a 1
b 2
c 5
d 10
e 20

36. Mark the statement which is not true:

a the Stanford Guideline limit for whole body exposure of radiation workers is 500 mrem/year
b the State limit for whole body exposure of radiation workers is 5000 mrem/year

c small amounts of radiation are regarded as harmless
d a unit of dose equivalent is the rem

37. The incident beam intensity is best expressed in units of:

a rads
b rems
c Roentgens
d MeV/cm2-sec

38. Suppose the average natural background rate in the U.S. for some reason increased from 100 mrem/year to 200 mrem/year. Using the cancer risk factor of 1 per 3000 per rem per person estimate the increased rate of cancer incidence in a population of 230,000,000 people. Which answer is correct?

a 80 cases
b 800 cases
c 8000 cases
d 80000 cases

39. Each user shall maintain current utilization logs containing the following information:

a the name of the operator
b the dates of each use
c the magnitudes of the voltage and current
d the start and stop times
e all of the above

40. An <u>authorized</u> user of an XRD machine is best described by which of the following statements:

a User is certified by Health Physics as having satisfactorily passed a general safety examination on XRD machines.
b User has permission to use a particular XRD machine by the project director of the CRA involved.
c User customarily wears film badges and finger rings assigned to the project.
d User follows posted safety procedures and has read the latest CRA renewal document including machine surveys and compliance of project personnel with safety procedures.
e All of the above.

41. The whole body dose limit for one week for a radiation worker according to the Stanford University Guideline is about:

a 1 mrem
b 2 mrem
c 10 mrem

d 50 mrem

42. The following action should be taken with the end cap of an ionization chamber when surveying an XRD unit.

a the cap should be left on to absorb background beta radiation
b the cap should be left on to protect the thin end window
c no action, because the cap is transparent to X-radiation
d remove the cap, proceed with the survey, making sure that the hand holding the instrument is not exposed to high intensity radiation.

43. The dose limit for whole body exposure of a member of the general public to radiation is which one of the following fractions of a maximum permissible legislated dose for occupational workers?

a 1/10
b 1/20
c 1/50
d 1/100

44. The annual severe injury rate per 100 XRD units is about

a 0.5
b 1
c 2
d 3

45. An ionization chamber is exposed to a beam of X-rays and reads 2 mR/hr. Which of the following expressions is correct?

a if the beam area is equal to the end-face area the exposure rate is 2 mR/hr.
b if the beam area is equal to or greater than the end-face area the exposure rate cannot be determined.
c the reading could be wrong because of high ionic recombination
d if the beam area is less than the end-face area the exposure rate is less than 2 mR/hr

46. Stanford requires all XRD machine users to comply with which of the following:

a wear film badges and finger rings.
b posting of warning signs, emergency procedures, and a copy of the last health physics survey.
c survey by the operator after a new setup.
d all of the above.

47. Please mark any incorrect statement(s) in the following regarding the use of personnel dosimeters (film badges and finger rings).

- a A personnel dosimeter should be processed immediately whenever a serious exposure is suspected.
- b A personal dosimeter assigned to one individual may be used by another individual.
- c Failure of employees to wear dosimeters in areas where they are required will result in appropriate disciplinary action.
- d A personnel dosimeter assigned to an individual may be used to monitor radiation exposure in an area near an X-ray machine when the individual is not actually present in that area.