PH203 Phase Line Writ 1, Fall 2005 Name: Answers
Lesson 9 / 100 Marks / 30 Minutes Section _____ A Hour

Authorized References: Calculator, Physics Reference Card

Wt. No.

10 1. A convex spherical mirror has a focal length of 12.0 cm. An object is placed 6.00 cm away from the mirror on the central axis. Calculate the image distance.

ANS: -4.00 cm

10 2. When ^{214}Po (Z = 84) undergoes alpha decay, it must transform to

a. ^{214} Po (Z = 84).
b. ^{210} Pb (Z = 82).
c. ^{214} At (Z = 85).
d. ^{218} Po (Z = 84).
e. ^{210} Bi (Z = 83).

10 3. Assuming that the mass of a radioactive sample is doubled, from the list below, circle all that apply.

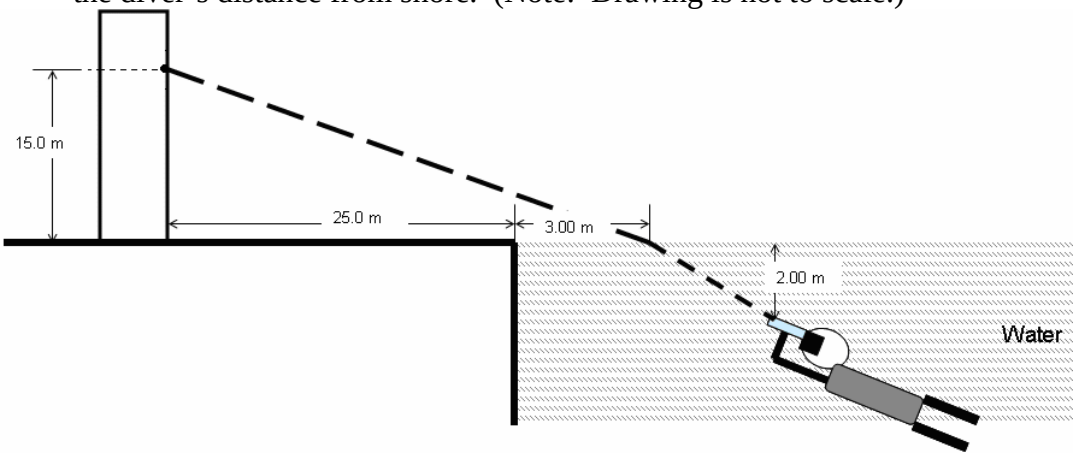
a. The activity increases.
b. The activity decreases.
c. The activity remains the same.
d. The disintegration constant increases.
e. The disintegration constant decreases.
f. The disintegration constant remains the same.

10 4. In a particular nuclear reaction, an isotope with initial mass of 235.0439 u fragments into fission products with a total final mass of 233.8117 u. Calculate the disintegration energy of the above reaction.

ANS: 1147.8 MeV

Wt. No.

60 5. A diver is using a laser designator to illuminate a target from a position 2.00 m below the surface of the water. The target is a point on the building. The target is 15.0 m above the ground and 25.0 m from the shore. The laser exits the surface of the water 3.00 m from the shore and strikes the target point. Assume that the index of refraction for air is 1.00 and that the index of refraction for water is 1.33. Calculate the diver's distance from shore. (Note: Drawing is not to scale.)



ANS: 4.77 m

Bonus (5 marks): The diver also has a light that acts like a point source, sending off light in all directions. Assuming that the light source is at a depth of 2.00 m, what is the diameter of the circle on the surface through which the light can be seen by an observer above the water?

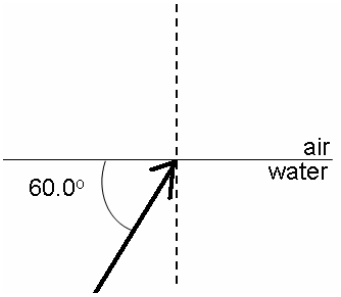
ANS: 4.56 m

PH203 Phase Line Writ 1, Fall 2005 Name: ANSWERS
Lesson 9 / 100 Marks / 30 Minutes Section _____ C Hour

Authorized References: Calculator, Physics Reference Card

Wt.	No.	
10	1.	Light is incident at the air surface as shown in the diagram below. Assuming that $n_{water} = 1.33$ and $n_{air} = 1.00$, calculate the angle of refraction.

ANS: 41.7^{o}



10 2. An object is located on the central axis of a spherical mirror. The lateral magnification is -3. This means that

a. its image is real, inverted, and on the same side of the mirror.
b. its image is virtual, upright, and on the opposite side of the mirror.
c. its image is real, upright, and on the same side of the mirror.
d. its image is real, inverted, and on the opposite side of the mirror.
e. its image is virtual, inverted, and on the opposite side of the mirror.

10 3. When ^{177}Ir (Z = 77) undergoes decay, it transforms to ^{173}Re (Z = 75) and

a. a neutron.
b. an alpha particle.
c. a deuteron. (^{2}H)
d. a gamma particle.
e. two beta particles.

10 4. The decay constant for ^{98}Nb is 1.35×10^{-2} min^{-1}. Calculate the half-life of ^{98}Nb.

ANS: 51.3 min

Wt.	No.	
60	5.	A possible fission reaction involving ^{235}U is shown below.

$$^{235}U + n \rightarrow {}^{140}Ce + {}^{94}Zr + 2n$$

Calculate the mass of ^{235}U necessary to yield a 15.0 kT detonation rating. Assume that only 1.25% of the ^{235}U fissions and that all fission reactions are the same as the one above.

Some masses and the rating conversion that you may find useful are listed below.

^{235} U: 235.0439 u	^{140} Ce: 139.9054 u
^{94} Zr: 93.9063 u	$1kT = 4.19 \times 10^{12}$ J

ANS: 58.8 kg

Bonus (5 marks): Define critical mass.

The mass of fissionable material required such that each fission induces an average of one subsequent fission.

PH203 Phase Line Writ 1, Fall 2005 Name: ANSWERS
Lesson 9 / 100 Marks / 30 Minutes Section _____ G Hour

Authorized References: Calculator, Physics Reference Card

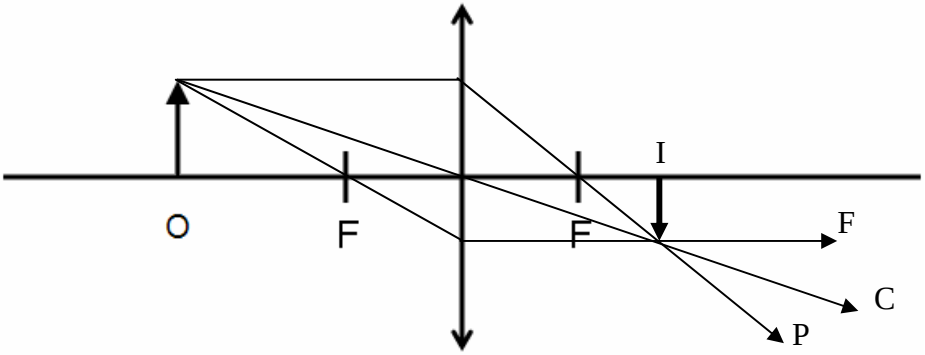
Wt.	No.	
10	1.	^{210}Bi (an isotope of bismuth) has a half-life of 5.01 days. Calculate the time for three-quarters of a sample of ^{210}Bi to decay. ANS: 10.0 d
10	2.	You observe that as monochromatic light travels from one medium to another, it is bent farther away from the normal. You conclude that a. the speed of light has decreased in the new medium. b. chromatic dispersion must occur. c. the second medium has a larger index of refraction than the first. d. the second medium has a smaller index of refraction than the first. e. no change in speed has occurred.
10	3.	There are four samples of radioactive material listed below. For the given activity and disintegration constant, which sample contains the greatest amount of atoms? a. Sample A: 6.00 Bq (λ = 2.00 y^{-1}). b. Sample B: 4.00 Bq (λ = 4.00 y^{-1}). c. Sample C: 2.00 Bq (λ = 6.00 y^{-1}). d. Sample D: 1.00 Bq (λ = 8.00 y^{-1}) e. There is not enough information.
10	4.	A soldier receives a dose equivalent of 151 mSv of neutron radiation with a relative biological effectiveness of 9.00. Calculate the soldier's absorbed dose. ANS: 16.8 mGy

Wt.	No.	
60	5.	Using a converging lens, you project an inverted image onto a screen. The height of the image is 7.50 m. You note that the height of the object is 21.3 mm and the focal length of the converging lens is 9.00 cm. The lens is housed in a projector with mass 20.5 kg.

(45) a. Calculate the distance from the projector to the screen.

ANS: 31.8 m

(15) b. Draw the 3-ray diagram for the scenario described above.



Bonus (5 marks): The most common radium isotope found on Earth, ^{226}Ra, has a half-life of about 1600 years. If the Earth was formed well over 10^9 years ago, why is there any radium left now?

There is ^{226}Ra remaining now because ^{226}Ra is the byproduct of the radioactive decay of numerous larger nuclei.

PH203 Phase Line Writ 1, Fall 2005 Name: ANSWERS
Lesson 9 / 100 Marks / 30 Minutes Section _____ I Hour

Authorized References: Calculator, Physics Reference Card

Wt.	No.	
10	1.	The index of refraction of benzene is 1.81. Calculate the critical angle for a benzene-air interface.

ANS: 33.5^{o}

10	2.	Select the statement below that most accurately describes the decay constant for the following nuclear disintegration: $A \rightarrow B$.

a. The decay constant depends solely on the initial number of *A*.
b. The decay constant depends solely on the initial number of *B*.
c. The decay constant is an exponentially increasing function of time.
d. The decay constant is an exponentially decreasing function of time.
e. The decay constant does not depend on the initial number of *A* or *B*. Rather; it is a characteristic value for the radionuclide *A*.

10	3.	A generic fission event for ^{235}U (Z = 92) is $^{235}\text{U} + \text{n} \rightarrow X + Y + 2\,\text{n}$. Which of the following pairs cannot represent *X* and *Y*? (Circle all that apply.)

a. ^{156}Nd (Z = 60) and ^{79}Ge (Z = 32)
b. ^{121}In (Z = 49) and ^{113}Ru (Z = 44)
c. ^{139}Cs (Z = 55) and ^{95}Rb (Z = 37)
d. ^{141}Xe (Z = 54) and ^{93}Sr (Z = 38)
e. ^{140}I (Z = 53) and ^{94}Rb (Z = 37)

10	4.	The magnitude of the focal length of a diverging lens is 10.0 cm. You place an object 20.0 cm from the lens. Calculate the image distance.

ANS: -6.67 cm

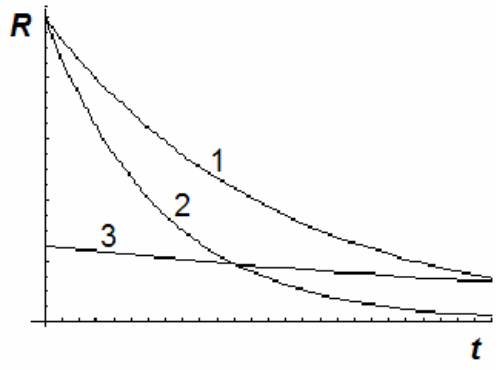
Wt.	No.	
60	5.	SPC Snuffy, an 83.0-kg soldier in your platoon, accidentally ingests 3.15 mg of ^{90}Sr dust. You recall that ^{90}Sr decays by beta emission with a decay constant of 2.44 x 10^{-2} y^{-1} and has a mass of 89.9077 u. Assume that all the ^{90}Sr resides in the soldier's body for 3.00 days and that all emitted beta particles are absorbed within the body.
(30)		a. Calculate the number of ^{90}Sr atoms that decay during the 3.00 days.

ANS: 4.23 x 10^{15} atoms

(30) b. Assume your answer for part a is 2.00 x 10^{12} atoms. The energy of the emitted beta particles is 0.544 MeV with an RBE factor of 1. Calculate SPC Snuffy's absorbed dose.

ANS: 2.10 x 10^{-3} Gy

Bonus (5 marks): The graph shows the activity *R* as a function of time *t* for three radioactive samples. Rank the samples according to their half-lives, shortest to longest.



2, 1, 3 ANS