PH203 Phase Line Writ 1, Fall 2004 Name: _____
Lesson 9 / 100 Marks / 30 Minutes Section _____ A Hour

Authorized References: Calculator, Physics Reference Card

Wt.	No.	
50	1.	While leading a patrol in Baghdad, your platoon occupies an abandoned hospital. You enter the radiology department and find an old radiation therapy machine. The data tag on the machine indicates that the radiation source is a mass of ^{60}Co. The ^{60}Co source had an initial mass of 0.833 kg when the machine was manufactured 27.4 years ago. From PH203, you remember that ^{60}Co emits two gamma rays with an average energy of 1.25 MeV per gamma ray as it decays. The half-life of ^{60}Co is 5.27 years, and its atomic mass is 59.9338 u. Calculate the present activity of the ^{60}Co.

$R = \underline{\underline{9.50 \text{ x } 10^{14} \text{ Bq}}}$ ANS

Wt.	No.	
50	2.	Your vertical construction engineer platoon is completing the renovation of the post CIF facility. A particular hallway contains a 90° turn. To allow someone approaching the hallway to see anyone coming around the corner from the other direction, you plan to position a spherical convex mirror in the outer corner of the turn. You find such a mirror in an old storage room, and attempt to determine its optical properties. When you stand 3.56 m away from the mirror along its central axis, your image appears to be ¼ your height.

(40) a. Calculate the focal length of the mirror.

$f = -1.19$ m ANS

(10) b. Calculate the mirror's radius of curvature.

$r = -2.37$ m or 2.37 m ANS

Bonus (5 marks): Describe chromatic dispersion.

The index of refraction of any medium depends upon the wavelength of light. A light beam consisting of several wavelengths will be refracted at multiple angles by a surface; the different colors of the light beam spread out due to refraction at the surface of the two different media.

PH203 Phase Line Writ 1, Fall 2004 Name: _____
Lesson 9 / 100 Marks / 30 Minutes Section _____ C Hour

Authorized References: Calculator, Physics Reference Card

Wt.	No.	
50	1.	While leading a patrol in Baghdad, your platoon occupies the radiology department inside an abandoned hospital. While clearing one of the rooms, one of your soldiers discovers an unshielded radioactive object. Concerned about the radiation dose the soldier likely received from the radioactive object, you evacuate the soldier to a field hospital. The soldier is examined by a doctor 128 minutes after being exposed to the radiation. The doctor estimates that the soldier of mass 72.6 kg received a whole body absorbed dose of 23.5 mGy.

(30) a. Calculate the amount of energy the soldier absorbed.

$\underline{\underline{E = 1.71\,\text{J}}}$ ANS

(10) b. The doctor indicates that the soldier was irradiated by gamma rays with an RBE of 1.21. Calculate the dose equivalent that the soldier received.

$\underline{\underline{H = 0.0284\,\text{Sv}}}$ ANS

(10) c. If the soldier had been wearing MOPP IV gear when exposed to the gamma radiation, would the soldier's absorbed dose or the dose equivalent be significantly changed? Justify your answer.

No, the absorbed dose and the dose equivalent would not significantly change. Gamma rays are very penetrating and would easily pass through the MOPP gear, causing the same amount of biological damage to the soldier.

Wt.	No.	
50	2.	While helping your platoon unload wooden crates of 5.56 mm ammunition, you get a splinter in the palm of your hand. You use a magnifying glass to view the splinter such that the splinter's length is perpendicular to the central axis of the lens. The lens has a mass of 127 g and a focal length of 21.0 cm. You hold the magnifying glass 10.4 cm from your palm in order to see the splinter.

(5) a. Is a magnifying glass a converging or diverging lens?

Converging

(45) b. The magnifying glass creates an image of the splinter with a height of 1.17 cm. Calculate the length of the sliver.

$\underline{\underline{h = 0.591\,\text{cm}}}$ ANS

Bonus (5 marks): List the four conditions that must be satisfied in order for a fission bomb to function.

1) The bomb must contain a neutron source
2) The nuclear fuel must be fissionable
3) Each fission event must produce more neutrons than it consumes
4) The bomb must use the released neutrons efficiently so that each fission induces an average of more than one subsequent fission

PH203 Phase Line Writ 1, Fall 2004 Name: _____
Lesson 9 / 100 Marks / 30 Minutes Section _____ G Hour

Authorized References: Calculator, Physics Reference Card

Wt.	No.	
50	1.	An Army compass uses the decay of tritium to illuminate the compass needle. Tritium is a hydrogen atom with two neutrons in its nucleus. Tritium has an atomic mass of 3.016049 u and decays with a half-life of 12.33 years. Calculate the binding energy of tritium.

$\Delta E_{be} = 8.4821\,\text{MeV}$ ANS

Wt.	No.	
50	2.	Your engineer platoon at Fort Riley, Kansas is building a bridge over a small stream that is 56.8 cm deep. One of your soldiers drops a bolt into the water. From your location 1.24 m above the water's surface, you see the bolt while looking down at an angle of 34.6° with respect to the horizontal. The index of refraction for air is 1.00 and for water is 1.33.

(30) a. Calculate the angle of incidence at the air-water boundary for the light you see reflected from the bolt.

$\theta_1 = \underline{\underline{38.2^\circ}}$ ANS

(10) b. Calculate the minimum angle at which total internal reflection will occur at the water-air interface.

$\theta_c = \underline{\underline{48.8^\circ}}$ ANS

(10) c. Calculate the speed at which light travels in the water.

$v = \underline{\underline{2.25 \text{ x } 10^8 \frac{\text{m}}{\text{s}}}}$ ANS

Bonus (5 marks): List five characteristics of a nuclear explosion.

1) Fireball 2) Blast wave 3) Radioactive cloud 4) Electromagnetic pulse 5) Fallout

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Lesson 9 / 100 Marks / 30 Minutes Section _____ I Hour

Authorized References: Calculator, Physics Reference Card

Wt.	No.	
50	1.	You are a medical service officer concerned about the radiation effects casued by the armor of an M1A2 Abrams tank, which incorporates ^{238}U in the metal. ^{238}U decays with a half-life of 4.468×10^9 years according to the following reaction:

$$^{238}U \rightarrow {}^{234}Th + {}^{4}He$$

The disintegration energy of this decay is 4.27007 MeV. ^{238}U has an atomic mass of 238.05078 u and the helium atom has an atomic mass of 4.0026032 u. Calculate the mass of the ^{234}Th in atomic mass units.

$\underline{\underline{m_{^{234}Th} = 234.04 \text{ u}}}$ ANS

Wt.	No.	
50	2.	You are a public affairs officer at Fort Riley, Kansas. The post is planning a formal dinner event to honor the mayor of Manhattan, Kansas. While attending the dinner, you approach the mayor to take her picture for publication in the local newspapers. Your camera has a converging lens with a focal length of 50.0 mm. The mayor is 181 cm tall, and you are 177 cm tall. Calculate the distance in meters that the mayor must stand from the camera lens in order to create an image on the film that is 30.0 mm high.

$p = 3.07$ m ANS

Bonus (5 marks): Describe the nature of an image formed by a convex spherical mirror for all object locations relative to the focal length. Include the relative size of the image, whether the image is real or virtual, and its orientation.

The image is smaller, upright and virtual for all object locations