UNIVERSITÄT
DUISBURG
ESSEN

Prof. H. Franke
Angewandte Physik
ISE Physics 2010

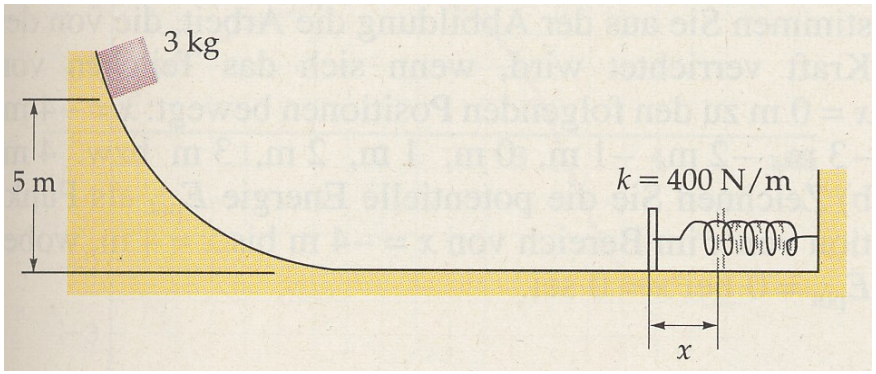
problems for the course „physics“ 20.08.10 14.00 – 16.00Uhr
maximum amount of points : **50**
allowed are max. 2 DINA4 pages with notes on both sides
no mobile phones in “on”mode!

constants:	$c = 3 \cdot 10^8$ m/s	$m_p = 1.0073$ u
	$e_o = 1.6 \cdot 10^{-19}$ As	$m_n = 1.0087$ u
	$g = 9.81$ m/s²	$h = 6{,}626 \cdot 10^{-34}$ Js
	$m_e = 9.109 \cdot 10^{-31}$ kg	$1u = 1.66054 \cdot 10^{-27}$ kg

Problems (40points) A

Problem 1: (5 points)

A body with mass m=3kg is released from a height h=5m on a curved, frictionless surface. At the end there is a spring with a spring constant k=400N/m. The body moves along the slope and compresses the spring about a distance x before changing its moving direction.
a) Determine x.
b) Describe what happens after the spring is compressed and the body is at rest for a short time.



Problem 2: (6 points)

During the Tschernobyl accident in 1986 the isotope ^{137}Cs was released. The half-life time is 30 years. The activity of a small sample is at the beginning about $A_0 = 10^6$ Bq.
(a) How is the activity after 75 years?
(b) When will the activity of ^{137}Cs reach 5 % of its initial value?

Problem 3 (5 points)

A 10 g bullet is fired into a 1000 g wood block that hangs from a 100 cm long string. The bullet embeds itself into the block, and then swings out to an angle of 30°. What is the speed of the bullet?

Problem 4 (6 points)

A sinusoidal wave with an amplitude of 2 cm and a frequency of 70 Hz travels at 140m/s in the positive x-direction. At t=0 s, the point x=1m is on the crest of the wave.
a) Determine A, v, λ, k, f, ω, T, and ϕ_0 for this wave.
b) Write down the equation for the wave’s displacement as it travels.
c) Draw a snapshot graph of the wave at t=0 s

Problem 5: (5 points)

An object is 100 cm from a screen. What are the radii of a symmetric converging plastic lens (n=1,49) that will form an image on the screen which is three times the height of the object? Make a drawing!

Problem 6: (5points)

The external photo effect is measured in an experiment using light with λ=220nm and an unidentified metal. For an opposite voltage of U = –1,85 V the photocurrent could be compensated. Calculate first the energy of one photon and then the value of the work function Φ from these data!

Problem 7: (8 points)

An airplane starts with an acceleration of $a_1 = 5$ m/s^2. After $t = 45$ s, a_1 changes to $a_2 = 2{,}5$ m/s^2 for another $t = 45$ s.

a) How fast is the airplane now?
b) The airplane flies now with a constant velocity from above for one hour. How far is it away from its starting-point?
c) Now cross wind blows with $v_{cw} = 25$ m/s from the right side of the flight direction (south to north). How much is the total velocity? Use vectors.
d) Which angle has the pilot to steer in order to get straight to the north?

Flight direction:south to north
Wind blows from east to west

Questions (10 points)

Question 1: (3 points)
Name the three Newton's laws and explain them.

Question 2: (1 point)
Define a standing wave.

Question 3: (1 point)
When does total reflection occurs?

Question 4: (1 point)
A 75kg man weighs himself at the north pole and at the equator. Which scale reading is higher? Why?

Question 5: (1 point)
What is the length of a mathematical pendulum when it's period is 4s?

Question 6: (2 points)
Please tell the quantum numbers and explain them.

Question 7: (1 point)
Does the frequency of a approaching siren increase or decrease?

Good luck!

Problems (40points)

Problem 1 (3 points)

Assume a cylinder of a material with the density ρ=8.5 g/cm^3 , diameter 2r= 6cm and the height h=9cm. What pressure in Pascal is produced by this cylinder due to its weight?

Problem 2 (4 points)

What energy (in MeV) will be produced during the splitting of a $^{235}_{92}U$ (A_U = 235.044) nucleus by a single neutron, when 2 free neutrons and the stable nuclei $^{96}_{44}Ru$ (A_{Ru} = 95.907) and $^{138}_{56}Ba$ (A_{Ba} = 137.905) are produced? Here: c = 299 792 km/s, $A_{neutron}$ = 1,0087, A_{proton} = 1,0073.

Problem 3 (4 points)

In an amusement parc ride shoots a car up a frictionless track inclined at 30°. The car rolls up, then rolls back down.
If the height of the track is 20m, which is the maximum allowable speed with which the car can start?

Problem 4 (6 points)

A sinusoidal wave with an amplitude of 2 cm and a frequency of 50 Hz travels at 150m/s in the positive x-direction. At t=0 s, the point x=1m is on the crest of the wave.

d) Determine A, v, λ , k, f, ω , T, and ϕ_0 for this wave.
e) Write down the equation for the wave's displacement as it travels.
f) Draw a snapshot graph of the wave at t=0 s

Problem 5 (6 points)

A fish and a sailor look at each other through a 10cm thick glass porthole in a submarine. There happens to be a small air bubble right in the middle of the glass. How far behind the surface of the glass does the air bubble appear to the fish? And to the sailor? The index of refraction of air is 1, the index of glass 1,55 and the index of water 1,33. Represent the air bubble as a point source. Make a drawing.

Problem 6 (3 points)

A diffraction grating is illuminated simultaneously with red light of wavelength 660nm and light of an unknown wavelength. The fifth order maximum of the unknown wavelength overlaps the third-order maximum of the red light. What is the unknown wavelength?

Problem 7 (4 points)

A cannonball is shot straight up with an initial speed of 100m/s. How high does it go?
Represent the cannonball as a particle. Assume air friction as negligible.

Problem 8 (5 points)

The external photo effect is measured in an experiment using light with λ = 330 nm and an unidentified metal. For an opposite voltage of U = –1,9 V the photocurrent could be compensated. Calculate first the energy of one photon and then the value of the work function Φ from these data!

Problem 9 (5 points)

A 12 g bullet is fired into a 1000 g wood block that hangs from a 80 cm long string. The bullet embeds itself into the block, and then swings out to an angle of 30°. What is the speed of the bullet?

Questions (10 points)

Question 1 (2 point)
Transform the unit "eV" (electron volt) in the SI-based unit "J". How much is 1 eV in this unit?

Question 2 (1 point)
A mass is circling at constant angular velocity around a center.
Is this a uniform motion? Explain.

Question 3 (3 points)
Please tell all kinds of nuclear decay mechanisms.

Question 4 (1 point)
What is the length of a mathematical pendulum when it's period is 2s?

Question 5 (2 points)
Please tell the quantum numbers and explain them.

Question 6 (1 point)
Does the frequency of a receding siren increase or decrease?

Good luck!