FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

MODULE	**PHY1DB1**
CAMPUS	**DFC**
EXAM	**NOVEMBER 2019 (FINAL)**

DATE: 15/11/2019 **SESSION 8:30 - 11:30**

ASSESSOR(S) **PROF L. REDDY**

INTERNAL MODERATOR **MR. T. NEMAKHAVHANI**
DURATION: 3 HOURS **MARKS: 100**

NUMBER OF PAGES: 4 PAGES

INSTRUCTIONS

Do not use tippex. Corrections must be made neatly by crossing out the incorrect answer and writing the correct answer instead.

For all calculations, clearly show:

- **every step you have taken.**
- **all formulae used.**

Answer all the questions.

Calculators are permitted.

QUESTION 1

1.1 The boiling point of liquid hydrogen is 20.3 K at atmospheric pressure. What is this temperature on:

1.1.1 the Celsius scale and

1.1.2 the Fahrenheit scale? (4)

1.2 A spherical steel ball has a diameter of 2.54 cm at 25^0C

1.2.1 What is its diameter when its temperature is raised to 100^0C?

1.2.2 What temperature is required to increase its volume by 1%? (8)

1.3 Suppose 1g of water vaporizes isobarically at atmospheric pressure (1.013 x 10^5 Pa). Its volume in the liquid state is $V_i = V_{liquid} = 1$ cm^3, and its volume in the vapor state is $V_f = V_{vapor} = 1671$ cm^3. Find the work done in the expansion and the change in internal energy of the system. Ignore any mixing of the steam and surrounding air – imagine that the steam supply pushes the surrounding air out of the way (8)

1.4 A student is trying to decide what to wear. The surrounding (his bedroom) is at 20^0C. If the skin temperature of the unclothed student is 35^0C, what is the net energy loss from his body in 10 minutes by radiation? Assume that the emissivity of the skin is 0.900 and that the surface area of the student is 1.50m^2. (6)

1.5 Some picnickers stop at a convenience shop to buy some food, including bags of potato chips. They then drive up into the mountains to their picnic site. When they unload the food, they notice that the bags of chips are puffed up like balloons. Why did that happen? (3)

1.6 A popular brand of cola contains 6.5 g of carbon dioxide in 1L of soft drink. If the evaporating carbon dioxide is trapped in a cylinder at 1 atmospheric pressure and 20^0C, what volume does the gas occupy? (7)

1.7 What is the difference between Latent Heat of Fusion and Latent Heat of Vaporization? (4)

1.8 What mass of steam initially at 130^0C is needed to warm 200 g of water in a 100 g glass container from 20^0C to 50^0C? (10)

1.9 Is it possible to construct a heat engine that creates no thermal pollution? Explain.

(3)

1.10 A Carnot engine has power output of 150kW. The engine operates between 2 reservoirs at 20^0C and 500^0C.

1.10.1 How much energy enters the engine by heat per hour?

1.10.2 How much energy is exhausted by heat per hour? (7)

[60]

QUESTION TWO

2.1 A parallel beam of monochromatic light is allowed to fall normally on a plane transmission grating having 6000 lines/cm and the first order spectrum is formed at an angle of 15^0.Calculate the wavelength of light. (5)

2.2 Light from a helium – neon laser (λ = 633 nm) passes through a narrow slit and is seen on a screen 2 m behind the slit. The first minimum in the diffraction pattern is 1.2 cm from the central maximum. How wide is the slit? (5)

2.3 Light passes through a 0.12 mm wide slit and forms a diffraction pattern on a screen 1.0 m behind the slit. What is the wavelength of the light? (5)

[15]

QUESTION THREE

3.1 A concave spherical mirror has a radius of curvature of 40 cm. Determine the position of the virtual image and the magnification for object distances of

3.1.1 30 cm

3.1.2 60 cm

Are the images in 3.1.1 and 3.1.2 upright or inverted? (10)

3.2 A dentist uses a spherical mirror to examine a tooth. The tooth is 1 cm in front of the mirror, and the image is formed 10 cm behind the mirror. Determine

3.2.1 the mirror's radius of curvature and

3.2.2 the magnification of the image (5)

[15]

QUESTION FOUR

4.1 A diverging lens has a focal length of magnitude 20 cm.

4.1.1 locate the image for object distances of

(a) 40 cm

(b) 20 cm

For each case, state whether the image is

(c) real or virtual, and

(d) upright or inverted

4.1.2 In each case find the magnification. (12)

4.2. An object's distance from a converging lens is 5.00 times the focal length.

4.2.1 Determine the location of the image. Express the answer as a fraction of the focal length.

4.2.2 Find the magnification of the image and indicate whether it is

4.2.3 upright or inverted, and

4.2.4 real or virtual (6)

[18]

FORMULAE

1. $T_F = 9/5\ Tc + 32^0F$
2. $\alpha(\text{copper}) = 1.7 \times 10^{-5}\ (^0C)^{-1}$
3. $\alpha(\text{steel}) = 1.1 \times 10^{-5}\ (^0C)^{-1}$
4. Density of copper = 8.92×10^3 kg/m^3
5. $W = -P\Delta V$
6. $\Delta V = 3\alpha V_o \Delta T$
7. $Q = L_v \Delta m$
8. $Q = mc\Delta T$
9. $\Delta E_{int} = Q + W$
10. $P_{av} = \sigma Ae(T^4 - T_0^4)$, where $\sigma = 5.67 \times 10^{-8}$ W/m^{2}K^4
11. PV = nRT, R = 8.31 J/mol.K
12. $c_w = 4186$ J/kg.^{0}C
13. $c_g = 837$ J/kg.^{0}C
14. $c_s = 2010$ J/kg.^{0}C
15. $c_{Cu} = 387$ J/kg.^{0}C
16. $c_c = 900$ J/kg.^{0}C
17. $c_{Al} = 920$ J/kg^{0}C
18. $c_{ice} = 2090$ J/kg^{0}C
19. $L_f = 3.33 \times 10^5$J/kg
20. $L_v = 2.26 \times 10^6$ J/kg
21. $e = W_{eng}/Q_h$
22. $Q_c = Q_h - W_{eng}$
23. $d\sin\theta = n\lambda$
24. $1/p + 1/q = 1/f$
25. Magnification = -q/p
26. $e = 1 - T_c/T_h$
27. $COP = Q_L/W$
28. $W = Q_h - Q_L$
29. $c_g = 837$ J/kg.^{0}C
30. $c_s = 2010$ J/kg.^{0}C
31. $L_v = 2.26 \times 10^6$ J/kg
32. $e = W_{eng}/Q_h$
33. $Q_c = Q_h - W_{eng}$
34. $d\sin\theta = n\lambda$
35. $1/p + 1/q = 1/f$
36. Magnification = -q/p
37. $e = 1 - T_c/T_h$
38. $W = nRT\ln(V_i/V_f)$