UNIVERSITY OF JOHANNESBURG

DFC
Final Exam 2019

Degree Program : B.Eng
Course Title : Foundation Physics
Date of Exam : 22-Nov-2019
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Moderators : Y. Marowa, T. Mathe
Course Code : FPYEDO1

Semester : 2nd
Time Duration : 3 hours
Total Mark : 110

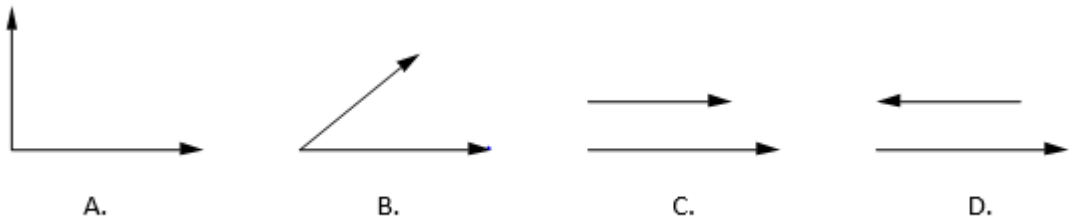
SECTION A-MULTIPLE CHOICE QUESTIONS [Marks: 30]

Answer this section on the multiple choice answer sheet provided. Follow the instructions on the sheet carefully. Do not mark more than one answer! If you make a mistake please, carefully erase/scratch out your first answer and, using your pencil/pen, fill in the answer you want. Do not fold or crease the answer sheet in any way.

1. A block of ice with volume 5.5 m^3 has a mass of 5060 kg. The density of ice is ....
   A. 920 $g.m^{-3}$
   B. 920 $kg.cm^{-3}$
   C. 920 $kg.m^{-2}$
   D. 0.920 $g.cm^{-3}$

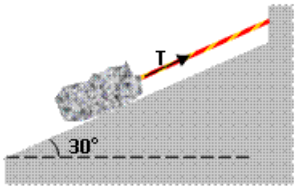
2. Converting polar coordinates (17, 298.07^o) into Cartesian coordinates we get,
   A. (8,15)
   B. (-8,15)
   C. (-15,8)
   D. (8,-15)

3. Two forces act on a hockey puck. For which orientation of the forces will the puck acquire an acceleration with the largest magnitude?



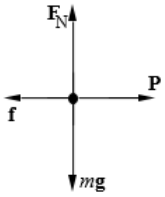
4. A rope holds a 10-kg rock at rest on a frictionless inclined plane as shown. The tension in the rope is

   A. 9.8 N
   B. 20 N
   C. 49 N
   D. 85 N



5. A block is pulled along a rough level surface at constant speed by the force P. The figure shows the free-body diagram for the block. F_N represents the normal force on the block; and f represents the force of kinetic friction. If the coefficient of kinetic friction, μ_k, between the block and the surface is 0.30 and the magnitude of the frictional force is 80.0 N, what is the weight of the block?

   A. 1.6 N
   B. 4.0 N
   C. 160 N
   D. 270 N



6. Complete the following sentence: The operation of a hydraulic jack is an application of

   A. Pascal's principle.
   B. Atmospheric pressure principle.
   C. Archimedes principle.
   D. Newton's principle.

7. Archimedes' Principle states that...

   A. The buoyant force acting on an object equals the volume of the fluid displaced by the object.
   B. The buoyant force acting on an object will always be equal to the weight of the object in fliud.
   C. The buoyant force acting on an object equals the weight (force of gravity) of the fluid displaced by the object.
   D. The buoyant force acting on an object equals the pressure exerted on the object by the fluid.

8. One litre of water at 30 degree Centigrade is mixed with one litre of water at 50 degree Centigrade. The final temperature of the mixture will be

    A. 80 degree Centigrade

    B. 20 degree Centigrade

    C. 40 degree Centigrade

    D. between 30 degree Centigrade and 50 degree Centigrade

9. Which best expresses the value for the coefficient of volume expansion, β, for given material as a function of its corresponding coefficient of linear expansion α.

    A. $\beta = \alpha^3$

    B. $\beta = 3\alpha$

    C. $\beta = \alpha^2$

    D. $\beta = 2\alpha$

10. Which one of the following processes of heat transfer requires the presence of a fluid?

    A. Conduction

    B. Radiation

    C. Convection

    D. Sublimation

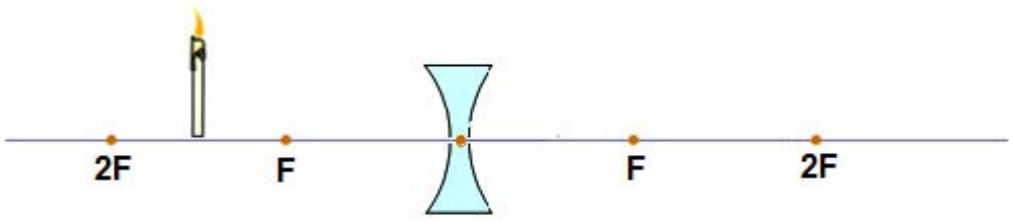
11. An object is placed in front of a diverging lens at a distance between F and 2F. The image produced by the lens is:

    A. Real, inverted and demagnified

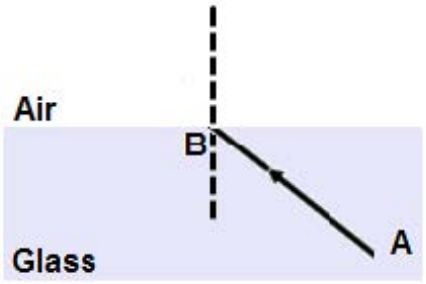
    B. Real, inverted and magnified

    C. Virtual, upright and magnified

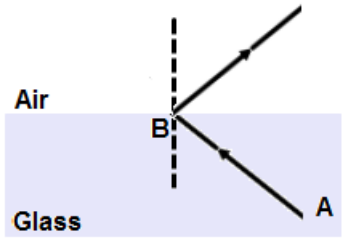
    D. Virtual, upright and demagnified



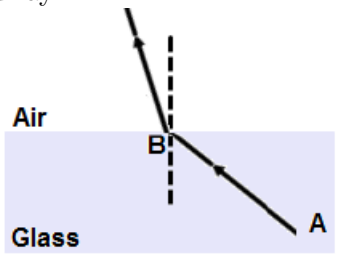
12. A light ray AB passes from glass into air at the critical angle.



Which of the following diagrams represents the refracted ray?



(A)



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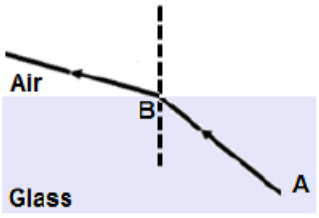

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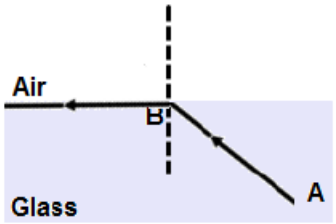


(D)

13. Law stating that "force is directly proportional to product of charges and inversely proportional to square of separation between them" is called

    A. Newton's law
    B. Coulomb's law
    C. Gauss's law
    D. Ohm's law

14. Unit of voltage (V) is equivalent to unit

    A. JC^{-1}
    B. CJ^{-1}
    C. J
    D. C

15. You have to replace 1 500 Ω resistor in radio. You have no 1 500 Ω resistor but have several 1000 Ω ones which you would connect

    A. two in parallel

    B. two in parallel and one in series

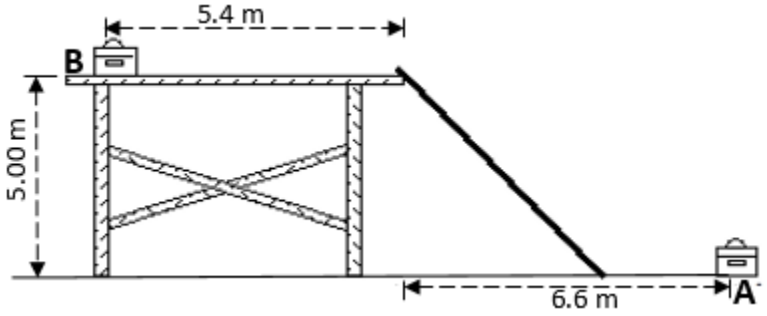
    C. three in parallel

    D. three in series

SECTION B-LONG QUESTIONS [Marks: 80]

Question1 .[25]

1.1 An engineering student carried a toolbox from the base of a ladder at point A as shown in the figure. The toolbox comes to a rest on a scaffold 5.00 m above the ground at point B. Use the correct number of significant figures to answer the following questions.

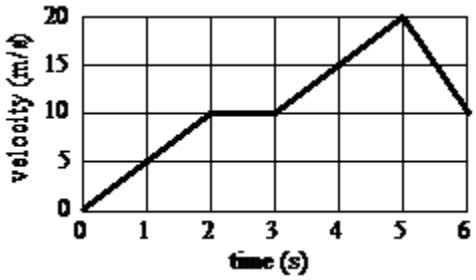


1.1.1 Distinguish between distance and displacement. [2]

1.1.2 What is the magnitude of the distance of the toolbox in its movement from point A to point B? [2]

1.1.3 What is the magnitude and direction of the displacement of the toolbox in its movement from point A to point B? [4]

1.2 An object is moving along a straight line. The graph shows the objects velocity as a function of time.



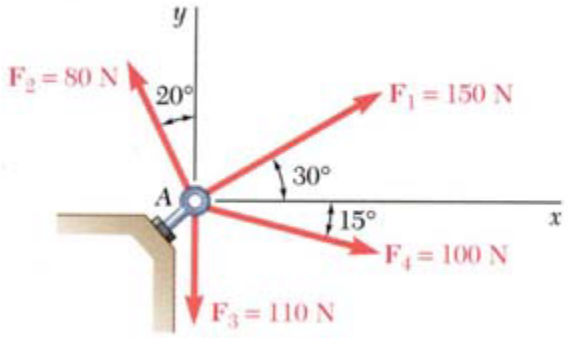
1.2.1 During which interval(s) of the graph does the object travel at constant velocity? [1]

1.2.2 During which interval(s) of the graph does the speed of the object increase by equal amounts in equal times? [2]

1.2.3 Name the physical quantity represented by the slope of this graph. [2]

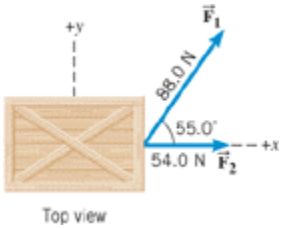
1.2.4 Determine the slope of the graph for the interval from t = 5 s to t = 6 s? [3]

1.3 Four forces act on bolt A as shown. Determine the resultant of the forces on the bolt shown in figure below. [5]



1.4 The drawing shows a 25.0-kg crate that is initially at rest. Note that the view is one looking down on the top of the crate. Two forces, (F_1)and(F_2), are applied to the crate, and it begins to move. The coefficient of kinetic friction between the crate and the floor is $\mu_k = 0.350$.

1.4.1 Determine the magnitude of the acceleration of the crate. [4]



Question2 .[11]

2.1 In a hydraulic system, a piston with a cross-sectional area of 21 square centimeters pushes on an incompressible liquid with a force of 38 newtons. The far end of the hydraulic pipe connects to a second piston with a cross-sectional surface area of 100 square centimeters.

2.1.1 State Pascal's principle. [2]

2.1.2 What is the force on the second piston? [4]

2.2 A paperweight, when weighed in air, has a weight of W_{air}= 6.9 N. When completely immersed in water, however, it has a weight of W_{water}= 4.3 N. Find the volume of the paperweight. [5]

Question3 .[12]

3.1 A glass container with volume of 4 liters filled with water, then heated until the increase in temperature is 20 ^oC. Some water spilled. The coefficient of linear expansion for glass $= 9 \times 10^{-6}$ $^oC^{-1}$; the coefficient of volume expansion for water $= 2.1 \times 10^{-4}$ $^oC^{-1}$.

3.1.1 Determine the volume of spilled water. [6]

3.2 A piece of glass has a temperature of 83.0 ^oC. Liquid that has a temperature of 43.0 ^oC is poured over the glass, completely covering it, and the temperature at equilibrium is 53.0 ^oC. The mass of the glass and the liquid is the same. Specific heat capacity of glass = 840 $J/(kg.^oC)$ Ignoring the container that holds the glass and liquid and assuming that the heat lost to or gained from the surroundings is negligible, answer the following questions.

3.2.1 Determine the specific heat capacity of the liquid. [6]

Question4 .[18]

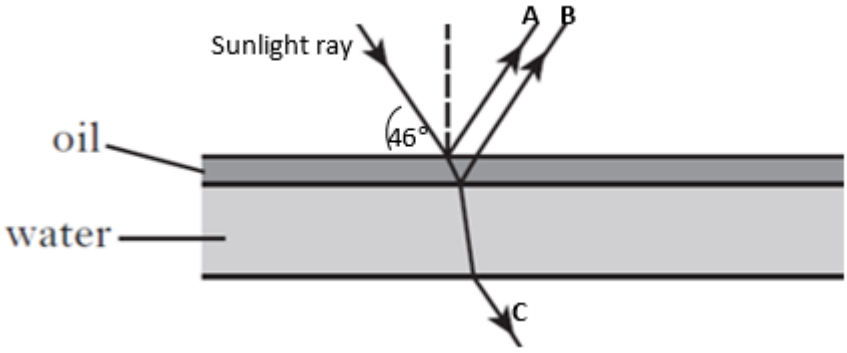
4.1 The image behind a convex mirror (radius of curvature = 68 cm) is located 22 cm from the mirror.

4.1.1 Where is the object located and [2]

4.1.2 What is the magnification of the mirror? [2]

4.1.3 State any 2 properties of the image formed [2]

4.2 When sunlight hits a thin film of oil floating on the surface of water, rays A,B and C are observed as shown on the diagram below. Study the diagram below and answer questions that follow. n_{oil} =1.56, n_{air} =1 and n_{water} = 1.33



4.2.1 Define the term "critical angle" [2]

4.2.2 Name the processes that occur at when the sunlight ray hits the oil-water boundary. [2]

4.2.3 Calculate the angle with which A makes with the normal line. [2]

4.2.4 Determine the angle of refraction when the sunlight encounters air oil boundary. [3]

4.3 One method of determining the refractive index of a trans parent solid is to measure the critical angle when the solid is in air. If θ_C is found to be 40.5^o, what is the index of refraction of the solid? [3]

Question5 .[14]

5.1 Two charges attract each other with a force of 1.5 N. What will be the force if the distance between them is reduced to one-ninth of its original value? [3]

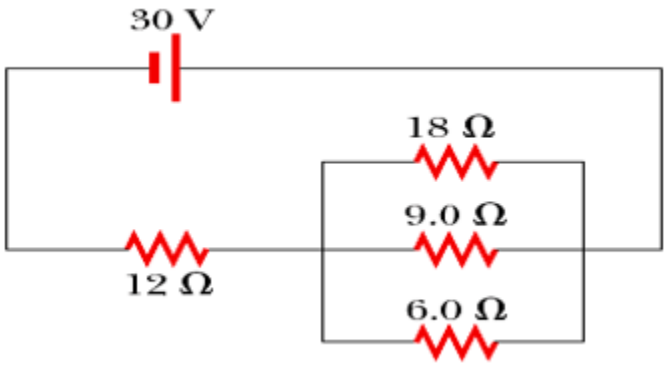
5.2 An electric field of 260 000 N/C points due west at a certain spot. What are the magnitude and direction of the force that acts on a charge of -7 μC at this spot? [3]

5.3 Define electric current. [2]

5.4 In the circuit diagram below. Calculate the

5.4.1 total resistance of the circuit. [3]

5.4.2 current flowing through the 12 resistor. [3]



PHYSICS FORMULA SHEET

OPTICS

1. $f = \frac{R}{2}$
2. $m = \frac{v}{u}$
3. $m = \frac{v}{f} - 1$
4. $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$
5. $n = \frac{\sin\theta_1}{\sin\theta_2}$
6. ${}_1n_2 = \frac{n_1}{n_2}$
7. $n = \frac{c}{v}$
8. $n = \frac{real\ depth}{apparent\ depth}$
9. $n_1 \sin i_1 = n_2 \sin i_2$

MECHANICS

1. $s = ut + \frac{1}{2}at^2$
2. $s = vt - \frac{1}{2}at^2$
3. $s = \left(\frac{u+v}{2}\right)t$
4. $v = u + at$
5. $v^2 = u^2 + 2as$
6. $\Sigma F = ma$
7. $w = mg$
8. $W = F.s$
9. $E_p = mgh$
10. $E_k = \frac{1}{2}mv^2$

FLUIDS

1. $P = \rho gh$
2. $W = \rho gV$
3. $B = \rho_{liquid} gV$
4. $RD_S = \frac{w_{in\ air}}{w_{in\ air} - w_{in\ water}}$
5. $RD = \frac{W\ in\ air - W\ in\ liquid}{W\ in\ air - W\ in\ water}$

HEAT

1. $\Delta l = l_1 \alpha \Delta T)$
2. $\Delta A = \gamma\ A\Delta T$
3. $\Delta V = \beta V \Delta T$
4. $Q = mc\Delta T$
5. $T(^oC) = (T + 273)K$

ELECTRICITY

1. $V = IR$
2. $emf = I(R + r)$
3. $W = VIt$
4. $P = VI$
5. $F = kQ_1Q_2/r^2$
6. $E = F/Q$

CONSTANTS

$g = 9.8\,1 m/s^2$

$k = 9.0 \times 10^9\ N\ m^2/C^2$

CONVERSIONS

1 litre = 1 000 cm^3

1 atm = 760 torr = 1.013 x 10^5 Pa = 760 mmHg

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