PHYSICS

WORK SHEET-1

(Basic- Calculas, Geometry, Trigonometry)

1. The volume V of a ball (solid sphere) of radius r is given by the function $V(r) = (4/3)\pi (r)^3$
The volume of a ball of radius 3m is ?

2. Suppose that the function F is defined for all real numbers r by the formula $F(r) = 2(r - 1) + 3$.
Evaluate F at the input values 0, 2, x + 2, and F(2).

3. A function $f(x)$ is defined as $f(x) = x^2 + 3$,
Find $f(0)$, $f(1)$, $f(x^2)$, $f(x+1)$ and $f(f(1))$.

4. If function F is defined for all real numbers x by the formula $F(x) = x^2$.
Evaluate F at the input values 0,2, x + 2 and F(2)

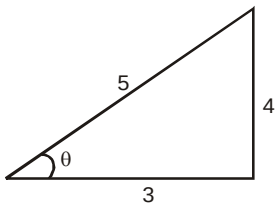
5. (i) Convert 45º to radians.

(ii) Convert $\frac{\pi}{6}$ rad to degrees.

6. Convert 30º to radians.

7. Convert $\frac{\pi}{3}$ rad to degrees.

8. Find the six trigonometric ratios from given figure



9. Find the sine and cosine of angle θ shown in the unit circle if coordinate of point p are as shown.

10. Evaluate sin 120°

11. Evaluate cos 135°

12. Evaluate cos 210°

13. Evaluate tan 210°

14. $\frac{d}{dx}(8) = 0$, $\frac{d}{dx}\left(-\frac{1}{2}\right) = 0$, $\frac{d}{dx}\left(\sqrt{3}\right) = 0$

15.

f	x	x^2	x^3	x^4	....
f'	1	2x	$3x^2$	$4x^3$	....

16. (i) $\frac{d}{dx}\left(\frac{1}{x}\right) = \frac{d}{dx}(x^{-1}) = (-1)x^{-2} = -\frac{1}{x^2}$

(ii) $\frac{d}{dx}\left(\frac{4}{x^3}\right) = 4\frac{d}{dx}(x^{-3}) = 4(-3)x^{-4} = -\frac{12}{x^4}$.

17. (a) $\frac{d}{dx}(x^{1/2}) = \frac{1}{2}x^{-1/2} = \frac{1}{2\sqrt{x}}$

Function defined for $x \geq 0$ derivative defined only for $x > 0$

(b) $\frac{d}{dx}(x^{1/5}) = \frac{1}{5}x^{-4/5}$

Function defined for $x \geq 0$ derivative not defined at x = 0

18. The derivative formula
$\frac{d}{dx}(3x^2) = 3(2x) = 6x$ says that if we rescale the graph of $y = x^2$ by multiply ing each y–coordinate by 3, then we multiply the slope at each point by 3.

19. A useful special case
The derivative of the negative of a differentiable function is the negative of the function's derivative.
Rule 3 with c = –1 gives.

$$\frac{d}{dx}(-u) = \frac{d}{dx}(-1 \cdot u) = -1 \cdot \frac{d}{dx}(u) = -\frac{d}{dx}(u)$$

20. Find the derivatives of $y = (x^2 + 1)(x^3 + 3)$.

21. Let y = uv be the product of the functions u and v.
Find y'(2) if u(2) = 3, u'(2) = –4, v(2) = 1, and v'(2) = 2.

22. Find the derivative of $y = \frac{t^2 - 1}{t^2 + 1}$

23. (a) y = 5x + cos x

$\frac{dy}{dx} = \frac{d}{dx}(5x) + \frac{d}{dx}(\cos x)$ Sum Rule $= 5 - \sin x$

(b) y = sinx cosx

$\frac{dy}{dx} = \sin x \frac{d}{dx}(\cos x) + \cos x \frac{d}{dx}(\sin x)$ Product Rule

$= \sin x (-\sin x) + \cos x (\cos x) = \cos^2 x - \sin^2 x$

24. (a) $\frac{d}{dx}(3x + \cot x) = 3 + \frac{d}{dx}(\cot x) = 3 - \text{cosec}^2 x$

(b) $\frac{d}{dx}\left(\frac{2}{\sin x}\right) = \frac{d}{dx}(2\text{cosec } x) = 2\frac{d}{dx}(\text{cosec } x)$

$= 2(-\text{cosec } x \cot x) = -2 \text{ cosec } x \cot x$

25. The function $y = 6x - 10 = 2(3x - 5)$ is the composite of the functions y = 2u and u = 3x – 5. How are the derivatives of these three functions related ?

26. We sometimes have to use the Chain Rule two or more times to find a derivative.
Here is an example.
Find the derivative of g(t) = tan (5 – sin 2t)

27. The position of a particle is given by the equation

$s = f(t) = t^3 - 6t^2 + 9t$

where t is measured in seconds and s in meters.

Find the acceleration at time t. What is the accelera tion after 4 s ?

28. The area A of a circle is related to its diameter by the equation $A = \frac{\pi}{4} D^2$.

How fast is the area changing with respect to the diam eter when the diameter is 10 m?

29. Particle's position as a function of time is given as $x = 5t^2 - 9t + 3$. Find out the maximum value of position co-ordinate? Also, plot the graph.

30. A police cruiser, approaching a right-angled intersection from the north, is chasing a speeding car that has turned the corner and is now moving straight east. When the Cruiser is 0.6 mi north of the intersection and the car is 0.8 mi to the east, the police determine with radar that the distance between them and the car is increasing at 20 mph. If the cruiser is moving at 60 mph at the instant of measurement, what is the speed of the car?

31. Evaluate $\int 2x\,dx$.

32. Term–by–term integration

Evaluate : $\int (x^2 - 2x + 5)\,dx$.

WORK SHEET-2 (Vector)

1. A bird moves with velocity 10 ms^{-1} in a direction making angle 60º with the eastern line and 60º with vertical upward. Represent the velocity vector in the rectangular form.

2. The torque of a force F about a point of position vector $\vec{r}$ is given by $\vec{\tau} = \vec{r} \times \vec{F}$. Use this formula to find for mula to find torque of force $2\hat{i} + 5\hat{j}$ abut a point $2\hat{i} + \hat{j} - \hat{k}$.

3. Find the unit vector perpendicular to $2\hat{i} + 2\hat{j} - \hat{k}$ and $6\hat{i} - 3\hat{j} + \hat{k}$

4. Find the area of the parallelogram whose sides are $\hat{i} + 2\hat{j} + 3\hat{k}$ and $2\hat{i} + \hat{j}$.

5. Find the area of the parallelogram whose diagonals are given by $\hat{i} + 2\hat{j} - \hat{k}$ and $\hat{i} + \hat{j} + 2\hat{k}$.

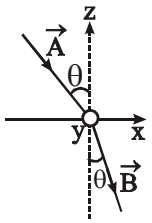
6. Find the x-coordinate of a point (x, 2) collinear with (3, 4) and (1, 0).

7. Find the area of the trigonal formed by $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} + \hat{k}$.

8. Prove that $(\vec{a} + \vec{b}) \times (\vec{a} - \vec{b}) = -2(\vec{a} \times \vec{b})$.

9. A force $\vec{F} = \hat{i} + 2\hat{j} + \hat{k}$ newton is to be projected on the line $\hat{i} + \hat{j} + \hat{k}$. Find the vector component and its magnitude.

10. Write the vector represents of the vectors A and B with respect to the frame of reference shown in the figure.



WORK SHEET-3 (Kinematics)

1. A man has to go 50 m due north, 40 m due east and 20 m due south to reach a field,
(a) What distance he has to walk to reach the field ?
(b) What is his displacement from his house to the field ?

2. A particle starts from the origin, goes along the X-axis to the point (20 m, 0) and then returns along the same line to the point (-20 m, 0). Find the distance and displacement of the particle during the trip.

3. It is 260 km from Patna to Ranchi by air and 320 km by road. An aeroplane takes 30 minutes to go from Patna to Ranchi whereas a delux bus takes 8 hours, (a) Find the average speed of the plane, (b) Find the average speed of the bus. (c) Find the average velocity of the plane, (d) Find the average velocity of the bus.

4. An athelete takes 2.0 s to reach his maximum speed of 18.0 km/h. What is the magnitude of his average acceleration ?

5. An object having a velocity 4.0 m/s is accelerated at the rate of 1.2 m/s for 5.0 s. Find the distance travelled during the period of acceleration.

6. A person travelling at 43.2 km/h applies the brake giving a deceleration of 6.0 m/s^2 to his scooter. How far will it travel before stopping ?

7. A train starts from rest and moves with a constant acceleration of 2.0 m/s^2 for half a minute. The brakes are then applied and the train comes to rest in one minute. Find (a) the total distance moved by the train, (b) the maximum speed attained by the train and (c) the position(s) of the train at half the maximum speed.

8. A bullet travelling with a velocity of 16 m/s penetrates a tree trunk and comes to rest in 0.4 m. Find the time taken during the retardation.

9. A bullet going with speed 350 m/s enters a concrete wal and penetrates a distance of 5.0 cm before coming to rest. Find the deceleration.

10. A particle starting from rest moves with constant acceleration. If it takes 5.0 s to reach the speed 180 km/h find (a) the average velocity during this period, and (b) the distance travelled by the particle during this period.

WORK SHEET-4 (Electrostatics)

1. At what separation should two equal charges, 10 C each, be placed so that the force between them equals the weight of a 50 kg person ?

2. Two charges 20×10^{-6} C and 1.0×10^{-6} C are placed at a separation of 10 cm. Where should a third charge be placed such that it experiences no net force due to these charges ?

3. Two charged particles are placed at a distance 10 cm apart. What is the minimum possible magnitude of the electric force acting on each charge ?

4. Estimate the number of electrons in 100 g of water. How much is the total negative charge on these elec trons ?

5. Two insulating small spheres are rubbed against each other and placed 1 cm apart. If they attract each other with a force of 0.1 N, how many electrons were trans ferred from one sphere to the other during rubbing ?

6. Four equal charges 2×10^{-6} C each are fixed at the four corners of a square of side 5 cm. Find the Coulomb force experienced by one of the charges due to the rest three.

7. Two identical pith balls, each carrying a charge *q,* are suspended from a common point by two strings of equal length *l.* Find the mass of each ball if the angle between the strings is 2θ in equilibrium.

8. Two particles *A* and *B,* each having a charge Q, ere placed a distance *d* apart. Where should a particle of charge *q* be placed on the perpendicular bisector of *AB* so that it experiences maximum force ? What is the magnitude of this maximum force ?

9. Two particles *A* and *B* having charges of $+ 2 \times 10^{-6}$ C and of $- 4 \times 10^{-6}$ C respectively are held fixed at a sepa ration of 20 cm. Locate the point (s) on the line *AB* where (a) the electric field is zero (b) the electric poten tial is zero.

10. *A* water particle of mass 10 mg and having a charge of 1.50×10^{-6} C stays suspended in a room. What is the magnitude of electric field in the room ? What is its direction ?

11. A rod of length *L* has a total charge *Q* distributed uni formly along its length. It is bent in the shape of a semi circle. Find the magnitude of the electric field at the cen tre of curvature of the semicircle.

12. A ball of mass 100 g and having a charge of 4.9×10^{-5} C is released from rest in a region where a horizontal elec tric field of 2.0×10^{4} N/C exists, (a) Find the resultant force acting on the ball, (b) What will be the path of the ball ? (c) Where will the ball be at the end of 2 s ?

13 12 J of work has to be done against an existing electric field to take a charge of 0.01 C from A to B. How much is the potential difference $V_B - V_A$?

14. Two equal charges, 2.0×10^{-7} C each, are held fixed at a separation of 20 cm. A third charge of equal magni tude is placed midway between the two charges. It is now moved to a point 20 cm from both the charges. How much work is done by the electric field during the process ?

15. An electric field $\vec{E} = (\vec{i}20 + \vec{j}30)$ N/C exists in the space. If the potential at the origin is taken to be zero, find the potential at (2 m, 2 m).

WORK SHEET- 5 (Current Electricity)

1. The amount of charge passed in time t through a 'cross-section of a wire is

$$Q(t) = At^2 + Bt + C.$$

(A) Write the dimensional formulae for A, B and C.
(B) If the numerical values of A, B and C are 5, 3 and 1 respectively in SI units, find the value of the current at t = 5 s.

2. An electron gun emits 2.0 x 10 electrons per second. What electric current does this correspond to?

3. The electric current existing in a discharge tube is $2.0\mu A$. How much charge is transferred across a cross-section of the tube in 5 minutes ?

4. The current through a wire depends on time as

$$i = i_0 + \alpha t,$$

where i_0 = 10 A and α = 4 A/s. Find the charge crossed through a section of the wire in 10 seconds.

5. A current of 1.0 A exists in a copper wire of cross-section 1.0 mm^2. Assuming one free electron per atom calculate the drift speed of the free electrons in the wire. The density of copper is 9000 $kg/m^{3.}$

6. A wire of length 1 m and radius 0.1 mm has a resistance of 100 Ω. Find the resistivity of the material.

7. A uniform wire of resistance 100 Ω is melted and recast in- a wire of length double that of the original. What would be the resistance of the wire ?

8. Consider a wire of length 4 m and cross-sectional area 1 mm^2 carrying a current of 2 A. If each cubic metre of the material contains 10^{29} free electrons, find the average time taken by an electron to cross the length of the wire.

9. What length of a copper wire of cross-sectional area 0.01 mm will be needed to prepare a resistance of 1 kΩ ? Resistivity of copper = 1.7×10^{-8} Ω–m.

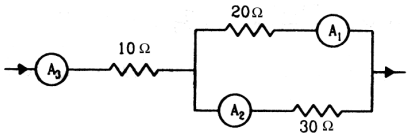
10. A copper wire of radius 0.1 mm and resistance 1 kΩ is connected across a power supply of 20 V. (A) How many electrons are transferred per second between the supply and the wire at one end ? (B) Write down the current density in the wire.

11. Calculate the electric field in a copper wire of cross-sectional area 2.0 mm carrying a current of 1 A. The resistivity of copper = 1.7 x 10^{-8} Ω–m.

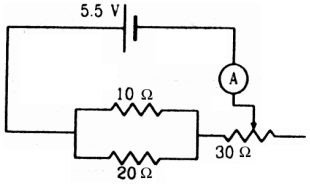
12. A wire has a length of 2.0 m and a resistance of 5.0 Ω. Find the elecric field existing inside the wire if it carries a current of 10 A.

13 The current in a conductor and the potential difference across its ends are measured by an ammeter and a voltmeter. The meters draw negligible currents. The ammeter is accurate but the voltmeter has a zero error (that is, it does not read zero when no potential different is applied). Calculate the zero error if the readings for two different conditions are 1.75 A, 14.4 V and 2.75 A, 22.4 V.

14. At the reading of ammeter A_1 in fig. is 2.4 A, what will the ammeters A_2 and A_3 read ? Neglect the resistances of the ammeters.



15. The resistance of the rheostat shown in fig. is 30 Ω. Neglecting the meter resistance, find the



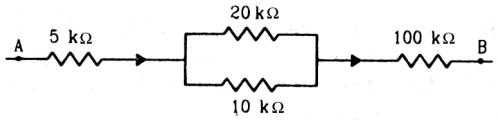
minimum and maximum currents through the ammeter as the rheostat is varied.

16. Three bulbs, each having a resistance of 180 Ω, are connected in parallel to an ideal battery of emf 60 V. Find the current delivered by the battery when (A) all the bulbs are switched on, (B) two of the bulbs are switched on and (C) only one bulb is switched on.

17. Suppose you have three resistors of 20 Ω, 50 Ω and 100 Ω. What minimum and maximum resistances can you obtain from these resistors ?

18. A bulb is made using two filaments. A switch selects whether the filaments are used individually or in parallel. When used with a 15 V battery, the bulb can be operated at 5 W, 10 W or 15 W. What should be the resistances of the filaments ?

19. Fig. shows a part of a circuit. If a current of 12 mA exists in the 5 kΩ resistor, find the currents in the other three resistors. What is the potential difference between the points A and B ?



20. An ideal battery sends a current of 5 A in a resistor, hen another resistor of value 10 Ω is connected in parallel, the current through the battery is increased 6A. Find the resistance of the first resistor.