Q1.
The force F applied on a particle is given by the relation $F = K \rho A B^2$, where K is a dimensionless constant, ρ is a density and A is an area. Find the dimension of B.

A) L/T
B) L^2/T^2
C) T/L
D) T^2/L^2
E) M/T

Q2.
Gold has a density of 19.3 g/cm^3. If a sample of gold of mass 30.5 g is pressed so as to make a sheet of 1.00 micrometer thickness, what is the area of the sheet? (1 micrometer = 10^{-6} m)

A) 1.58 m^2
B) 3.05 m^2
C) 2.45 m^2
D) 5.32 m^2
E) 10.5 m^2

Q3.
An airplane must reach a speed of 400 km/h on a runway for takeoff. What is the lowest constant acceleration (in m/s^2) for takeoff from a 2.00 km runway assuming the plane starts from rest?

A) 3.09
B) 1.25
C) 3.27
D) 4.50
E) 10.4

Q4.
A stone is thrown vertically up from the edge of the top of a 100-m high building. It reaches the ground (at the bottom of the building) after 10.0 s. What is the initial speed of the stone?

A) 39.0 m/s
B) 29.0 m/s
C) 49.0 m/s
D) 59.0 m/s
E) 69.0 m/s

Q5.
A car travels up a hill at a constant speed of 30 km/h and down the same hill at a constant speed of 50 km/h. Calculate the average speed of the car for the round trip (up and down the hill, the same distance).

A) 38 km/h
B) 40 km/h
C) zero
D) 20 km/h

E) 80 km/h

Q6.
Figure 1 shows the acceleration-time graph of a particle moving along an axis. In which of the time intervals indicated in the figure, does the particle move at constant speed?

A) a and e
B) c and g
C) d and f
D) a, c, e, and g
E) b

Q7.
The vectors $\vec{X}$, $\vec{Y}$, and $\vec{Z}$ are related by $\vec{Z} = \vec{Y} - \vec{X}$. Which diagram shown in figure 3 illustrates this relationship?

A) E
B) B
C) C
D) D
E) A

Q8.
Let $\vec{S} = \hat{i} - 2\hat{j} + 2\hat{k}$ and $\vec{T} = 3\hat{i} + 4\hat{k}$. The angle between these two vectors is:

A) 42.8^0
B) 29.9^0
C) 77.2^0
D) 21.0^0
E) 90.0^0

Q9.
In Figure 2, vector $\vec{A}$ has magnitude 12.0 m and vector $\vec{B}$ has magnitude 8.00 m. Vector $\vec{A} - \vec{B}$ is:

A) $(12.9\,\hat{i} + 6.40\,\hat{j})$ m
B) $(12.9\,\hat{i} + 14.4\,\hat{j})$ m
C) $(0.900\,\hat{i} - 14.4\,\hat{j})$ m
D) $(14.4\,\hat{i} + 12.9\,\hat{j})$ m
E) $(14.4\,\hat{i} + 0.900\,\hat{j})$ m

Q10.
The airplane shown in Figure 4 flies horizontally at an altitude of 1.00 km with a speed of 150 km/h. At what distance D should it release a package to hit the target X?

A) 596 m
B) 345 m

C) 783 m
D) 234 m
E) 930 m

Q11.
A particle is moving in the xy-plane with a constant acceleration $\vec{a} = -\ 1.0\ \hat{i}\ -\ 0.50\,\hat{j}$ (m/s^2). It leaves the origin with an initial velocity $3.0\ \hat{i}$ (m/s). What is the velocity in m/s of the particle when it reaches its maximum x coordinate?

A) $-1.5\,\hat{j}$
B) zero
C) $+1.5\,\hat{j}$
D) $-1.5\ \hat{i}$
E) $+1.5\ \hat{i}$

Q12.
A car is moving north at 20 km/h. It makes a gradual 180° turn (U-turn) at the same speed, changing its direction of travel from north to south in 20 s. The average acceleration of the car for this turn is:

A) 2.0 km/h·s, toward the south
B) 1.0 km/h·s, toward the south
C) 1.0 km/h·s, toward the north
D) 2.0 km/h·s, toward the north
E) zero

Q13.
A boat is traveling at 14 km/h in still water (water is not flowing). A man runs directly across the boat, from one side to the other (perpendicular to the direction of motion of the boat), at 6 km/h relative to the boat. The speed of the man relative to the ground is:

A) 15 km/h
B) 13 km/h
C) 14 km/h
D) 8.0 km/h
E) 20 km/h

Q14.
In figure 5, a particle P is in uniform circular motion, centered at the origin of an xy coordinate system. At what point shown in the figure is the magnitude of the particle's vertical acceleration a_y maximum?

A) A
B) B
C) C
D) D
E) E

Q15.
In the system shown in Figure 6, a horizontal force $\vec{F}$ acts on the 8.0-kg object. The horizontal surface is frictionless. What is the magnitude of $\vec{F}$ if the 5.0-kg object has a downward acceleration of 1.0 m/s^2?

A) 54 N
B) 9.6 N
C) 3.6 N
D) 84 N
E) zero

Q16.
The coefficient of kinetic friction:

A) is a dimensionless quantity
B) is greater than the coefficient of static friction
C) is the ratio of force to area
D) can have units of Newtons
E) is in the direction of the frictional force

Q17.
Figure 7 shows four possible choices for the direction of **ONE force** of magnitude F to be applied to a block on an inclined plane of angle 30°. The directions are either horizontal or vertical. (for all choices, we assume that the block remains on the inclined plane). Rank the choices according to the magnitude of **the normal force** on the block from the plane, **greatest first**.

A) choice 4, choice 3, choice 1, choice 2
B) choice 3, choice 4, choice 1, choice 2
C) choice 1, choice 3, choice 4, choice 2
D) choice 2, choice 3, choice 1, choice 4
E) (choice 3 and choice 4) tie, (choice 1 and choice 2) tie

Q18.
A block of mass 2.0 kg is being pushed by a force $\vec{F}$ parallel to the ground as shown in Figure 8. The block is observed to have an acceleration of 1.0 m/s^2 down the incline. Assume the incline is frictionless. Calculate the magnitude of the force $\vec{F}$.

A) 9.0 N
B) 11 N
C) 6.5 N
D) 1.9 N
E) 14 N

Q19.
A block of mass 3.0 kg is pushed against a rough wall (coefficient of kinetic friction is 0.20) by a force P = 30 N that makes an angle of 50° with the horizontal as shown in Figure 9. Assuming the block is sliding down, find the magnitude of its acceleration.

A) 0.85 m/s^2
B) 9.8 m/s^2
C) 1.8 m/s^2
D) 0.17 m/s^2
E) 2.1 m/s^2

Q20.
A pilot of mass 75.0 kg in a jet aircraft executes a loop-the-loop, as shown in Figure 10. In this maneuver, the aircraft moves in a vertical circle of radius R = 3.00 km at a constant speed of 250 m/s. Determine the magnitude of the force exerted by the seat on the pilot at the bottom of the loop.

A) 2.30×10^3 N
B) 828 N
C) 735 N
D) 5.20×10^3 N
E) 1.50×10^3 N

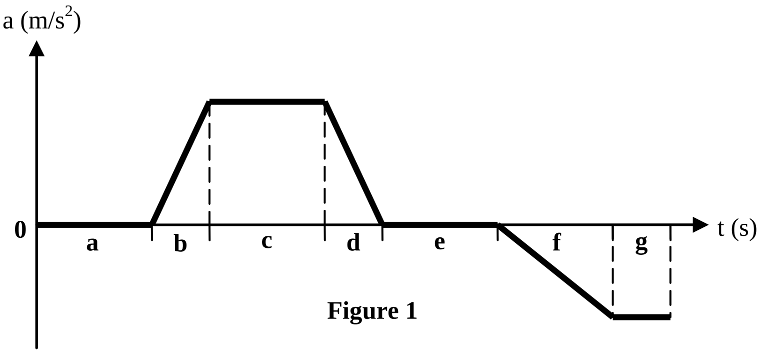

Figure 1

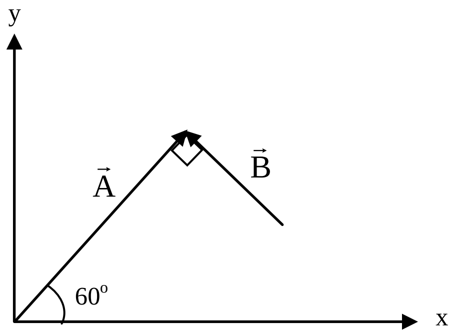

Figure 2

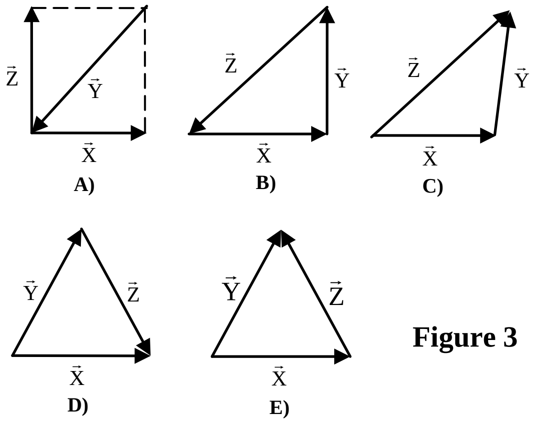

Figure 3

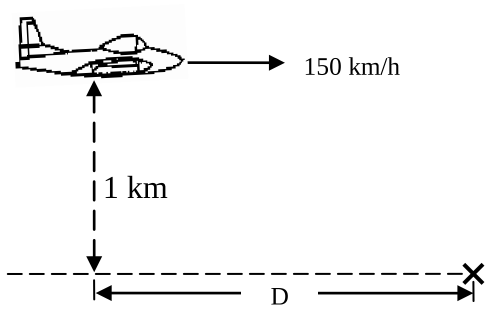

Figure 4

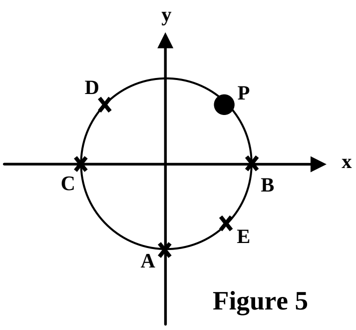

Figure 5

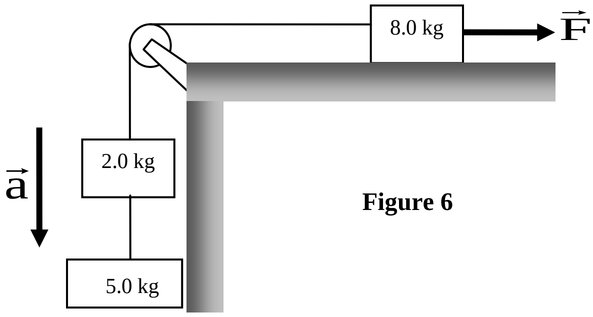

Figure 6

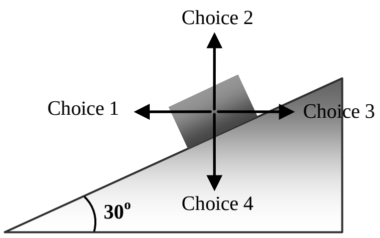

Figure 7

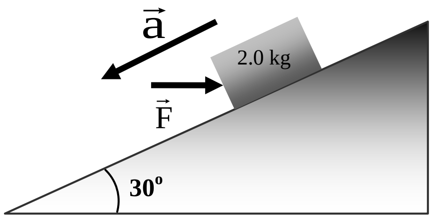

Figure 8

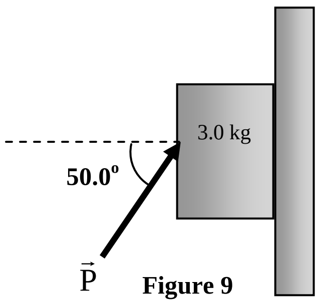

Figure 9

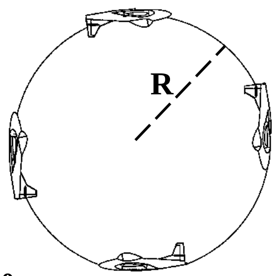

Figure 10

Bottom

Formula Sheet for PHYS101-092-First Major

$$y = x^n; \qquad \frac{dy}{dx} = nx^{n-1}$$

Motion in One Dimension

$$v = \frac{dx}{dt}; \qquad a = \frac{dv}{dt}; \qquad v_{avg} = \frac{\Delta x}{\Delta t}; \qquad a_{avg} = \frac{\Delta v}{\Delta t}$$

Motion with Constant Acceleration

$v = v_o + a\,t$	$x - x_o = v_o t + \frac{1}{2} a\,t^2$	
$v^2 = v_o^2 + 2a(x - x_o)$	$x - x_o = \frac{1}{2}(v + v_o)t$	$x - x_o = v\,t - \frac{1}{2} a\,t^2$

Free Fall

$$a = -g; \qquad g = 9.80 m/s^2$$

Vector Multiplications

$$\vec{a} \cdot \vec{b} = ab\cos\phi \qquad \left|\vec{a} \times \vec{b}\right| = ab\sin\phi$$

Motion in Two Dimensions

$$\vec{v} = \frac{d\vec{r}}{dt}; \qquad \vec{a} = \frac{d\vec{v}}{dt}$$

$$\vec{r} = x\hat{i} + y\hat{j} \qquad \vec{r} - \vec{r}_o = \vec{v}_o t + \frac{1}{2}\vec{a}t^2; \qquad \vec{v} = \vec{v}_o + \vec{a}t$$

Projectile Motion

$a_x = 0$	$a_y = -9.80 m/s^2$
$v_x = v_o \cos\theta_o$	$v_y = v_o \sin\theta_o - g\,t$
$x - x_o = v_o \cos\theta_o\, t$	$y - y_o = v_o \sin\theta_o\, t - \frac{1}{2} g\, t^2$

Uniform Circular Motion

$$a_r = \frac{v^2}{r}$$

$$T = \frac{2\pi r}{v}$$

Relative Motion

$$\vec{v}_{PA} = \vec{v}_{PB} + \vec{v}_{BA}$$

$$\vec{v}_{AB} = \text{velocity of A relative to B} = -\vec{v}_{BA}$$

Newton's Second Law

$$\sum \vec{F} = m\vec{a} \quad \Leftrightarrow \quad \sum F_x = \text{m}a_x; \quad \sum F_y = \text{m}a_y$$

Friction

$$f_{s,\max} = \mu_s N; \quad f_k = \mu_k N$$