Grade 11 Physics EOT Term 1 Example Questions

Example Question 1A

A car slows down from 31.0 m/s to a speed of 12.0 m/s over a distance of 380 m. Assuming constant acceleration, what is the acceleration of the car?

Example Question 1B

A car speeds up from 10.0 m/s to 25.0 m/s over a distance of 2.50 km. Assuming constant acceleration, what is the acceleration of the car?

Example Question 2A

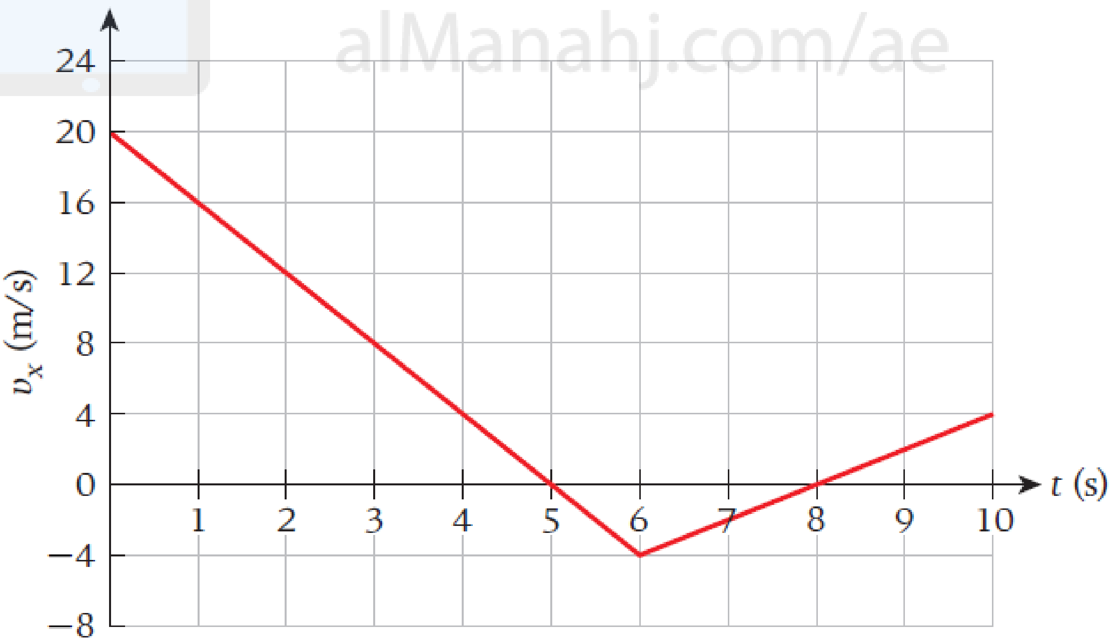
A car starts from rest and has an acceleration given by $a = Bt^2 - \frac{1}{2}Ct$, where B = 2.00 m/s^4 and C = -4.00 m/s^3. What is the object's velocity after 5.00 s?

Example Question 2B

A car starts from rest and has an acceleration given by $a = Ht^2 - \frac{1}{4}Kt$, where H = 4.00 m/s^4 and K = -6.00 m/s^3. What is the object's velocity after 2.00 s?

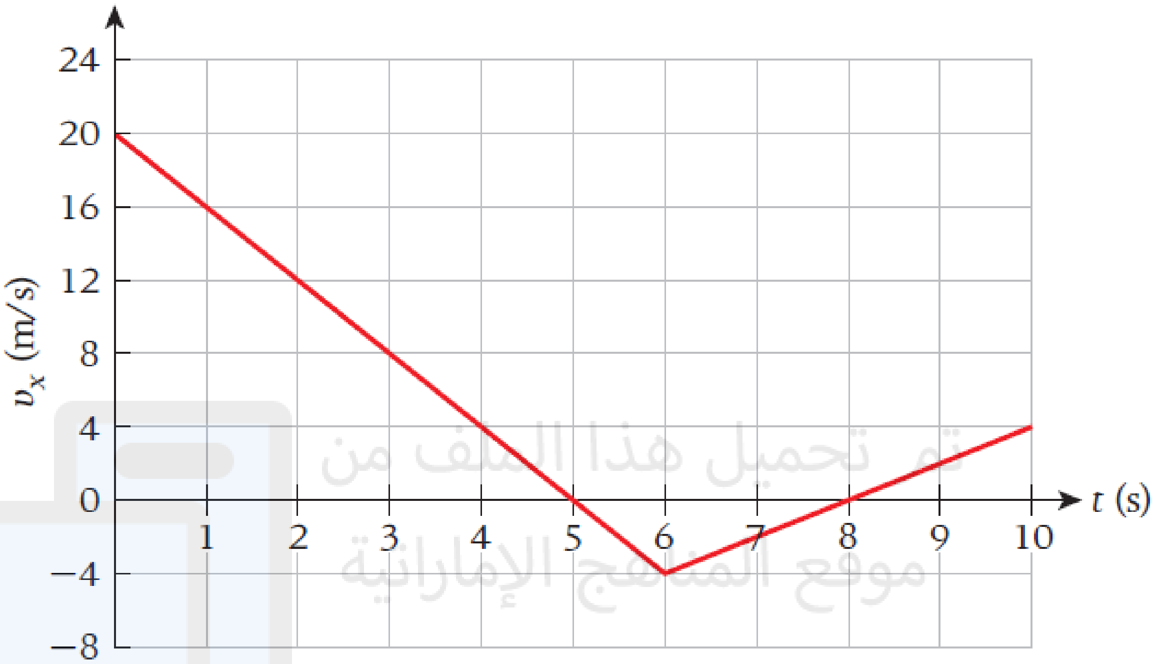
Example Question 3A

A car is moving along the x-axis and its velocity, v_x, varies with time as shown in the figure. If x_0 = 2.0 m at t_0 = 2.0 s, what is the position of the car at t = 10.0 s?



Example Question 3B

A car is moving along the x-axis and its velocity, v_x, varies with time as shown in the figure. If $x_0 = 4.0$ m at $t_0 = 2.0$ s, what is the position of the car at $t = 10.0$ s?

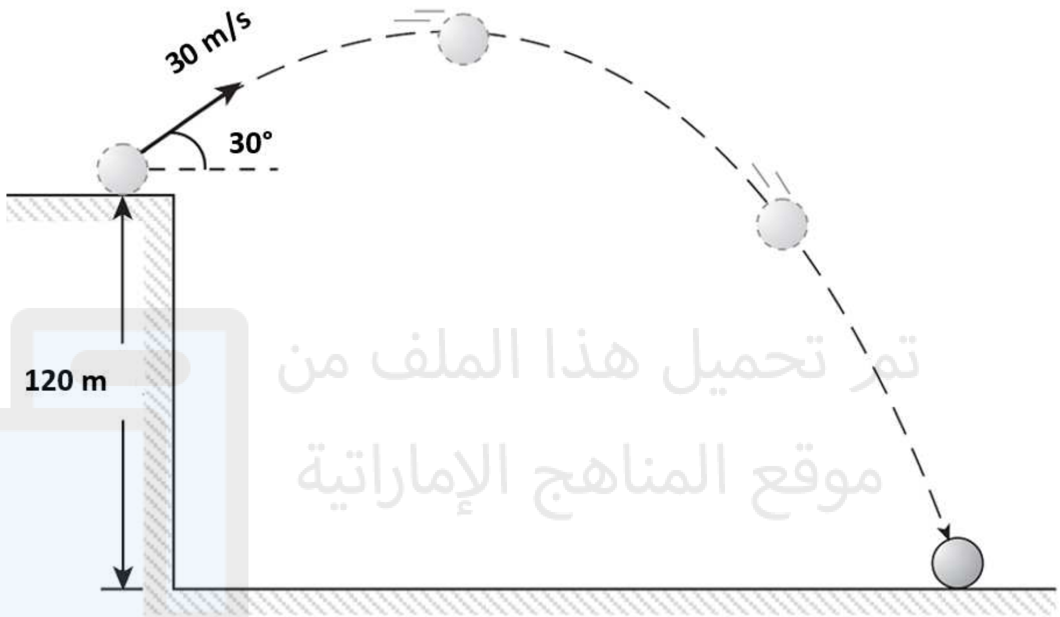


Example Question 4A

A cannon is fired from a hill 116.7 m high at an angle of 22.7° with respect to the horizontal. If the muzzle velocity is 36.1 m/s, what is the speed of a 4.35 kg cannonball when it hits the ground 116.7 m below?

Example Question 4B

A cannonball is fired from a hill 120.0 m high, with a velocity of 30 m/s, at an angle of 30.0° with respect to the horizontal, as shown below. What is the magnitude of the velocity of the cannonball when it hits the ground 120.0 m below? (Use g = 10 m/s^2)

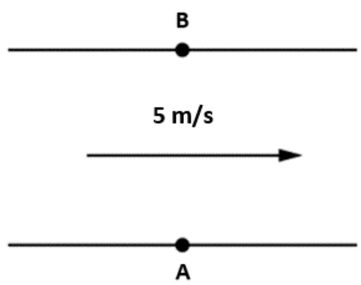


Example Question 5A

The captain of a boat wants to travel directly across a river that flows due east with a speed of 1.00 m/s. He starts from the south bank of the river and heads toward the north bank. The boat has a speed of 6.10 m/s with respect to the water. In what direction (in degrees) should the captain steer the boat? Note that 90° is east, 180° is south, 270° is west, and 360° is north.

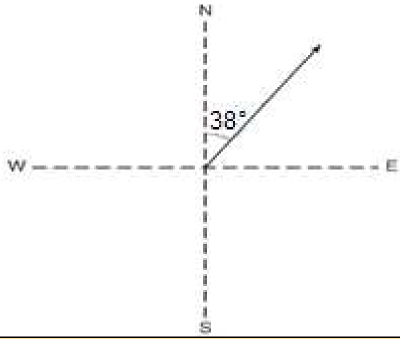
Example Question 5B

A person wants to paddle a canoe from point A to point B, which is directly across a river from point A, as shown below. The water in the river flows at 5 m/s, and the person paddle the canoe at 10 m/s in still water. One the diagram draw a vector to represents the appropriate heading for the canoe if it is to land at point B?



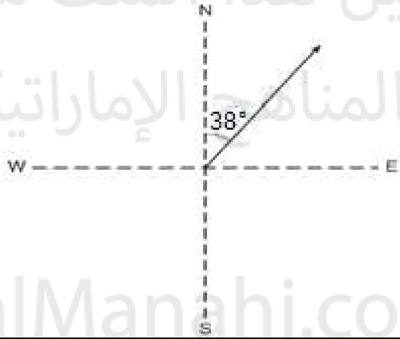
Example Question 6A

The vector diagram represents the velocity of a car traveling 18 m/s 38° east of north. What is the magnitude of the component of the car's velocity that is directed eastward?



Example Question 6B

The vector diagram represents the velocity of a car traveling 18 m/s 38° east of north. What is the magnitude of the component of the car's velocity that is directed northward?



Example Question 7A

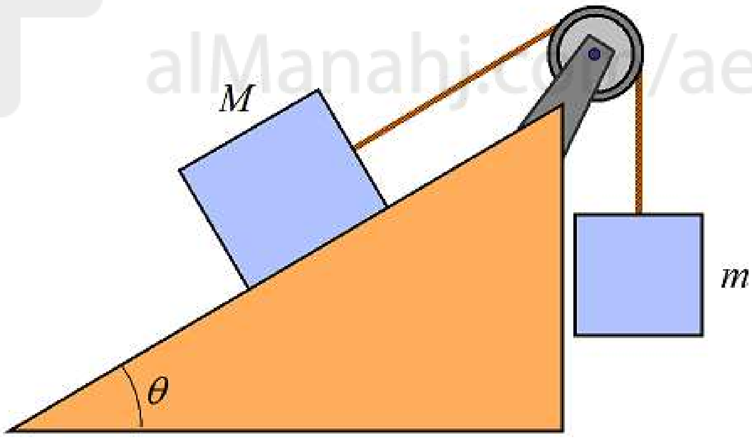
A 423.5 N force accelerates a go-cart and its driver from 10.4 m/s to 17.9 m/s in 5.00 s. What is the mass of the go cart plus driver?

Example Question 7B

A net force of 400 N is required to accelerate a go cart and its driver from 12.5 m/s to 22.5 m/s in 5.00 s. What is the mass of the go cart plus driver?

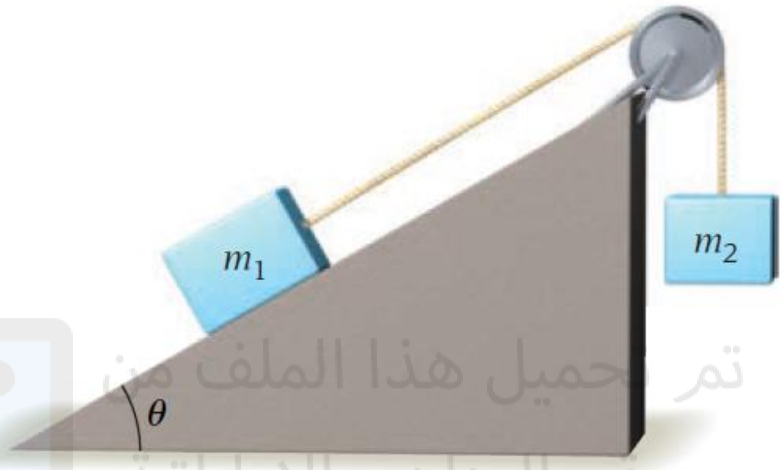
Example Question 8A

A mass, M = 20.0 kg, on a frictionless ramp is attached to a light string. The string passes over a frictionless pulley and is attached to a hanging mass, m. The ramp is at an angle of θ = 30.0° above the horizontal. If mass M moves up the ramp at constant speed, what is mass of m?



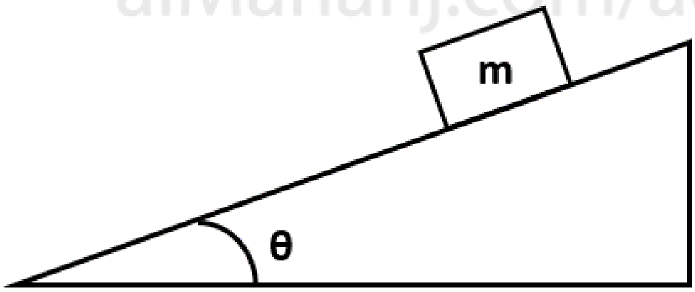
Example Question 8B

A mass, m_1 = 30.0 kg, on a frictionless ramp is attached to a light string. The string passes over a frictionless pulley and is attached to a hanging mass, m_2. The ramp is at an angle of θ = 15.0° above the horizontal. If mass m_1 moves up the ramp at constant speed, what is mass of m_2?



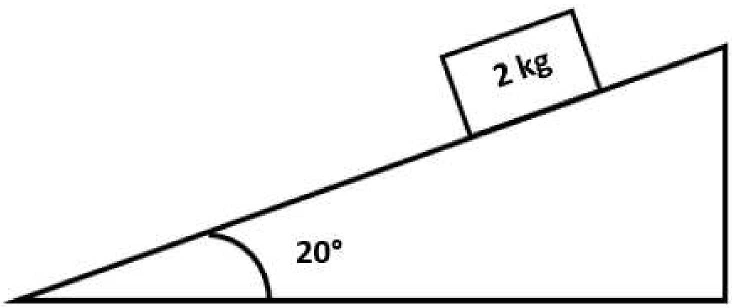
Example Question 9A

A block of mass *m* is sliding down an inclined plane that makes an angle *θ* with the horizontal, as shown below. The coefficient of kinetic friction between the surface and the block is *μ*. Derive an expression for the acceleration of the block.



Example Question 9B

A block of mass 2 kg is sliding down an inclined plane that makes an angle 20° with the horizontal, as shown below. The coefficient of kinetic friction between the surface and the block is 0.2. What is the acceleration of the block?



Example Question 10A

Calculate the centripetal force exerted on a vehicle of mass m = 1500 kg that is moving at a speed of 15.0 m/s around a curve of radius R = 400 m. Which force plays the role of the centripetal force in this case?

Example Question 10B

A car of mass 1600 kg driving around a horizontal circular track of radius 400 m at a speed of 22 m/s. What is the centripetal force exerted on the car?

Example Question 11A

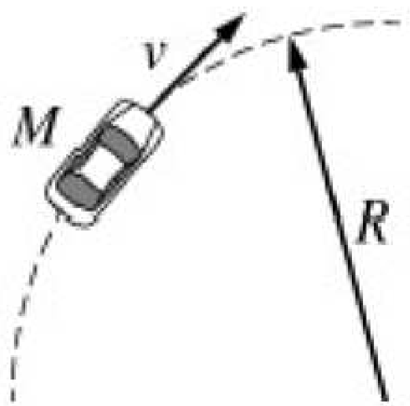
A coffee filter of mass *m* is dropped from rest, and it falls through the air. The magnitude of the drag force of the air on the coffee filter follows the equation $F_D = kv^2$, where *k* is a positive integer. Derive an equation in terms of m, g and k, to represent the terminal velocity of the coffee filter.

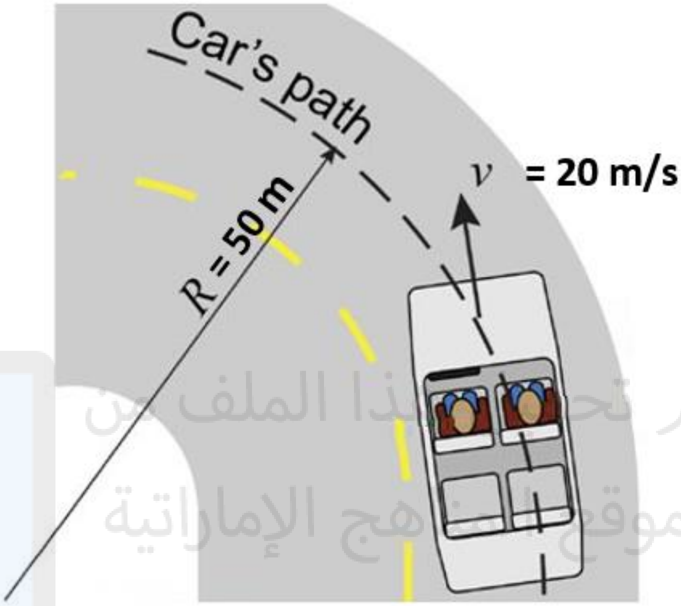
Example Question 11B

A skydiver of mass 80.0 kg fall through air with a (drag) constant *k* of 0.3. The magnitude of the drag force of the air on the skydiver follows the equation $F_D = kv^2$, where *k* is 0.3. Calculate the terminal velocity of the skydiver?

Example Question 12A

A car of mass *M* moves with constant speed *v* around a flat horizontal circular racetrack of radius *R,* as shown below. Derive an equation in terms of g, R and v, to represent the minimum coefficient of static friction required for the race car to continue to follow the circular path.



Example Question 12B
A car of mass 1500 kg moves with constant speed 20 m/s around a flat horizontal circular racetrack of radius 50 m, as shown below. Calculate the minimum coefficient of static friction required for the race car to continue to follow the circular path. (Use g = 10 m/s^2) 

Example Question 13A
An object of mass 10.0 kg starts from rest at time $t = 0$ and moves in a straight line. For time t > 0, the object's velocity v as a function of time t is given by $v = t + 2t^2$, where v is in m/s and t is in seconds. How much work is done by the net force between $t = 0$ and $t = 3$ s?

Example Question 13B
An object of mass 20.0 kg starts from rest at time $t = 0$ and moves in a straight line. For time t > 0, the object's velocity v as a function of time t is given by $v = 3t + 4t^2$, where v is in m/s and t is in seconds. How much work is done by the net force between $t = 1$ and $t = 3$ s?

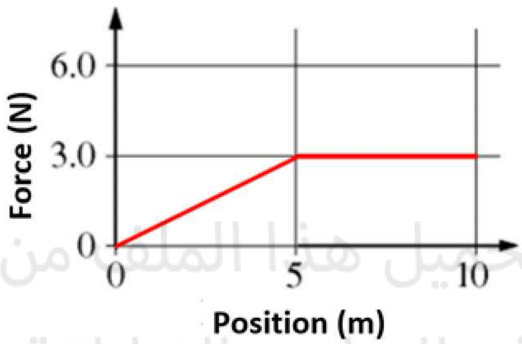
Example Question 14A
An accelerating car of mass 1550 kg, can reach a speed of 60 mph (26.8 m/s) in 7.1 s. What is the average power needed to accomplish this? (Assume that the car starts from rest.)

Example Question 14B
A car of mass 1200 kg, accelerates from rest to 25 m/s in a time of 4.0 s. What is the average power required to achieve this acceleration?

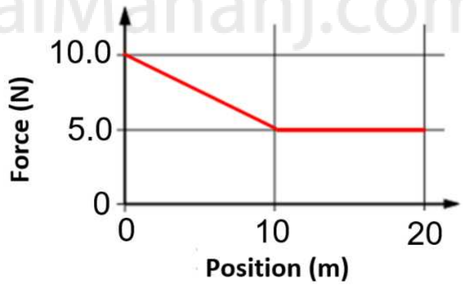
Example Question 15A
A box of mass m is lifted at a constant velocity v to a height h in a time t. Derive an equation for the power of the force lifting the box in terms of m, g, h and t.

Example Question 15B
A box of weight 100 N is lifted at a constant velocity of 1 m/s to a height of 20 m in a time 20 s. Calculate the power of the force lifting the box.

Example Question 16A
A student pulls a box 10 m across a smooth floor. The student uses a spring scale to measure the force applied. The student plots the force applied against position on the graph below. What is the total work done moving the box across the floor?



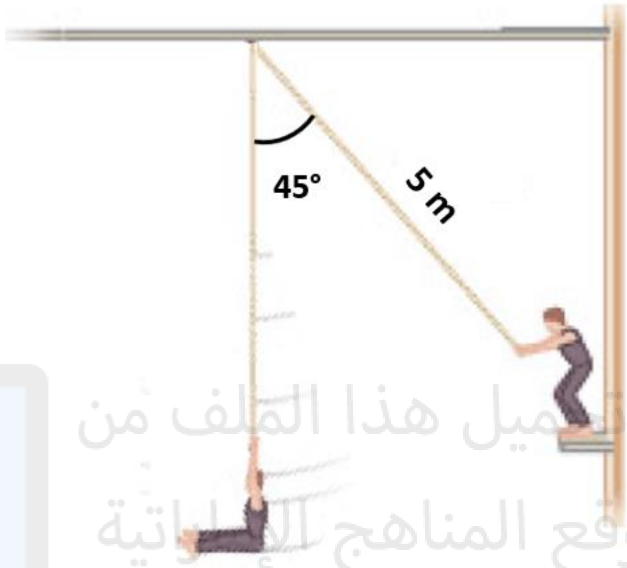
Example Question 16B
A student pulls a box 20 m across a smooth floor. The student uses a spring scale to measure the force applied. The student plots the force applied against position on the graph below. What is the total work done moving the box across the floor?



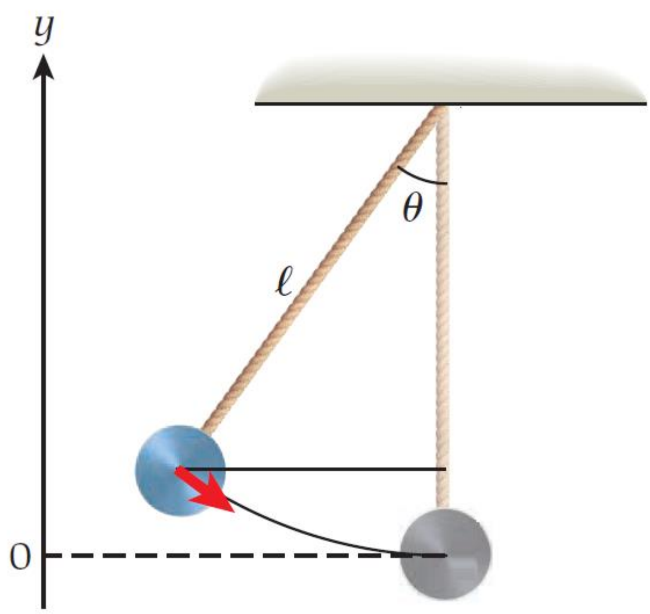
Example Question 17A
The potential energy of a particle in a system, as a function of position *y* is given by $U(y) = ay^{-5/2} + b$, where a and b are constants. Derive an expression for the force on the particle as a function of position y.

Example Question 17B
A particle is moving along the x-axis subject to the potential energy function $U(x) = a(1/x) + bx^2 + cx - d$, where $a = 7.00$ Jm, $b = 10.0$ j/m^2, $c = 6.00$ J/m, and $d = 28.0$ J. Express the force felt by the particle as a function of x.

Example Question 18A
A trapeze artist starts his motion with the trapeze at rest at an angle of 45.0° to the vertical. The trapeze ropes have a length of 5.00 m. What is his speed at the lowest point in his trajectory?



Example Question 18B
A pendulum starts its motion with the pendulum at rest at an angle of θ = 30.0° to the vertical. The length of the pendulum is l = 3.00 m. What is his speed at the lowest point in its trajectory? (Use $g = 10\ m/s^2$)



Example Question 19A
When an object is moved from rest at point S to rest at point T in a gravitational field. Does the net work done by the gravitational field depend on the mass of the object?
Example Question 19B
When an object is moved from rest at point S to rest at point T in a gravitational field. Does the net work done by the gravitational field depend on the path taken between positions S and T?
Example Question 20A
A car moving in a horizontal circle at a constant speed of 10 km/h. Explain why the car is accelerating.
Example Question 20B
An object is moving with constant speed. Describe a situation when the velocity of the object could change despite having constant speed.

ADVANCED PLACEMENT PHYSICS C TABLE OF INFORMATION

CONSTANTS AND CONVERSION FACTORS	
Proton mass, $m_p = 1.67 \times 10^{-27}$ kg	Electron charge magnitude, $e = 1.60 \times 10^{-19}$ C
Neutron mass, $m_n = 1.67 \times 10^{-27}$ kg	1 electron volt, $1\text{ eV} = 1.60 \times 10^{-19}$ J
Electron mass, $m_e = 9.11 \times 10^{-31}$ kg	Speed of light, $c = 3.00 \times 10^{8}$ m/s
Avogadro's number, $N_0 = 6.02 \times 10^{23}\ \text{mol}^{-1}$	Universal gravitational constant, $G = 6.67 \times 10^{-11}\ (\text{N}\cdot\text{m}^2)/\text{kg}^2$
Universal gas constant, $R = 8.31$ J/(mol·K)	Acceleration due to gravity at Earth's surface, $g = 9.8\ \text{m/s}^2$
Boltzmann's constant, $k_B = 1.38 \times 10^{-23}$ J/K	

1 unified atomic mass unit,	$1\text{ u} = 1.66 \times 10^{-27}\ \text{kg} = 931\ \text{MeV}/c^2$
Planck's constant,	$h = 6.63 \times 10^{-34}\ \text{J}\cdot\text{s} = 4.14 \times 10^{-15}\ \text{eV}\cdot\text{s}$
	$hc = 1.99 \times 10^{-25}\ \text{J}\cdot\text{m} = 1.24 \times 10^{3}\ \text{eV}\cdot\text{nm}$
Vacuum permittivity,	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/(\text{N}\cdot\text{m}^2)$
Coulomb's law constant,	$k = 1/(4\pi\varepsilon_0) = 9.0 \times 10^{9}\ (\text{N}\cdot\text{m}^2)/\text{C}^2$
Vacuum permeability,	$\mu_0 = 4\pi \times 10^{-7}\ (\text{T}\cdot\text{m})/\text{A}$
Magnetic constant,	$k' = \mu_0/(4\pi) = 1 \times 10^{-7}\ (\text{T}\cdot\text{m})/\text{A}$
1 atmosphere pressure,	$1\text{ atm} = 1.0 \times 10^{5}\ \text{N/m}^2 = 1.0 \times 10^{5}$ Pa

UNIT SYMBOLS								
	meter,	m	mole,	mol	watt,	W	farad,	F
	kilogram,	kg	hertz,	Hz	coulomb,	C	tesla,	T
	second,	s	newton,	N	volt,	V	degree Celsius,	°C
	ampere,	A	pascal,	Pa	ohm,	Ω	electron volt,	eV
	kelvin,	K	joule,	J	henry,	H		

PREFIXES		
Factor	Prefix	Symbol
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

VALUES OF TRIGONOMETRIC FUNCTIONS FOR COMMON ANGLES							
θ	0°	30°	37°	45°	53°	60°	90°
$\sin\theta$	0	1/2	3/5	$\sqrt{2}/2$	4/5	$\sqrt{3}/2$	1
$\cos\theta$	1	$\sqrt{3}/2$	4/5	$\sqrt{2}/2$	3/5	1/2	0
$\tan\theta$	0	$\sqrt{3}/3$	3/4	1	4/3	$\sqrt{3}$	∞

The following assumptions are used in this exam.

I. The frame of reference of any problem is inertial unless otherwise stated.
II. The direction of current is the direction in which positive charges would drift.
III. The electric potential is zero at an infinite distance from an isolated point charge.
IV. All batteries and meters are ideal unless otherwise stated.
V. Edge effects for the electric field of a parallel plate capacitor are negligible unless otherwise stated.

ADVANCED PLACEMENT PHYSICS C EQUATIONS

MECHANICS

$$v_x = v_{x0} + a_x t$$
$$x = x_0 + v_{x0}t + \frac{1}{2}a_x t^2$$
$$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$$
$$\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$$
$$\vec{F} = \frac{d\vec{p}}{dt}$$
$$\vec{J} = \int \vec{F}\,dt = \Delta\vec{p}$$
$$\vec{p} = m\vec{v}$$
$$|\vec{F}_f| \le \mu|\vec{F}_N|$$
$$\Delta E = W = \int \vec{F}\cdot d\vec{r}$$
$$K = \frac{1}{2}mv^2$$
$$P = \frac{dE}{dt}$$
$$P = \vec{F}\cdot\vec{v}$$
$$\Delta U_g = mg\Delta h$$
$$a_c = \frac{v^2}{r} = \omega^2 r$$
$$\vec{\tau} = \vec{r} \times \vec{F}$$
$$\vec{\alpha} = \frac{\sum\vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$$
$$I = \int r^2\,dm = \sum mr^2$$
$$x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$$
$$v = r\omega$$
$$\vec{L} = \vec{r} \times \vec{p} = I\vec{\omega}$$
$$K = \frac{1}{2}I\omega^2$$
$$\omega = \omega_0 + \alpha t$$
$$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$$

a = acceleration
E = energy
F = force
f = frequency
h = height
I = rotational inertia
J = impulse
K = kinetic energy
k = spring constant
ℓ = length
L = angular momentum
m = mass
P = power
p = momentum
r = radius or distance
T = period
t = time
U = potential energy
v = velocity or speed
W = work done on a system
x = position
μ = coefficient of friction
θ = angle
τ = torque
ω = angular speed
α = angular acceleration
ϕ = phase angle

$$\vec{F}_s = -k\Delta\vec{x}$$
$$U_s = \frac{1}{2}k(\Delta x)^2$$
$$x = x_{max}\cos(\omega t + \phi)$$
$$T = \frac{2\pi}{\omega} = \frac{1}{f}$$
$$T_s = 2\pi\sqrt{\frac{m}{k}}$$
$$T_p = 2\pi\sqrt{\frac{\ell}{g}}$$
$$|\vec{F}_G| = \frac{Gm_1m_2}{r^2}$$
$$U_G = -\frac{Gm_1m_2}{r}$$

ELECTRICITY AND MAGNETISM

$$|\vec{F}_E| = \frac{1}{4\pi\varepsilon_0}\left|\frac{q_1q_2}{r^2}\right|$$
$$\vec{E} = \frac{\vec{F}_E}{q}$$
$$\oint \vec{E}\cdot d\vec{A} = \frac{Q}{\varepsilon_0}$$
$$E_x = -\frac{dV}{dx}$$
$$\Delta V = -\int \vec{E}\cdot d\vec{r}$$
$$V = \frac{1}{4\pi\varepsilon_0}\sum_i \frac{q_i}{r_i}$$
$$U_E = qV = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r}$$
$$\Delta V = \frac{Q}{C}$$
$$C = \frac{\kappa\varepsilon_0 A}{d}$$
$$C_p = \sum_i C_i$$
$$\frac{1}{C_s} = \sum_i \frac{1}{C_i}$$
$$I = \frac{dQ}{dt}$$
$$U_C = \frac{1}{2}Q\Delta V = \frac{1}{2}C(\Delta V)^2$$
$$R = \frac{\rho\ell}{A}$$
$$\vec{E} = \rho\vec{J}$$
$$I = Nev_dA$$
$$I = \frac{\Delta V}{R}$$
$$R_s = \sum_i R_i$$
$$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$$
$$P = I\Delta V$$

A = area
B = magnetic field
C = capacitance
d = distance
E = electric field
$\mathcal{E}$ = emf
F = force
I = current
J = current density
L = inductance
ℓ = length
n = number of loops of wire per unit length
N = number of charge carriers per unit volume
P = power
Q = charge
q = point charge
R = resistance
r = radius or distance
t = time
U = potential or stored energy
V = electric potential
v = velocity or speed
ρ = resistivity
Φ = flux
κ = dielectric constant

$$\vec{F}_M = q\vec{v} \times \vec{B}$$
$$\oint \vec{B}\cdot d\vec{\ell} = \mu_0 I$$
$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\,d\vec{\ell} \times \hat{r}}{r^2}$$
$$\vec{F} = \int I\,d\vec{\ell} \times \vec{B}$$
$$B_s = \mu_0 nI$$
$$\Phi_B = \int \vec{B}\cdot d\vec{A}$$
$$\mathcal{E} = \oint \vec{E}\cdot d\vec{\ell} = -\frac{d\Phi_B}{dt}$$
$$\mathcal{E} = -L\frac{dI}{dt}$$
$$U_L = \frac{1}{2}LI^2$$

ADVANCED PLACEMENT PHYSICS C EQUATIONS

GEOMETRY AND TRIGONOMETRY

Rectangle
$A = bh$

Triangle
$A = \frac{1}{2}bh$

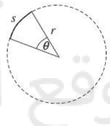
Circle
$A = \pi r^2$
$C = 2\pi r$
$s = r\theta$

Rectangular Solid
$V = \ell wh$

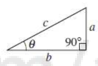
Cylinder
$V = \pi r^2\ell$
$S = 2\pi r\ell + 2\pi r^2$

Sphere
$V = \frac{4}{3}\pi r^3$
$S = 4\pi r^2$

A = area
C = circumference
V = volume
S = surface area
b = base
h = height
ℓ = length
w = width
r = radius
s = arc length
θ = angle



Right Triangle
$a^2 + b^2 = c^2$
$\sin\theta = \frac{a}{c}$
$\cos\theta = \frac{b}{c}$
$\tan\theta = \frac{a}{b}$



CALCULUS

$$\frac{df}{dx} = \frac{df}{du}\frac{du}{dx}$$
$$\frac{d}{dx}(x^n) = nx^{n-1}$$
$$\frac{d}{dx}(e^{ax}) = ae^{ax}$$
$$\frac{d}{dx}(\ln ax) = \frac{1}{x}$$
$$\frac{d}{dx}[\sin(ax)] = a\cos(ax)$$
$$\frac{d}{dx}[\cos(ax)] = -a\sin(ax)$$
$$\int x^n\,dx = \frac{1}{n+1}x^{n+1},\ n \ne -1$$
$$\int e^{ax}\,dx = \frac{1}{a}e^{ax}$$
$$\int \frac{dx}{x+a} = \ln|x+a|$$
$$\int \cos(ax)\,dx = \frac{1}{a}\sin(ax)$$
$$\int \sin(ax)\,dx = -\frac{1}{a}\cos(ax)$$

VECTOR PRODUCTS

$$\vec{A}\cdot\vec{B} = AB\cos\theta$$
$$|\vec{A} \times \vec{B}| = AB\sin\theta$$