AP Physics B: Intro to Phys & Energy 80min K Name ~~Key~~ Per__

(Includes: Unit Conversion & Unit Prefixes, Significant Figures, Estimation, Algebra & Trig Review, Energy - K, U_g, Us, Q, Work, Power, Springs, Pendulums and Simple Harmonic Motion)

22.8 km/hr 1. Convert 6.32 m/s into km/hr. $\frac{6.32\ m}{s} \cdot \frac{1 km}{1000 m} \cdot \frac{3600 s}{1 hr} =$

Questions 2-3) How may significant figures do this numbers have?

4 2. 0.02090 m

5 3. $605.30

#18 is bonus
35 min MC 23×2pts = 46pts
45 min FR = 40pts
86pts

Exact

Questions 4-5) Calculate these numbers to the **correct significant figures**.

0.27 4. (1200)/(232.75) (18.76) = 0.274826

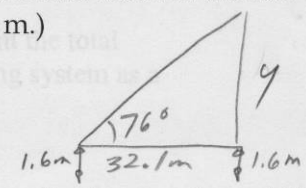
270 5. 270 + 0.05439 + 1.4 = 271.45439

2.07 m 6. If a plane flies at 690 m/s, how far does it travel in 3.0 ms? (That's 2.0 milliseconds.) (typo: 3)

$V = \frac{\Delta x}{\Delta t}$ $\Delta x = V \Delta t = 690\ m/s\ (3E-3\ s)$

130 m 7. You are in Denver and you want to find out how tall a building is. You stand 32.1 m away from the building on horizontal ground. You have to look up at an angle of 76.0 degrees to see the top of the building. Now you have all the information you need to find the height for the building in units of meters. (Being a good AP Physics student, you remember to take into account the fact that your eyes are above the ground by approximately 1.60 m.)

Not 128.7 m



$\tan 76° = \frac{y}{32.1}$

$y = 128.746$

$h = y + 1.6 m$

Questions 8-9) You walk 4 km north, and then 3 km east to get to Maria's house.

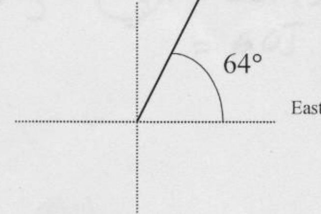
5 km 8. How far is the straight-line distance to Maria's house?

53° 9. In what direction is this straight-line distance to Maria's house?

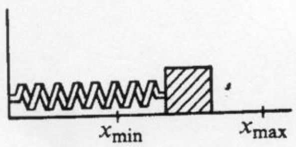
Polar Coordinates

15.3 km 10. A bird flies 17 km at an angle of 64° from the easterly direction as shown in the figure to the right. How far north has the bird flown?

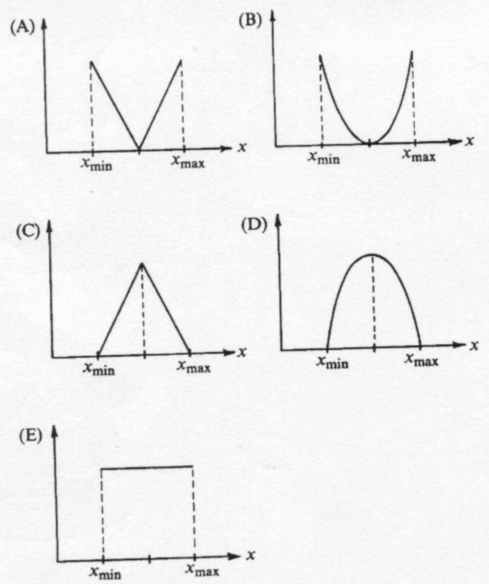
$y = 17 km \sin 64°$



Questions 11-12



A block oscillates without friction on the end of a spring as shown above. The minimum and maximum lengths of the spring as it oscillates are, respectively, x_{min} and x_{max}. The graphs below can represent quantities associated with the oscillation as functions of the length x of the spring.

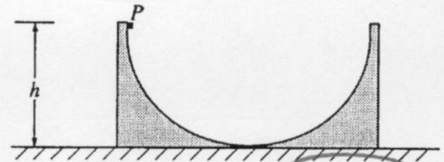


E 11. Which graph can represent the total mechanical energy of the block-spring system as a function of x?

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

D 12. Which graph can represent the kinetic energy of the block as a function of x?

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



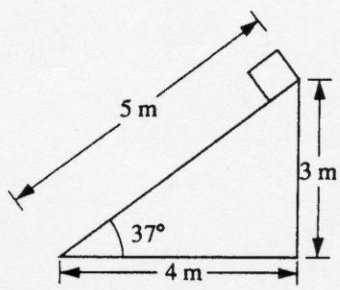
E 13. The figure above shows a rough semicircular track whose ends are at a vertical height h. A block placed at point P at one end of the track is released from rest and slides past the bottom of the track. Which of the following is true of the height to which the block rises on the other side of the track?

(A) It is equal to $h/2\pi$.
(B) It is equal to h/4.
(C) It is equal to h/2.
(D) It is equal to h.
(E) It is between zero and h; the exact height depends on how much energy is lost to friction.

E 14. A weight lifter lifts a mass m at constant speed to a height h in time t. What is the average power output of the weight lifter?

(A) mg
(B) mh
(C) mgh
(D) $mght$
(E) mgh/t

$P = \frac{\Delta E}{\Delta t} = \frac{\Delta U_g}{\Delta t} = \frac{mgh}{t}$



B 15. A plane 5 meters in length is inclined at an angle of 37°, as shown above. A block of weight 20 Newtons is placed at the top of the plane and allowed to slide down. The work done on the block by the gravitational force during the 5-meter slide down the plane is most nearly

(A) 20 J
(B) 60 J
(C) 80 J
(D) 100 J
(E) 130 J

$W = \Delta U_g = mgh = 20N(3) = 60J$

____16. A student weighing 700 N climbs at constant speed to the top of an 8 m vertical rope in 10 s. The average power expended by the student to overcome gravity is most nearly

(A) 1.1 W
(B) 87.5 W
(C) 560 W
(D) 875 W
(E) 5,600 W

____16. Units of power include which of the following?

I. Watt
II. Joule per second
III. Kilowatt-hour

(A) I only
(B) III only
(C) I and II only
(D) II and III only
(E) I, II, and III

____18. A child pushes horizontally on a box of mass m which moves with constant speed υ across a horizontal floor. The coefficient of friction between the box and the floor is μ. At what rate does the child do work on the box?

(A) $\mu m g \upsilon$
(B) $m g \upsilon$
(C) $\upsilon / \mu m g$
(D) $\mu m g / \upsilon$
(E) $\mu m \upsilon^2$

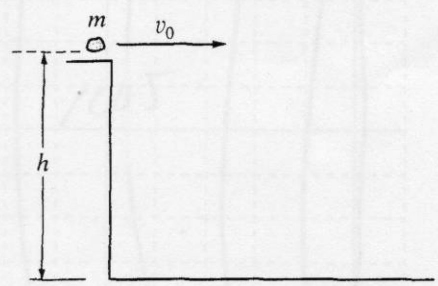
____19. The length of a simple pendulum with a period on Earth of one second is most nearly

(A) 0.12 m
(B) 0.25 m
(C) 0.50 m
(D) 1.0 m
(E) 10.0 m

____20. An object swings on the end of a cord as a simple pendulum with period T. Another object oscillates up and down on the end of a vertical spring, also with period T. If the masses of both objects are doubled, what are the new values for the periods?

	Pendulum	Mass on Spring
(A)	$\frac{T}{\sqrt{2}}$	$\sqrt{2}T$
(B)	T	$\sqrt{2}T$
(C)	$\sqrt{2}T$	T
(D)	$\sqrt{2}T$	T
(E)	$\sqrt{2}T$	$T\sqrt{2}$

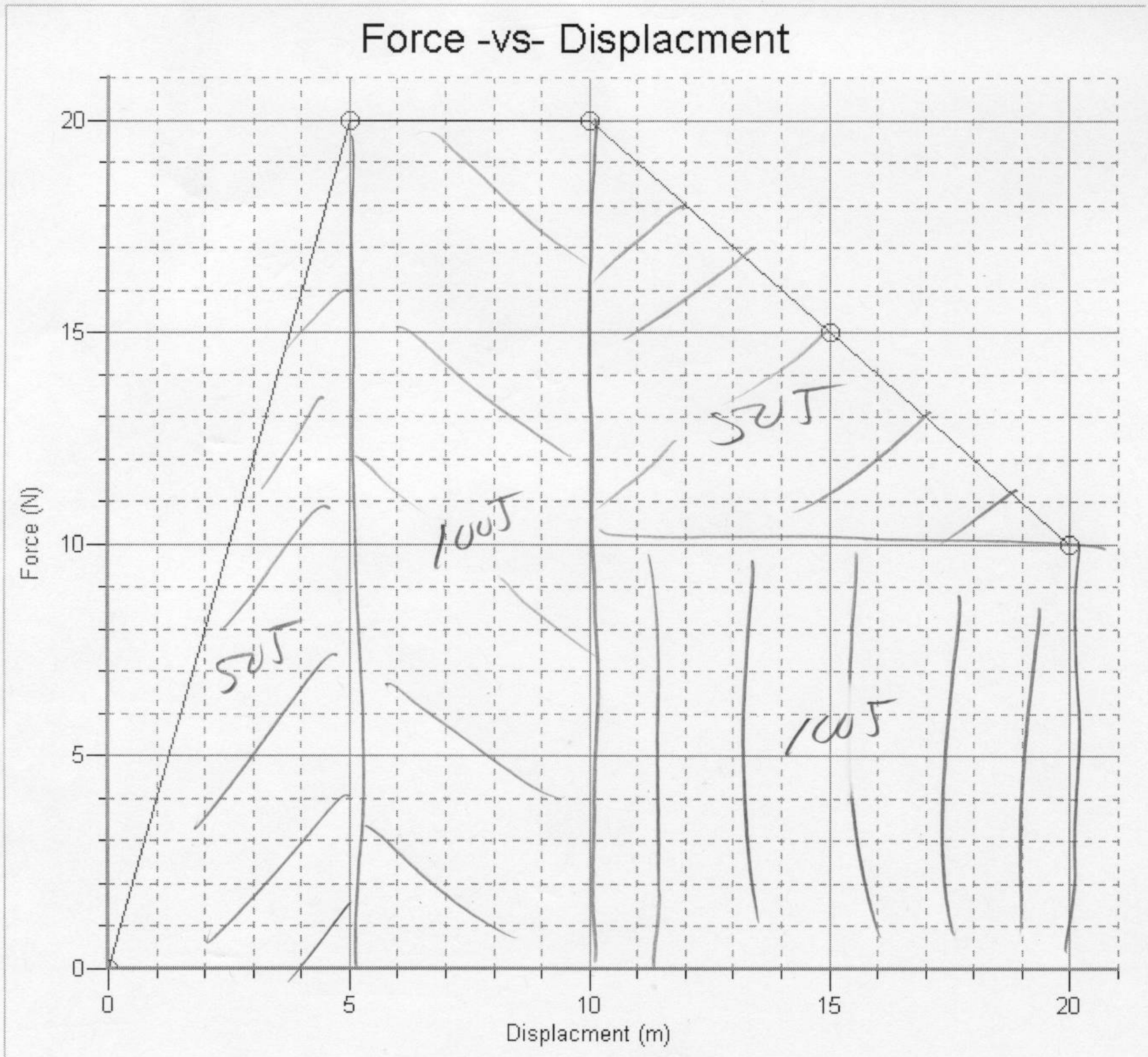
Questions 59-60



A rock of mass m is thrown horizontally off a building from a height h, as shown above. The speed of the rock as it leaves the thrower's hand at the edge of the building is υ_0.

____60. What is the kinetic energy of the rock just before it hits the ground?

(A) mgh
(B) $\frac{1}{2}m\upsilon_0^2$
(C) $\frac{1}{2}m\upsilon_0^2 - mgh$
(D) $\frac{1}{2}m\upsilon_0^2 + mgh$
(E) $mgh - \frac{1}{2}m\upsilon_0^2$



Questions 22-24

The graph above shows the horizontal force a father applies to her 25kg girl on an ice skating rink. Assume that friction is small.

D ______22) If the girl starts from rest, how much work does the father do in the first 5 meters?
A) 0
B) 5J
C) 20J
D) 50J
E) 100J

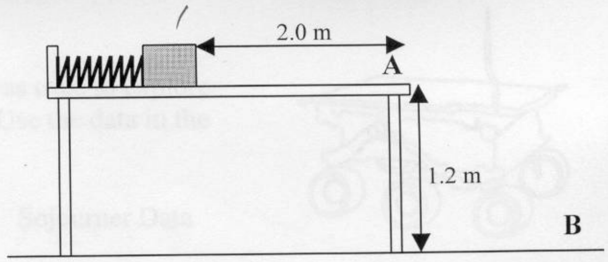
C ______23) How fast will the girl be traveling after 5 meters?
A) 1.3 m/s
B) 1.4 m/s
C) 2.0 m/s
D) 2.8 m/s
E) 4 m/s

$W = \Delta K$

$50J = \frac{1}{2}(25)v^2$

B ______24) The girl's kinetic energy increase over the entire 20 meters is most nearly.
A) 200J
B) 300J
C) 400J
D) 500J
E) 600J

25) (15 points) A 2.4 kg block is compressed 0.5 m against a spring and held in place on a table top of negligible friction as shown. The spring constant is 80 N/m. The block is released and slides to the right.



a) What is the velocity of the block at point A?

4pts

$E_1 = E_A$

$\frac{1}{2}kx^2 = \frac{1}{2}mv_A^2$

$(80\,N/m)(.5\,m)^2 = (2.4\,kg)\,v_A^2$

$v_A = 2.9\,m/s$

Can neglect U_g this time —

b) What is the velocity of the block right before it hits the floor at point B?

4pts

$E_1 = E_B$

$\frac{1}{2}kx^2 + mgh = \frac{1}{2}mv_B^2$

$\frac{1}{2}(80)(.5)^2 + (2.4)(9.8)(1.2) = \frac{1}{2}(2.4)v_B^2$

$v_B = 5.6\,m/s$

Must include ΔU_g this time —

7pts c) On the grid provided draw a graph of:

i) Kinetic ~~typo~~

ii) Gravitational Potential

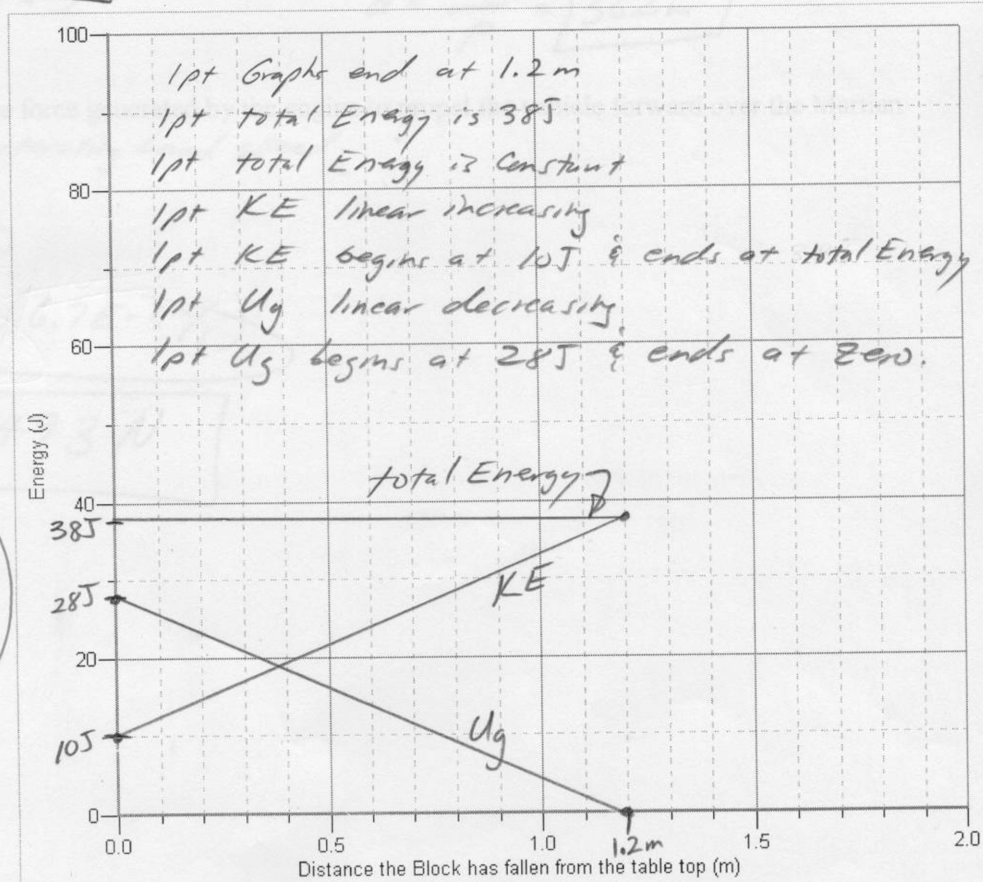
iii) Total Energy

Draw each as a function of the distance the block has fallen from the table. ~~Assume the~~

Carefully label each graph or provide a key.

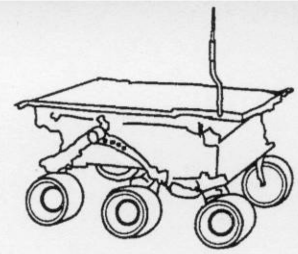
Use the floor as the zero point for gravitational potential energy.

typo



26) (6 points - 1999B1 modified)

The Sojourner rover vehicle shown in the sketch to the right was used to explore the surface of Mars as part of the Pathfinder mission in 1997. Use the data in the tables below to answer the questions that follow.



Mars Data		Sojourner Data	
Radius:	0.53 x Earth's radius	Mass of Sojourner vehicle:	11.5 kg
Mass:	0.11 x Earth's mass	Wheel diameter:	0.13 m
		Stored energy available:	5.4×10^5 J
		Power required for driving under average conditions:	10 W
		Land speed:	6.7×10^{-3} m/s

3 pts (a) Determine the maximum distance that Sojourner can travel on a horizontal Martian surface using its stored energy.

1 $P = \frac{\Delta E}{\Delta t}$

$\Delta t = \frac{\Delta E}{P} = \frac{5.4E5\,J}{10\,W} = 5.4E4\,s$

1 $X = Vt$

$= (6.7E-3\,m/s)\,5.4E4\,s$

$=$ 1 **362 m**

\- or - $W = Fd$ and $P = Fv$

$d = \frac{vW}{P} =$ **362 m**

3 pts (b) Determine the average force generated by the engine to propel the vehicle forward over the Martian surface. at its operating Land speed.

1 $P = Fv$

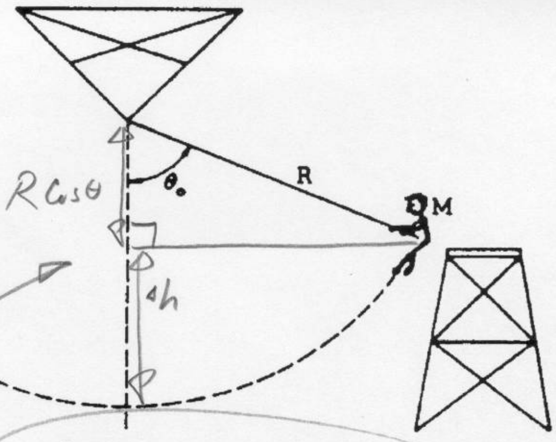
1 $10\,W = F_{Avg}(6.7E-3\,m/s)$

1 **$F_{Avg} = 1493\,N$**

27) **1982 PHYSICS B MECHANICS**

(10 points)

A child of mass M holds onto a rope and steps off a platform. Assume that the initial speed of the child is zero. The rope has length R and negligible mass. The initial angle of the rope with the vertical is θ_0, as shown in the drawing above.



(a) Using the principle of conservation of energy, develop an expression for the speed of the child at the lowest point in the swing in terms of g, R, and cos θ_0.

6pts

Attempting to solve for Δh by constructing a triangle

$\Delta h = R - R\cos\theta$

$E_1 = E_2$

$mg\Delta h = \frac{1}{2}mv^2$

$g(R - R\cos\theta) = \frac{1}{2}v^2$

$V = \sqrt{2g(R - R\cos\theta)}$

2pts (b) Let R = 9 meters and θ_0 = 15 degrees, calculate the speed of the child at the lowest point in the swing.

$E_1 = E_2$

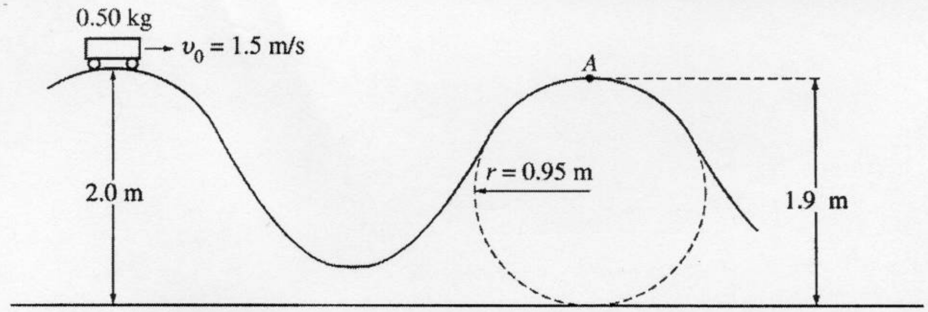
$V = \sqrt{2g(R - R\cos\theta)}$

$= \sqrt{2(9.8)(9 - 9\cos 15°)}$

$= 2.45\,m$

2pts (c) How long will it take for the child to swing all the way out and then return back to the platform?

$T_p = 2\pi\sqrt{\ell/g} = 2\pi\sqrt{9m/9.8} = 6s$



28) 2004B1B modified. (9 points)

A designer is working on a new roller coaster, and she begins by making a scale model. On this model, a car of total mass 0.50 kg moves with negligible friction along the track shown in the figure above. The car is given an initial speed v_o = 1.5 m/ s at the top of the first hill of height 2.0 m. Point *A* is located at a height of 1.9 m at the top of the second hill, the upper part of which is a circular arc of radius 0.95 m.

(a) Calculate the speed of the car at point *A*.

4pts

$E_1 = E_A$

$(K + U_g)_1 = (K + U_g)_A$ or $K_1 + \Delta U_g = K_A$

$\frac{1}{2}mv^2 + mg\Delta h = \frac{1}{2}mv_A^2$

$\frac{1}{2}(1.5)^2 + 9.8(0.1) = \frac{1}{2}V_A^2$

$V_A = 2.05\ \text{m/s}$

(b) In order to stop the car at point *A*, some friction must be introduced.

3pts i) Calculate the work that must be done by the friction force in order to stop the car at point *A*.

$W = \Delta E = E_A - E_1$ (stopped)

$= mgh_A - (mgh_1 + \frac{1}{2}mv_1^2)$

$= .5(9.8)(1.9) - .5(9.8)(2) - \frac{1}{2}(.5)(1.5)^2$

$= -1.05\ \text{J}$

ii) When the car has stopped at point *A*, its mechanical energy is less than its initial value at the top of the first hill. Explain what has happened to the energy.

2pts

The Negative work of Friction has decreased the energy of the car.

– or –

The Energy that was lost was converted to other forms of Energy - like Thermal Energy.