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UNIVERSITY OF OTTAWA
Principles of Physics
PHY1321/31Fall 2018
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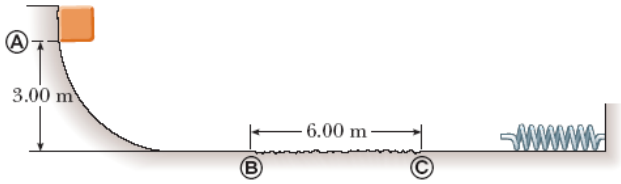
STUDENT #: _____

NAME:
_____

ASSIGNMENT 10:
Linear Momentum,
Ballistic Pendulum,
Swinging mass problem

Released: Nov19 19, Due: Nov 26 5:30PM

1 10.0-kg block is released from point A with speed of initial speed 1m/s. (Block is given a push). The track is frictionless except for the portion between points B and C which has a length of 6.00 m. The block travels down the track, hits a spring of force constant 2 000 N/m, and compresses the spring 0.300 m from its equilibrium position before coming to rest momentarily. Determine the coefficient of kinetic friction between the block and the rough surface between B and C.



$$E_C - E_A = W_{BC} \Longrightarrow E_C - E_A = W_{BC} \Longrightarrow \tfrac{1}{2}kx^2 - (mgh + \tfrac{1}{2}mv^2) = -\mu mgL \Rightarrow$$
$$\Rightarrow \mu = -\tfrac{1}{mgL}\left(\tfrac{1}{2}kx^2 - mgh - \tfrac{1}{2}mv^2\right) = \tfrac{209}{588}$$

2 On Oct 31 2015massive asteroid TB145 nicknamed "Spooky" passed near the Earth vicinity. Given the measured diameter of the asteroid (450meters) and its speed relative to the Sun:125000km/h, find the total maximum and minimum energy released in the completely inelastic collision of this object with Earth. (NOTE you are not given the parameters of collision so they becem important part of the "worst case –best case scenario.") Treat the asteroid as spherical object with the density of between 3g/ cm^3 to 6g/cm^3. Earth orbit around the sun has radius =150 x 10^6 km.
State your answers in Jules and in mega-tones of TNT.(1 megaton of TNT= 4.184 10^{15})
34.722km/s vs 29.89km/s

WORST CASE SCENARIO:

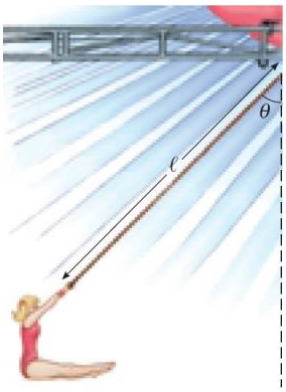
Maximum
density = 6g/cm^3
mass 2.29 10^{12}kg
relative speed 64.6 km/s
Kinetic Energy 9.51 10^{21} J
2 273 000 megatonnes of TNT.
Approx. 600 times the world total stockpiled nuclear weapons!

BEST CASE SCENARIO:

Minimum
density 3g/ cm^3
mass 1.15 10^{12}
relative speed 4.83 km/s
Kinetic Energy 1.34 10^{19}
3203 megatonnes of TNT.

(about 20% of the world stockpiled weapons)

3. A circus trapeze consists of a bar suspended by two parallel ropes, each of length ℓ, allowing performers to swing in a vertical circular arc. Suppose a performer with mass *m* holds the bar and steps off an elevated platform, starting from rest with the ropes at an angle ϑ_i with respect to the vertical. Suppose the size of the performer's body is small compared to the length ℓ, she does not pump the trapeze to swing higher, and air resistance is negligible.
(a) Show that when the ropes make an angle ϑ with the vertical, the performer must exert a force *mg* (3cosϑ – 2cosϑ_i) so as to hang on.
(b) Determine the angle ϑ_i for which the force needed to hang on at the bottom of the swing is twice the performer's weight.



Provide the full solution on the opposite page. Problem solved in class

4 Bullet of mass 80grams, hits the stationary block of mass 10kg (originally frictionless surface. The block then moves on a rough surface (u_k=0.2) by an distance of 10 meters, before coming to stop. Find the speed of the bullet when it hits the block

$$(M+m)u = mv \Rightarrow v = \frac{M+m}{m}u$$

$$\frac{(M+m)u^2}{2} = \mu_{kin} n\Delta x = \mu_{kin}(M+m)g\Delta x u^2 = 2\mu_{kin} g\Delta x \Rightarrow$$

$$\Rightarrow u = \sqrt{2\mu_{kin} g\Delta x} = \sqrt{2(0.2)(9.8)10} = \sqrt{39.2}$$

$$v = \frac{M+m}{m}u = \frac{10.08}{0.08}\sqrt{39.2}$$

5. A 7.00-g bullet, when fired from a gun into a 1.00-kg block of wood held in a vise, penetrates the block to a depth of 8.00 cm. This block of wood is next placed on a frictionless horizontal surface, and a second 7.00-g bullet is fired from the gun into the block. To what depth will the bullet penetrate the block in this case?

Problem was solved in class

6 A 1kg particle moves under influence of conservative force whose potential energy is shown in the diagram. At t=0 particle has K=4J at x= 8m.

a What is the kinetic energy of the particle at x=3m?

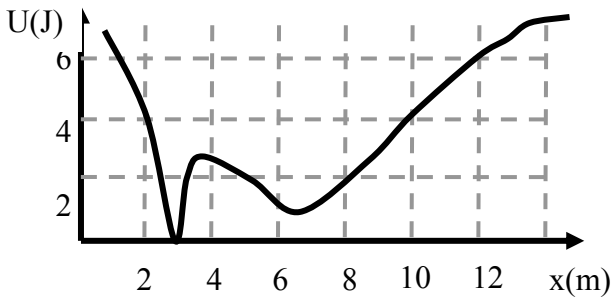
b) What is the direction of the force at x=2m

c) What is the right turning point?

d) What is the left turning point?

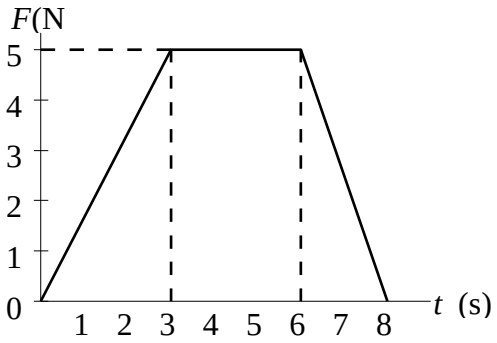
Ans A: 6J B: to the right

C: x=12 D: x=1m



7 A 2.5 kg body moving horizontally with speed v= 1m/s is acted on by a horizontal force as shown in the graph. What is the body speed at x=3s?

a) 1m/s
b) 2m/s
c) 3m/s
d) 4m/s
e) 5m/s



8 Answer or fill the blanks the following: (each correct answer is worth 1 point)

A) List 4 fundamental forces in the from the strongest to the weakest.
ANS:
1_____ 2_____ 3_____ 4_____

B) In your own words explain the essence of the Noether's Theorem?

C) According to Standard model all matter is made out of 6_____ and 6 _____ and the_____ bosons mediating interactions between them.

D) The model of the evolution of the universe according which, it started at the state of great density and infinitely small radius is known as _____ Model.

E) The absence of the antimatter in Universe is known as_____ Problem

F) The observations of the galaxies rotations lead astrophysicists to hypothesis of _____.

G) Accelerated expansion of the Universe is attributed to the existence of hypothetical _____.

H) It is well established fact that stars evolve. Given the mass of our Sun and the current state of knowledge about stellar nucleosynthesis, what is the most probable final stage of the Sun's Evolution?

ANS:_____

I) Existence of the Gravitational Waves have been just recently confirmed by Ground Based Observatories. These observatories are essentially very large _____ .

J) Arrow of Time is result of the _____ processes, whose direction is always the same and dictated by the _____ Law of Thermodynamics