PHYSICS 149 TEST 2 26 October, 2000

This 18-question test is worth 100 points, each question is weighted equally. Please fill out the answer sheet with soft lead pencil. Be sure to give your name, student ID #, date, Course #, Test 2, and SIGN the answer sheet. Be prepared to present your Student picture ID card when handing in your answer sheet. You may keep the sheets with the questions and your work.

Pick the nearest value for your answer (there may be slight roundoff errors).

Don't get hung up too long over any one question until you have tried all of them.

You are expected to bring your own sheet of equations and words explaining the equations. Here are a few possibly useful equations. You will need to know when they are valid and when they are not.

$g = 9.8\ m/s^2$ $G = 6.67 \times 10^{-11} Nm^2/kg^2$

$v = v_o + a t$ for each vector component of **v** and **a**

$x = x_o + v_o t + \frac{1}{2} a t^2$ and ditto for y and z components

$v_x^2 - v_{ox}^2 = 2a(x - x_o)$ etc. average $v_x = \Delta x/\Delta t$ etc.

$x = x_o + \frac{1}{2}(v_o + v)t$ etc. average $\mathbf{a} = \Delta \mathbf{v}/\Delta t$ and etc. for each component

$x = r\cos(\theta)$ $y = r\sin(\theta)$ $\tan(\theta) = y/x$

The Earth's mass and radius are 5.98×10^{24} kg and 6.38×10^{6}, respectively

$\mathbf{F} = m\mathbf{a}$ F of A on B = -F of B on A $f_k = \mu_k N$ $f_s^{MAX} = \mu_s N$

1. Two masses are connected by a stretched spring and released on a frictionless surface. The 2 kg mass accelerates with +13 m/s^2 *towards* the 7 kg mass. What is the vector acceleration of the 7 kg mass, in the same one-dimensional coordinate system?

a) -2.7 m/s^2
b) +2.7 m/s^2
c) -3.7 m/s^2
d) +3.7 m/s^2
e) -4.7 m/s^2

2. As a 0.8 kg basketball bounces off the floor, its velocity changes from -3.1 m/s to +2.7 m/s. If the ball is in contact with the floor for 0.9 ms, what is the magnitude of the average force on the ball?

a) 3.2 kN
b) 4.2 kN
c) 5.2 kN
d) 6.2 kN
e) 7.2 kN

3. $\mathbf{r}$ = (50m, 50m); $\mathbf{R}$ = (60m, 13m). What is the direction of $\mathbf{C} = \mathbf{r} + \mathbf{R}$, relative to the x-axis ?

a) 20°
b) 30°
c) 45°
d) 60°
e) 75°

4. A sky diver of mass 80 kg experiences a 650 N force of air resistance when she spreads her arms and legs. What is the magnitude of her acceleration in terms of $g = 9.8\ m/s^2$, the acceleration of gravity?

a) 0.07 g
b) 0.17 g
c) 0.27 g
d) 0.37 g
e) 0.47 g

5. If Mahmoud weighs 70 kg and the mountain weighs 10^8 kg, and he is 1.3 km away from the center of the mountain, how does he accelerate towards the mountain (magnitude of acceleration)? [Neglect the recoil of the mountain, and assume, of course, that they are in space with no friction and no other forces present except mutual gravitation.]

a) 4×10^{-9} m/s^2
b) 6×10^{-9} m/s^2
c) 8×10^{-9} m/s^2
d) 1×10^{-8} m/s^2
e) 1.3×10^{-8} m/s^2

6. A planet has 57 times the mass of the earth and a radius three times that of the earth. What is its surface gravity, g' ? (Try not to use the mass and radius of the Earth, just scale Earth's gravity appropriately.)

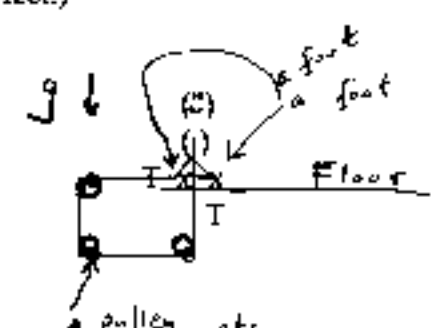
a) 57 m/s^2
b) 19 m/s^2
c) 31 m/s^2
d) 62 m/s^2
e) 98 m/s^2

7. A block sliding with a speed of 20 m/s on a level floor with kinetic coefficient of friction $\mu_k = 1.2$ will come to rest in what length of time?

a) 0.7 s
b) 1.7 s
c) 2.7 s
d) 3.7 s
e) 4.7 s

8. A clown pulls upward on a rope that runs through a hole in the floor, and then passes around three pulleys so that the other end, which is attached to his feet, pulls exactly sideways with the same tension, T, that the clown pulls with. What value of the static coefficient of friction, μ, will be just sufficient to prevent him from slipping NO MATTER HOW HARD HE PULLS ON THE ROPE? (Hint: first set up and solve the vertical "balance" equation to find the normal force, N, on his feet.)

a) 0.500
b) 0.707
c) 1.000
d) 1.414
e) 2.000



9. A mass of 170 kg is hung on a Y-shaped cable truss where both top branches of the Y make an angle of 30° to the horizontal. What is the tension, T, in each of the upper cables?

a) 0.83 kN
b) 1.44 kN
c) 1.66 kN
d) 1.92 kN
e) 2.35 kN

10. A student comes barreling into a 40° steep slope on Ruthie's Run at Aspen Mountain, with an initial speed of 30 miles per hour (that's 13.4 m/s). It's total glare ice, the coefficient of friction is essentially zero, and the skis have no metal edges. How fast is she going 3 seconds later, when she finally comes to powder snow and a chance to slow down? (Hint: first work out her value of acceleration, a, along the slope. Don't forget to scale m/s back to mi/hr for your final answer.)

a) 60 mi/hr
b) 72 mi/hr
c) 84 mi/hr
d) 96 mi/hr
e) 108 mi/hr

11. Two masses, of 18 kg and 21 kg, are hung at the two ends of a very light rope which passes over a very low-mass low-friction pulley. How big is the 21 kg mass's downward acceleration?

a) (1/13)g
b) (1/18)g
c) (1/21)g
d) (1/39)g
e) (1/3)g

12. Now the 21 kg mass is laid on a 33-degree-above-horizontal frictionless slope, with the rope aiming upwards also at 33° towards the pulley. The 18 kg mass still hangs straight down off the other side of the pulley. What is the downward acceleration of the 18 kg mass?

a) 0.07 g
b) 0.17 g
c) 0.27 g
d) 0.37 g
e) 0.47 g

13. A boat takes 5 minutes to cross a river which is 650 m wide and flowing at 3.8 m/s. How far is the boat from its starting point (DIAGONAL distance) when it reaches the opposite bank?

a) 1.14 km
b) 0.65 km
c) 1.31 km
d) 1.79 km
e) 2.01 km

14. A 7 kg box is dropped from rest off of a tower. A strong side-wind exerts a 30 N CONSTANT force sideways on the box. How far does the box drop in 4 seconds?

a) 78.4 m
b) 98.0 m
c) 39.2 m
d) 19.6 m
e) 108.4 m

15. How far does the box blow sideways in 4 seconds?

a) 17.1 m
b) 25.6 m
c) 98.0 m
d) 34.3 m
e) 68.6 m

16. During this time, in what shape of curve does the box travel? (Hint: if you can't visualize this, try calculating the x and y locations at a couple of other times, say, 2 s and 3 s after release and crudely plot the results. Or better still, work out symbolically the ratio of y/x as a function of time and think about that result.)

a) A curve that starts horizontal and bends steeper and steeper downward.
b) A curve that starts with a downward slope and bends steeper with time.
c) A sloping straight line.
d) A curve that starts with a downward slope and bends less steeply with time.
e) A curve that starts vertically downward and bends more and more horizontally with time.

17. A rubber eraser lies on a drafting table, which is slowly tilted until the eraser just begins to slip when the table surface is tilted at 77 degrees above horizontal. What is the coefficient of static friction between the eraser and the table?

a) 0.97
b) 0.22
c) 0.23
d) 4.33
e) 1.03

18. A ball is launched at 35 degrees above the horizontal. It hits the ground, which is at the same height, 65 m away after 3.05 seconds. What is the launching **speed** of the ball (not just one component of the velocity)? (Hint: first EITHER work out v_{ox} from the distance and time given OR work out v_{oy} using g and the fact that t(top) = t(hit)/2. Knowing one of these components, you can calculate the total speed in one more step using a little trig. An alternative method is to use the range formula directly, but that's more complicated, and I don't supply that formula on this test.)

a) 26 m/s
b) 52 m/s
c) 13 m/s
d) 38 m/s
e) 67 m/s