Solutions

Physics 1114
Midterm #2 – Spring 2014

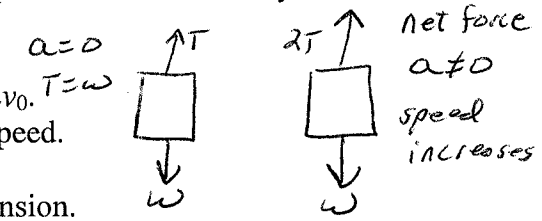
Version A

Multiple choice (6 points each for questions 3-19)

1) Which exam version do you have?
   A) A
   B) B
   C) C
   D) D

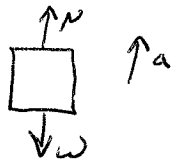
2) What discussion section are you in?
   A) Section 11: 8:30-9:20 AM Physical Science Center 359 (Tang)
   B) Section 12: 10:30-11:20 AM Nielsen Hall Room 251 (Tang)
   C) Section 13: 11:30-12:20 PM Adams Hall Room 101 (Savoy)
   D) Section 14: 12:30-1:20 PM Physical Science Center 359 (Savoy)

3) A steel cable is attached to an elevator and is pulling the elevator up at a constant velocity of v_0. If the tension in the cable is doubled, the elevator
   a) moves up at a constant velocity of $2v_0$.
   b) moves up at velocity greater than v_0, but not necessarily $2v_0$.
   c) speeds up for a while, but eventually reaches a constant speed.
   (d) moves up at a continually faster speed.
   e) moves up at a constant velocity of v_0 but with a greater tension.



4) You are standing on a scale in a stationary elevator which shows your weight to be 710 N. As the elevator accelerates upward, you notice that the scale shows you have an apparent weight of 860 N. What is the magnitude of your acceleration in m/s^2?
   a) .211
   b) 1.21
   (c) 2.07
   d) 4.37
   e) 21.8

$F_{net}=ma$



$N-w=ma$

$860N-710N=72kg\cdot a$

$a=2.07$

$w=mg$

$m=\frac{710N}{9.8m/s^2}$

$m=72kg$

5) A bicycle is hanging from a garage ceiling by means of a rope. The earth pulls down on the bicycle with a weight of 110 N. If this is the "action force," what is the equal and opposite "reaction force" according to Newton's 3rd law?

   a) The rope pulling upward on the bicycle with a 110 N force.
   b) The ceiling pulling upward on the rope with a 110 N force.
   c) The rope pulling downward on the ceiling with a 110 N force.
   (d) The bicycle pulling upward on the earth with a 110 N force.
   e) The bicycle pulling downward on the rope with a 110 N force.

Earth pulls on bike
3rd law partner
bike pulls on earth

6) A 4.0 kg mass is moving with a speed of 2.0 m/s. A 1.0 kg mass is moving with a speed of 4.0 m/s Both objects encounter the same constant braking force and are brought to rest. What object travels the greater distance before stopping?

A) The 4.0 kg mass
B) The 1.0 kg mass
C) Both travel the same distance
D) Cannot be determined from the given information

$K.E_f = 0$ since $v_f = 0$

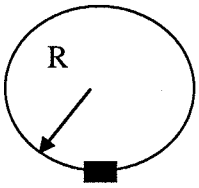
$W_{net} = F_{\parallel} \cdot d = \Delta K.E$

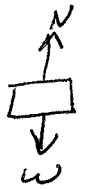
1) $K.E_i = \frac{1}{2}(4kg)(2m/s)^2 = 8J$

2) $K.E_i = \frac{1}{2}(1kg)(4m/s)^2 = 8J$

So same change in K.E, same force same distance

7) What is the *normal force* exerted by a roller coaster track (with radius R)on a car (with mass M) moving with speed V at the bottom of a vertical loop?





$N - w = m\frac{v^2}{r}$

$N = \frac{mv^2}{r} + w = \frac{mv^2}{r} + mg$

$N = \frac{mv^2}{r} + mg$ larger than mg

a) Mg
b) More than Mg
c) Less than Mg
d) Less than Mg and exactly zero.
e) Not enough information to tell.

8) Suppose a planet exists that has half the mass of earth and half its radius. On the surface of that planet, the acceleration due to gravity is

A) twice that on earth.
B) the same as that on earth.
C) half that on earth.
D) one-fourth that on earth.
E) none of these.

$F = \frac{G m_1 m_2}{r^2}$ $m_2 \to m/2$ $r \to r/2$

$F = \frac{G m_1 m_2/2}{(\frac{r}{2})^2} = 2\frac{G m_1 m_2}{r^2}$ twice

9) Two satellites (satellite A with mass M and satellite B with mass 2M) orbit about the Earth with the same radius R. What is the ratio of the periods of the two satellites?

a) $\frac{T_A}{T_B} = 2$

b) $\frac{T_A}{T_B} = 1/2$

c) $\frac{T_A}{T_B} = 1$

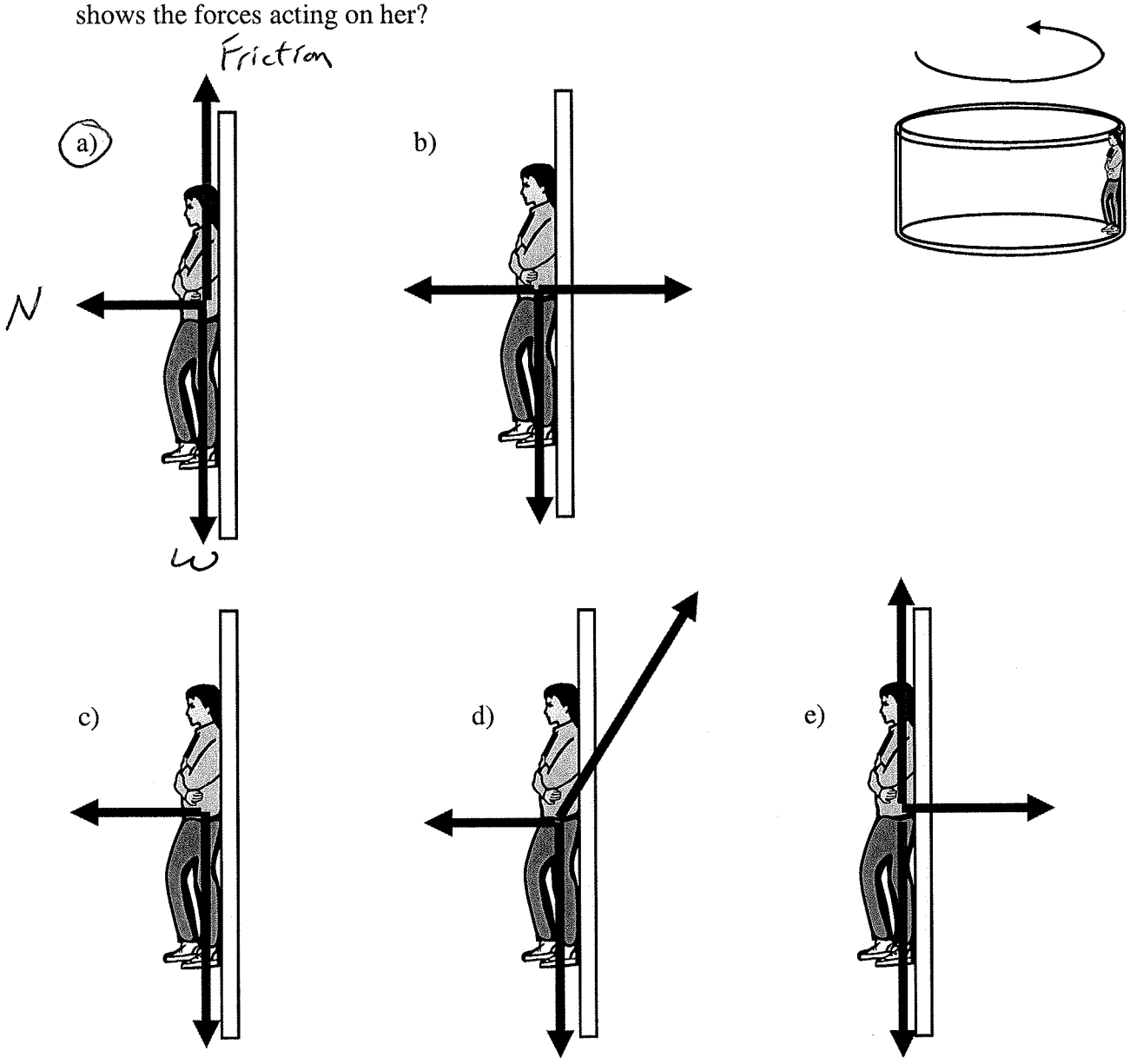
d) $\frac{T_A}{T_B} = 2^{3/2}$

e) None of the above.

$\frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3}$ $r_1 = r_2$

$\frac{T_1^2}{T_2^2} = 1$ so $\frac{T_1}{T_2} = 1$

10) A rider in an amusement park is riding the "barrel of fun" Which diagram correctly shows the forces acting on her?

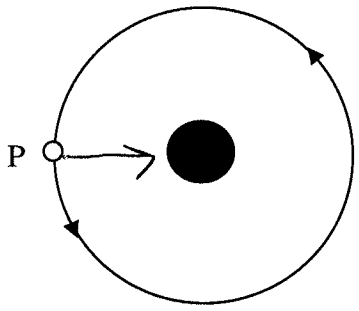


11) Which of the following objects experience no net force?

A. A ball at the highest point of its trajectory in the air.
B. An astronaut orbiting the earth.
C. A skier going down a mountain at constant velocity.
D. A person in an elevator dropping after its cable has been severed.
E. A car rounding a curve.

No net force means $a = 0$ which means constant velocity

12) A satellite orbits a planet as shown below. In what direction is the acceleration of the satellite at point P?



always toward center

a. Towards the top of the page.
b. Towards the bottom of the page.
c. Towards the right.
d. Towards the left.
e. Some combination of two of the above.

13) I drag a 20 kg sack of grain 5 m along the horizontal floor of my Uncle's barn. The sack is moved at constant velocity against a 100 N friction force. What is the net work done on the sack of grain?

A. 0
B. 100 J
C. 500 J
D. 1000 J
E. It is impossible to say.

$W_{net} = \Delta K.E$

V constant so K.E does not change so $W_{net} = 0$

14) You sit in a rolling chair and push with your feet on a stationary couch so that you and the chair roll across the floor. The couch does not move. While you are pushing, moving and still touching the couch

A) Neither you nor the couch exert any force on each other
B) You and the couch exert the same magnitude of force on each other
C) You exert a force on the couch, but the couch does not exert any force on you
D) You and the couch exert a force on each other, but the force you exert is greater
E) You and the couch exert a force on each other, but the force the couch exerts is greater.

3rd law

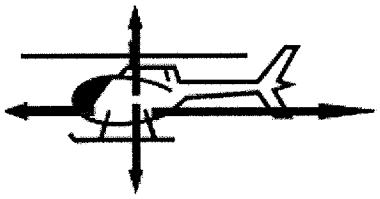
Force of me on couch = Force of couch on me

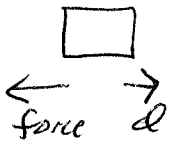
15) A 4.2 kg box sliding along a horizontal floor is brought to rest by a 6.1 N frictional force over a distance of 2.8 m. How much work did the frictional force do on the box?

A) -12 J
B) -17 J
C) 12 J
D) 17 J
E) -26 J

$W = F_{\parallel} d$

$W = 6.1\ N \cdot 2.8\ m = 17\ J$





since force opposite to direction of motion

$-17\ J$

16) A helicopter has four forces acting on it as shown in the diagram. The length of each arrow shows the relative strength of each force. Which of the following must be true about the motion of the helicopter.

A) It is accelerating to the right
B) It is moving to the left
C) It is moving to the right
D) Is it moving at a constant velocity
E) More than one of the above must be true

net force to right
so accelerating to right

17) The earth has a radius of 6.38×10^6 m and a mass of 5.98×10^{24} kg. A 3000 kg satellite orbits the earth in a circular orbit at a speed of 6500 m/s at a distance of 3.12×10^6m from the surface of the earth. What is the centripetal acceleration of the satellite?

A) 2.1 m/s^2
B) 4.4 m/s^2
C) 6.7 m/s^2
D) 13.5 m/s^2
E) 40,500 m/s^2

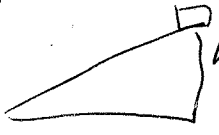
$a_c = \frac{v^2}{r}$

$r = r_e + 3.12 \times 10^6 m = 9.5 \times 10^6 m$

$a_c = \frac{(6500\ m/s)^2}{(9.5 \times 10^6 m)} = 4.4\ m/s^2$

18) A sled starts from rest from the top of a frictionless hill of height 10 m and slides to the bottom. What is the speed of the sled at the bottom?

A) 196 m/s
B) 14 m/s
C) 9.9 m/s
D) 3.4 m/s
E) Cannot be determined since the mass is not given



$KE = 0$
$PE = mgh$

$PE = 0$
$KE = \frac{1}{2}mv^2$

$mgh = \frac{1}{2}mv^2$

$v = \sqrt{2gh}$

$v = \sqrt{2 \cdot 9.8 m/s^2 \cdot 10 m} = 14 m/s$

19) A block is on a horizontal frictionless table near the earth's surface. A horizontal force causes the block to accelerate at 1 m/s^2. If the block weighs 9.8 N what force is required to achieve this acceleration?

A) 9.8 N
B) 3.4 N
C) 2.1 N
(D) 1.0 N
E) 0.5 N

$F = ma$

$w = mg$

$m = \frac{9.8\ N}{9.8\ m/s^2} = 1\ kg$

$F = (1\ kg)(1\ m/s^2) = 1\ N$