AP forces quiz.pdf

CHAPTER 3 REVIEW QUESTIONS

SECTION I: MULTIPLE CHOICE

1. A person standing on a horizontal floor feels two forces: the downward pull of gravity and the upward supporting force from the floor. These two forces

   (A) have equal magnitudes and form an action/reaction pair.
   (B) have equal magnitudes but do not form an action/reaction pair.
   (C) have unequal magnitudes and form an action/reaction pair.
   (D) have unequal magnitudes and do not form an action/reaction pair.
   (E) None of the above

2. A person who weighs 800 N steps onto a scale that is on the floor of an elevator car. If the elevator accelerates upward at a rate of 4.9 m/s^2, what will the scale read?

   (A) 400 N
   (B) 800 N
   (C) 1000 N
   (D) 1200 N
   (E) 1600 N

3. A frictionless inclined plane of length 20 m has a maximum vertical height of 5 m. If an object of mass 2 kg is placed on the plane, which of the following best approximates the net force it feels?

   (A) 5 N
   (B) 10 N
   (C) 15 N
   (D) 20 N
   (E) 30 N

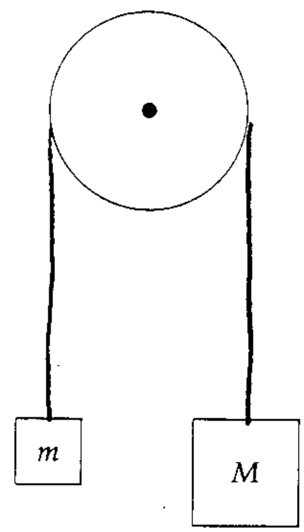
4. A 20 N block is being pushed across a horizontal table by an 18 N force. If the coefficient of kinetic friction between the block and the table is 0.4, find the acceleration of the block.

   (A) 0.5 m/s^2
   (B) 1 m/s^2
   (C) 5 m/s^2
   (D) 7.5 m/s^2
   (E) 9 m/s^2

5. The coefficient of static friction between a box and a ramp is 0.5. The ramp's incline angle is 30°. If the box is placed at rest on the ramp, the box will

   (A) accelerate down the ramp.
   (B) accelerate briefly down the ramp but then slow down and stop.
   (C) move with constant velocity down the ramp.
   (D) not move.
   (E) Cannot be determined from the information given

6.



Assuming a frictionless, massless pulley, determine the acceleration of the blocks once they are released from rest.

   (A) $\frac{m}{M+m}g$
   (B) $\frac{M}{M+m}g$
   (C) $\frac{M}{m}g$
   (D) $\frac{M+m}{M-m}g$
   (E) $\frac{M-m}{M+m}g$

7. If all of the forces acting on an object balance so that the net force is zero, then

(A) the object must be at rest.
(B) the object's speed will decrease.
(C) the object will follow a parabolic trajectory.
(D) the object's direction of motion can change, but not its speed.
(E) None of the above

8. A block of mass m is at rest on a frictionless, horizontal table placed in a laboratory on the surface of the earth. An identical block is at rest on a frictionless, horizontal table placed on the surface of the Moon. Let **F** be the net force necessary to give the Earth-bound block an acceleration of **a** across the table. Given that g_{Moon} is one-sixth of g_{Earth}, the force necessary to give the Moon-bound block the same acceleration **a** across the table is

(A) **F**/12
(B) **F**/6
(C) **F**/3
(D) **F**
(E) 6**F**

9. A crate of mass 100 kg is at rest on a horizontal floor. The coefficient of static friction between the crate and the floor is 0.4, and the coefficient of kinetic friction is 0.3. A force **F** of magnitude 344 N is then applied to the crate, parallel to the floor. Which of the following is true?

(A) The crate will accelerate across the floor at 0.5 m/s^2.
(B) The static friction force, which is the reaction force to **F** as guaranteed by Newton's Third Law, will also have a magnitude of 344 N.
(C) The crate will slide across the floor at a constant speed of 0.5 m/s.
(D) The crate will not move.
(E) None of the above

10. Two crates are stacked on top of each other on a horizontal floor; Crate #1 is on the bottom, and Crate #2 is on the top. Both crates have the same mass. Compared to the strength of the force $\mathbf{F}_1$ necessary to push only Crate #1 at a constant speed across the floor, the strength of the force $\mathbf{F}_2$ necessary to push the stack at the same constant speed across the floor is greater than F_1 because

(A) the force of the floor on Crate #1 is greater.
(B) the coefficient of kinetic friction between Crate #1 and the floor is greater.
(C) the force of kinetic friction, but not the normal force, on Crate #1 is greater.
(D) the coefficient of static friction between Crate #1 and the floor is greater.
(E) the weight of Crate #1 is greater.

11. An object moves at constant speed in a circular path. Which of the following statements is/are true?

I. The velocity is constant.
II. The acceleration is constant.
III. The net force on the object is zero since its speed is constant.

(A) II only
(B) I and III only
(C) II and III only
(D) I and II only
(E) None of the above

5. An amusement park ride consists of a large cylinder that rotates around its central axis as the passengers stand against the inner wall of the cylinder. Once the passengers are moving at a certain speed v, the floor on which they were standing is lowered. Each passenger feels pinned against the wall of the cylinder as it rotates. Let r be the inner radius of the cylinder.

(a) Draw and label all the forces acting on a passenger of mass m as the cylinder rotates with the floor lowered.

(b) Describe what conditions must hold to keep the passengers from sliding down the wall of the cylinder.

(c) Compare the conditions discussed in part (b) for an adult passenger of mass m and a child passenger of mass $m/2$.

6. A curved section of a highway has a radius of curvature of r. The coefficient of friction between standard automobile tires and the surface of the highway is μ_s.

(a) Draw and label all the forces acting on a car of mass m traveling along this curved part of the highway.

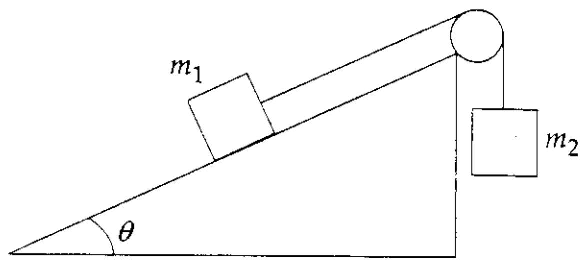
(b) Compute the maximum speed with which a car of mass m could make it around the turn without skidding in terms of μ_s, r, g, and m.

City engineers are planning on banking this curved section of highway at an angle of θ to the horizontal.

(c) Draw and label all of the forces acting on a car of mass m traveling along this banked turn. Do not include friction.

(d) The engineers want to be sure that a car of mass m traveling at a constant speed v (the posted speed limit) could make it safely around the banked turn even if the road were covered with ice (that is, essentially frictionless). Compute this banking angle θ in terms of r, v, g, and m.

3. In the figure shown, assume that the pulley is frictionless and massless.



(a) If the surface of the inclined plane is frictionless, determine what value(s) of θ will cause the box of mass m_1 to

(i) accelerate up the ramp;

(ii) slide up the ramp at constant speed.

(b) If the coefficient of kinetic friction between the surface of the inclined plane and the box of mass m_1 is μ_k, derive (but do not solve) an equation satisfied by the value of θ which will cause the box of mass m_1 to slide up the ramp at constant speed.

4. A sky diver is falling with speed v_0 through the air. At that moment (time $t = 0$), she opens her parachute and experiences the force of air resistance whose strength is given by the equation $F = kv$, where k is a proportionality constant and v is her descent speed. The total mass of the sky diver and equipment is m. Assume that g is constant throughout her descent.

(a) Draw and label all the forces acting on the sky diver after her parachute opens.

(b) Determine the sky diver's acceleration in terms of m, v, k, and g.

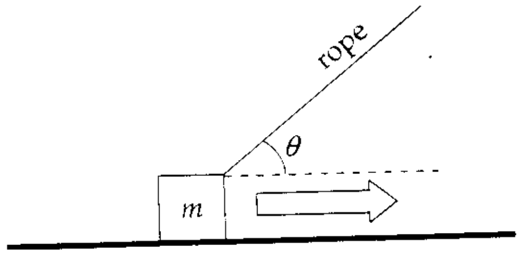
(c) Determine the sky diver's terminal speed (that is, the eventual constant speed of descent).

(d) Sketch a graph of v as a function of time, being sure to label important values on the vertical axis.

(e) [C] Derive an expression for her descent speed, v, as a function of time t since opening her parachute in terms of m, k, and g.

SECTION II: FREE RESPONSE

1. This question concerns the motion of a crate being pulled across a horizontal floor by a rope. In the diagram below, the mass of the crate is m, the coefficient of kinetic friction between the crate and the floor is μ, and the tension in the rope is $\mathbf{F}_T$.



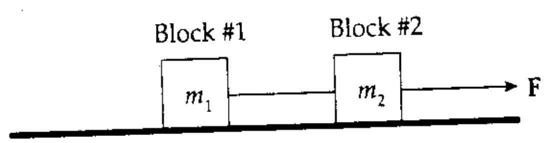
   (a) Draw and label all of the forces acting on the crate.

   (b) Compute the normal force acting on the crate in terms of m, F_T, θ, and g.

   (c) Compute the acceleration of the crate in terms of m, F_T, θ, μ, and g.

   (d) [C] Assume that the magnitude of the tension in the rope is fixed but that the angle θ may be varied. For what value of θ would the resulting horizontal acceleration of the crate be maximized?

2. In the diagram below, a massless string connects two blocks—of masses m_1 and m_2, respectively—on a flat, frictionless tabletop. A force **F** pulls on Block #2, as shown:



   (a) Draw and label all of the forces acting on Block #1.

   (b) Draw and label all of the forces acting on Block #2.

   (c) What is the acceleration of Block #1?

   (d) What is the tension in the string connecting the two blocks?

   (e) If the string connecting the blocks were not massless, but instead had a mass of m, figure out

      (i) the acceleration of Block #1, and

      (ii) the difference between the strength of the force that the connecting string exerts on Block #2 and the strength of the force that the connecting string exerts on Block #1.

Questions 12–13:

A 60 cm rope is tied to the handle of a bucket which is then whirled in a vertical circle. The mass of the bucket is 3 kg.

12. At the lowest point in its path, the tension in the rope is 50 N. What is the speed of the bucket?

    (A) 1 m/s
    (B) 2 m/s
    (C) 3 m/s
    (D) 4 m/s
    (E) 5 m/s

13. What is the critical speed below which the rope would become slack when the bucket reaches the highest point in the circle?

    (A) 0.6 m/s
    (B) 1.8 m/s
    (C) 2.4 m/s
    (D) 3.2 m/s
    (E) 4.8 m/s

14. An object moves at a constant speed in a circular path of radius r at a rate of 1 revolution per second. What is its acceleration?

    (A) 0
    (B) $(2\pi^2\ s^{-2})r$
    (C) $(2\pi^2\ s^{-2})r^2$
    (D) $(4\pi^2\ s^{-2})r$
    (E) $(4\pi^2\ s^{-2})r^2$