

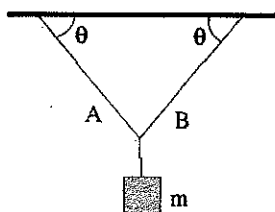
PHYSICS C
MECHANICS: SAMPLE EXAM 2

Time – 45 minutes

35 Questions

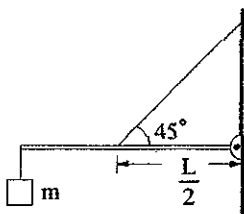
Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case.

1. The diagram below depicts a system in static equilibrium. What is the tension in chord A?



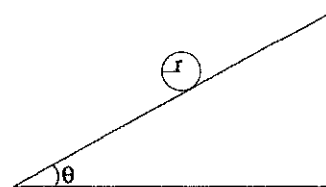
- (A) $0.5mg \csc \theta$
 (B) $mg \sec \theta$
 (C) $mg \sin \theta$
 (D) $\frac{mg}{\sin \theta}$
 (E) mg

2. The diagram below shows a system in static equilibrium. The boom of length L is massless. The chord is attached to the midpoint of the boom. The tension in the chord is most nearly



- (A) $0.7mg$
 (B) $1.0mg$
 (C) $1.4mg$
 (D) $2.0mg$
 (E) $2.8mg$

3. As shown below, a ball of mass m , moment of inertia I , and radius r rolls down an inclined plane of slope angle θ without slipping. The acceleration of the ball is



- (A) $\frac{mgr^2 \sin \theta}{I + mr^2}$
 (B) $\frac{mgr^2 \cos \theta}{I - mr^2}$
 (C) $\frac{mgr^2}{I}$
 (D) $g \sin \theta$
 (E) g

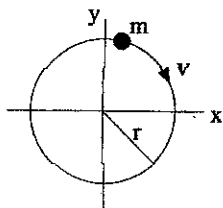
4. An object falls a distance h with no air resistance. The instantaneous power with which gravity acts on the object is

- I. mgh
 II. mgv , where v is the instantaneous speed of the object
 III. dW/dt , where W is work and t is time

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

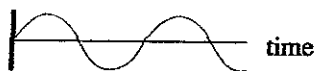
Questions 5 - 7

An object of mass m moves in uniform circular motion of speed v and radius r , as shown below.



5. Which of the following remains constant?
- I. the angular velocity of the object
 - II. the angular momentum vector of the object
 - III. the linear momentum vector of the object
- (A) I only
 (B) II only
 (C) III only
 (D) I and II
 (E) I and III

6. If the graph below refers to the object in uniform circular motion, what does the vertical axis of the the graph likely represent?



- I. the tangential speed of the object
- II. the angular acceleration of the object
- III. the displacement of the object in one dimension

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

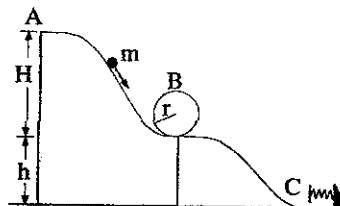
7. The centripetal acceleration of the object is

- I. directly proportional to m
- II. inversely proportional to r
- III. directly proportional to v

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

Questions 8 - 10

A ball of mass m and negligible moment of inertia rolls down the ramp shown from zero initial velocity at point A, around the loop and through point B, and to point C where it strikes a fixed spring of spring constant k . Assume there are no nonconservative forces present.



8. The kinetic energy of the ball at point B is

- (A) 0
 (B) mgh
 (C) $mg(h+r)$
 (D) mgH
 (E) $mg(H-2r)$

9. The distance the spring at C is compressed by the ball is

- (A) $\sqrt{\frac{mg}{k}}$
 (B) $\sqrt{\frac{k}{m}}$
 (C) $\sqrt{\frac{mgH}{k}}$
 (D) $\sqrt{\frac{2mg(H+h)}{k}}$
 (E) $\sqrt{\frac{2mg(H+h-r)}{k}}$

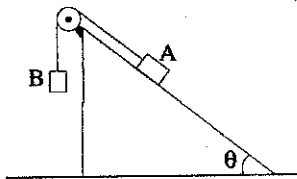
10. If the ball is not to fall off the ramp as it approaches point B, which of the following conditions must hold?

- I. the centripetal force at point B must be zero
- II. the centripetal force at B must be at least as great as mg
- III. H must be at least as great as $2.5r$

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

Questions 11 and 12

As shown in the diagram below, block A is held on a frictionless inclined plane of slope angle θ and is attached by a massless chord running over a massless, frictionless pulley to block B. Block B hangs freely. Both blocks have identical mass m .



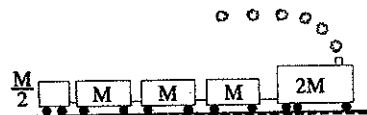
11. When block A is released, the acceleration of the system is
 - (A) $0.5g(1 - \sin \theta)$
 - (B) $0.5g(1 - \cos \theta)$
 - (C) $g \sin \theta$
 - (D) $g(1 + \sin \theta)$
 - (E) g

12. When block A is released, the tension in the chord is
 - (A) mg
 - (B) $2mg$
 - (C) $0.5mg(1 + \sin \theta)$
 - (D) $mg(1 - \cos \theta)$
 - (E) 0

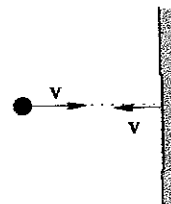
13. An object of mass m accelerates from speed v to speed $2v$. The work done on the object in this process is
 - (A) 0
 - (B) $0.5mv^2$
 - (C) mv^2
 - (D) $1.5mv^2$
 - (E) $2.0mv^2$

14. A force $F = AT$ acts on an object from time $t = 0$ to time $t = T$, where A is a constant. The impulse on the object over this period is
 - (A) A
 - (B) AT
 - (C) $0.5AT$
 - (D) $0.5AT^2$
 - (E) AT^2

15. A train consists of a locomotive of mass $2M$ followed by three freight cars of mass M and a caboose of mass $\frac{M}{2}$ as shown below. The locomotive pulls the train (and itself) with a force F , giving it a uniform acceleration. Assuming there is no frictional drag on the train, the net force acting on the caboose is



- (A) 0
 - (B) $\frac{F}{11}$
 - (C) $\frac{F}{4}$
 - (D) $\frac{F}{2}$
 - (E) F
16. A hard rubber ball of mass m hits a wall squarely at speed v , as shown below. It rebounds 180 degrees from its original direction, also at speed v . The impulse that the wall gives to the ball is



- (A) $\frac{mv}{4}$
- (B) $\frac{mv}{2}$
- (C) mv
- (D) $2mv$
- (E) $4mv$

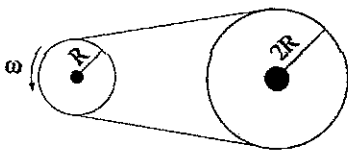
Questions 17 and 18

As diagrammed below, a block of mass m slides on a frictionless surface at speed v . It makes an inelastic collision with a block of mass $2m$, initially at rest.



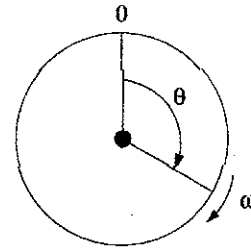
17. The speed of the first block after the collision is
- (A) $-3v$
 - (B) $-v$
 - (C) $\frac{v}{3}$
 - (D) $\frac{v}{2}$
 - (E) v
18. The kinetic energy lost in the collision is most nearly
- (A) 0
 - (B) $0.3mv^2$
 - (C) $0.5mv^2$
 - (D) mv^2
 - (E) $2mv^2$

19. A wheel of radius R rotates at angular velocity ω . A belt connects this wheel to another wheel of radius $2R$ with no slippage, as shown below. The angular velocity of the second wheel is

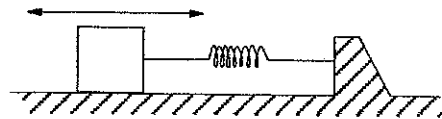


- (A) $\frac{\omega}{4}$
- (B) $\frac{\omega}{2}$
- (C) ω
- (D) 2ω
- (E) 4ω

20. A wheel of moment of inertia I is at rest. A torque acts on the wheel to bring it up to angular velocity ω over an angle θ , as shown below. The magnitude of the torque on the wheel is



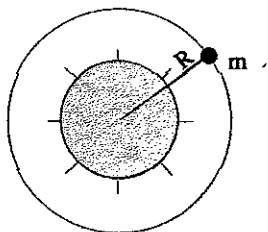
- (A) $\frac{\omega\theta}{I}$
 - (B) $\frac{I\omega}{\theta}$
 - (C) $I\theta\omega^2$
 - (D) $\frac{I\omega^2}{2\theta}$
 - (E) $0.5I\omega^2$
21. A block oscillates at the end of a spring, as shown below. If there is a nonzero coefficient of friction between the block and the table, the oscillatory motion will damp out until the spring comes to rest. During this process,



- I. the frequency of the oscillations decreases
 - II. the amplitude of the oscillations decreases
 - III. the period of the oscillations increases
- (A) I only
 - (B) II only
 - (C) III only
 - (D) I and II
 - (E) I and III

Questions 22 - 24

A planet is in a circular orbit about a star of mass M . The radius of the orbit is R . The planet may be considered to be a point of mass m . Refer to the diagram below.



22. The angular momentum of the planet in its orbit is proportional to
- (A) MmR
- (B) $\frac{Mm}{R}$
- (C) $m\sqrt{\frac{M}{R}}$
- (D) $m\sqrt{MR}$
- (E) Mm
23. If G represents the Universal Gravitational Constant, the kinetic energy of the planet is equal to
- (A) $\frac{GMm}{2R}$
- (B) $\frac{GMm}{R}$
- (C) 0
- (D) GMR^2
- (E) mR^2
24. The gravitational force between the planet and the star is directly proportional to
- I. M
 II. m
 III. R
- (A) I only
 (B) II only
 (C) III only
 (D) I and II only
 (E) I, II, and III

25. The acceleration due to gravity on the surface of the moon is one-sixth of what it is on the surface of the earth. A pendulum has period T on the earth. Its period on the moon is most nearly

- (A) $0.17T$
 (B) $0.41T$
 (C) $1.00T$
 (D) $2.45T$
 (E) $6.00T$

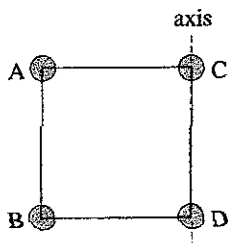
Questions 26 and 27

An object is in simple harmonic motion of period T and amplitude A .

26. The maximum acceleration of the object is most nearly
- (A) A
- (B) $\frac{A}{T}$
- (C) $\frac{A}{T^2}$
- (D) $\frac{6.28A}{T}$
- (E) $\frac{39.5A}{T^2}$
27. The kinetic energy of the object is maximum when
- I. the object is at the equilibrium position
 II. the object is at its maximum displacement from equilibrium
 III. the potential energy of the object is at its maximum
- (A) I only
 (B) II only
 (C) III only
 (D) I and II
 (E) II and III

Questions 28 - 30

Refer to the diagram below. The object shown consists of four point masses, each of identical mass m , fixed to the corners of a square by four rigid, massless rods. The object is free to rotate with period T about an axis which passes through objects C and D, as indicated. The length of one side of the square is L .



28. The angular momentum of the object as it rotates is most nearly

- (A) $\frac{6.28ML^2}{T}$
- (B) $\frac{12.6ML^2}{T}$
- (C) $\frac{39.5ML^2}{T}$
- (D) $\frac{ML}{T}$
- (E) $\frac{39.5ML}{T}$

29. The kinetic energy of the object as it rotates is

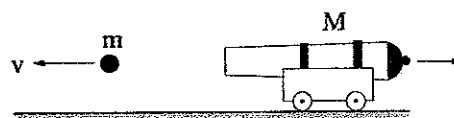
- (A) 0
- (B) $0.5M\left(\frac{L}{T}\right)^2$
- (C) $6.28M\left(\frac{L}{T}\right)^2$
- (D) $12.6M\left(\frac{L}{T}\right)^2$
- (E) $39.5M\left(\frac{L}{T}\right)^2$

30. The moment of inertia of the object would be maximized by placing the axis of rotation

- (A) perpendicular to the plane of the square and through the center
- (B) along a diagonal of the square, through objects A and D
- (C) perpendicular to the plane of the square and through object A
- (D) right where it is, through objects C and D
- (E) through objects A and B

Questions 31 and 32

A cannon of mass M is initially at rest but free to move on its wheels, as shown below. It fires a shell of mass m horizontally at speed v .



31. The recoil speed of the cannon is

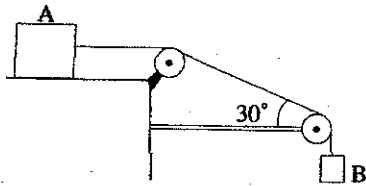
- (A) 0
- (B) $\frac{mv}{M}$
- (C) $\frac{Mv}{m}$
- (D) $\frac{mv}{M+m}$
- (E) $\frac{mv}{M-m}$

32. The change in kinetic energy of the system consisting of the cannon and the shell is

- I. positive
- II. negative
- III. equal to the sum of the kinetic energy of the cannon and the kinetic energy of the shell after firing

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

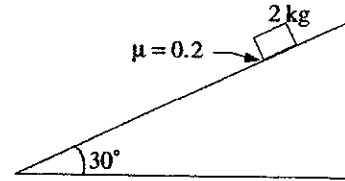
33. Block A and block B in the figure below have the same mass. Block A rests on a table and is connected by a massless chord which passes over massless, frictionless pulleys to block B, which hangs freely. For the system to be in static equilibrium, which conditions must exist?



- I. the coefficient of friction between block A and the table must be zero
 - II. the normal force the table exerts on block A must be zero
 - III. the frictional force on block A must be equal to the tension in the horizontal portion of the chord
- (A) I only
 (B) II only
 (C) III only
 (D) I and II
 (E) II and III

Questions 34 and 35

A block of mass 2 kg slides down an inclined plane of slope angle 30 degrees, as shown below. The coefficient of friction between the block and the plane is 0.2 and the plane is 1 m high at its highest point.



34. The acceleration of the block is most nearly
- (A) 3.2 m/s²
 (B) 4.9 m/s²
 (C) 6.6 m/s²
 (D) 7.5 m/s²
 (E) 9.5 m/s²
35. The time it takes the block to slide from the top to the bottom of the plane is most nearly
- (A) 0.6 s
 (B) 0.8 s
 (C) 1.1 s
 (D) 3.1 s
 (E) 5.2 s

Name Key
AP Physics

Date _____

Part 1 Answer Sheet

Exam # SE#02

Place the best answer to each question in the space provided.

- | | |
|---------------|---------------|
| 1. <u>A</u> | 19. <u>AB</u> |
| 2. <u>BE</u> | 20. <u>AD</u> |
| 3. <u>DA</u> | 21. <u>AB</u> |
| 4. <u>DE</u> | 22. <u>D</u> |
| 5. <u>D</u> | 23. <u>DA</u> |
| 6. <u>C</u> | 24. <u>D</u> |
| 7. <u>BB</u> | 25. <u>D</u> |
| 8. <u>AE</u> | 26. <u>AE</u> |
| 9. <u>AD</u> | 27. <u>A</u> |
| 10. <u>BE</u> | 28. <u>B</u> |
| 11. <u>BA</u> | 29. <u>E</u> |
| 12. <u>CC</u> | 30. <u>BC</u> |
| 13. <u>D</u> | 31. <u>BB</u> |
| 14. <u>BD</u> | 32. <u>CD</u> |
| 15. <u>AB</u> | 33. <u>BC</u> |
| 16. <u>D</u> | 34. <u>DA</u> |
| 17. <u>AC</u> | 35. <u>BC</u> |
| 18. <u>B</u> | |

Number correct _____ x 1 = _____

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Number incorrect _____ x -.25 = _____

Score (out of 35) _____

Grade _____ AP Score _____