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TAMS Tournament 2011 Physics Exam Answer Sheet

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TAMS Tournament 2011 Physics Exam

1. A car moves in a straight line cruising at a constant velocity v_0 . At time t_0 , the car driver notices a red light and begins to slow down at a constant acceleration $-a_0$. How much time will it take for the car to come to a complete stop?

- A) v_0/a_0
- B) a_0/v_0
- C) $v_0/(2a_0)$
- D) $(2v_0)/a_0$

2. A 4.0 kg ball with an initial velocity of $(4\mathbf{i} + 3\mathbf{j})$ m/s collides with a wall and rebounds with a velocity of $(-4\mathbf{i} + 3\mathbf{j})$ m/s. What is the impulse exerted on the ball by the wall?

- A) $+24\mathbf{j}$ N s
- B) $-24\mathbf{j}$ N s
- C) $+32\mathbf{i}$ N s
- D) $-32\mathbf{i}$ N s

3. A constant force of 30 N in the negative y direction acts on a particle as it moves in the positive y direction 3 meters. How much work is done by the force during this displacement?

- A) +60 J
- B) -60 J
- C) +90 J
- D) -90 J

4. A 1500 kg car accelerates at 2.0 m/s^2 starting from rest along a horizontal stretch of road. What is the instantaneous power being delivered by the car when the velocity of the car is 6 m/s?

- A) 13.5 kW
- B) 9.0 kW
- C) 27 kW
- D) 18 kW

5. A 20 kg mass with velocity $v_1 = 6\text{ m/s}$ and 10 kg mass with velocity $v_2 = 12\text{ m/s}$ slide toward each other on a horizontal frictionless surface. What is the velocity of the center of mass of this system?

- A) 18 m/s
- B) 8 m/s
- C) 9 m/s
- D) -6 m/s

6. The position of an object as a function of time is given by $x = 18t^3 - t^2$. The object's acceleration at $t = 0.50$ seconds is

- A) -42 m/s^2
- B) 53 m/s^2
- C) 150 m/s^2
- D) -2.5 m/s^2

7. What is the maximum possible range of a projectile launched directly upward 50 meters in the air? Neglect air resistance.

- A) 25 m
- B) 50 m
- C) 100 m
- D) 200 m

8. Bob accelerates at constant rate from rest to top speed of 11.2 m/s in a distance of 9.5 meters. What is his acceleration?

- A) 13.2 m/s^2
- B) 6.60 m/s^2
- C) 1.18 m/s^2
- D) 3.30 m/s^2

9. Which of the following is incorrect?

- A) An object can accelerate even though its speed is constant.
- B) The magnitude of an object's displacement is less than or equal to the distance it travels.
- C) An object's acceleration is in the direction of the net force acting on it.
- D) An object's velocity and acceleration are always directed with 90° of each other.

10. The "reaction" force does not cancel the "action" force because

- A) They act on different bodies.
- B) The reaction force is greater than the action force.
- C) They are in the same direction.
- D) The forces are of different types.

11. An observer on the bank watches a motorboat crossing a river. From the perspective of the boat's driver, the boat is pointed straight north and is moving at 15 m/s with respect to the water. The river's current carries the boat 11 m/s to the east. What is the speed of the boat with respect to the observer?

- A) 18.6 m/s
- B) 5.10 m/s
- C) 26.0 m/s
- D) 15.0 m/s

12. An astronaut in a centrifuge is being whirled around in a circle of radius 5 meters at constant speed. If the astronaut experience free-fall at a rate of 29.4 m/s^2 , how fast is he moving?

- A) 5.4 m/s
- B) 7.0 m/s
- C) 15.0 m/s
- D) 12.1 m/s

13. A baseball is hit straight up and is caught by the catcher 2.0 seconds later. What is the maximum height of the ball during this flight?

- A) 9.8 m
- B) 7.4 m
- C) 4.9 m
- D) 12.6 m

14. A displacement B is added to displacement $C = 6i - 8j$ meters. The resultant displacement is in the positive x direction and has a magnitude equal to that of B. What is the magnitude of B in meters?

- A) 11
- B) 8.3
- C) 7.1
- D) 12.2

15. A ball moves in a circle at constant speed v_1 . A second ball moves at constant speed v_2 in a circle twice the radius of the first. For what speed v_2 will the second ball have 4 times the acceleration of the first ball?

- A) $v_2 = v_1$
- B) $v_2 = 1.41v_1$
- C) $v_2 = 2v_1$
- D) $v_2 = 2.82v_1$

16. If the displacement, x , is given by $x = bt^4 + ct^2 + dt$, where b , c , and d are constants and t is the time, determine the acceleration, a .

- A) $a = 4bt^2 + 2ct + d$
- B) $a = 12bt^2 + 2c$
- C) $a = 24bt$
- D) $a = 4bt^3 + 2ct$

17. If a wheel rotating about its axis has an angular speed of 15 rad/s, and it turns through 25 radians in the next 2.0 sec, what is its angular acceleration?

- A) -5.0 rad/s^2
- B) -2.5 rad/s^2
- C) -1.25 rad/s^2
- D) 5.0 rad/s^2

18. A force of 8 N acts on an object on a frictionless horizontal surface. The force acts in a vertical plane at an angle of 30° with respect to the object's direction of motion. If the force displaces the object by a horizontal distance $d = 4 \text{ m}$, how much work is done by the force?

- A) 28 J
- B) 16 J
- C) 32 J
- D) 12 J

19. An object of mass $m = 3 \text{ kg}$ has an initial kinetic energy of $K = 20 \text{ J}$. What is its speed after work $W = 8 \text{ J}$ has been done to it?

- A) 12 m/s
- B) 2.8 m/s
- C) 8 m/s
- D) 4.3 m/s

20. An object has initial kinetic energy $K = 5 \text{ J}$ and initial potential energy $U = 8 \text{ J}$. After work $W = -9 \text{ J}$ is done on the object by nonconservative forces, what is its final mechanical energy?

- A) 4 J
- B) 13 J
- C) 22 J
- D) 17 J

21. An object of mass $m = 15 \text{ kg}$ falls from rest. At the moment it has fallen through distance $h = 3 \text{ m}$, what is the instantaneous power developed by the gravitational force acting on the mass?

- A) 440 W
- B) 560 W
- C) 8.64 W
- D) 1.13 W

22. Bob wants to throw a ball from the ground. At what angle from the ground should Bob throw the ball if he wants to maximize the range of the ball's trajectory?

- A) 30°
- B) 45°
- C) 60°
- D) 90°

23. Given a uniform net system force of $F(x) = 5x^2 - 10x + 5$, determine the potential energy (U) of the system assuming no non-conservative forces.

- A) $10x - 10$
- B) $-10x + 10$
- C) $(5/3)x^3 - 5x^2 + 5x + C$
- D) $-(5/3)x^3 + 5x^2 - 5x + C$

24. Assume Shannon and Patrick are sitting together on a Merry-Go-Round. Patrick is sitting at a distance of r from the center while Shannon is sitting at a distance of $2r$ from the center. Which of the following values would be true?

- A) Shannon has a smaller angular acceleration
- B) Shannon has a smaller tangential speed.
- C) Patrick has a larger linear acceleration.
- D) Patrick covers more angular distance in a shorter time.

25. Which of these objects would roll down a hill of height h the fastest given that enough friction prevents any sliding from occurring and all objects are released from rest? Note that all these shapes have a fixed radius of r and mass m .

- A) Cylinder
- B) Sphere
- C) Rod
- D) Hoop

26. Two identical satellites orbit the earth in stable orbits. One satellite orbits with a speed v at a distance r from the center of the earth. The second satellite travels at a speed that is less than v . At what distance from the center of the earth does the second satellite orbit?

- A) At a distance that is less than r .
- B) At a distance that is equal to r .
- C) At a distance that is greater than r .
- D) Cannot be determined.

27. A couple of astronauts agree to rendezvous in space after hours. Their plan is to let gravity bring them together. She has a mass of 66.0 kg and he a mass of 70.0 kg, and they start from rest 23.0 m apart. Find the male astronaut's initial acceleration.

- A) $8.83 \times 10^{-12} \text{ m/s}^2$
- B) $8.33 \times 10^{-12} \text{ m/s}^2$
- C) 1.30 m/s^2
- D) 1.22 m/s^2

28. A satellite of mass M orbits a planet from a distance of R . Find the orbital speed of the satellite in terms of G , M , and R .

- A) $\frac{GMm}{2R}$
- B) $\sqrt{4\pi^2 \frac{R^3}{GM}}$
- C) $\sqrt{\frac{GM}{R}}$
- D) $\frac{\sqrt{GMmR^2}}{\sqrt{R^3}}$

29. David and Angela are seesawing on the school playground and decide to make the seesaw balance. Angela applies a force of 400 N and she sits 2 meters to the left of the seesaw's fulcrum. How far opposite of Angela from the fulcrum should David sit if he applies a force of 450 N on the seesaw?

- A) 1.78 m
- B) 2.25 m
- C) 0.44 m
- D) 0.56 m

30. Two particles become equally charged as they come into contact of each other in an electro-magnetic field. If the force between the particles is $4 \times 10^{-23} \text{ N}$ when they are 0.03 m apart, what is the charge on one of the pieces?

- A) $2 \times 10^{-18} \text{ C}$

- B) $4 \times 10^{-36} \text{ C}$
- C) $4 \times 10^{-26} \text{ C}$
- D) $1 \times 10^{-34} \text{ C}$

31. In describing the photoelectric effect, the classic theory predicts that

- A) The photocurrent increases with an increase in the incident light intensity.
- B) The maximum kinetic energy depends on the frequency of the incident light.
- C) There is no photocurrent if the frequency of the incident light is below a certain value.
- D) The photocurrent is always observed immediately, independent of the frequency of the incident light.

32. A closed loop wire of resistance R and area A is placed in a horizontal plane that is situated in a magnetic field described by $B(t) = B \cdot \sin(\omega t)$. The magnetic field is perpendicular to the horizontal plane. What is the maximum instantaneous current in the loop?

- A) $AB\cos(\omega)/R$
- B) $AB\sin(\omega)/R$
- C) $AB\omega/R$
- D) $AB\omega R$

33. A particle of charge $+q$ is a distance r away from a charged flat surface and experiences a force of magnitude F pulling it toward the surface. What is the magnitude of the force exerted on a particle of charge $+q$ that is a distance $2r$ from the surface?

- A) $1/8 F$
- B) $1/4 F$
- C) $1/2 F$
- D) F

34. A solid copper sphere has a charge of $+Q$ on it. Where on the sphere does the charge reside?

- A) $+Q$ at the center of the sphere
- B) $Q/2$ at the center of the sphere and $Q/2$ on the outer surface
- C) $-Q$ at the center of the sphere and $+2Q$ on the outer surface
- D) $+Q$ on the outer surface

35. How much heat is produced in a 5 ohm resistor in 10 s when a current of 2 A flows through it?

- A) 10 J
- B) 200 J
- C) 100 J

D) 20 J

36. Two identical capacitors are arranged in a circuit. What is the ratio of the equivalent capacitance of the circuit when the capacitors are in series to that when they are in parallel?

- A) $\frac{1}{4}$
- B) $\frac{1}{2}$
- C) 1
- D) 2

37. A charged particle is moving in a circular orbit in a magnetic field. If the strength of the magnetic field doubles, how does the radius of the particle's orbit change?

- A) It is quartered
- B) It is halved
- C) It is doubled
- D) It is quadrupled

38. A device that transforms mechanical energy into electrical energy is called a

- A) Transformer
- B) Inductor
- C) Galvanometer
- D) Generator

39. A radio station emits at 108.0 KHz. You have a 365pF capacitor and unlimited amounts of wire with negligible reactance. You want to build a tuned LC circuit to receive this frequency. What inductor do you need to complete this circuit?

- A) $5.95 \times 10^{-3} \text{H}$
- B) $5.95 \times 10^{-2} \text{H}$
- C) $2.93 \times 10^{-3} \text{H}$
- D) $2.93 \times 10^{-2} \text{H}$

40. A wire carrying 5.0 V is applied to a transformer. The primary coil has 5 turns and the secondary coil has 10 turns. What is the electromagnetic force induced in the secondary coil?

- A) 5 V
- B) 10 V
- C) 50 V
- D) 100 V