Sample Final questions for PS 150

1) Which of the following is an accurate statement?
A) Rotating a vector about an axis passing through the tip of the vector does not change the vector.
B) The magnitude of a vector can be zero even though one of its components is not zero.
C) The magnitude of a vector is independent of the orientation of the coordinate system used.
D) It is possible to add a scalar quantity to a vector.
E) Even though two vectors have unequal magnitudes, it is possible that their vector sum is zero.

2) Two vectors are given as follows: $\vec{A} = 3\hat{i} - 2\hat{j} - 2\hat{k}$ and $\vec{B} = -2\hat{i} - 5\hat{j} + 2\hat{k}$. The scalar product $\vec{A} \cdot \vec{B}$ is closest to
A) -20
B) -12
C) zero
D) 8
E) 12

3) A ball is projected upward at time t = 0.0 s, from a point on a roof 30 m above the ground. The ball rises, then falls and strikes the ground. The initial velocity of the ball is 32.5 m/s. Consider all quantities as positive in the upward direction. At time t = 2.1 s, the **acceleration** of the ball is closest to:
A) -5 m/s^2
B) -10 m/s^2
C) zero
D) +10 m/s^2
E) +5 m/s^2

4) A test rocket is fired straight up from rest with a net acceleration of 20 m/s^2. After 4 seconds the motor turns off, but the rocket continues to coast upward. What **maximum elevation** does the rocket reach?
A) 320 m
B) 408 m
C) 160 m
D) 327 m
E) 487 m

5) A package is dropped from an airplane traveling horizontally at constant speed. Friction is negligible. One second later a second package is dropped. Which of the following is an accurate statement?
A) The distance between the two packages will remain constant as they fall.
B) The horizontal distance between the packages will increase as they fall.
C) The horizontal distance between the two packages will decrease as they fall.
D) The distance between the two packages will steadily increase as they fall.
E) The second package will hit the ground more than one second after the first hits.

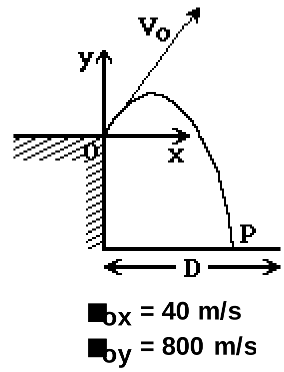
6) The x- and y-coordinates of a particle in motion (measured in meters), as functions of time t (measured in seconds), are given by:

$$x = 4t^2 - 3t + 6 \text{ and } y = 2t^3 - 3t^2 - 12t - 8$$

At the instant the x-component of velocity is equal to zero, the y-component of the acceleration is closest to:

A) -1.5 m/s^2
B) -15 m/s^2
C) -10 m/s^2
D) 3.0 m/s^2
E) -3.7 m/s^2

7) A projectile is fired at time t = 0.0s, from point 0 at the edge of a cliff, with initial velocity components of $v_{0x} = 40$ m/s and $v_{0y} = 800$ m/s. The projectile rises, then falls into the sea at point P. The time of flight of the projectile is 200 seconds. When the projectile's y-component of velocity equals 640 m/s, it's **x-coordinate** is closest to



A) 690 m
B) 620 m
C) 560 m
D) 650 m
E) 590 m

8) A geosynchronous satellite travels around the earth once every 24 hours (thereby always staying above the same point on the earth's surface). Such satellites are at a distance of 4.23×10^7 m from the center of the earth. How fast is such a satellite moving with respect to the earth?

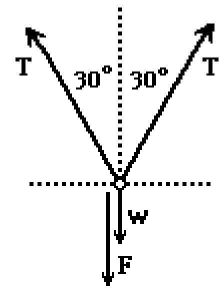
A) 5.55 x 10^2 m/s
B) 2.40 x 10^3 m/s
C) 7.17 x 10^5 m/s
D) 5.67 x 10^4 m/s
E) 3.08 x 10^3 m/s

9) A block is on a frictionless table, on earth. The block accelerates at 5.3 m/s^2 when a 80 N horizontal force is applied to it. The block and table are then set up on the moon. The acceleration due to gravity at the surface of the moon is 1.62 m/s^2. The **weight** of the block on the **moon** is closest to:

A) 15 N
B) 21 N
C) 12 N
D) 24 N
E) 18 N

10) A man pushes against a rigid, immovable wall. Which of the following is the most accurate statement concerning this situation?
A) Since the wall cannot move, it cannot exert any force on the man.
B) The friction force on the man's feet is directed to the left.
C) If the man pushes on the wall with a force of 200 N, we can be sure that the wall is pushing back with a force of exactly 200 N on him.
D) The man can never exert a force on the wall which exceeds his weight.
E) The man cannot be in equilibrium since he is exerting a net force on the wall.

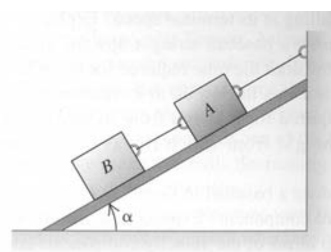
11) A 9.7 kg box is held at rest by two ropes that form 30^{o} angles with the vertical. An additional external force F = 550 N acts vertically downward on the box. The force exerted by each of the two ropes is denoted by T. A diagram showing the four forces that act on the box in equilibrium is at the right. The magnitude of T is closest to:



A) 373 N
B) 324 N
C) 518 N
D) 647 N
E) 259 N

12) You are driving down the highway at 100 km/h, rounding a curve with a radius of 500 m. You suddenly hit a patch of oil, which effectively reduces the coefficient of friction to zero. At what angle (**in degrees**) must the road be banked so that you don't slide off the road?
A) 10^{-5}
B) 0.1
C) 1
D) 10
E) 50

13) In the figure to the right, if the masses of both blocks are 10 kg, and the angle $\alpha = 30^{o}$, what is the **tension** in the rope between **A and B**? (All surfaces are frictionless.)



A) 4.9 N
B) 9.8 N
C) 49 N
D) 98 N
E) 490 N

14) The 5,000-kg Apollo command module re-enters the Earth's atmosphere at an altitude of approximately 200 km, traveling at about 11,000 m/s. Between re-entry and when the spacecraft reaches the ground (at near zero speed), how much **work** did the force of air resistance do?
A) 3×10^{7} J
B) 3×10^{9} J
C) 3×10^{11} J
D) 3×10^{13} J
E) 3×10^{15} J

15) A motor pulls a 2000-kg elevator upward at the rate of 3.0 m/s. How much **power** must the motor deliver in order to lift the elevator?
A) 10,000 W
B) 17,000 W
C) 26,000 W
D) 38,000 W
E) 59,000 W

16) A car is traveling on a level road at a speed v, when the brakes are applied. If the coefficient of friction between the tires and the road is μ, what is the **stopping distance** of the car?
A) $v^2 / 2\mu g$
B) $v^2 g / \mu$
C) mgv^2 / μ
D) mg / v^2
E) $g / \mu v^2$

17) When we speak of a conservative force, what is it that is being “conserved”?
A) Linear momentum
B) Force
C) Kinetic energy
D) Potential energy
E) Total mechanical energy

18) A spring with a spring constant of 600 N/m is compressed 4 **cm**. How much **energy** does it store (in Joules)?
A) 0.24
B) 0.48
C) 0.96
D) 24
E) 4800

19) A satellite circles planet “Roton” every 2.8 h in an orbit having a radius of 1.2×10^7 m. If the radius of Roton is 5.0×10^6 m, what is the magnitude of the free-fall acceleration on the surface of Roton in $\mathrm{m/s^2}$?
a. 31
b. 27
c. 34
d. 40
e. 19

20) An 8 g bullet is shot into a 4 kg block, initially at rest on a frictionless horizontal surface. The bullet remains lodged in the block. The block then moves into a spring and compresses it by 5.1 cm. The spring constant is 1900 N/m. The **initial speed** of the **bullet** is (m/s):
A) 530
B) 560
C) 580
D) 600
E) 620

21) A football player kicks a 0.41 kg football initially at rest. If the kicker's foot was in contact with the ball for 0.051 s and the ball's initial speed after the collision is 21 m/s, what was the magnitude of the **average force** on the football (in N)?
A) 9.7
B) 46
C) 81
D) 170
E) 210

22) A 0.05 kg lump of clay moving horizontally at 12 m/s strikes and **sticks** to a stationary 0.1 kg cart that is free to move on a frictionless air track. Determine the speed of the cart and clay after the collision (in m/s).
A) 2
B) 4
C) 6
D) 8
E) 12

23) A bicycle with wheels of radius 0.4 m travels on a level road at a speed of 8 m/s. What is the **angular speed** of the wheels (in rad/s)?
a) 10
b) 20
c) $\pi/10$
d) 10π
e) $20/\pi$

24) A Ferris wheel has a radius of 38m and completes a full revolution every two minutes. If the wheel were uniformly slowed to a stop in 35 seconds, what would be the magnitude of the **tangential** acceleration at the outer rim of the wheel (in m/sec2)?
a) 0.0015
b) 0.056
c) 0.54
d) 1.6
e) 6.8

25) A torque of 2000 Nm is applied to a merry-go-round, accelerating it from rest to an angular speed of 0.4 rad/sec in 10 seconds. What is the **moment of inertia** of the merry-go-round (in kg m2) about the axis of rotation?
a) 400
b) 800
c) 5000
d) 50,000
e) can't be determined since the radius is not specified

26) A 1 kg wheel in the form of a solid disk rolls (without slipping) along a horizontal surface with a speed of 6 m/s. What is the **total** kinetic energy of the wheel (in J)?

a) 9
b) 18
c) 27
d) 36
e) 54

27) The **torque** (in Nm) for **F** = 2.00**i** + 3.00**j** N and **r** = 4.00**i** + 5.00**j** m is

1) 2.00**k**
2) –4.00**k**
3) 10.0**k**
4) –12.0**k**
5) 14.0**k**

28) The position vector of a "particle" of mass M kg is given as a function of time by the equation **r** = (4**i** + 5t**j)** meters, where t is in seconds. Calculate its **angular momentum** about the origin of the displacement vector.