

Physics Prize Test (Part I)

- If the side of a square is increased by 10%, its area will increase by about
 - 1%
 - 10%
 - 11%
 - 21% *
 - 42%
- Objects A and B both start from rest. Object A's acceleration is twice as large as that of object B. If they travel the same distance, what is the ratio of object A's travel time to object B's travel time (t_A/t_B)?
 - 1/2
 - $1/\sqrt{2}$ *
 - 1
 - 2
 - 4
- A polar bear starts at the North Pole. It travels 1.0 km South, then 1.0 km East. Finally it travels another 1.0 km North to reach its starting point. The whole trip lasts 1.0 hour. The average velocity of the bear during the trip is
 - 0.0 km/h *
 - 1.0 km/h
 - 1.5 km/h
 - 3.0 km/h
 - 6.0 km/h
- A boat can travel with constant speed V in still water. For which of the following trips will the time elapsed be the least?
 - The boat travels a distance $2d$ in still water. *
 - The boat travels in a flowing river a distance d upstream and then travels downstream to its starting point.
 - The boat travels in a flowing river a distance d downstream and then travels upstream to its starting point.
 - The boat travels in a flowing river a distance d at a 45 degree angle relative to the stream of water and then travels back to its starting point in the opposite direction.
 - The time is the same for all the above trips.
- Vector \mathbf{A} has components $A_x = 5$ and $A_y = -8$ and vector \mathbf{B} has components $B_x = 1$ and $B_y = 2$ in a rectangular x - y coordinate system. The components of the vector $\mathbf{C} = \mathbf{B} - 2\mathbf{A}$ are
 - $C_x = 9$ and $C_y = -18$
 - $C_x = -9$ and $C_y = 18$ *
 - $C_x = -4$ and $C_y = 10$
 - $C_x = 3$ and $C_y = -12$
 - $C_x = -3$ and $C_y = 12$
- A long-jump athlete goes into the jump at a speed of 11 m/s and at an angle of 20° above the horizontal. Neglecting air-resistance about how far does the jumper jump?
 - 7.5 m
 - 7.7 m
 - 7.9 m *
 - 8.1 m
 - 8.3 m

7. Action-reaction forces

- a) sometimes act on the same object.
- b) always act on the same object.
- c) sometimes are at right angles with each other.
- d) are always at right angles with each other.
- e) always act on different objects. *

8. Object A weighs 40 N on Earth and object B weighs 40 N on the Moon. The gravity force on the surface of the Moon is six times smaller than the gravity force on the surface of the Earth. Then,

- a) A has 3 times the mass of B.
- b) B has 3 times the mass of A.
- c) A and B have the same mass.
- d) The situation stated is impossible.
- e) None of the above. *

9. A horizontal force of 5.0 N accelerates a 4.0 kg mass from rest at a rate of 0.5 m/s^2 . The friction force on the mass is about

- a) 0.0 N
- b) 2.0 N
- c) 3.0 N *
- d) 4.0 N
- e) 5.0 N

10. A wheel of radius $R = 0.5 \text{ m}$ starts from rest and rolls on a horizontal surface without slipping for a distance of 314.0 m, reaching an angular speed of 10.0 rad/s. The average angular acceleration of the wheel is about

- a) 0.08 rad/s^2 *
- b) 1.15 rad/s^2
- c) 3.14 rad/s^2
- d) 10.0 rad/s^2
- e) 15.7 rad/s^2

11. When a ball of mass m moves vertically upwards to a height h and then horizontally a distance d , the total work done by the gravitational force is:

- a) $+2mgh$
- b) $+mgh + mgd$
- c) $+mgh - mgd$
- d) $-mgh - mgd$
- e) $-mgh$ *

12. A car is taking a horizontal circular turn at a constant speed without skidding. The force that acts as the centripetal force on the car is

- a) the weight of the car.
- b) the normal force exerted by the road on the car.
- c) the kinetic friction between the tires and the road.
- d) the static friction between the tires and the road. *
- e) the vector sum of the normal force and the static friction.

13. An elevator is accelerating vertically downwards at a rate $a = g/4$. A person of mass $m = 60$ kg is standing inside it, on top of a flat scale, calibrated in Newtons. The reading of the scale is about

- a) 147 N
- b) 441 N *
- c) 588 N
- d) 735 N
- e) 882 N

14. A rigid body starts rotating from rest at a constant angular acceleration.

- a) The centripetal acceleration at each point is proportional to the time.
- b) The centripetal acceleration at each point is proportional to the time squared. *
- c) The tangential acceleration at each point is proportional to the angular velocity squared.
- d) The tangential acceleration at each point is proportional to the time.
- e) The total acceleration is the same at all points in the body.

15. If the radius of a sphere is doubled but its mass becomes four times smaller its moment of inertia will

- a) become twice larger.
- b) become four times larger.
- c) become twice smaller.
- d) become four times smaller.
- e) remain the same. *

16. The displacement from equilibrium of a simple harmonic oscillator is $x = 2 \sin(10t)$, where x is in meters and t in seconds. Its maximum acceleration is

- a) 200 m/s^2 . *
- b) 100 m/s^2 .
- c) 20 m/s^2 .
- d) 10 m/s^2 .
- e) 2 m/s^2 .

17. If the length of a tube closed at one end is doubled its first-overtone frequency will

- a) become 4 times larger.
- b) become 2 times larger.
- c) remain the same.
- d) become 2 times smaller. *
- e) become 4 times smaller.

18. Two masses m_1 and m_2 are vertically suspended from one spring each and perform vertical harmonic oscillations at the same frequency and same energy. If the amplitude of the oscillations of m_1 is twice that of m_2 , then

- a) $m_1 = 2 m_2$
- b) $m_1 = 4 m_2$
- c) $m_1 = \frac{1}{2} m_2$
- d) $m_1 = \frac{1}{4} m_2$ *
- e) $m_1 = m_2$

19. Two coherent sound sources, S_1 and S_2 , placed 3 m apart emit waves of the same wavelength equal to $\lambda = 1$ m, in phase. An observer located at point A, 2 m away from S_1 on the S_1 - S_2 line, will observe
- a) Completely constructive interference. *
 - b) Partially constructive interference.
 - c) Completely destructive interference.
 - d) Non-linear superposition of the waves.
 - e) The observer cannot hear such sound waves.

20. A wave propagates from a medium in which its speed is v_1 to a medium in which its speed is $v_2 > v_1$. The angle of incidence is more than 0° . The angle of refraction
- a) will be the same as the angle of incidence.
 - b) will be larger than the angle of incidence. *
 - c) will be smaller than the angle of incidence.
 - d) will be exactly 90° .
 - e) will be exactly 0° .

21. A box of mass $3m$ is on a frictionless horizontal table. Another box of mass m is placed on top of it. The surface of contact of the two boxes is horizontal and rough. If, when the lower box is pulled by a horizontal force F , the upper box does not slide off the static friction between the boxes is
- a) F
 - b) $F/2$
 - c) $F/3$
 - d) $F/4$ *
 - e) $F/6$

22. The average distance from the Earth to the Sun is defined as one Astronomical Unit (1 AU). An asteroid orbits around the Sun on a circle in one-third of an Earth year. The distance of the asteroid from the Sun is
- a) 0.19 AU
 - b) 0.48 AU *
 - c) 2.10 AU
 - d) 5.20 AU
 - e) 6.00 AU

23. A stone that weighs 30.0 N and is initially at rest is dropped from a height of 10.0 m and strikes the ground with velocity of 7.00 m/s. The average force of air-resistance on the stone is about
- a) 22.5 N *
 - b) 7.5 N
 - c) 3.0 N
 - d) 1.4 N
 - e) 0.5 N

24. A very massive object moving with velocity v collides head-on with a very light object moving with velocity $-v$. The collision is elastic and there is no friction. The massive object barely slows down. The velocity of the light object after the collision is

- a) nearly v .
- b) nearly $2v$
- c) nearly $3v$ *
- d) about $-v$
- e) practically infinite

25. Two telephone poles are separated by 40 m and connected by a horizontal wire of negligible weight, fixed at its two ends. A bird of mass 0.50 kg lands in the middle of the wire causing the midpoint to move downwards by 2 m. The tension on the (slightly extensible) wire is about

- a) 4.8 N
- b) 6.2 N
- c) 12 N
- d) 25 N *
- e) 40 N