PHY1124–Fundamentals of physics for engineers, Winter 2015

Practice test for final exam

The test is closed book, closed notes. You can use the questionnaire sheets for your work. Non-programmable, non-graphing Faculty-approved calculator allowed. Answers and formulas are at the end. (Number of pages : 5)

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1. Suppose $A = BC$ and A has units of m/kg and C of m/s. The units of B are :

(a) s/kg **(b)** m^2/kg s **(c)** s kg/m^2 **(d)** m/s^3 **(e)** m/s^4

2. Two automobiles are 120 km apart traveling towards each other. One is moving at 35 km/hr and the other at 45 km/hr. In how many hours will they meet ?

(a) 2.5 **(b)** 2.0 **(c)** 1.75 **(d)** 1.5 **(e)** 1.25

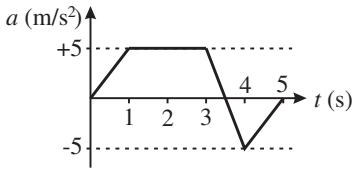
3. Over a short interval starting at $t = 0$, the coordinate of a vehicle in meters is given by $x(t) = 27t - 4.0t^3$ where t is in seconds. The velocity at $t = 1$ is :
(a) 4 m/s **(b)** 12 m/s **(c)** 12 m/s **(d)** 15 m/s **(e)** 27 m/s

4. A racing car with constant acceleration initially at rest travels 20 m/s in straight line in 4 seconds. The acceleration is :

(a) 0.4 m/s^2 **(b)** 1.3 m/s^2 **(c)** 2.5 m/s^2 **(d)** 4.9 m/s^2 **(e)** 9.8 m/s^2

5. The acceleration of an object, starting from rest, is shown in the graph below. Other than at $t = 0$, when is the velocity of the object equal to zero ?

(a) between 1 s and 3 s
(b) 3.5 s
(c) 4 s
(d) 5 s
(e) none of these answers.



6. A jet plane in horizontal flight travels north at 200 m/s then turns and travels west at 200 m/s. The change in velocity is :

(a) zero
(b) 200 m/s west
(c) 282 m/s west of north
(d) 282 m/s south of west
(e) 400 m/s south of west

7. A particle moves at constant speed on a circular path. The velocity and acceleration vectors are :

(a) both tangent to the circular path
(b) both perpendicular to the circular path
(c) perpendicular to each other
(d) opposite to each other
(e) none of these answers

8. A plane is in level flight at an altitude of 500 m and at speed 150 km/hr. It needs to drop a heavy package and hit a target on the ground. Neglecting air resistance, how far from the target should the package be dropped ?

(a) 150 m **(b)** 293 m **(c)** 421 m **(d)** 508 m **(e)** 792 m

9. A golf ball is tied to a rope 1.2 m long and rotates at 2 m/s in a vertical circle. Its acceleration in m/s^2 at the bottom of the circle is :

(a) 9.8 up **(b)** 9.8 down **(c)** 13.1 up **(d)** 3.3 down **(e)** 3.3 up

10. The mass of a body

(a) is slightly different at different locations on the Earth
(b) is a vector
(c) is independent of gravitational acceleration
(d) can only be expressed in the metric system
(e) is what is measured by a spring scale

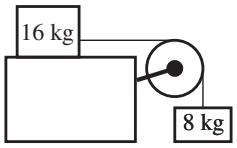
11. In a tug-of-war competition, two students each pull on the rope with a force of 100 N in opposite directions. The tension in the rope is :

(a) 100 N **(b)** 141 N **(c)** 200 N **(d)** zero **(e)** 50 N

12. A 1000 kg elevator is rising and its speed is increasing at 3.0 m/s^2. The tension in the elevator cable is :

(a) 6800 N **(b)** 1000 N **(c)** 3000 N **(d)** 9800 N **(e)** 12800 N

13. A 16 kg body and a 6 kg body are connected by a massless string over a massless, frictionless pulley, and there is no friction. The magnitude of the acceleration of the 16 kg body in m/s^2 is :



(a) 0.33 **(b)** 1.11 **(c)** 2.18 **(d)** 3.27 **(e)** 9.8

14. A 6.0 N horizontal force is applied to a 1.0 kg block initially at rest on a rough surface. If $\mu_s = 0.5$ and $\mu_k = 0.4$, the friction force on the block is :

(a) 6.0 N **(b)** 4.9 N **(c)** 3.9 N **(d)** 2.1 N **(e)** 1.1 N

15. A block is placed on a rough wooden plank. It is found that when the plank is tilted 30 degrees from horizontal, the block will slide down at constant speed. The coefficient of kinetic friction is :

(a) 0.500 **(b)** 0.577 **(c)** 0.707 **(d)** 0.866 **(e)** 0.911

16. A 90 kg arctic explorer is stuck in the middle of a patch of frictionless ice. Deperate to return to his vehicle, he throws his left boot (1.1 kg) at 12 m/s relative to the ice. After throwing the boot he will move at :

(a) 12.0 m/s **(b)** 13.2 m/s **(c)** 1.2 m/s **(d)** 0.46 m/s **(e)** none of these answers

17. Two bodies of unequal mass placed on a frictionless surface are acted on by equal horizontal forces for equal times. Just after the forces are removed, the body of greater mass will have :

(a) received the larger impulse
(b) the greater acceleration
(c) the smaller momentum
(d) the larger momentum
(e) the same momentum as the other body.

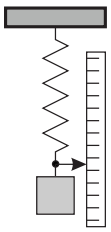
18. A golf ball of mass m is hit by a golf club so that the ball leaves with velocity v. The club is in contact with the ball during time t. The average force on the ball during time t is :

(a) mvt **(b)** mv/t **(c)** $(1/2)mv^2t$ **(d)** $mv^2/(2t)$ **(e)** $mt^2/(2v)$

19. Blocks A and B are moving towards each other. A has mass of 2 kg and velocity 50 m/s while B has mass 4 kg and velocity -25 m/s. They suffer a perfectly inelastic collision. The kinetic energy dissipated during the collision is :

(a) 0 J **(b)** 1250 J **(c)** 2500 J **(d)** 3750 J **(e)** none of these answers

20. A spring with a pointer attached to its end hangs next to a ruler as shown. When a 100 N weight is hung, the pointer indicates "40". With a 200 N weight, it indicates "60". With an unknown weight it indicates "30". The unknown weight is :



(a) 10 N **(b)** 20 N **(c)** 30 N **(d)** 40 N **(e)** 50 N

21. A 2.0 kg particle on the end of a spring with constant 200 N/m is pulled out and released from rest. When it passes the equilibrium position its speed is 5 m/s. How far was it pulled out ?

(a) 0 m **(b)** 0.05 m **(c)** 0.5 m **(d)** 0.25 m **(e)** 5 m/s

22. A man pushes a 15 kg crate on frictionless wheels a distance 5.0 m along a slope making an angle of 30 degrees with horizontal. The force he exerts is parallel to the slope. If the speed of the crate increases at a rate of 1.5 m/s^2, the work done by the man is :

(a) 480 J **(b)** 512 J **(c)** 735 J **(d)** 320 J **(e)** 96 J

23. A 0.75 kg block slides on a rough horizontal table. Just before it hits a horizontal spring of constant 1200 N/m, its speed is 3.5 m/s. The spring is compressed before the block comes to rest. The amount of heat that is released due to friction during the compression is 2.6 J. The spring was compressed :

(a) 1.2 cm **(b)** 3.1 cm **(c)** 5.7 cm **(d)** 8.1 cm **(e)** none of these answers

24. A sailboat is sailing at 12 km/hr in a direction 30 degrees west of north with respect to the river water. The river flows 6 km/hr relative to shore. As observed from shore, the sailboat is going :

(a) 30° east of north
(b) north
(c) 30° east of north
(d) 45° east of north
(e) none of these answers

25. An electrical insulator is a material :

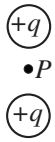
(a) containing no electrons
(b) containing free electrons
(c) through which electrons do not flow easily
(d) that must be a crystal
(e) can not be a pure chemical element

26. Two particles have charges $+q$ and $-q$ (identical but opposite). For the net force on a third charge to be zero, this charge must be placed :

(a) midway between $+q$ and $-q$
(b) on a line perpendicular to the line joining $+q$ and $-q$
(c) on the line joining $+q$ and $-q$ on the same side as $+q$
(d) on the line joining $+q$ and $-q$ on the same side as $-q$
(e) at none of these places.

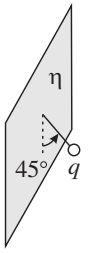
27. Two point charges are arranged as seen below right. The electric field at point P is :

(a) zero **(b)** down **(c)** up **(d)** right **(e)** left



28. A polystyrene ball 0.005 kg is attached by a very light insulating thread to a very large plate holding uniform surface charge density $\eta = 289$ nC/m^2. The ball holds an electrical charge and the thread makes an angle of 45 degrees from the vertical. The charge on the ball must be :

(a) 300 nC
(b) 2 μC
(c) 3 μC
(d) -3 μ
(e) -300 nc

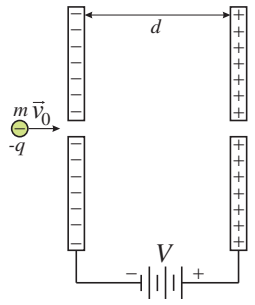


29. If 250 W are required to carry 40 C of charges in 0.2 s, the potential difference between the two points is :

(a) 1.25 V **(b)** 12.5 V **(c)** 125 V **(d)** 25 V **(e)** none of these answers

30. A particle of mass m and negative charge $-q$ is projected with speed v_0 into the region between two parallel plates as shown. The potential difference between the two plates is V and their separation is d. The change in kinetic energy of the particle as it traverses this region is

(a) $-qV/d$
(b) $2qV/mv_0^2$
(c) qV
(d) $mv_0^2/2$
(e) none of these answers



1-D : $\Delta x = x_f - x_i \quad \Delta t = t_f - t_i \quad v_{x\,\text{avg}} = \frac{\Delta x}{\Delta t}$

$v_x = \frac{dx}{dt} \quad a_{x\,\text{avg}} = \frac{\Delta v_x}{\Delta t} \quad a_x = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}$

a_x const. : $v_{fx} = v_{ix} + a_x \Delta t \quad x_f = x_i + v_{ix}\Delta t + \frac{1}{2}a_x \Delta t^2$

$v_{fx}^2 = v_{ix}^2 + 2a_x(x_f - x_i)$

3-D : $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k} \quad \Delta\vec{r} = \vec{r} - \vec{r}_0$

$\vec{v}_{\text{avg}} = \frac{\Delta\vec{r}}{\Delta t} \quad \vec{v} = \frac{d\vec{r}}{dt} \quad \vec{a}_{\text{avg}} = \frac{\Delta\vec{v}}{\Delta t} \quad \vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{r}}{dt^2}$

$\vec{a}$ const. : $\vec{v}_f = \vec{v}_i + \vec{a}\Delta t \quad \vec{r}_f = \vec{r}_i + \vec{v}_i \Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$g \approx 9.80\ \text{m/s}^2 \quad G \approx 6.67 \times 10^{-11}\ \text{N m}^2/\text{kg}^2$

$\vec{v}_{AB}$ const. : $\vec{r}_{CB} = \vec{r}_{CA} + \vec{r}_{AB}$

$\vec{v}_{CB} = \vec{v}_{CA} + \vec{v}_{AB} \qquad \vec{a}_{CB} = \vec{a}_{CA}$

$\omega = \frac{d\theta}{dt} \quad v_t = r\omega \quad a_c = r\omega^2 = \frac{v_t^2}{r} \quad T = \frac{2\pi}{\omega} \quad \theta = \frac{s}{r}$

$\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \ldots \quad \vec{a} = \frac{1}{m}\vec{F}_{\text{net}}$

$F_G = \frac{GMm}{R^2} \quad g = \frac{GM}{R^2} \quad F_G \approx mg$ (Earth surface)

$f_s \le \mu_s n \quad f_k = \mu_k n \quad f_r = \mu_r n \quad D = \frac{1}{2}C\rho A v^2$

$\vec{p} = m\vec{v} \quad \vec{F} = \frac{d\vec{p}}{dt} \quad \Delta p_x = \int_{t_i}^{t_f} F_x dt$ (area under $F_x(t)$)

$\vec{P} = \vec{p}_1 + \vec{p}_2 + \ldots \quad \frac{d\vec{P}}{dt} = \vec{F}_{\text{net}} = 0 \Rightarrow \vec{P}_f = \vec{P}_i$

$U_g = mgy \quad U_s = \frac{1}{2}k(\Delta s)^2 \quad (F_{\text{sp}})_s = -k\Delta s$

$W = \int_{s_i}^{s_f} \vec{F}\cdot d\vec{s} = \int_{s_i}^{s_f} F_s ds = \int_{s_i}^{s_f} F\cos\theta\ ds$

Const. force : $W = F\cos\theta(s_f - s_i)$

$K_f + U_f = K_i + U_i + W_{\text{nc}}$

$W_{\text{nc}} = W_{\text{ext}} + W_f + W_D + \ldots$

$P = \frac{\Delta W}{\Delta t} = \vec{F}\cdot\vec{v} = Fv\cos\theta$

$\vec{r}_{12} = \vec{r}_2 - \vec{r}_1 \quad \hat{r}_{12} \equiv \frac{\vec{r}_{12}}{|\vec{r}_{12}|}$

$\vec{F}_{1\text{ on }2} = \vec{F}_{12} = K\frac{q_1 q_2}{|\vec{r}_{12}|^2}\,\hat{r}_{12} = K\frac{q_1 q_2}{|\vec{r}_{12}|^3}\,\vec{r}_{12} = -\vec{F}_{21}$

$\epsilon_0 \equiv 8.854187817 \times 10^{-12}\ \text{C}^2\text{N}^{-1}\text{m}^{-2}$ (exact)

$K \equiv \frac{1}{4\pi\epsilon_0} \approx 8.99 \times 10^9\ \text{Nm}^2/\text{C}^2$

$\vec{E} = \vec{F}_{\text{on }q}/q \quad \vec{F} = q\vec{E} \quad \vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \ldots$

$\vec{a} = \frac{q}{m}\vec{E} \quad e \approx 1.602 \times 10^{-19}\ \text{C}$

$\lambda = Q/L$ in C/m $\quad \eta = Q/A$ in C/m^2

Infinite line of charge : $E = \frac{1}{4\pi\epsilon_0}\frac{2\lambda}{r}$ away from line

Infinite plane of charge : $E = \frac{\eta}{2\epsilon_0}$ away from plane

$\|$-plate capacitor : $E = \frac{\eta}{\epsilon_0}$ (inside), 0 (outside)

$V = U_e/q \quad \Delta V = V_f - V_i = -\int_{s_i}^{s_f} \vec{E}\cdot d\vec{s}$

Const. field : $\Delta V = \vec{E}\cdot\Delta\vec{s} = E\cos\theta(s_f - s_i)$

1 n$X = 10^{-9}X \quad 1\ \mu X = 10^{-6}X \quad 1$ m$X = 10^{-3}X$

1 c$X = 10^{-2}X \quad 1$ k$X = 10^{+3}X \quad 1$ M$X = 10^{+6}X$

Answers : 1 (a) 2 (d) 3 (d) 4 (c) 5 (e) 6 (d) 7 (c) 8 (c) 9 (e) 10 (c) 11 (a) 12 (e) 13 (d) 14 (c) 15 (b) 16 (e) 17 (e) 18 (b) 19 (d) 20 (e) 21 (c) 22 (a) 23 (c) 24 (b) 25 (c) 26 (e) 27 (a) 28 (c) 29 (a) 30 (c)