CT2-1. Classify the following ODE:

$$y'' + t\,y + 1 = 0$$

A) Linear
B) Homogeneous
C) Constant coefficients
D) Linear and homogeneous
E) Linear and homogeneous with constant coefficients

CT2-2. Classify the following ODE:

$$y'' = t\,y$$

A) 1st order, nonlinear
B) 2nd order, nonlinear
C) 2nd order, linear, inhomogeneous, variable coefficients
D) 2nd order, linear, homogeneous, constant coefficients
E) 2nd order, linear, homogeneous, variable coefficients

CT2-3. Which of the following ODEs are separable?

$$(1)\ y' = \frac{y^2}{t} - t \qquad (2)\ y' = e^t\,\frac{y+1}{\sqrt{t}} \qquad (3)\ y' = 3 - t$$

A) none are separable
B) (1) and (2) are separable
C) (2) and (3) are separable
D) (1) and (3) are separable
E) (1), (2) and (3) are separable

CT4. Consider the ODE

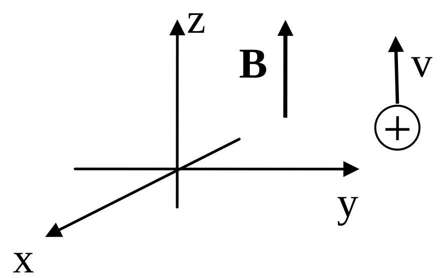
$$\frac{dN}{dt} - k\,N = 0$$

with k > 0 and N(t=0) = N_o > 0. What is the behavior of N(t) as t goes to infinity?

A) N(t) decays to zero.
B) N(t) doesn't change.
C) N(t) diverges (approaches infinity).
D) The behavior of N(t) can't be determined from the information given.

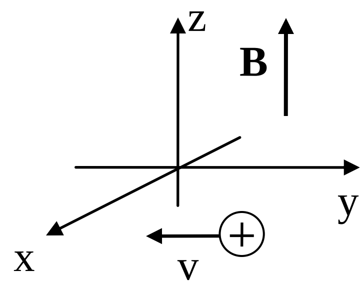
CT2-5. The magnetic force on a particle with charge q moving with velocity v in a magnetic field B is $\vec{F}_B = q\,\vec{v}\times\vec{B}$.
A particle with positive charge q is initially moving in the +z direction in a constant, uniform magnetic field $\vec{B} = B\hat{z}$ as shown. What is the subsequent motion of the particle?

A) A circular orbit in the xz plane
B) A circular orbit in the yz plane
C) A circular orbit in the xy plane
D) Linear motion parallel to the z-axis
E) Oscillatory motion back and forth parallel to the z-axis

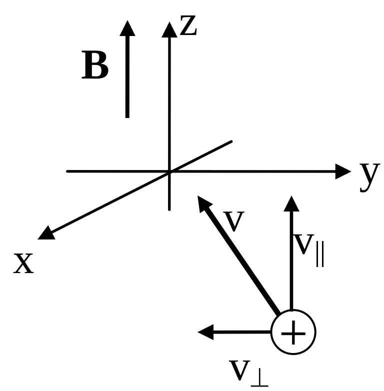


CT2-6. A particle with positive charge is initially moving in the negative y direction, again in a constant, uniform magnetic field $\vec{B} = B\hat{z}$. What is the subsequent motion of the particle?

A) A circular orbit in the xz plane
B) A circular orbit in the yz plane
C) A cicular orbit in the xy plane
D) Linear motion parallel to the y-axis
E) Oscillatory motion back and forth parallel to the y-axis



CT2-7. The same particle (charge q, in a unform field $\vec{B} = B\hat{z}$) now has an initial velocity **v** that has a component $v_{\parallel}$ parallel to the B-field and a component $v_{\perp}$ perpendicular to the B-field, as shown. The particle is initially in the z = 0 plane and is found to cross the z = z_{final} plane at time T. What happens to the passage time T if the initial perpendicular component $v_{\perp}$ is increased?



A) Nothing, because T is independent of $v_{\perp}$.
B) T increases as $v_{\perp}$ increases.
C) T decreases as $v_{\perp}$ increases.

CT2-8. The vector $\vec{A}$ is in the xy plane. The vector $\vec{B} = B\,\hat{z}$ is parallel to the z-axis. Which of the following statements about the cross-product $\vec{P} = \vec{A}\times\vec{B}$ is always true?

A) The vector $\vec{P}$ lies in the xy plane.
B) The component $P_x = 0$ always.
C) The component $P_y = 0$ always.
D) The vector $\vec{P}$ is perpendicular to the xy plane.
E) None of these statements is always true.

CT2-9. Given a particle with mass m and velocity $\vec{v}$, momentum $\vec{p} = m\vec{v}$, and angular momentum $\vec{L} = \vec{r} \times \vec{p}$, what is $\vec{L} \bullet \vec{p}$?

A) zero

B) a non-zero vector parallel to $\vec{p}$

C) a non-zero vector perpendicular to $\vec{p}$

D) a non-zero number (a scalar)

E) impossible to tell without knowing more about $\vec{p}$ and $\vec{L}$

CT2-10. Consider the following situations:

1) Start: a book in my hand (at rest).
   I lower the book at constant speed to the floor.
   End: the book on the floor, at rest.
2) Start: a book in my hand (at rest).
   I throw a book up in the air.
   End: the book at its highest point, where it is at rest.
3) Start: a book in my hand (at rest).
   I drop the book, which lands on a spring. (The spring is specially arranged to catch once it has reached full compression.)
   End: the book on the compressed spring, at rest.

For which of these situations does the Work-Energy theorem apply?

A) 1 and 2

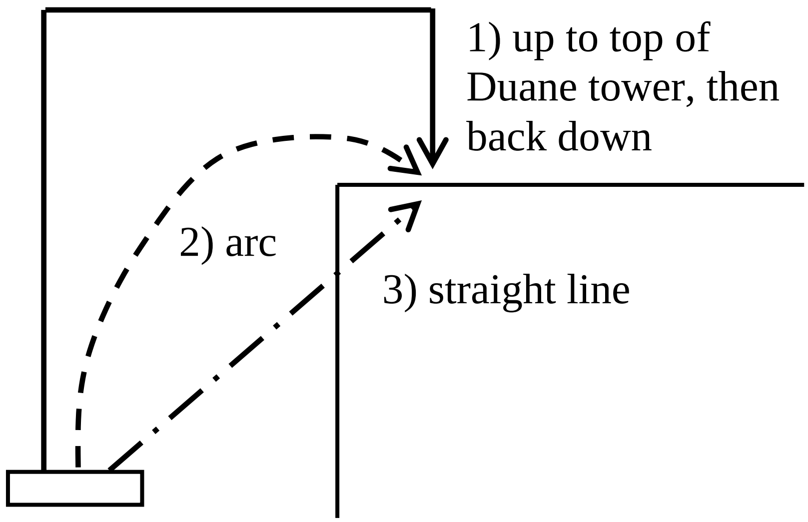
B) 2 and 3

C) 1 and 3

D) 1, 2, and 3

E) none

CT2-11. Consider motion of a book from the floor to the table by the following paths:



Which path has the smallest value of the work done? Recall

$$W = \int \vec{F} \bullet d\vec{r}$$

A) 1

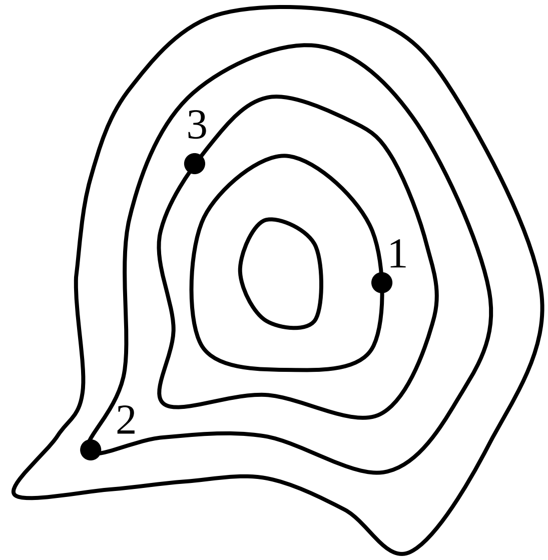
B) 2

C) 3

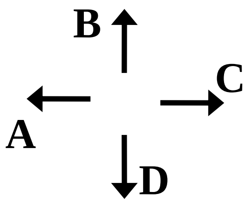
D) all paths result in the same work done

E) Impossible to determine

CT2-12. Consider the contour plot of a function f(x,y), where the central contour corresponds to the largest value of f.

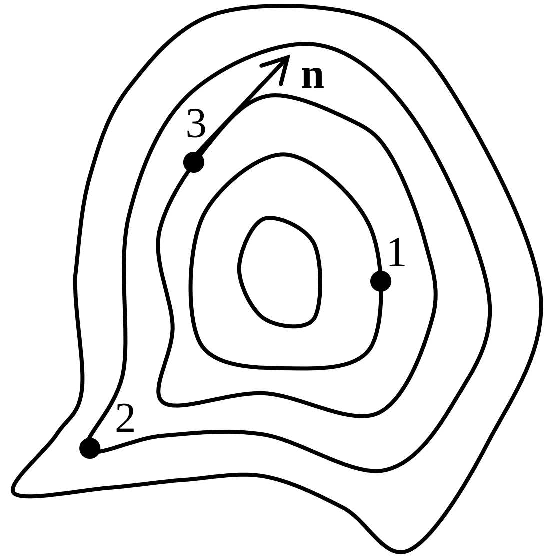


What direction is the gradient of f(x,y) at point 1?



E) None of these

CT2-13. Consider the contour plot of a function f(x,y), where the central contour corresponds to the largest value of f.



What is the sign of the directional derivative of f(x,y) at point 3, in the direction of the unit vector **n** (shown by the arrow)?

A) $\mathbf{n}\cdot\nabla f > 0$
B) $\mathbf{n}\cdot\nabla f = 0$
C) $\mathbf{n}\cdot\nabla f < 0$
D) The sign of $\mathbf{n}\cdot\nabla f$ can't be determined from the information given.