Doppler effect

1] JEE Advanced 2024

A source of light moves directly away from an observer at a speed of 0.3 c. The observed frequency is f'. According to the relativistic Doppler shift formula, what is the ratio f'/f₀?

Single Correct

A] √((1 – 0.3)/(1 + 0.3))

B] √((1 + 0.3)/(1 – 0.3))

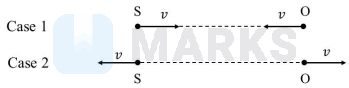
C] (0.7)/(1.3)

D] (1.3)/(0.7)

Ans: A

2] JEE ADV 2024

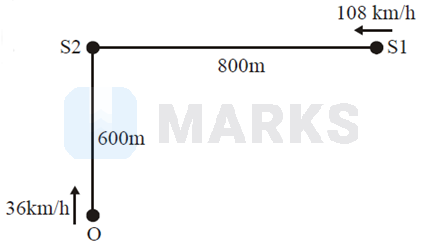
A source (S) of sound has frequency 240 Hz. When the observer (O) and the source move towards each other at a speed v with respect to the ground (as shown in Case 1 in the figure), the observer measures the frequency of the sound to be 288 Hz. However, when the observer and the source move away from each other at the same speed v with respect to the ground (as shown in Case 2 in the figure), the observer measures the frequency of sound to be n Hz. The value of n is \_\_\_\_\_\_



Ans: 200

4] JEE ADV 2019

A train S1, moving with a uniform velocity of 108 km/h, approaches another train S2 standing on a platform. An observer 0 moves with a uniform velocity of 36 km/h towards S2, as shown in figure. Both the trains are blowing whistles of same frequency 120 Hz. When 0 is 600 m away from S2 and distance between S1 and S2 is 800 m, the number of beats heard by 0 is [Speed of the sound = 330 m/s]



Ans : 8.128

5] JEE ADV 2018

Two men are walking along a horizontal straight line in the same direction. The man in front walks at a speed 1.0 m/s and the man behind walks at a speed 2.0 m/s . A third man is standing at a height 12 m above the same horizontal line such that all three men are in a vertical plane. The two walking men are blowing identical whistles which emit a sound of frequency 1430 Hz. The speed of sound in air is 330 m/s. At the instant, when the moving men are 10 m apart, the stationary man is equidistant from them. The frequency of beats in Hz, heard by the stationary man at this instant, is

Ans: 5

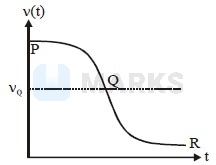
6] JEE ADV 2017

A stationary source emits sound of frequency fo = 492 Hz . The sound is reflected by a large car approaching the source with a speed of 2 m/s. The reflected signal is received by the source and superposed with the original. What will be the beat frequency of the resulting signal in Hz? (Given that the speed of sound in air is 330 m/s and the car reflects the sound at the frequency it has received).

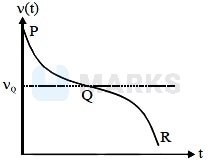
Ans: 6

7] JEE ADV 2016

Two loudspeakers M and N are located 20m apart and emit sound at frequencies 118 Hz and 121 Hz, respectively. A car is initially at a point P, 1800 m away from the midpoint Q of the line MN and moves towards Q constantly at 60 km/hr along the perpendicular bisector of MN. It crosses Q and eventually reaches a point R, 1800 m away from Q. Let v(t) represent the beat frequency measured by a person sitting in the car at time t. Let V(P), V(Q) and V® be the beat frequencies measured at locations P, Q and R, respectively. The speed of sound in air is 330 ms-1. Which of the following statement(s) is (are) true regarding the sound heard by the person?

A] The plot below represents schematically the variation of beat frequency with time 

B] The plot below represents schematically the variations of beat frequency with time



C] The rate of change in beat frequency is maximum when the car passes through Q

D] ν(P)+ν(R)=2ν(Q)

Ans: A,C,D

8] JEE ADV 2013

Two vehicles, each moving with speed u on the same horizontal straight road, are approaching each other. Wind blows along the road with velocity w. One of these vehicles blows a whistle of frequency f1. An observer in the other vehicle hears the frequency of the whistle to be f2. The speed of sound in still air is V. The correct statement (s) is (are) :

Multiple Correct

A] If the wind blows from the observer to the source, f2 > f1.

B] If the wind blows from the source to the observer, f2> f1.

C] If the wind blows from the observer to the source, f2 < f1.

D] If the wind blows from the source to the observer, f2 < f1.

Ans: A,B

9] JEE ADV 2011

A police car with a siren of frequency 8kHz is moving with uniform velocity 36 km/h towards a tall building which reflects the sound waves. The speed of sound in air is 320 m/s. The frequency of the siren heard by the car driver is

A] 8.5 kHz

B] 8.25 kHz

C] 7.75 kHz

D] 7.50 kHz

Ans: A

10] JEE ADV 2010

A stationary source is emitting sound at a fixed frequency fo, which is reflected by two cars approaching the source. The difference between the frequencies of sound reflected from the cars is 1.2% of fo. What is the difference in the speeds of the cars (in km per hour) to the nearest integer ? (The cars are moving at constant speeds much smaller than the speed of sound which is 330 m/s)

Ans: 7

11] JEE ADV 2007

Two trains A and B are moving with speeds 20 m/s and 30 m/s, respectively in the same direction on the same straight track, with B ahead of A. The engines are at the front ends. The engine of train A blows a long whistle.

Assume that the sound of the whistle is composed of components varying in frequency from f1 = 800 Hz to f2 = 1120 Hz, as shown in the figure. The spread in the frequency (highest frequency - lowest frequency) is thus 320 Hz. The speed of sound in still air is 340 m/s.

The speed of sound of the whistle is

A] 340 m/s for passengers in A and 310 m/s for passengers in B

B] 360 m/s for passengers in A and 310 m/s for passengers in B

C] 310 m/s for passengers in A and 360 m/s for passengers in B

D] 340 m/s for passengers in both trains

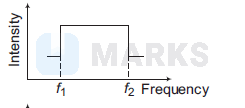
Ans : B

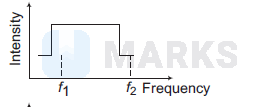
12] JEE ADV 2007

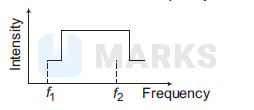
Two trains A and B are moving with speeds 20 m/s and 30 m/s, respectively in the same direction on the same straight track, with B ahead of A. The engines are at the front ends. The engine of train A blows a long whistle.

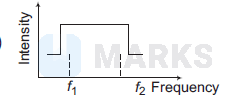
Assume that the sound of the whistle is composed of components varying in frequency from f1 = 800 Hz to f2 = 1120 Hz, as shown in the figure. The spread in the frequency (highest frequency - lowest frequency) is thus 320 Hz. The speed of sound in still air is 340 m/s.

The distribution of the sound intensity of the whistle as observed by the passengers in train A is best represented by

A] 

B] 

C] 

D] 

Ans: A

13] JEE ADV 2007

Two trains A and B are moving with speeds 20 m/s and 30 m/s, respectively in the same direction on the same straight track, with B ahead of A. The engines are at the front ends. The engine of train A blows a long whistle.

Assume that the sound of the whistle is composed of components varying in frequency from f1 = 800 Hz to f2 = 1120 Hz, as shown in the figure. The spread in the frequency (highest frequency - lowest frequency) is thus 320 Hz. The speed of sound in still air is 340 m/s.

The spread of frequency as observed by the passengers in train B is

A] 310

B] 330

C] 350

D] 290

Ans : A

Mass energy relation:

JEE Advanced 2012  
Imagine that a reactor converts all given mass into energy and operates at a power of 10⁹ W. The mass of the fuel consumed per hour is:  
Single Correct  
A] 0.96 g  
B] 0.8 g  
C] 4 × 10⁻² g  
D] 6.6 × 10⁻⁵ g  
Ans: C

JEE Level  
Energy obtained when 1 mg mass is completely converted to energy is:  
Single Correct  
A] 3 × 10⁸ J  
B] 3 × 10¹⁰ J  
C] 9 × 10¹³ J  
D] 9 × 10¹⁵ J  
Ans: C

JEE Level  
If 1 g hydrogen is converted into 0.993 g helium in a thermonuclear reaction, the energy released is:  
Single Correct  
A] 63 × 10⁷ J  
B] 63 × 10¹⁰ J  
C] 63 × 10¹⁴ J  
D] 63 × 10²⁰ J  
Ans: B

JEE Level  
Nuclear fission and fusion are explained on the basis of:  
Single Correct  
A] Conversion of energy principle  
B] Einstein mass-energy equivalence relation  
C] Binding energy per nucleon variation  
D] Mass variation in nucleus  
Ans: B

HC Verma Ex‑46 Q4

Calculate the energy released in the reaction: 7Li + p → α + α, given masses: 7Li = 7.0160 u, p = 1.007276 u, α = 4.0026 u.

Numerical

Ans: 16.83 MeV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HC Verma Ex‑46 Q5

Find the binding energy per nucleon of 197₇₉Au given its atomic mass 196.96 u; mₚ = 1.007276 u, mₙ = 1.008665 u.

Numerical

Ans: 7.74 MeV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HC Verma Ex‑46 Q6(a)

Calculate the energy released when ²³⁸U emits an α-particle using masses: ²³⁸U=238.0508 u, ²³⁴Th=234.04363 u, α=4.00260 u.

Numerical

Ans: 4.255 MeV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HC Verma Ex‑46 Q6(b)

Calculate energy required to remove two protons and two neutrons separately from ²³⁸U (same masses as above plus p/n masses).

Numerical

Ans: 23.00 MeV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HC Verma Ex‑46 Q7

Find energy liberated in ²²³Ra → ²⁰⁹Pb + ¹⁴C using atomic masses: Ra=223.018 u, Pb=208.981 u, ¹⁴C=14.003 u.

Numerical

Ans: 31.65 MeV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

USAPhO 2017 Part A Q4

Find minimum proton energy Ep ≈ (mΔ² – mp²)/(4Eb) for Δ-formation in p+γ collision.

Numerical

Ans: ~1.4×10^20 eV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Advanced 2013

If mass–energy equivalence is taken into account, when water is cooled to form ice, the mass of water should

Single Correct

A] increase

B] remain unchanged

C] decrease

D] first increase then decrease

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Advanced 2022

The minimum kinetic energy needed by an alpha particle to cause a nuclear reaction (masses given).

Numerical

Ans: 2.33 MeV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Main 2013 (Thermo variant)

If E = mc² is applied, cooling a substance releases energy; what happens to its mass?

Single Correct

A] increases  B] decreases  C] unchanged  D] fluctuates

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

CIE A‑Level nuclear def

Compute energy released by a given mass defect in a nuclear reaction via E = mc².

Numerical (open‑ended)

Ans: problem‑specific values

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

GeeksforGeeks star‑mass loss

One star radiates 7×10²² J/s. Find mass decrease Δm using ΔE = Δm·c².

Numerical

Ans: 0.78×10⁶ kg/s

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Vedantu CBSE

Find rest‑mass energy of an electron (m = 9.11×10⁻³¹ kg).

Single Correct

A] 8.18817×10⁻¹⁴ J

B] 8.18807×10⁻¹⁴ J

C] 8.18907×10⁻¹⁴ J

D] 8.19807×10⁻¹⁴ J

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

NCERT‑Exemplar

Show energy equivalent of 1 u is 931.5 MeV using E = mc², m = 1.67×10⁻²⁷ kg.

Derivation

Ans: 931.5 MeV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Doubtnut

Show that energy equivalent of 1 u = 931.5 MeV; compute E = m c².

Derivation

Ans: 931.5 MeV

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Typical JEE‑style

If binding energy per nucleon is 1.115 MeV for deuterium, find its mass defect in u.

Numerical

Ans: 0.0048 u

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Typical JEE numerical

In nuclear fission, 0.1% mass converts to energy. Find energy released per kg mass.

Numerical

Ans: ~9×10¹³ J

**Inertial and non-inertial frames:**  
  
JEE Advanced 2016

A block slides in a radial slot in a rotating disc (angular speed ω). Its position r(t) satisfies:

Single Correct

A] (R/2) cos 2ωt

B] (R/2) cos ωt

C] (R/2)(e^(ωt)+e^(−ωt))

D] (R/2)(e^(2ωt)+e^(−2ωt))

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Advanced (rotating disc concept)

Coordinate system fixed on a rotating disc (constant ω) is:

Single Correct

A] inertial

B] non‑inertial

C] pseudo‑inertial

D] none

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Main variant (accelerating elevator)

A mass inside an upward‑accelerated elevator shows?

Single Correct

A] lighter

B] heavier

C] same

D] zero weight

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Main variant (braking car)

In a braking car, passenger feels thrown forward. Pseudo‑force acts:

Single Correct

A] backward

B] forward

C] upward

D] downward

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HC Verma Ch5 Ex‑Section

Mass on spring in accelerating car—find equilibrium extension with acceleration a.

Numerical

Ans: x = m(g + a)/k

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

USAPhO 2017 Part A Q1

Bead on rotating hoop (non‑inertial frame analysis): derive equilibrium position equation.

Numerical

Ans: tan θ = 2ω²R/g

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

USAPhO 2020 Part A Q2

Block in accelerating cart—find normal reaction via pseudo force.

Numerical

Ans: N = m√(g² + a²)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Typical JEE question (elevator angle)

Ball hangs in accelerating elevator—angle of string makes?

Numerical

Ans: tan θ = a/g

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Typical JEE numerical (centrifugal + Coriolis)

Find centrifugal and Coriolis forces for mass moving radially in rotating frame.

Numerical

Ans: F\_cent = mω²r, F\_cor = 2mωv\_rad

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Standard JEE numeric (accelerating frame)

Frame accelerating downwards—normal reaction N = m(g − a).

Numerical

Ans: N = m(g − a)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Olympiad-style (rotating coin)

Coin on rotating turntable—why friction acts inward?

Single Correct

A] centrifugal

B] centripetal

C] Coriolis

D] pseudo

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Advanced style (radial slot again)

If radial slot is frictionless and disc rotates, which equation for r(t) is correct?

Single Correct

A] r = R cos ωt

B] r = R cos 2ωt

C] r ∝ e^(ωt)

D] r is constant

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Main-style (cart acceleration)

In a cart accelerating rightwards, a pendulum bob deflects:

Single Correct

A] leftwards

B] rightwards

C] stays vertical

D] oscillates

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Main numeric (accelerated car)

Car accelerates at a; string mass m swings to angle θ. Value of θ?

Numerical

Ans: tan θ = a/g

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HC Verma format (spring inside elevator)

Spring-mass in elevator accelerating downwards with a. Stretch:

Numerical

Ans: x = m(g − a)/k

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HC Verma MCQ (pseudo force direction)

In a car accelerating forward, pseudo‑force on rider acts:

Single Correct

A] forward

B] backward

C] upward

D] downward

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Typical JEE numeric (rotating frame equilibrium)

Mass moves on vertical rotating rod with ω; find equilibrium r.

Numerical

Ans: r = (ω²/4g) (or from balance F = 0: r = …)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Olympiad numeric (radial motion on disc)

Block at r = R on rotating table slides outward; find time to reach edge.

Numerical

Ans: t = (1/ω) arccosh(R/r₀)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Olympiad MCQ (Coriolis deflection)

Object dropped from North pole deflects due to Coriolis toward:

Single Correct

A] east

B] west

C] north

D] south

Ans: A

**Velocity Addition Formula:**

Kevin Zhou Physics Olympiad: Headlight Aberration

Headlight beam angle θ in the car’s frame vs θ′ in Earth frame:

Single Correct

A] θ′ > θ

B] θ′ = θ

C] θ′ < θ

D] can’t say

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Kevin Zhou Physics Olympiad: Mirror Image Speed

A mirror moves at speed v toward a stationary source. Image speed relative to source:

Single Correct

A] 2v

B] v

C] 2v/(1 + v²/c²)

D] c

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

OpenStax College Physics 28.4

Light from a car’s headlight on a moving car arrives at a sidewalk observer at speed:

Single Correct

A] > c

B] = c

C] < c

D] unpredictable

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Kevin Zhou (Chegg-sourced)

Frame S′ moves at 0.25 c. In S′, a particle moves at 0.8 c in the same direction. Speed in S is:

Single Correct

A] 0.650 c

B] 0.980 c

C] 0.545 c

D] 0.875 c

Ans: D

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Scribd: Physics Concepts and Connections

Two spaceships move toward each other, each at speed v as seen from Earth. Their relative speed is 0.70 c. What is v?

Single Correct

A] 0.80 c

B] 0.60 c

C] 0.99 c

D] 0.41 c

Ans: D

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Scribd: Physics Concepts and Connections

A positron at 0.95 c and an electron at 0.85 c move in opposite directions. What is their relative speed?

Single Correct

A] 0.99 c

B] 0.996 c

C] 0.97 c

D] 0.90 c

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

OpenStax College Physics 28.4

A spaceship moves at 0.5 c and turns on a laser beam in the forward direction. What speed is observed for the beam?

Single Correct

A] > c

B] = c

C] < c

D] depends on direction

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HC Verma Conceptual MCQ (adapted)

If two objects move at 0.9 c toward each other, what is their relative speed using special relativity?

Single Correct

A] 1.8 c

B] 0.99 c

C] 0.994 c

D] c

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Kevin Zhou Physics Olympiad: Velocity Addition Concept

In S', object moves at 0.6 c and S' moves at 0.6 c. What is object's speed in S?

Single Correct

A] 1.2 c

B] 0.88 c

C] 0.75 c

D] 0.6 c

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

JEE Advanced-style MCQ

Light emitted backward from a spaceship moving at 0.5 c (relative to Earth). What is the speed of light in Earth frame?

Single Correct

A] c

B] c/2

C] 1.5 c

D] 0.5 c

Ans: A

**Time dilation and length contraction:**

1. Kevin Zhou Physics Olympiad Q14

Why do moving clocks run slow, but moving rods contract?

Single Correct

A] Both are illusions

B] Involves relativity of simultaneity

C] Only clocks change

D] Only rods change

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. UBC Physics Problem 1.6

At what speed must a clock move so it runs at half the rate of a stationary clock?

Single Correct

A] 0.50 c

B] 0.707 c

C] 0.866 c

D] 0.943 c

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. UBC Physics Problem 1.7

At what speed must a meter stick move so its length contracts to 0.5 m?

Single Correct

A] 0.707 c

B] 0.866 c

C] 0.943 c

D] 0.500 c

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. McGill Olympiad

Muon proper lifetime 2.2 μs, moving at 0.95 c—apparent lifetime observed?

Single Correct

A] 4.52 μs

B] 6.69 μs

C] 1.10 μs

D] 2.20 μs

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. OpenStax Time Dilation

Spacecraft clock measures 10 h; Earth sees 20 h. Speed is:

Single Correct

A] 0.577 c

B] 0.707 c

C] 0.866 c

D] 0.949 c

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. OpenStax Length Contraction

Object appears half its rest length. Speed is:

Single Correct

A] 0.707 c

B] 0.866 c

C] 0.500 c

D] 0.950 c

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. Wikipedia Ladder Paradox

Which assumption leads to ladder‑fitting paradox?

Single Correct

A] Absolute simultaneity

B] Time dilation

C] Energy conservation

D] Inertial motion

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. Wikipedia Bell’s Spaceship

Why does string between accelerating ships break?

Single Correct

A] Time dilation

B] Length contraction

C] Simultaneity of acceleration

D] Relativistic mass

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9. Kevin Zhou Velocity Concept Q20(c)

Between moving frames, measured velocity ratio:

Single Correct

A] Always > 1

B] Always < 1

C] Can exceed c

D] Equals c only for photons

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. Physics MCQ (Scribd): Two rods move at ±0.5c. How does one look to the other?

Single Correct

A] 4/5 L

B] 3/5 L

C] 5/3 L

D] 1/5 L

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

11. Varsity Tutors: Length contraction only occurs in:

Single Correct

A] Direction of motion

B] Perpendicular to motion

C] Both

D] Neither

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

12. Varsity Tutors Cube Volume Q

Cube side L₀ moves parallel to an edge. Volume becomes:

Single Correct

A] L₀³

B] L₀³ / √(1−v²/c²)

C] L₀³ (1−v²/c²)

D] L₀³ √(1−v²/c²)

Ans: D

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

13. MCQ.EPCLand Q3

Which is true about time dilation?

Single Correct

A] Only for accelerating observers

B] Occurs only for objects in motion

C] Occurs even at rest

D] Independent of speed

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14. MCQ TestBook: 45° rod contraction

Rod at 45° moving at v = 1/√2 c. Length in lab is:

Single Correct

A] √3/2 m

B] √5/3 m

C] √2/3 m

D] 2/3 m

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

15. TestBook: Which contracts?

Single Correct

A] Only length

B] Only time

C] Both

D] Neither

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

16. Quizizz example: 2 m ruler contracts to 0.5 m. Speed is:

Single Correct

A] 0.1 c

B] 0.3 c

C] 0.5 c

D] 0.8 c

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

17. Reddit AskPhysics Concept

Time dilation and length contraction both occur due to:

Single Correct

A] Only time dilation

B] Only length contraction

C] Both occur together

D] Neither

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

18. OpenStax contrived MCQ

Length contraction symmetrical: rod at rest in S is contracted in S′. True?

Single Correct

A] Yes

B] No

C] Only if v ≪ c

D] Only for accelerating frames

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

19. Wikipedia Time Dilation Fact

Orbiting ISS sees daily time slip of:

Single Correct

A] 0.00458 s per day

B] 0.005 s per day

C] 0.01 s per day

D] 0.02 s per day

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

20. Ives–Stilwell experiment validated:

Single Correct

A] Time dilation

B] Length contraction

C] Velocity addition

D] Relativistic mass

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

21. Kennedy–Thorndike experiment tested:

Single Correct

A] Time dilation

B] Length contraction

C] Both

D] Neither

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

22. Kevin Zhou: effect of simultaneity

Length contraction arises due to:

Single Correct

A] Clocks synchronization

B] Energy changes

C] Inertial mass

D] Gravity

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

23. Kevin Zhou: time dilation origin

Time dilation is a result of:

Single Correct

A] Lorentz transformations

B] Newtonian mechanics

C] Quantum effects

D] Thermal time flow

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

24. UBC Physics implied MCQ

Proper length L₀ measured in its own rest frame—lab measures L = L₀/γ. True?

Single Correct

A] Yes

B] No

C] Only for light

D] Only for massless particles

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

25. Physics MCQ Scribd

Which is invariant under Lorentz transform?

Single Correct

A] Space interval

B] Time interval

C] Light interval (cΔt)² – Δx²

D] Momentum

Ans: C

Lorentz Transformations

1. Testbook

Under conventional Lorentz transformation, which is correct?

Single Correct

A] x′ = (x − vt)/√(1–v²/c²); y′ = y; z′ = z

B] x′ = (x + vt)/√(1–v²/c²); y′ = y; z′ = z

C] x′ = (x − vt)/√(1+v²/c²); y′ = y; z′ = z

D] None

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Sanfoundry Engineering Physics

A rod of length 5 m moves at 0.6 c. Observed length perpendicular to motion is:

Single Correct

A] 5 m

B] 4 m

C] 3 m

D] 2 m

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Testbook: Lorentz Principle MCQ – Principle Basis

Lorentz transformations are based on:

Single Correct

A] Invariance of the speed of light

B] Galilean relativity

C] Newton’s laws

D] Conservation of energy

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. IIT JAM Physics (via Doorstep Tutor)

Time transformation: t′ = γ(t – vx/c²). Which statement is true?

Single Correct

A] Events simultaneous in S are simultaneous in S′

B] Simultaneity is relative between frames

C] Time dilation does not follow

D] Only x transforms with time

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. Testbook: Lorentz Transformation MCQ

Which is the inverse x–t Lorentz transformation?

Single Correct

A] x = γ(x′ + vt′)

B] x = γ(x′ – vt′)

C] x = x′ + vt′

D] x = x′ – vt′

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. Testbook

Time transformation: t = γ(t′ + vx′/c²). Which choice is valid?

Single Correct

A] Valid only for v ≪ c

B] Inverse Lorentz time transformation

C] Contradicts special relativity

D] Describes simultaneity at rest

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. Doorstep Tutor / IIT JAM

Two successive Lorentz boosts with velocities v1 and v2 in the same direction equal a single boost with velocity:

Single Correct

A] (v1 + v2)/(1 + v1v2/c²)

B] v1 + v2

C] (v1 + v2)/(1 – v1v2/c²)

D] c always

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. Pearson MCQ

Event X has (x, t) = (1500 m, 3.5 μs). Frame P′ moves at 0.9 c. What is x′?

Single Correct

A] γ(x – vt)

B] γ(x + vt)

C] (x – vt)

D] x – vt

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9. Pearson Practice MCQ

Particle launched at 0.70 c left and another at 0.50 c right. What is speed of first relative to second?

Single Correct

A] (0.70 + 0.50)/(1 + 0.70\*0.50) c = 0.89 c

B] 1.20 c

C] 0.20 c

D] 0.50 c

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. Pearson Practice MCQ

Spacestation at 0.5 c ejects capsule at 0.7 c forward. Observer on Earth measures speed:

Single Correct

A] (0.7 + 0.5)/(1 + 0.7\*0.5) c = 0.89 c

B] 1.2 c

C] 0.2 c

D] 0.7 c

Ans: A

Relativistic Momentum

1] JEE Main Previous Year

Calculate the relativistic momentum of a particle of mass 1.76×10⁻²⁷ kg when its total relativistic energy is 3× its rest energy.

Single Correct

A] 2.86×10⁻¹⁸ kg·m/s

B] 9.68×10⁻¹⁸ kg·m/s

C] 2.05×10⁻¹⁷ kg·m/s

D] 1.29×10⁻¹⁷ kg·m/s

Ans: B

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. JEE Advanced (Orissa JEE 2005)

“If the velocity of a relativistic particle is doubled, its linear momentum will be:”

Single Correct

A] Doubled

B] Less than doubled

C] More than doubled

D] Unchanged

Ans: C

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. I.E Irodov solutions

A rod moves at speed v such that its length contraction is 0.5% (experiment setup). Determine v/c.

Single Correct

A] √(0.005×1.995)

B] ≈0.1 c

C] ≈0.2 c

D] ≈0.05 c

Ans: A

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. I.E. Irodov Problem 7 – BYJU’S

The proper lifetime of an unstable particle is Δt₀ = 10 ns. In the laboratory frame, its lifetime is Δt = 20 ns. Over what distance will it travel before decaying?

Single Correct

A] 3.0 m

B] 1.2 m

C] 2.45 m

D] 10.0 m

Ans: C

Link: https://byjus.com/jee/ie-irodov-solutions-part-1-relativistic-mechanics/ (Problem 7)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_