Danmarks Tekniske Universitet

Written exam, Thursday 23 May, 2024

Course Name Physics (Polytechnical Foundation)

Course no. 10060

Duration: 2 hours

Permitted aids: All aids allowed, but no internet access

"Weighting": The answer is assessed as a whole.

The set consists of 14 multiple-choice questions. Incorrect answers lower the assessment. The answer “Do not know” is neutral. Some questions have one correct answer, in others the correct answer is a combination of several options.

Question 1.

A stone is thrown vertically into the air from a height 1.60 ± 0.05 m above ground and with an initial speed of 4.20 ± 0.05 m/s. The gravitational acceleration is 9.82 ± 0.01 m/s^2. The uncertainties are independent.

At what time, t, does the rock hit the ground?

A) $t = 1.14 \pm 0.01$ s
B) $t = 0.73 \pm 0.21$ s
C) $t = 0.66 \pm 0.04$ s
D) $t = 1.063 \pm 0.035$ s
E) $t = 1.2 \pm 0.3$ s
F) $t = -0.286 \pm 0.007$ s
G) $t = 1.06 \pm 0.0.04$ s
H) $t = 0.94 \pm 0.08$ s
I) $t = 1.141 \pm 0.011$ s
J) Do not know

Question 2. [Continuation of previous question]

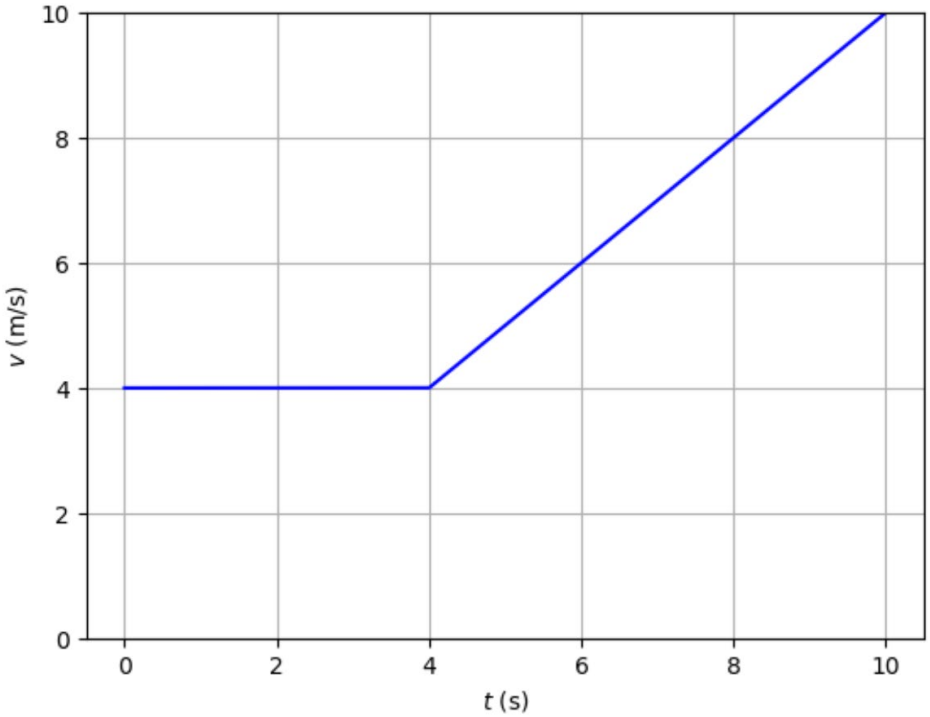
Let $\delta t(h)$ be the uncertainty contribution from the h on t, i.e. $\delta t = \sqrt{\delta t(h)^2 + \delta t(v)^2 + \delta t(g)^2}$.

How do the uncertainty contributions from the terms v, h and g relate to each other?

A) $\delta t(h) > \delta t(v)$
B) $\delta t(h) < \delta t(v)$
C) $\delta t(h) > \delta t(g)$
D) $\delta t(h) < \delta t(g)$
E) $\delta t(v) > \delta t(g)$
F) $\delta t(v) < \delta t(g)$
G) Do not know

Question 3.

The figure below shows the velocity of a body as a function of time. At time $t = 0$ s the position of the body is, $x = 10.0$ m.



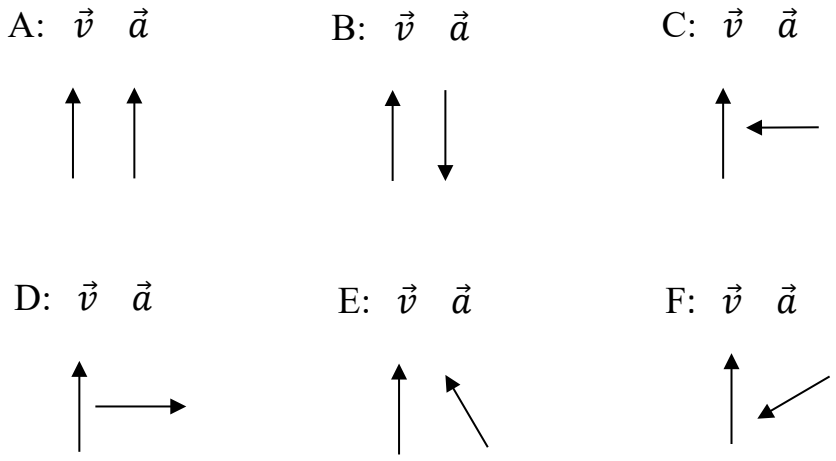
What is the position, x, of the body at time $t = 10$ s?

A) $x = 30.0$ m
B) $x = 33.0$ m
C) $x = 38.0$ m
D) $x = 45.0$ m
E) $x = 47.0$ m
F) $x = 51.0$ m
G) $x = 58.0$ m
H) $x = 60.0$ m
I) $x = 68.0$ m
J) Do not know

Question 4.

A car drives straight ahead on a horizontal road. A situation arises that makes the car accelerate.

The figure below shows the velocity and acceleration of the car.

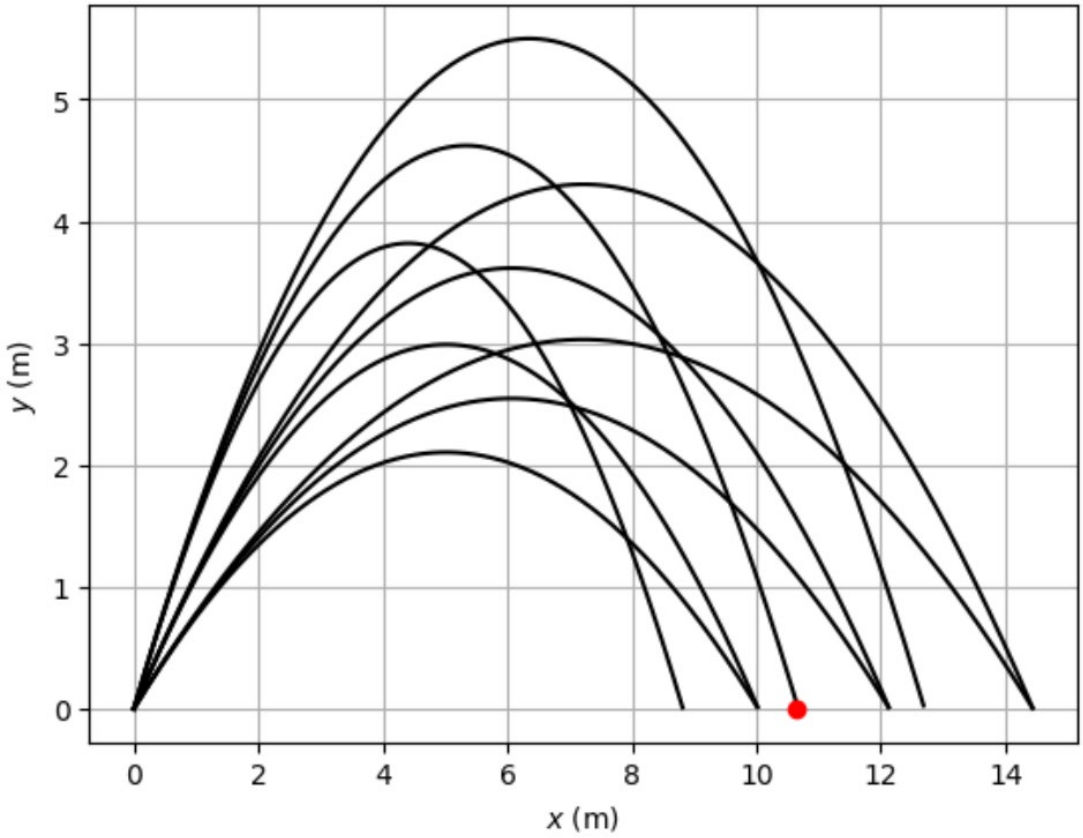


In what situations does the car turn?

A) A
B) B
C) C
D) D
E) E
F) F
G) Do not know

Question 5.

The figure below shows throws without air resistance. The initial speed is 10 m/s, 11 m/s or 12 m/s and the initial angles are 40°, 50° and 60°.



The point of impact of one of the throws is marked with a red circle.

What is the initial speed and initial angle of this throw?

A) 10 m/s and 40°
B) 10 m/s and 50°
C) 10 m/s and 60°
D) 11 m/s and 40°
E) 11 m/s and 50°
F) 11 m/s and 60°
G) 12 m/s and 40°
H) 12 m/s and 50°
I) 12 m/s and 60°
J) Do not know

Question 6.

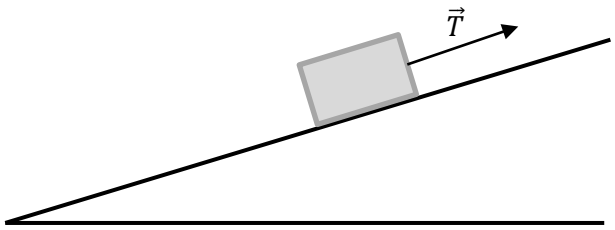
In connection with an experiment, the model $a = f(m, v, L, g, F)$ is examined, where a is an acceleration, m is a mass, v is a velocity, L is a length, g is the gravitational acceleration, and F is a force.

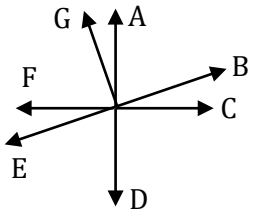
Which of the following are natural scales for length (λ) and time (τ) in the model?

A) $\lambda = v$
B) $\lambda = L$
C) $\lambda = vL$
D) $\lambda = \frac{v^2}{g}$
E) $\tau = \frac{L}{g}$
F) $\tau = \frac{L}{v}$
G) $\tau = \frac{v}{L}$
H) $\tau = \sqrt{\frac{mL}{F}}$
I) Do not know

Question 7.

A box is pulled up a smooth, inclined plane with a constant force, $\vec{T}$.



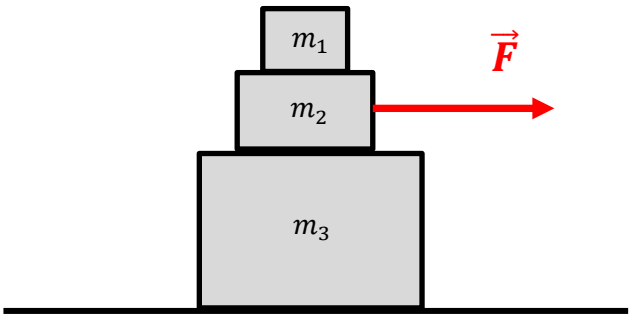


Which of the forces shown (A-G) must be included in a force diagram for the box?

A) A
B) B
C) C
D) D
E) E
F) F
G) G
H) Do not know

Question 8.

Three boxes are placed on top of each other. The middle box is pulled by a force, $\vec{F}$, torwards right. The contact surfaces between the three boxes and the substrate are rough. The three boxes accelerate to the right like a body, i.e. they do not move in relation to each other.



How many forces affect the top box?

A) m_1 affected by exactly one force
B) m_1 affected by exactly two forces
C) m_1 affected by exactly three forces
D) m_1 affected by exactly four forces
E) m_1 affected by exactly five forces
F) m_1 affected by exactly six forces
G) Do not know

Question 9. [Continuation of previous question]

How many forces affect the middle box?

A) m_2 affected by exactly one force
B) m_2 affected by exactly three forces
C) m_2 affected by exactly three forces
D) m_2 affected by exactly four forces
E) m_2 affected by exactly five forces
F) m_2 affected by exactly six forces
G) Do not know

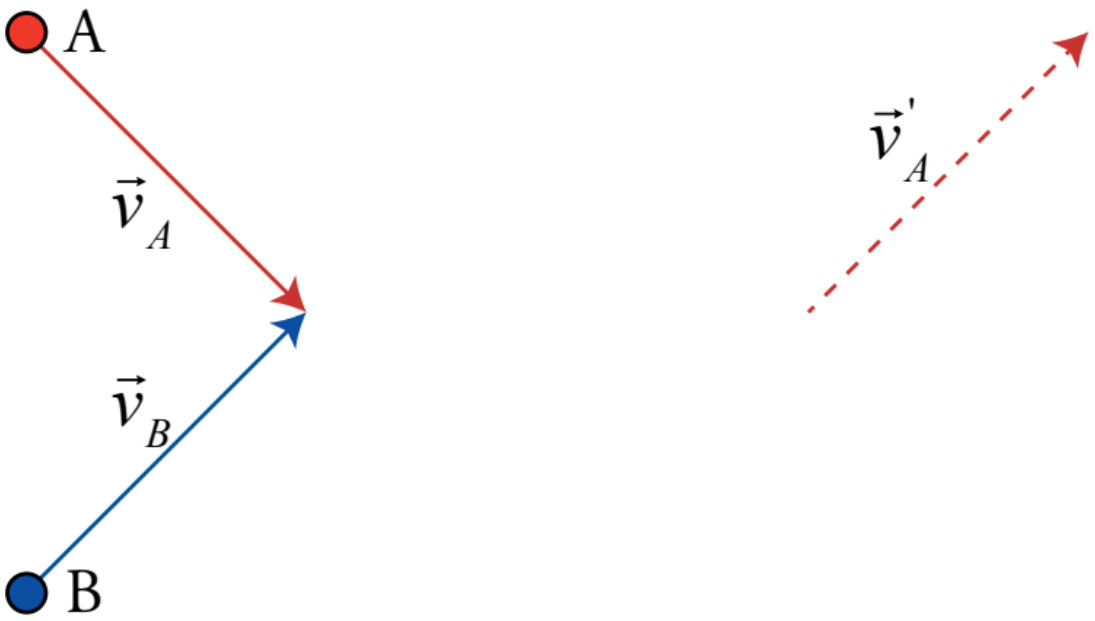
Question 10. [Continuation of previous question]

How many forces affect the bottom box?

A) m_3 affected by exactly one force
B) m_3 affected by exactly two forces
C) m_3 affected by exactly three forces
D) m_3 affected by exactly four forces
E) m_3 affected by exactly five forces
F) m_3 affected by exactly six forces
G) Do not know

Question 11.

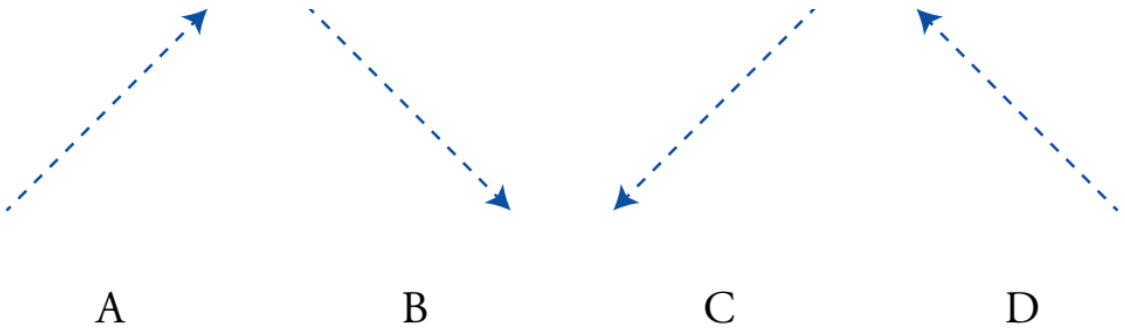
Two particles with identical masses, A and B, collide with each other at velocities as shown on the left in the figure below. After the impact, particle A has the velocity as shown to the right in the figure.



Below are a number of options for the speed of B after the impact.

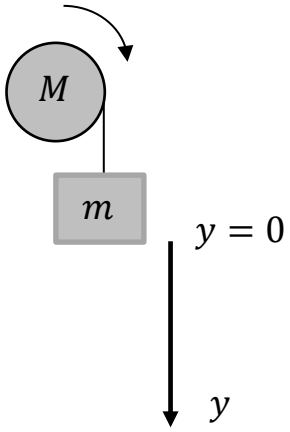
Which figure shows the velocity of B after the impact?

A) A
B) B
C) C
D) D
E) Do not know

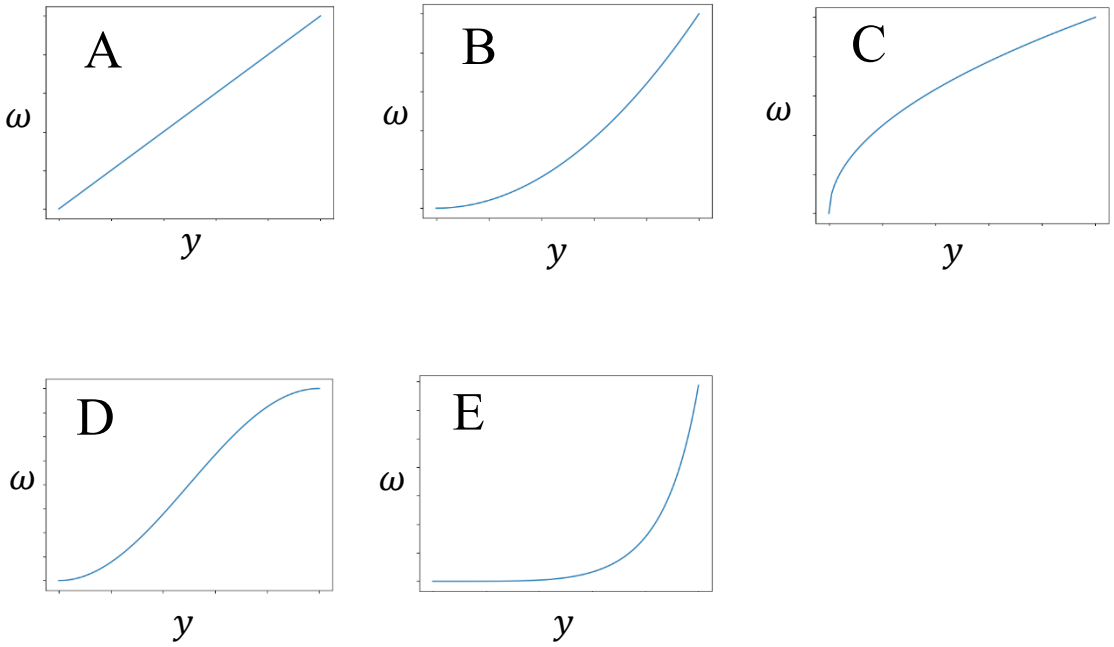


Question 12.

A box with mass m falls from a standstill and pulls a frictionless pulley which has a mass M that can is spun via a string. The string does not slip on the pulley. The positive direction of rotation for the pulley is given in the figure.



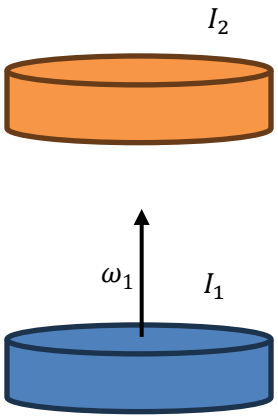
Which of the curves below best describes the angular velocity of the pulley as a function of y, the vertical position of the box? Note that the y-axis is directed downwards.



A) A
B) B
C) C
D) D
E) E
F) Do not know

Question 13.

A homogeneous disc with moments of inertia, I_1, is located on a horizontal smooth surface. The disk rotates at an angular speed, ω_1.

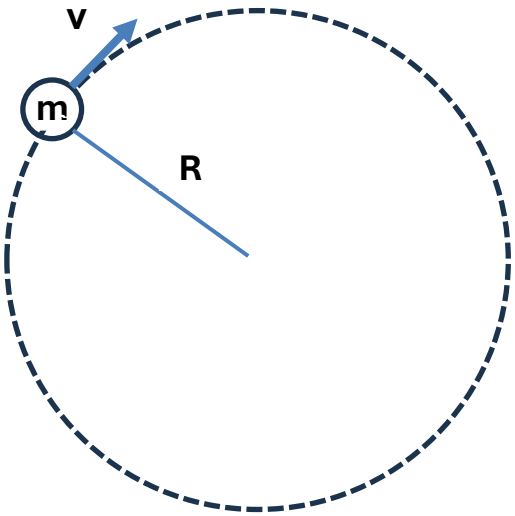


Another disc with moment of inertia, I_2, that does not rotate, is carefully placed on top of the first disc. After a short period of time, the two disks rotate at the common angular velocity, $\omega_2 = \frac{3}{5}\omega_1$.

What is the moment of inertia, I_2?

A) $I_2 = \frac{1}{2}I_1$
B) $I_2 = \frac{1}{3}I_1$
C) $I_2 = \frac{1}{4}I_1$
D) $I_2 = \frac{2}{3}I_1$
E) $I_2 = \frac{3}{4}I_1$
F) $I_2 = \frac{2}{5}I_1$
G) $I_2 = \frac{3}{5}I_1$
H) $I_2 = \frac{4}{5}I_1$
I) $I_2 = \frac{5}{3}I_1$
J) Do not know

Question 14.



A ball with the mass $m = 50$ kg is connected by a carbon fiber laminate with the length $R = 1.0$ m and diameter d. The ball rotates in a horizontal plane with a constant speed, $v = 100$ m/s. The carbon fiber has a maximum stress factor of $\sigma_{max} = 1600$ MPa, if this is exceeded, the fiber will break. Stress is defined as force per area, $\sigma = F/A$.

What is the minimum diameter the fiber should have if it is not to break at this speed?

A) $d = 2.0$ cm
B) $d = 1.0$ cm
C) $d = 0.50$ cm
D) $d = 2.0$ mm
E) $d = 1.0$ mm
F) $d = 0.5$ mm
G) Do not know