2023 MIDTERM 1 EXAM

1. An object moves along the horizontal axis as shown on the diagram. At which point or points is its acceleration zero?

2. A ball is dropped from the top of the building. In the absence of air resistance, the ball will hit the ground with a speed of 49 m/s. The height of the building is:

3. The relationship between the velocity of a body moving along the x axis and time is $v = 3.0t^2 - 2.0t$, where the units are SI units. The total distance the body travels between the times $t = 2.0$ s and $t = 4.0$ s is:

4. A stone with a mass m is dropped from an airplane that has a horizontal velocity v at a height h above a lake. If air resistance is neglected, the horizontal distance R from the point on the lake directly below the point of release to the point where the stone strikes the water is given by which formula?

5. An airplane pilot wishes to fly due west. A wind of 85.0 km/h is blowing toward the south. If the airspeed of the plane (its speed in still air) is 315 km/h, what is the speed of the plane over the ground?

6. A car is accelerating at the rate of 2.50 m/s2 . A mass of 255 g is hanging from the ceiling on a string 1.23 m long. The angle that the string makes with the vertical is

7. Two masses, m1 and m2, connected by a massless string, are accelerated uniformly on a frictionless surface, as shown. The ratio of the tensions T1/T2 is given by:

8. A 44.5-N weight is hung on a spring scale, and the scale is hung on a string. The string is lowered at a rate such that the entire assembly has a downward acceleration of 2.42 m/s2 . The scale reds:

9. An object with a mass M = 250 g is at rest on a plane that makes an angle θ = 30° above the horizontal. The coefficient of kinetic friction between M and the plane is μk = 0.100. Mass M is attached by a string to another mass m = 200 g, which hangs freely. When mass m has fallen 30.0 cm, its speed is:

10. A curve of radius 30.0 m is banked at an angle θ. Find θ for which a car can round the curve at 40.0 km/h even if the road is covered with ice so that friction is negligible.

11. As you drive clockwise around a turn (as viewed from overhead), you see backed-up traffic ahead and so you slow down. Which force diagram in the figure above best illustrates your acceleration?

12. A projectile is fired from point O at the edge of a cliff, with initial velocity components of $v0x = 60.0$ m/s and $v0y = 175$ m/s, as shown in the figure. The projectile rises and then falls into the sea at point P. The time of flight of the projectile is 40.0 s, and it experiences no appreciable air resistance in flight. What is the height of the cliff?

13. The figure shows the position of an object as a function of time, with all numbers accurate to two significant figures. Between time $t = 0.0$ s and time $t = 9.0$ s, the object's average speed and average velocity are, respectively,

14. The position of an object is given by $x = at^3 - bt^2 + ct$, where $a = 4.1$ m/s^3 , $b = 2.2$ m/s^2 , $c = 1.7$ m/s, and x and t are in SI units. What is the instantaneous acceleration of the object when $t = 0.7$ s?

1.

Point A: the position increases linearly, which means a constant velocity, ∴ no acceleration.

Point B: Position remains the same, object could be deaccelerating.

Point C: Position retracts, meaning the object must accelerate to go back.

Point D: Same as object B, the point can be turning around, which requires acceleration.

Point E: Object remains at rest, doesn't change position, which means no velocity, and no acceleration. $\boxed{A)}$

2.

$V=49\,m/s$

$V^2=V_i^2+2ah$

$h=\frac{v^2}{2a}$

$h=\frac{49^2}{2\cdot 9.8}$

$h=122.5\,m$ ↗ 2 sig figs

$h=120\,m$ $\boxed{D)}$

3.

$d=\int_2^4 3t^2-2t$

$d=\left[t^3-t^2\right]_2^4$

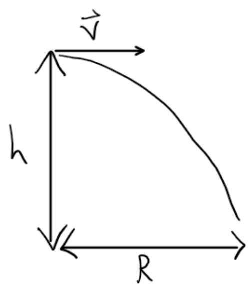
$=\left[4^3-4^2\right]-\left[2^3-2^2\right]$

$d=44m$ $\boxed{E)}$

4.

$V_{ix}=V$

$V_{iy}=0$



Along y-axis:

$h=V_{iy}t+\frac{1}{2}gt^2$

$h=\frac{1}{2}gt^2$

$t=\sqrt{\frac{2h}{g}}$

Along x-axis:

$R=V_{ix}t$

$R=vt$

$R=v\sqrt{\frac{2h}{g}}$ $\boxed{D)}$

5.

$V_{wind}=-85\,km/hr$

$V_p=315\,km/hr$

Using Pythagorean's theorem:

$R^2=V_{ground}^2+V_{wind}$

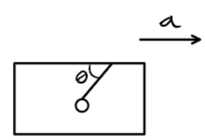
$315^2=V_{ground}^2+(-85)^2$

$V_{ground}=\sqrt{99225-7225}$

$V_{ground}=303.3150178$

$V_{ground}=303\,km$ $\boxed{B)}$

6.



$a=2.50\,m/s^2$ $m=255g=0.255kg$

$L=1.23m$

$\tan\theta=\frac{a}{g}$

$\theta=\tan^{-1}\left(\frac{2.50}{9.8}\right)$

$\theta=14.31104126$

$\theta=14.3$ toward the back of the car. $\boxed{A)}$

7.

Tension in T_1:

m_1g

Tension in T_2:

$(m_1+m_2)g$

Ratio:

$\frac{m_1g}{(m_1+m_2)g}=\frac{m_1}{m_1+m_2}$ $\boxed{D)}$

8.

$F=mg=44.5\,N$

$a=2.42\,m/s^2$

$44.5=m(9.8)$

$m=\frac{44.5}{9.8}$

$m=4.540816326\,53kg$

$F_T=F-F_a$

$F=44.5-ma$

$F=44.5-4.5408(2.42)$

$F=33.511264$

$F=33.5N$ $\boxed{B}$

9.

$M = 250g = 0.250kg$

$\theta = 30°$ $\mu_k = 0.100$ $m = 200g = 0.200kg$

$x = 0.30\,m$

Tension in the string:

$$T = Ma + Mg\sin\theta + \mu_K(Mg\cos\theta)$$

Also, $T = m(g-a)$, so:

$$m(g-a) = Ma + Mg\sin\theta + \mu_K(Mg\cos\theta)$$

$$mg - ma = Ma + Mg\sin\theta + \mu_K(Mg\cos\theta)$$

$$mg - Mg\sin\theta - \mu_K(Mg\cos\theta) = Ma + ma$$

$$a(M+m) = mg - Mg\sin\theta - \mu_K(Mg\cos\theta)$$

$$a = \frac{mg - Mg\sin\theta - \mu_K(Mg\cos\theta)}{M+m}$$

$$a = \frac{mg - Mg(\sin\theta + \mu_K\cos\theta)}{M+m}$$

$$a = \frac{g(m - M(\sin\theta + \mu_K\cos\theta))}{M+m}$$

$$a = \frac{9.8((0.200-0.250)(\sin 30° + 0.100\cos 30°))}{0.200+0.250}$$

$$a = 1.161830613\ m/s^2$$

Now using kinematics:

$$V = \sqrt{2ad}$$

$$V = \sqrt{2 \cdot 1.161830613 \cdot 0.3}$$

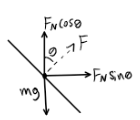
$$V = 0.8349241691\ m$$

$$V = 83cm \quad \boxed{E)}$$

10.

$r = 30m$

$V = 40km/hr \cdot \frac{1000m}{1km} \cdot \frac{1hr}{3600s} = 11.\bar{1}\ m/s$



Using centripital force:

$F_{NET_x} = F_c$ $\quad * F_N = \frac{mg}{\cos\theta}$

$F_N \sin\theta = \frac{mv^2}{r}$

$\frac{mg}{\cos\theta}\sin\theta = \frac{mv^2}{r}$

$mg\tan\theta = \frac{mv^2}{r}$

$\theta = \tan^{-1}\left(\frac{v^2}{gr}\right)$

$= \tan^{-1}\left(\frac{(11.1)^2}{9.8 \cdot 30}\right)$

$\theta = 22.77856024$

$\theta = 22.8°$ $\boxed{C)}$

11.

Centripital acceleration always moves towards the centre. If the car slows down, centripital acceleration will move away from the vehicle, moving acceleration to the opposing direction.

So, the correct diagram is $\boxed{C)}$

12.

$V_{ox} = 60m/s$

$V_{oy} = 175m/s$

$t = 40s$

Second equation of motion:

$y = V_{oy}t + \frac{1}{2}gt^2$

$y = 175(40) - \frac{1}{2}(9.8)(40)^2$

$y = 840m \longrightarrow$ -ve because the projectile moves down, switch to +ve.

$\boxed{E)}$

13.

$V_1 = \frac{3-0}{3-0} = 1$ $\quad V_3 = \frac{1-3}{9-6} = \frac{-2}{3}$

$V_2 = \frac{3-3}{6-3} = 0$

$$\text{Speed}_{avg} = \frac{V_1 t_1 + V_2 t_2 + V_3 t_3}{t_1 + t_2 + t_3}$$

$$= \frac{1(3) + 0(3) + \frac{2}{3}(3)}{3+3+3}$$

$$\text{Speed}_{avg} = 0.\overline{5}\ m/s \quad \boxed{A)}$$

$$V_{avg} = \frac{V_1 t_1 + V_2 t_2 + V_3 t_3}{t_1 + t_2 + t_3}$$

$$= \frac{1(3) + 0(3) - \frac{2}{3}(3)}{3+3+3}$$

$$V_{avg} = 0.\overline{1}\ m/s$$

14.

$x = at^3 - bt^2 + ct$

$a = 4.1 m/s,\ b = 2.2 m/s^2,\ c = 1.7 m/s$

$t = 0.7 s$

$V(t) = 3at^2 - 2bt + c$

$a(t) = 6at - 2b$

$a(0.7) = 6(4.1)(0.7) - 2(2.2)$

$a(0.7) = 12.82$

$a(0.7) = 13 m/s^2 \quad \boxed{D)}$