HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY
ADVANCED PROGRAMS - PHYSICS HOMEWORK

1. MECHANICS

1.2 KINEMATICS

Name:.. Date of birth:..

Class:.. Student ID:..

Grade table

Question:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Points:	3	5	4	3	7	3	6	6	5	4	6	17	4
Score:													

Question:	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	Total
Points:	5	5	10	5	4	6	7	5	3	6	5	3	137
Score:													

1. You are driving home from school steadily at $95\,\mathrm{km\,h^{-1}}$ for $180\,\mathrm{km}$. It then begins to rain and you slow to $65\,\mathrm{km\,h^{-1}}$. You arrive home after driving $4.5\,\mathrm{h}$. **3 p**

(**a**) How far is your hometown from school? [2]

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(**b**) What was your average speed? [1]

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2. (**a**) What is meant by: **5 p**

i. *average speed*, [1]

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ii. *average velocity*. [1]

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(**b**) In a complete round trip, the outgoing 250 km is covered at $95\,\mathrm{km\,h^{-1}}$, followed by a 1.0-h lunch break, and the return 250 km is covered at $55\,\mathrm{km\,h^{-1}}$. Calculate for the round trip:

i. the average speed, [2]

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ii. the average velocity. [1]

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3. An ion's position vector is initially $\vec{\mathbf{r}}_0 = 5.0\,\hat{\mathbf{x}} - 6.0\,\hat{\mathbf{y}} + 2.0\,\hat{\mathbf{z}}$, and 10 s later is $\vec{\mathbf{r}} = -2.0\,\hat{\mathbf{x}} + 8.0\,\hat{\mathbf{y}} - 2.0\,\hat{\mathbf{z}}$, all in meters. **4 p**

(**a**) In unit-vector notation, find the average velocity of the ion during the 10 s. [2]

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(**b**) State and explain whether or not it is possible to determine the average speed of the ion with the given information. [2]

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4. A bowling ball traveling with constant speed hits the pins at the end of a bowling lane 16.5 m long. The bowler hears the sound of the ball hitting the pins 2.80 s after the ball is released from his hands. What is the speed of the ball, assuming the speed of sound is $340\,\mathrm{m\,s^{-1}}$? [3]

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5. You throw a ball toward a wall at speed $25.0\,\mathrm{m\,s^{-1}}$ and at angle $\theta_0 = 40°$ above the horizontal, as shown in **Fig. 5.1**. The wall is distance $d = 22.0$ m from the release point of the ball. **7 p**

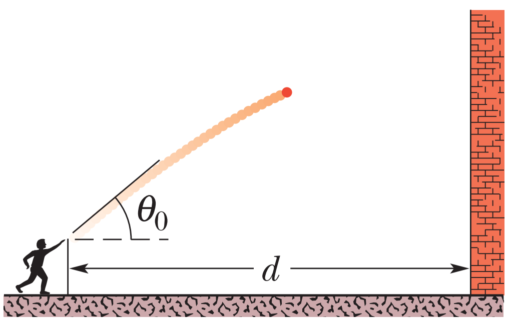

Fig. 5.1

(**a**) How far above the release point does the ball hit the wall? [3]

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(**a**) Determine, for the velocity of the ball as it hits the wall,

i. the horizontal component, [1]

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ii. the vertical component. [2]

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(**b**) When the ball hits, has it passed the highest point on its trajectory? [1]

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6. **3 p**

(**a**) Define *acceleration.* [1]

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(**b**) A sports car moving at constant velocity travels 120 m in 5.0 s. If it then brakes and comes to a stop in 4.0 s, what is the magnitude of its acceleration (assumed constant)? [2]

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7. A particle leaves the origin with an initial velocity $\vec{\mathbf{u}} = (3.00\,\hat{\mathbf{x}})\,\mathrm{m\,s^{-1}}$ and a constant acceleration $\vec{\mathbf{a}} = -1.00\,\hat{\mathbf{x}} - 0.500\,\hat{\mathbf{y}}$. When it reaches its maximum x coordinate, what is its **6 p**

(**a**) velocity vector, [4]

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(**b**) position vector? [2]

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8. In a jump spike, a volleyball player slams the ball from overhead and toward the opposite floor. [6]

Controlling the angle of the spike is difficult. Suppose a ball is spiked from a height of 2.30 m with an initial speed of $20.0\,\mathrm{m\,s^{-1}}$ at a downward angle of $18.0\cancel{0}^\circ$. How much farther on the opposite floor would it have landed if the downward angle were, instead, 8.00°? $\boxed{\textbf{6 p}}$

9. (**a**) In a uniform circular motion, explain why there is an acceleration even though the speed is constant. [2]

(**b**) An Earth satellite moves in a circular orbit (uniform circular motion) 640 km above Earth's surface with a period of 98.0 min. The Earth's radius is 6400 km. Calculate, for the satellite, $\boxed{\textbf{5 p}}$

i. its speed, [2]

ii. the magnitude of its centripetal acceleration. [1]

10. A world-class sprinter can reach a top speed (of about $11.5\,\mathrm{m\,s^{-1}}$) in the first $18.0\,\mathrm{m}$ of a race. **4 p**

(**a**) What is the average acceleration of this sprinter? [2]

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(**b**) How long does it take her to reach that speed? [2]

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11. **Fig. 11.1** shows a general situation in which a stream of people attempt to escape through an exit door that turns out to be locked.

The people move toward the door at speed $v_s = 3.50\,\mathrm{m\,s^{-1}}$, are each $d = 0.25\,\mathrm{m}$ in depth, and are separated by $L = 1.75\,\mathrm{m}$. The arrangement in **Fig. 11.1** occurs at time $t = 0$.

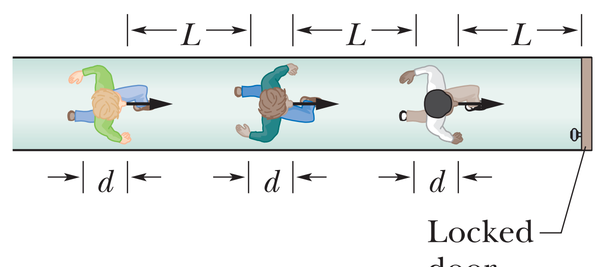

Fig. 11.1

6 p

(**a**) At what average rate does the layer of people at the door increase? [4]

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(**b**) At what time does the layer's depth reach $5.0\,\mathrm{m}$? [2]

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12. The position of a particle moving along the x axis depends on the time according to the equation

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

where x is in meters and t in seconds. **17 p**

(**a**) What are the units of the

i. constant c, [1]

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ii. constant b. [1]

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(**b**) Let the numerical values c and b be 3.0 and 2.0, respectively.

i. At what time does the particle reach its maximum positive x position? [4]

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ii. From $t = 0.0\,\text{s}$ and $t = 4.0\,\text{s}$,

1. what distance does the particle move [4]

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2. and what is the displacement of the particle? [1]

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iii. Find the velocity and the acceleration of the particle at times

1. 1.0 s, [3]

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2. 2.0 s, [1]

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3. 3.0 s, [1]

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4. 4.0 s. [1]

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13. Determine the stopping distances for an automobile going with a constant initial speed of $95\,\mathrm{km\,h^{-1}}$ and human reaction time of 0.40 s for **4 p**

(**a**) an acceleration of $-3.0\,\mathrm{m\,s^{-2}}$, [3]

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(**b**) an acceleration of $-6.0\,\mathrm{m\,s^{-2}}$. [1]

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14. **Fig. 14.1** depicts the motion of a particle moving along an x axis with a constant acceleration. The figure's vertical scaling is set by $x_s = 6.0\,\text{m}$. For the acceleration of the particle, determine its **5 p**

(**a**) magnitude, [4]

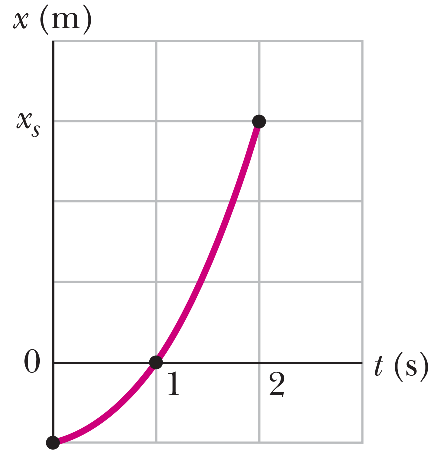

Fig. 14.1

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(**b**) direction. [1]

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15. An unmarked police car traveling a constant $95\,\text{km}\,\text{h}^{-1}$ is passed by a speeder traveling $135\,\text{km}\,\text{h}^{-1}$. Precisely $1.00\,\text{s}$ after the speeder passes, the police officer steps on the accelerator. If the police car's acceleration is $2.60\,\text{m}\,\text{s}^{-2}$, how much time passes before the police car overtakes the speeder (assumed moving at constant speed)? [5] **5 p**

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16. A rescue plane wants to drop supplies to isolated mountain climbers on a rocky ridge 235 m below. The plane is traveling horizontally with a speed of $250\,\mathrm{km\,h^{-1}}$. **10 p**

(**a**) How far in advance of the recipients (horizontal distance) must the goods be dropped? [3]

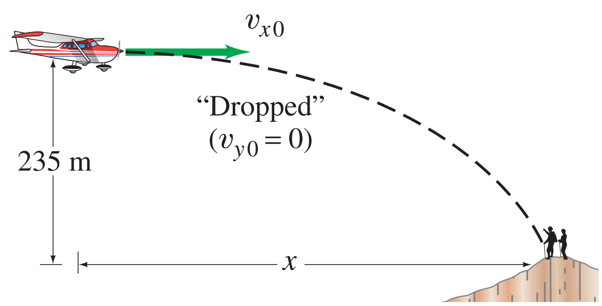

Fig. 16.1

(**b**) Suppose the plane releases the supplies a horizontal distance of 425 m in advance of the mountain climbers.

i. What vertical velocity (up or down) should the supplies be given so that they arrive precisely at the climbers' position? [5]

ii. With what speed do the supplies land? [2]

17. A car moves at constant speed of $40\,\mathrm{km\,h^{-1}}$ along the road shown in **Fig. 17.1**. The radius of curvature at A is $350\,\mathrm{m}$ and the total acceleration of the car at B is $1.0\,\mathrm{m\,s^{-2}}$. **5 p**

Fig. 17.1

(**a**) Find the total acceleration of the car at

i. A, [2]

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ii. C. [1]

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(**b**) Find the radius of curvature at B. [2]

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18. A centripetal-acceleration addict rides in uniform circular motion with radius $r = 3.00\,\mathrm{m}$. At one instant his acceleration is $\vec{\mathbf{a}} = 6.00\,\hat{\mathbf{x}} - 4.00\,\hat{\mathbf{y}}\ \mathrm{m\,s^{-2}}$. Let $\vec{\mathbf{r}}$ be his position vector with respect to the center of the orbit and $\vec{\mathbf{v}}$ be his velocity at that instant. Calculate the following products: **4 p**

(**a**) $\vec{\mathbf{v}} \cdot \vec{\mathbf{a}}$, [2]

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(**b**) $\vec{\mathbf{r}} \times \vec{\mathbf{a}}$. [2]

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19. Two particles move along an x axis. The position of particle 1 is given by $x = 6.00t^2 + 3.00t + 2.00$ (in meters and seconds); the acceleration of particle 2 is given by $a = -8.00t$ (in meters per second squared and seconds) and, at $t = 0$, its velocity is $20\,\mathrm{m\,s^{-1}}$. [6]

When the velocities of the particles match, what is their velocity? **6 p**

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20. A particle moves horizontally in uniform circular motion, over a horizontal xy plane. At one instant, it moves through the point at coordinates $(4.00\,\mathrm{m}, 4.00\,\mathrm{m})$ with a velocity of $(-5.00\,\mathrm{m\,s^{-1}})\,\hat{\mathbf{x}}$ and an acceleration of $(+12.5\,\mathrm{m\,s^{-2}})\,\hat{\mathbf{y}}$. Determine the coordinates of the center of the circular path. [7] **7 p**

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21. A falling stone takes 0.31 s to travel past a window 2.2 m tall, as shown in **Fig. 21.1**. From what height above the top of the window did the stone fall? Take $g = 9.8\,\mathrm{m\,s^{-2}}$. [5]

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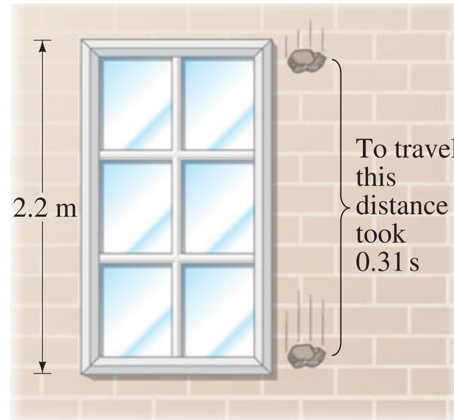

Fig. 21.1

22. **Fig. 22.1** shows the speed v versus height y of a ball tossed directly upward, along a y axis. Distance d is 0.40 m. The speed at height y_A is v_A. The speed at height v_B is $v_\mathrm{A}/3$. Calculate v_A. [3] **3 p**

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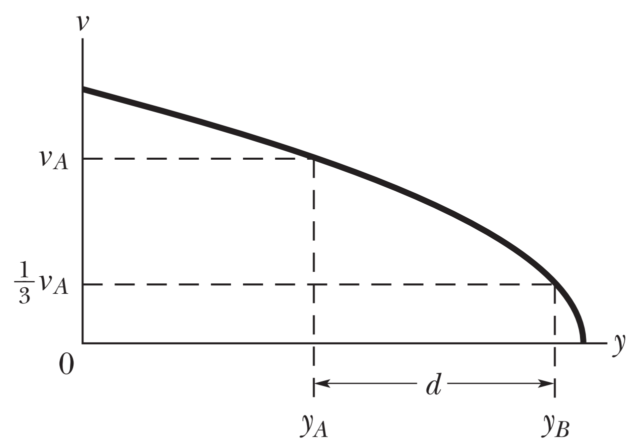

Fig. 22.1

23. A boy whirls a stone in a horizontal circle of radius 1.5 m and at height 2.0 m above level ground. The string breaks, and the stone flies off horizontally and strikes the ground after traveling a horizontal distance of 10 m. What is the magnitude of the centripetal acceleration of the stone during the circular motion? [6] **6 p**

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24. Estimate by what factor a person can jump farther on the Moon as compared to the Earth if the takeoff speed and angle are the same. [5]

The acceleration due to gravity on the Moon is one-sixth what it is on Earth. **5 p**

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25. A ball is thrown horizontally from the roof of a building 7.5 m tall and lands 9.5 m from the base. [3]

What was the ball's initial speed? **3 p**

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