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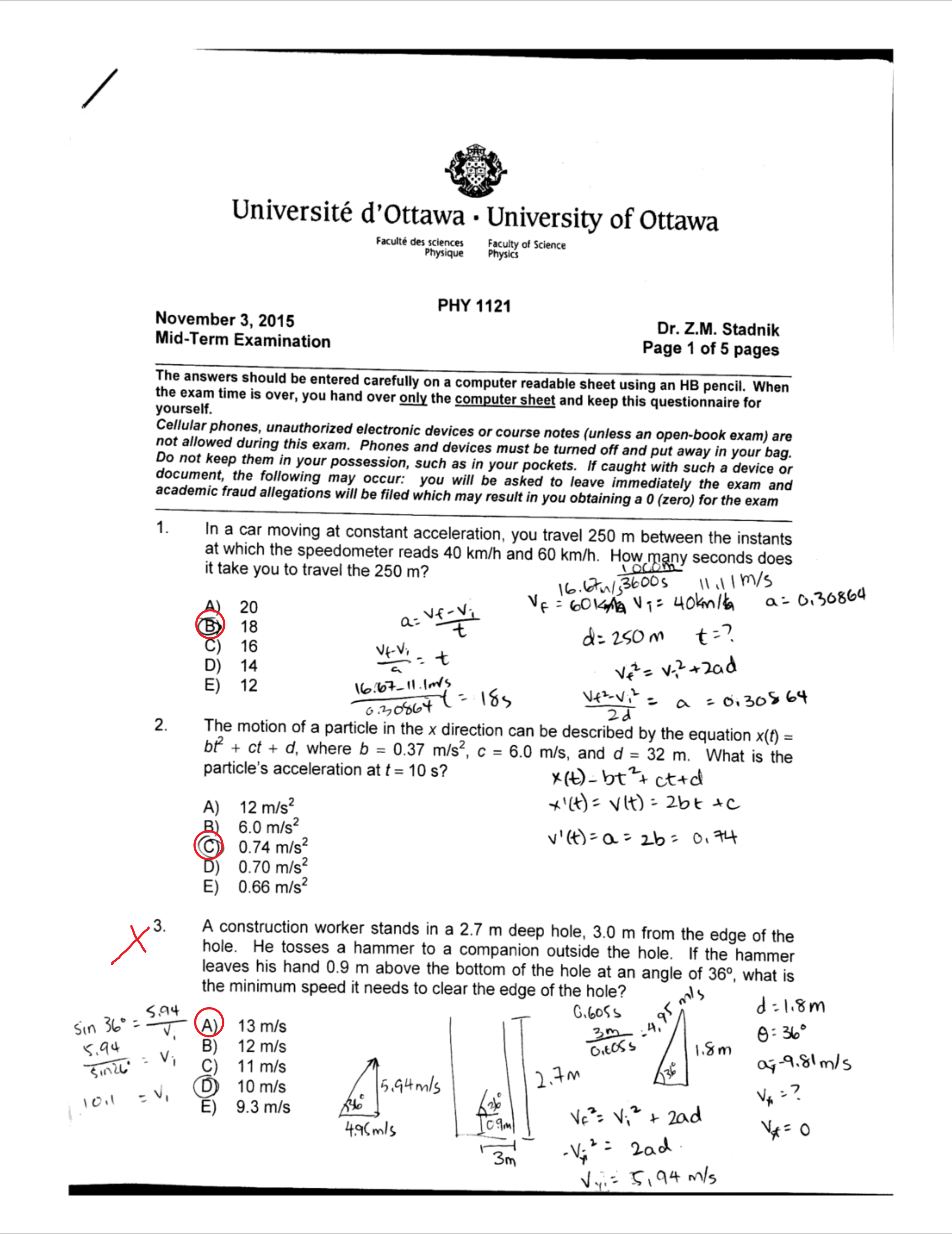

Université d'Ottawa · University of Ottawa

Faculté des sciences
Physique

Faculty of Science
Physics

PHY 1121

November 3, 2015
Mid-Term Examination

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The answers should be entered carefully on a computer readable sheet using an HB pencil. When the exam time is over, you hand over only the computer sheet and keep this questionnaire for yourself.

Cellular phones, unauthorized electronic devices or course notes (unless an open-book exam) are not allowed during this exam. Phones and devices must be turned off and put away in your bag. Do not keep them in your possession, such as in your pockets. If caught with such a device or document, the following may occur: you will be asked to leave immediately the exam and academic fraud allegations will be filed which may result in you obtaining a 0 (zero) for the exam

1. In a car moving at constant acceleration, you travel 250 m between the instants at which the speedometer reads 40 km/h and 60 km/h. How many seconds does it take you to travel the 250 m?

A) 20
[✓ B) 18]
C) 16
D) 14
E) 12

$a = \frac{v_f - v_i}{t}$

$\frac{v_f - v_i}{a} = t$

$\frac{16.67 - 11.1 m/s}{0.30864} t = 18s$

$\frac{1000m}{3600s}$

16.67m/s 11.11 m/s

$v_f = 60 km/h$ $v_i = 40 km/h$ $a = 0.30864$

$d = 250 m$ $t = ?$

$v_f^2 = v_i^2 + 2ad$

$\frac{v_f^2 - v_i^2}{2d} = a = 0.30864$

2. The motion of a particle in the x direction can be described by the equation $x(t) = bt^2 + ct + d$, where $b = 0.37$ m/s^2, $c = 6.0$ m/s, and $d = 32$ m. What is the particle's acceleration at $t = 10$ s?

A) 12 m/s^2
B) 6.0 m/s^2
[✓ C) 0.74 m/s^2]
D) 0.70 m/s^2
E) 0.66 m/s^2

$x(t) - bt^2 + ct + d$

$x'(t) = v(t) = 2bt + c$

$v'(t) = a = 2b = 0.74$

X 3. A construction worker stands in a 2.7 m deep hole, 3.0 m from the edge of the hole. He tosses a hammer to a companion outside the hole. If the hammer leaves his hand 0.9 m above the bottom of the hole at an angle of 36°, what is the minimum speed it needs to clear the edge of the hole?

[✓ A) 13 m/s]
B) 12 m/s
C) 11 m/s
[✓ D) 10 m/s]
E) 9.3 m/s

$\sin 36° = \frac{5.94}{V_i}$

$\frac{5.94}{\sin 36°} = V_i$

$10.1 = V_i$

5.94m/s
36°
4.95m/s

36°
0.9m
2.7m
3m

0.605s

$\frac{3m}{0.605s} = 4.95 m/s$

1.8m
36°

$V_f^2 = V_i^2 + 2ad$

$-V_i^2 = 2ad$

$V_{yi} = 5.94 m/s$

$d = 1.8m$

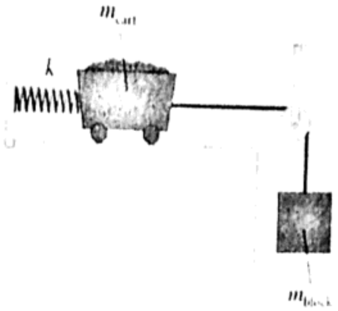
$\theta = 36°$

$a_y = -9.81 m/s$

$V_{yi} = ?$

$V_{yf} = 0$

4.



In the figure above, a hanging block of mass m_{block} suspended by a rope hung over a pulley is used to accelerate a loaded mine cart of mass m_{cart} along rail tracks to the edge of a cliff, where the load is dumped. To help reduce its acceleration as it nears the edge, the cart is attached to a horizontal spring of spring constant k, and the other end of the spring is attached to a wall. Ignoring friction, determine the acceleration of the cart when the spring is stretched a distance s beyond its relaxed length.

A) $\frac{m_{block}g-ks}{m_{block}+2m_{cart}}$

B) $\frac{m_{block}g-ks}{2m_{block}+m_{cart}}$

C) $\frac{m_{block}g-2ks}{m_{block}+m_{cart}}$

[✓ D)] $\frac{m_{block}g-ks}{m_{block}+m_{cart}}$

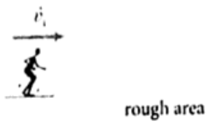
E) $\frac{2m_{block}g-ks}{m_{block}+m_{cart}}$

$F_{net} = m_{block}g + -ks$

$(m_{block} + m_{cart})a_{cart} = m_{block}g - ks$

$a_{cart} = \frac{m_{block}g - ks}{m_{cart} + m_{block}}$

5.



In the figure above, a 65-kg skier heads down a slope, reaching the speed v_i = 32 km/h. She then slides across a horizontal snow field but hits a rough area. Assume the snow before the rough area is so slippery that you can ignore any friction between the skis and the snow. If the frictional force exerted by the snow in the rough area is 39 N, how far across the rough area does the skier travel before stopping?

A) 49 m
B) 53 m
C) 56 m
D) 59 m
[✓ E)] 66 m

$V_i = 32\text{ km/h} \times \frac{1000\text{ m}}{3600\text{ s}} = 8.89\text{ m/s}$

$m = 65\text{ kg}$

$F_f = 39\text{N}$

$V_f = 0$

$F = ma$

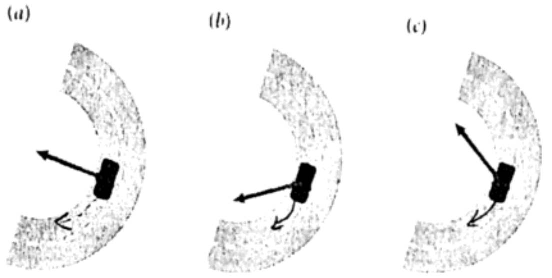
$39N = 65kg(a)$

$\frac{39N}{65kg} = a = -0.6\text{ m/s}^2$

$V_f^2 = V_i^2 + 2ad$

$\frac{V_f^2 - V_i^2}{2a} = d = 65.8\text{ m}$

6.



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?

A) (a)
B) (b)
[✓ C)] (c)
D) None of the above is correct.

towards centre if
v is constant
v is decreasing,
a is negative

7. Roads designed for high-speed travel have banked curves to give the normal force a component towards the center of the curve. That lets cars turn without relying on friction between tires and road. At what angle should a road with 340-m curvature radius be banked for travel at 95 km/h?

A) 13°
[✓ B)] 12°
C) 11°
D) 10°
E) 9.2°

$v = 95 km/h = 26.39 m/s$

$r = 340 m$

$a_c = \frac{v^2}{r}$

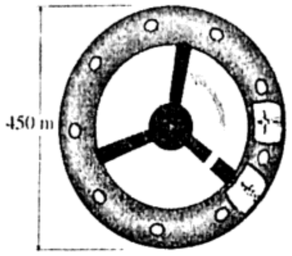
$F_c = \frac{mv^2}{r}$

$F_N = F_g \cos\theta$

$= mg$

$\sin^{-1}\left(\frac{F_c}{F_g \cos\theta}\right) = \theta$

8.



A space station is in the shape of a hollow ring, 450 m in diameter (see figure above). At how many revolutions per minute should it rotate in order to simulate Earth's gravity – that is, so the normal force on an astronaut at the outer edge would equal the astronaut's weight on Earth?

A) 1.4
B) 1.7
[✓ C)] 2.0
D) 2.4
E) 2.8

$d = 450 m$ $r = 225 m$

$a_c = g = 9.81 m/s$

$t = \frac{d}{v}$

$t = \frac{450\pi\ m}{46.98 m/s}$

$= 30.09 s$

$C = d\pi$

$= 450\pi$

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

$\sqrt{ar} = \sqrt{v^2}$

$v = 46.98 m/s$

$\frac{1 rev}{30.09 s} \times \frac{60 s}{1 min} = 1.994$

9. How much work does the force $\vec{F} = (67\text{ N})\hat{\imath} + (23\text{ N})\hat{\jmath} + (53\text{ N})\hat{k}$ do as it acts on a body moving in a straight line from $\vec{r}_1 = (16\,m)\hat{\imath} + (31\,m)\hat{\jmath}$ to $\vec{r}_2 = (21\,m)\hat{\imath} + (10\,m)\hat{\jmath} + (12\,m)\hat{k}$?

[✓ A)] 488 J
B) 622 J
C) 694 J
D) 725 J
E) 768 J

$W = Fd$
$= 67N(5m) + 23N(-21) + 53N(12m)$
$= 335J - 483J + 636J$
$= 488J$

10. Mass *m*, moving at speed 2*v*, approaches mass 4*m*, moving at speed *v*. The two collide elastically head-on. The speeds of masses *m* and 4*m* after the collision are

A) $\frac{7}{5}v, \frac{2}{5}v.$
B) $\frac{3}{5}v, \frac{7}{5}v.$
C) $\frac{7}{5}v, \frac{3}{5}v.$
[✓ D)] $\frac{2}{5}v, \frac{7}{5}v.$
E) $\frac{4}{5}v, \frac{6}{5}v.$

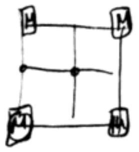
$V_{mf} = \left(\frac{m-4m}{m+4m}\right)2V + \left(\frac{2(4m)}{m+4m}\right)V$
$= \left(\frac{-3m}{5m}\right)2V + \frac{8m}{5m}V$
$= \left(2\left(\frac{-3m}{5m}\right)+\left(\frac{8m}{5m}\right)\right)V$
$= \left(-\frac{6m}{5m} + \frac{8m}{5m}\right)V = \frac{2}{5}V$

$\frac{3}{5}V + \frac{4}{5}V$
$= \frac{7}{5}V$

$V_{4mf} = \left(\frac{4m-m}{5m}\right)V + \left(\frac{2m}{5m}\right)2V$

11. Four equal masses are located at the corners of a square and connected by essentially massless rods. Find the ratio of the moment of inertia of this system about an axis that coincides with one side to the moment of inertia about an axis that bisects two opposite sides.

A) 0.6
B) 0.8
C) 1.2
D) 1.5
[✓ E)] 2.0



12. You rev your car's engine and watch the tachometer climb steadily from 1150 rpm to 5450 rpm in 2.72 s. How many revolutions does the engine make during this time?

4

A) 140
[✓ B)] 150
C) 160
D) 170
E) 180

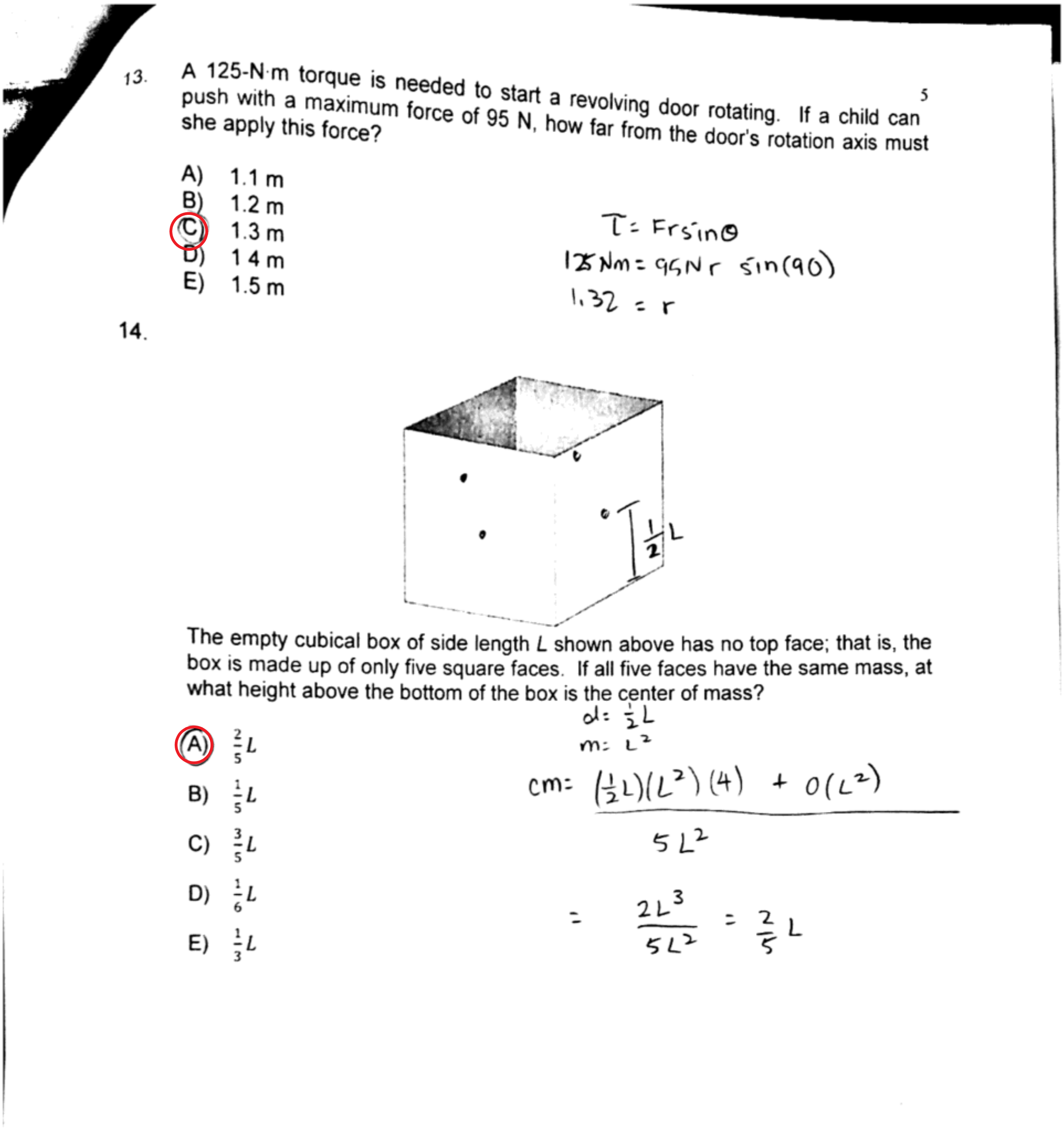
v_f
v_i
t
$d: ?$

$w_f =$ angular speed$_f$ $= 5450\text{ rpm} = 2\pi(3450\text{rpm})$
$= 10900\pi$
$w_i = 1150\text{ rpm} = 2300\pi$
$t = 2.72s = 0.04533\text{ min}$

$a = \frac{v_f - v_i}{t} =$

$v_f^2 = v_i^2 + 2ad$

$d = 595979/\text{min}$



13. A 125-N·m torque is needed to start a revolving door rotating. If a child can push with a maximum force of 95 N, how far from the door's rotation axis must she apply this force?

A) 1.1 m
B) 1.2 m
[✓ C) 1.3 m]
D) 1.4 m
E) 1.5 m

$\tau = Fr\sin\theta$

$125\,Nm = 95N\,r\ \sin(90)$

$1.32 = r$

14.

$\frac{1}{2}L$

The empty cubical box of side length L shown above has no top face; that is, the box is made up of only five square faces. If all five faces have the same mass, at what height above the bottom of the box is the center of mass?

[✓ A) $\frac{2}{5}L$]
B) $\frac{1}{5}L$
C) $\frac{3}{5}L$
D) $\frac{1}{6}L$
E) $\frac{1}{3}L$

d: $\frac{1}{2}L$

m: L^2

$$cm: \frac{(\frac{1}{2}L)(L^2)(4) + 0(L^2)}{5L^2}$$

$$= \frac{2L^3}{5L^2} = \frac{2}{5}L$$