Saigon International College

AEPHY

Test #5

Forces And Energy

Task Weighting: 4% of the school mark for this pair of units

Time: Reading: 5 minutes

Writing: 70 minutes

Student Name: Chu Minh Đăng

Score: 47/53 Excellent

SCIENCE DEPARTMENT
AEPHY Semester 2
TEST #5 – Forces and Energy

Time: 75 minutes **Total questions: 10**

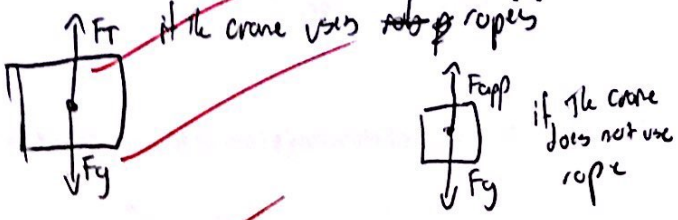
Show all you working for FULL marks. Where necessary use the constants and values supplied on the School Curriculum and Standards Authority Formula and Data sheet provided. Final answers in 3 s.f.

10

Question 1 (10marks)

A crane lifts a 1100 kg car vertically at a constant velocity. If the car is raised a total height of 4.0 m, determine:

a) a free-body diagram of forces acting on the car and label the forces. [2]



b) the magnitude of the force needed to lift the car. [2]

1100 × 9.81 = 10791

(9.8) 10800 N

c) the work done by the lifting force. [2]

mgh

1100 × 9.81 × 4 = 43164

= 43200 J

d) the new lifting force if the car is accelerated upwards at 2 ms^{-2}. [4]

F = ma

F = 1100 × 2

F = 2200 + 10800 = 13000 N

3

Question 2 (3marks)

Superman pushes against a wall with 15 000 N of force, but the wall does not move.

a) Is the wall exerting a force? If it is, how much? [1]

Yes The wall is exerting a 15 000 N force on Superman

b) Which of Newton's Law of Motion does this situation obey? State which law and define it. [2]

Newton's Third Law. Every action has an equal and opposite reaction

2

Question 3 (5marks)

a) Identify the situation where motion is accelerated only by the force of gravity. X [1]

A ball dropped out of a window of a building. Free-fall

b) Identify the situation where constant velocity is achieved in the type in part a) [1] X.

& where the ball reach terminal velocity. when air resistance force of is equal to the force of ~~gravity~~ gravity pulling down terminal velocity.

c) Identify the force that opposes gravity in part b. [1]

Fair or air resistance

d) What factors increase the force that opposes the gravity force? [2]

Surface Area, ~~Applied force~~ air resistance (density air),
smoothness of the surface X.

Question 4 (4marks)

4

A stationary car of mass 1150 kg is hit from behind by a car of mass 1800 kg traveling north at a constant velocity of 15.0 ms^{-1}. The stationary car is pushed northward at a speed of 11.5 ms^{-1}. Show your working. Calculate the velocity of the 1800 kg car after the collision and its direction.

Stationary
$m = 1150$
$u = 0$
$v = 11.5$

Hit
$m = 1800$
$u = 15$
$v = ?$

$mv + mv = mv + mv$
$0 + 1800 \times 15 = 1150 \times 11.5 + 1800 \times v$
$27000 - 13225 = 1800 \times v$
$v = 7.652\ ms^{-1}$
$v = 7.65\ ms^{-1}$ North

Question 5 (5marks)

5

A passenger in a car strikes his head against the unpadded dashboard with an average force of 56.0 N for 2.70 x 10^{-3}seconds during an accident. If a layer of foam padding was used in the dashboard, the impact would have lasted for 5.80 x 10^{-3}seconds. If impulse stays the same:

a) Calculate the average reaction force the padded dashboard would exert. [3]

$I = Ft$
$I = 56 \times 2.7 \times 10^{-3}$
$0.1512 = F \times 5.8 \times 10^{-3}$ $I = 0.1512\ Ns$
$F = 26.1\ N$

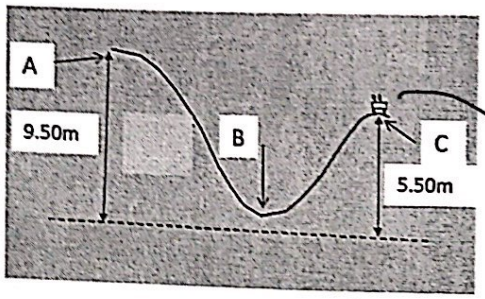
b) Using your knowledge of physics principles, explain why cars are designed to crumple when they hit something? [2]

To increase the time therefore it would decrease the force exerted on the person. This crumple zone allow the (Impulse to be spread out over a longer period of time which will decrease the energy exerted on the person.

7

Question 6 (9marks)

A roller coaster trolley has a mass of 280 kg. At point C, the speed of the roller coaster trolley was measured as 10.0 ms^{-1}.



m = 280

10 ms^{-1}

a) At which point along the track will the roller coaster have the greatest speed? [1]

.....B.....

b) Calculate the total energy of the trolley at point C. Show your working. [3]

$mgh - mgh = \frac{1}{2}mv^2$? ?

$280 \times 9.81 \times 9.5 - 280 \times 9.81 \times 5.5 + 0.5 \times 280 \times 10^2$ ✓

$280 \times 9.81 \times 4 + 0.5 \times 280 \times 10^2$ ✓

24987.2 J = 25000 J ✗

c) While the trolley was traveling from point A to Point C, it experienced a frictional force which caused it to lose 20% of its total energy. In other words, the energy at point C is only a percentage of the total at point A. Calculate the roller-coaster car's initial speed at point A. Show your working. [5]

25000 J ÷ 0.8 = 31250 J OK

$31250 = 9.5 \times 9.81 \times 280 + 0.5 \times 280 \times v^2$

$31250 - 26094.6 = 140 \times v^2$

$\frac{5155.4}{140} = v^2$

$v^2 = 36.82$ OE

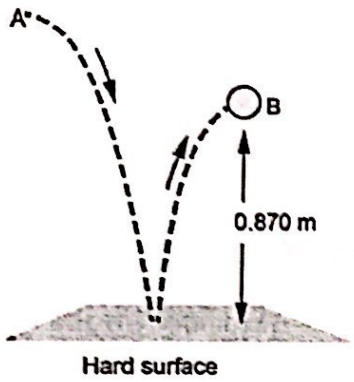
Using rounded answer → $v = 6.07\ ms^{-1}$ right

or $v = 6.06\ ms^{-1}$ right

exact answer

Question 7 (4marks)

A 0.250 kg ball bounces on a hard surface after being dropped from a height. The ball retains 80% of its kinetic energy in the collision and rises to a maximum height of 0.870 m above the ground. Calculate its potential energy at A.



$PE = mgh = 0.250 \times 9.81 \times 0.870$

$= 2.13\ J \div 0.8 = 2.67\ J$

2.665

Poor sig fig

Question 8 (5marks)

A bolt with a mass of 2.5×10^{-1} kg falls from a height to the ground. The ground consists of soft soil and the bolt enters the soil and stops 2.25×10^{-2} m below the surface. If the velocity was 25.0 m s^{-1} just before hitting the ground, calculate the magnitude of the force that the ground has exerted on the bolt.

$F = ma$

$F = mg$

$F = \frac{\Delta P}{t}$

$KE = \frac{1}{2}mv^2$

$= \frac{1}{2} 0.25 \times 25^2$

$KE = 78.1\ J$

$m = 0.25$

$25\ ms^{-1} \rightarrow$

$0.0225\ m$

$\Delta P = Ft$

$\Delta P = m(v-u)$

$W = Fs$

$v = u + at$

$0 = 25 + 13888\ t$

$t = 0.0018\ s$

$v^2 = u^2 + 2as$

$0 = 25^2 + 2 \times a \times 0.0225\ m$

$-625 = a \times 0.045$

$a = -13888\ ms^{-2}$

$F = \frac{0.25(0-25)}{0.0018}$

$F = 3472\ N$

$F = 3470\ N$

78.1 J

$F = ma$

$F = 0.25 \times 13888\ ms^{-2}$

$F = 3472\ N = 3470\ N$

Question 9 (5marks)

A 0.45 kg ball traveling at 20.0 ms^{-1} [south] hits a wall and bounces off at a velocity of 16.0 ms^{-1} [north]. The ball is in contact with the wall for 2.5 x 10^{-2} s. Include direction for full marks.

a) Calculate the initial momentum of the ball. [2]

$p = mv$
$p = 0.45 \times 20$
$p = 9\ kg\ ms^{-1}$ South

b) Calculate the change in momentum of the ball. [3]

$p = mv$ Next time.
$p = 0.45 \times 16$
$p = 7.2 + 9$
$p = 16.2$

$\Delta p = mv - mu$
$p = 0.45 \times (-16 - 20)$
$p = -16.2\ kgms^{-2}$
16.2 Ns South North

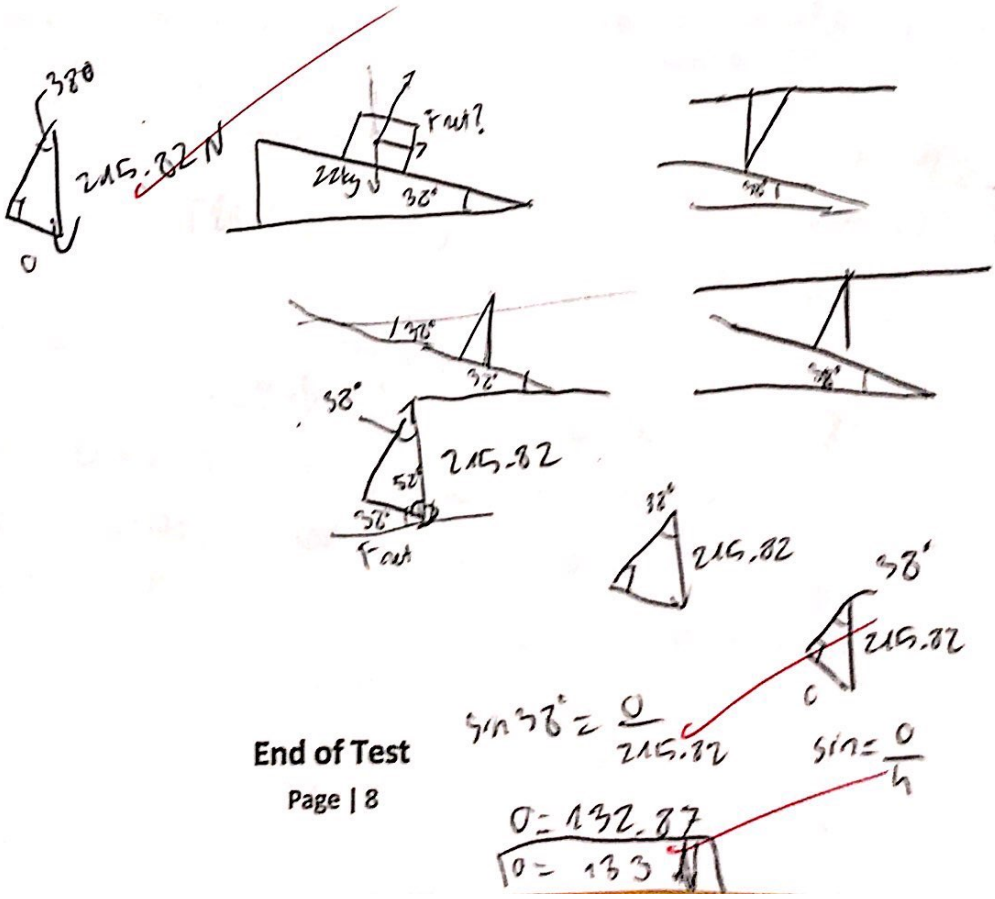
$a = \frac{-16 - 20}{2.5 \times 10^{-2}}$
$a = 1440\ ms^{-2}$

$\Delta p = 648 \times (2.5 \times 10^{-2})$
$\Delta p = 16.2\ kgms^{-2}$ North

$F = ma$
$F = 0.45 \times 1440 = -648$

Question 10 (3marks)

A box with a mass of 22.0 kg is placed on a ramp that is at an angle of 38.0 degrees above the horizontal. What is the magnitude of the net force?



$\sin 38° = \frac{O}{215.82}$
$O = 132.87$
$O = 133$

$\sin = \frac{O}{h}$

End of Test