Multiple Choice (PART I)

1.	A	21.	D
2.	A	22.	A
3.	C	23.	C
4.	A	24.	B
5.	C	25.	D
6.	A	26.	C
7.	D	27.	C
8.	B	28.	C
9.	B	29.	D
10.	A	30.	B
11.	D	31.	B
12.	A	32.	C
13.	D	33.	B
14.	A	34.	B
15.	C	35.	D
16.	A	36.	B
17.	D	37.	B
18.	D	38.	C
19.	B	39.	C
20.	C	40.	C

Part II- Constructed Response
Total Value : 60%

Answer ALL questions in the space provided. All necessary workings must be shown to receive full marks.

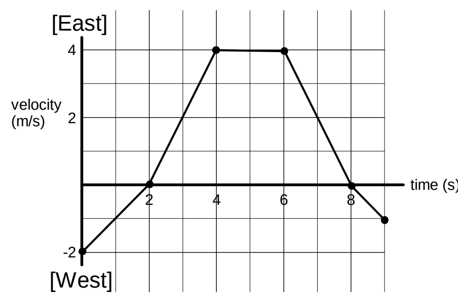
PART II
Total Value: 60%

Value

41. a) (i) At what time(s) was the object stopped?

1 — 2 s and 8 s

(ii) Calculate the acceleration of the object between 2 s and 4 s.



0.5 — $Acceleration = Slope = \frac{rise}{run}$

0.5 — $= \frac{4\ m/s - 0 m/s}{4s - 2s}$

1 — $= \frac{4m/s}{2s} = 2\ m/s^2$ [E]

(iii) Calculate the displacement between 0 s and 4 s.

$Displacement = Area$

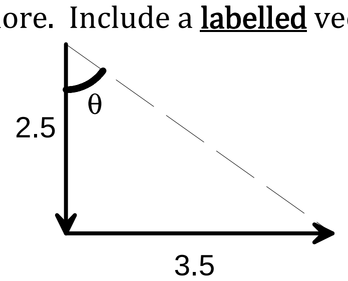
1 — $Disp_{(0-2)} = \frac{1}{2}bh = \frac{1}{2}(2)(-2) = -2m$

1 — $Disp_{(2-4)} = \frac{1}{2}(2)(4) = 4m$

1 — $Disp_{(Total)} = 2m[E]$

b) A river flows at 2.5 m/s [S]. A boater heads 3.5 m/s [E]. Calculate the boater's resultant velocity with respect to the shore. Include a <u>labelled</u> vector diagram in your answer.

1 (diagram)



${}_wV_g = 2.5\,\frac{m}{s}$, ${}_cV_w = 3.5\,\frac{m}{s}$

${}_cV_g^2 = {}_cV_w^2 + {}_wV_g^2 \rightarrow {}_cV_g^2 = (3.5m/s)^2 + (2.5\ m/s)^2$

1 — ${}_cV_g^2 = 12.25 + 6.25 = 18.50 \rightarrow {}_cV_g = \sqrt{18.50} = 4.3\ m/s$

$\tan\theta = \frac{3.5}{2.5} = 1.4$

1 — $\theta = 54^{\circ}$

1 — Resultant Velocity $= 4.3m/s[S\ 54^{\circ}\ E]$ or $4.3m/s[E\ 36°S]$.

(c) $v_1 = 0, a = 6.8\, m/s^2, t = 3.1s$

1.5 $v_2 = v_1 + at = 0 + (6.8\, m/s^2)(3.1s) = 21.08\, m/s$

The final velocity when accelerating is now the initial velocity when slowing down.

0.5 $v_1 = 21.08\text{ m/s},\ v_2 = 0\, m/s,\ \ a = -7.6 m/s^2,\ \Delta d = ?$

$v_2^2 = v_1^2 + 2a\Delta d$

1.5 $\Delta d = \frac{v_2^2 - v_1^2}{2a} = \frac{0-(21.08)^2}{2(-7.6)} = 29\text{ m}$

0.5 The car travels 29 m before it stops so it will hit the garbage can.

42. a) Total Momentum Before=Total Momentum After

0.5 $\overrightarrow{P_T} = \overrightarrow{P_P} + \overrightarrow{P_B}$

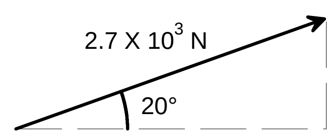
0.5 $m_T\vec{v}_T = m_P\vec{v}_P + m_b\vec{v}_b$

1 $(80)(0) = 65\vec{v}_P + (15)(5.0)$
$0 = 65\vec{v}_P + 75$
1 $-75 = 65\vec{v}_P$
0.5 $-1.2 = \vec{v}_P$

0.5 **The velocity of the player is $-1.2\ m/s$ or $1.2\ m/s$ [Left]**

b) A ship is being towed by two tugboats. Tugboat 1 exerts a force of 2.7×10^3N [E 20.0°N] and tugboat 2 exerts a force of 2.7×10^3N [E 20.0°S]. Calculate the net force exerted by the tugboats on the ship.

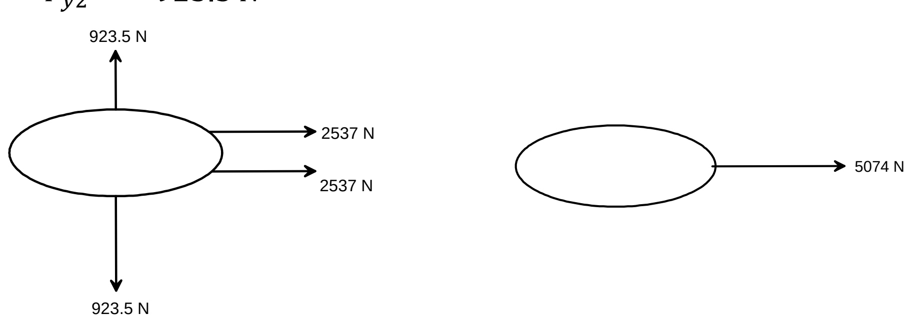
0.5 $F_{x1} = 2.7 \times 10^3 N \cdot \cos 20.0° = 2537\ N$



0.5 $F_{y1} = 2.7 \times 10^3 N \cdot \sin 20.0° = 923.5\ N$

0.5 $F_{x2} = 2537\ N$

0.5 $F_{y2} = -923.5\ N$

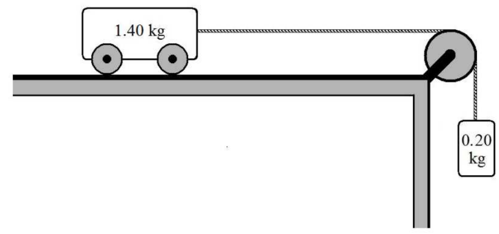


1 $F_{x(net)} = F_{x1} + F_{x2} = 2537\ N + 2537\ N = 5074\ N$

0.5 $F_{y(net)} = 0$

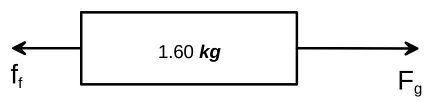
0.5 **The net force is 5074 N [E] or 5.1×10^3N using significant digits.**

c) A dynamics cart is connected to a 0.20 kg hanging mass by a massless string over a frictionless pulley. The force of friction between the cart and the table is 0.36 N.



One **possible** answer scheme is:

2 i) Calculate the magnitude of the acceleration of the system when the 0.20 kg mass is released.



$F_g = (0.20\ kg) \times 9.8 = 1.96\ N$

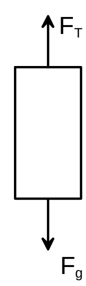
1 $ma = 1.96 - F_T$

$ma = 1.60N$

(1.60)a=1.60N

1 $a = 1.0m/s^2$

2 ii) Calculate the tension in the string when the 0.20 kg mass is released.



(ii) $F_{net} = F_g - F_T$

1 $F_{net} = 1.96N - 0.36N$

$(0.20)(1.0) = 1.96 - F_T$

$0.20 = 1.96 - F_T$

1 $F_T = 1.8N$

* Other reasonable methods are also acceptable.

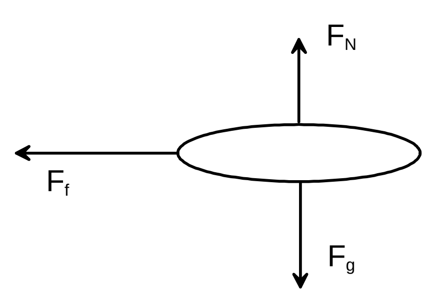
d) A 1200 kg car is travelling along a highway where the posted speed limit is 25 m/s. The driver fully applies the brakes and comes to a stop, leaving a skid mark 83 m long. The coefficient of friction between the tires and the road is 0.45. Using physics, determine if the driver was speeding before he slammed on his brakes.

$F_f = \mu F_N$

$ma = F_f$

$F_f = (0.45)(1200)(9.8)$

1 $a = -4.41m/s^2$



$F_{net} = F_f$

$F_f = \mu mg$

$(1200)a = -5292$

1 $F_f = 5292\ N$

$v_2^2 = v_1^2 + 2a\Delta d$

$v_1^2 = v_2^2 - 2a\Delta d$

$v_1^2 = (0) - 2(-4.41)(83)$

$v_1^2 = 732.06$

1.5 $v_1 = 27\ m/s$

0.5 **The initial velocity was 27 m/s so the car was speeding.**

43. (a) A 5.00×10^2 kg roller coaster travels at a speed of 15.0 m/s when at a height of 5.00 m above the ground (assume mechanical energy is conserved).

i) Calculate the kinetic energy at 5.00 m.

1 $E_k = \frac{1}{2}mv^2 = \frac{1}{2}(5.00 \times 10^2)(15.0m/s)^2 = 5.63 \times 10^4 J$

ii) Calculate the gravitational potential energy at 5.00 m.

1 $E_g = mgh = (5.00 \times 10^2)(9.8m/s^2)(5.00m) = 2.45 \times 10^4 J$

iii) Calculate the speed of the roller coaster when it is at a height of 10.0 m.

1 $E_T = E_k + E_g = 56300J + 24500J = 80800J$

$E_k = E_T - E_g = 80800J - (500)(9.8)(10.0)$

1 $= 31500J$

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

1 $v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2\times 31750}{500}} = 11.3\ m/s$

b) A 605 kg race car accelerates from 20.0 m/s to 60.0 m/s.

i) Calculate the work done during the acceleration.

0.5 $W = \Delta E = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$

$W = \frac{1}{2}(605)(60.0)^2 - \frac{1}{2}(605)(20.0)^2$

2 $W = 1.09 \times 10^6 - 1.21 \times 10^5$

0.5 $W = 9.68 \times 10^5 J$

ii) If the car generates 582 kW of power, calculate the time it took to accelerate.

1 $t = \frac{W}{P} = \frac{9.68\times 10^5}{582\ kW}$

0.5 $t = \frac{9.68\times 10^5}{582\ kW \times \frac{1000W}{1kW}}$

0.5 $t = 1.66\ s$

c) A horizontal spring having a spring constant of 40.0 N/m undergoes simple harmonic motion when a 1.20 kg mass stretches it 20.0 cm from its rest position. Calculate the speed of the mass when it is 5.00 cm from the rest position.

1 $E_{Total} = E_e = \frac{1}{2}kx^2 = \frac{1}{2}(40.0)(0.200)^2 = 0.800J$

At 5.00 cm,

1 $E_e = \frac{1}{2}kx^2 = \frac{1}{2}(40.0)(0.0500)^2 = 0.0500\ J$

0.5 $E_{Total} = E_e + E_k$

$0.800J = 0.0500J + E_k$

0.5 $E_k = 0.750\ J$

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

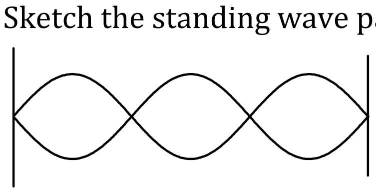
0.5 $0.750 = \frac{1}{2}(1.20)v^2$

0.5 $v = 1.12\ m/s$

44. a) A bass guitar string is 1.3 m long and vibrating in the third harmonic.

i) Sketch the standing wave pattern described above.

1



ii) Find the frequency if the speed of the wave is 181 m/s.

$L = 1.5\lambda$

$1.3 = 1.5\lambda$

1 $\lambda = 0.87m$

1 $f = \frac{v}{\lambda} = \frac{181\ m/s}{0.87\ m} = 210\ Hz$

b) A 310 Hz tuning fork is held over the mouth of a close-end air column. If the speed of sound is 352 m/s, determine the length of the air column which produces the second resonant sound.

1 $L = \frac{3}{4}\lambda$

$v = f\lambda$

1 $\lambda = \frac{v}{f} = \frac{352\ m/s}{310\ hz} = 1.135\ m$

1 $L = \frac{3}{4}\lambda = \frac{3}{4}(1.135) = 0.85\ m$

c) An ambulance siren emits a frequency of 440 Hz. If the air temperature is 22°C, calculate the frequency heard by an observer if the ambulance is coming toward him at 26 m/s.

1 $v = 332 + 0.6T = 332 + 0.6(22) = 345.2\ m/s$

1.5 $f = \frac{f_0 v_s}{v_s - v_0} = \frac{(440\ Hz)(345.2\ m/s)}{345.2\ m/s - 26\ m/s}$

1 $f = \frac{151888}{319.2}$=475.8 Hz

0.5 $f = 480\ Hz$

d) A light with a wavelength of 5.50×10^{-7} m is shone through two slits which are 3.0×10^{-6}m apart. Calculate the angle at which the first order maxima occur.

0.5 $n\lambda = dsin\ d_n$

1 $(1)(5.50 \times 10^{-7}) = (3.0 \times 10^{-6})(\sin\theta)$

1 $\sin\theta = \frac{(5.50\times10^{-7})}{(3.0\times10^{-6})} = 0.1833$

0.5 $\theta = 11°$

e) A student is standing at the edge of a pool that is 2.3 m deep. A set of keys is at the bottom of the pool, 3.2 m from the wall. The index of refraction for air is 1.0 and for water is 1.3. What is the angle of refraction in air?

$tan\theta = \frac{1.2}{2.3} = 0.5217$

1 $\theta = 27.6°$

$n_1 sin\theta_1 = n_2 sin\theta_2$

1 $1.3(\sin 27.6) = 1.0(\sin\theta_2)$

1 $\theta_2 = 37°$