Physics 2204 Sample Exam **Answer Key**

Part I
Selected Response
Total Value: 40%

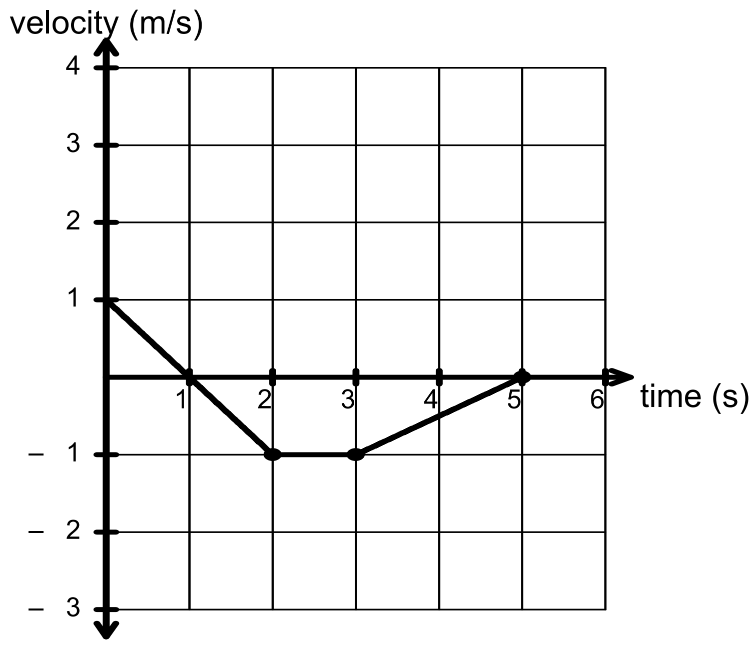
Item	Answer	Item	Answer
1	C	21	D
2	C	22	B
3	A	23	C
4	C	24	D
5	D	25	C
6	C	26	B
7	C	27	C
8	D	28	B
9	B	29	B
10	C	30	A
11	D	31	D
12	C	32	D
13	B	33	C
14	A	34	B
15	C	35	C
16	B	36	D
17	C	37	A
18	D	38	C
19	B	39	B
20	D	40	A

Part II
Constructed Response
Total Value: 60%

Answer ALL questions in the space provided. ***Show all workings and report all final answers with correct significant digits and units.***

Value

6 41. a) The motion of an object is shown on the velocity-time graph below.



(i) What is the velocity of the object at t = 1 s?

$\vec{v} = 0 m/s$ (1 mark)

(ii) What is the magnitude of the acceleration of the object at t = 4 s?

$Acceleration = slope$ (1 mark)

$slope = \frac{1m/s}{2s} = 0.5\frac{m}{s^2}$ (1 mark)

(iii) What is the displacement of the object between t = 0 s and t = 5 s?

$d_{0-1s} = \frac{1}{2}b \times h = \frac{1}{2}(1)(1) = 0.5m$ (0.5 marks)

$d_{1-2s} = \frac{1}{2}b \times h = \frac{1}{2}(1)(-1) = -0.5m$ (0.5 marks)

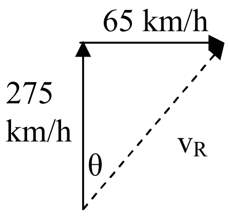
$d_{2-3s} = b \times h = (1)(-1) = -1m$ (0.5 marks)

$d_{3-5s} = \frac{1}{2}b \times h = \frac{1}{2}(2)(-1) = -1m$ (0.5 marks)

$d_{Total} = -2m$ (0.5 marks)

(0.5 marks) for knowing that area=displacement

4 b) An aircraft can fly at 275 km/hr in still air. The wind is blowing towards the east at 65 km/hr. If the aircraft flies towards the north, calculate the resulting velocity of the aircraft relative to the ground. Your answer should include a vector diagram.



(1 mark)

$$v_R^2 = v_P^2 + v_W^2$$

$$v_R = \sqrt{(275)^2 + (65)^2}$$ (1 mark)

$$v_R = 283\,km/h$$

$$\tan\theta = \frac{v_W}{v_P}$$

$$\theta = \tan^{-1}(\frac{65}{275})$$ (1 mark)

$$\theta = 13^o$$

$$\therefore v_R = 283\,km/h[N13^o\,E]$$ (1 mark)

4 c) A 65 kg skater is gliding along the ice at a constant speed of 4.00 m/s when he hits a rough patch. The coefficient of kinetic friction between the rough ice and the skate blades is 0.10. Calculate how far the skater will travel on the rough ice before stopping.

$$F_{netx} = -F_{fr}$$ (1mark)

$$ma = -u_k mg$$ (0.5marks)

$$a = -u_k g$$

$$a = -(0.10)(9.80 m/s^2)$$

$$a = -0.98 m/s^2$$ (0.5marks)

Then,

$$v_1 = 4.00 m/s$$

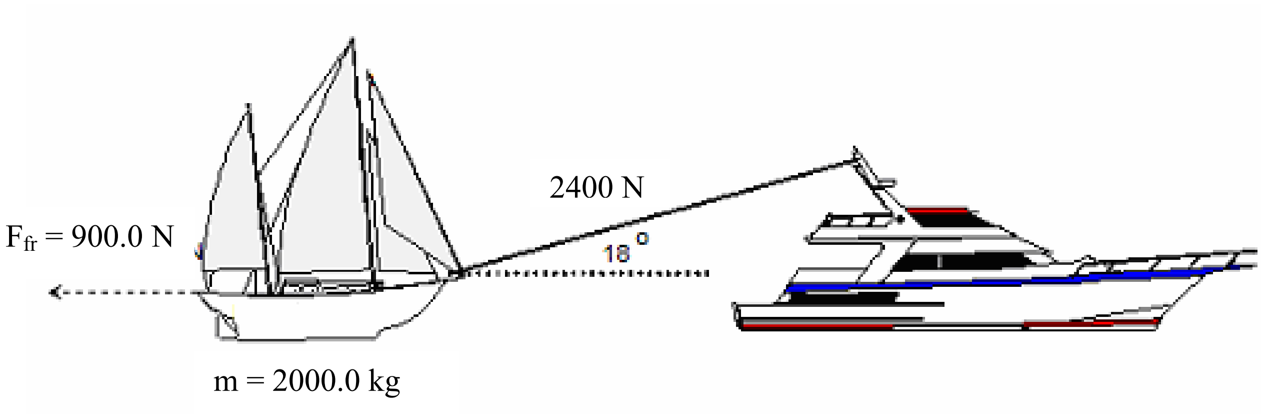
$$a = -0.98 m/s^2$$

$$v_2 = 0 m/s$$ (0.5marks)

$$d = ?$$

$$d = \frac{v_2^2 - v_1^2}{2a} = \frac{0-(4.00m/s)^2}{2(-0.98m/s^2)} = 8.2m$$ (1.5marks)

3 42. a) A disabled sailing vessel is under tow as shown. The towline is making an angle of 18^o with the horizontal and is supplying a force of 2400 N. If its mass is 2000.0 kg and it is experiencing a horizontal frictional force of 900.0 N, calculate the magnitude of the acceleration of the sailing vessel.



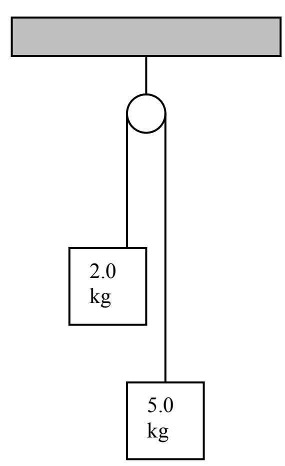
$$F_x = F\cos\theta$$
$$F_x = (2400N)\cos(18^\circ) \quad \text{(0.5 marks)}$$
$$F_x = 2283N$$

$$F_{Net} = ma$$
$$F_x - F_f = ma \quad \text{(1 mark)}$$

$$2283N - 900.0N = (2000kg)a$$
$$1383N = (2000kg)a \quad \text{(1 mark)}$$

$$\therefore a = 0.69\,m/s^2 \quad \text{(0.5 marks)}$$

5 b) A 2.0 kg block and a 5.0 kg block are connected by a rope over a frictionless pulley as shown.



(i) Calculate the magnitude of the acceleration of the system of blocks.

$$a = \frac{W_{5.0} - W_{2.0}}{m_{total}} \quad \text{(0.5 marks)}$$
$$a = \frac{(5.0kg)(9.80m/s^2) - (2.0kg)(9.80m/s^2)}{2.0kg + 5.0kg} \quad \text{(1.5 marks)}$$

$$a = \frac{29.4N}{7.0kg} = 4.2m/s^2 \quad \text{(1 mark)}$$

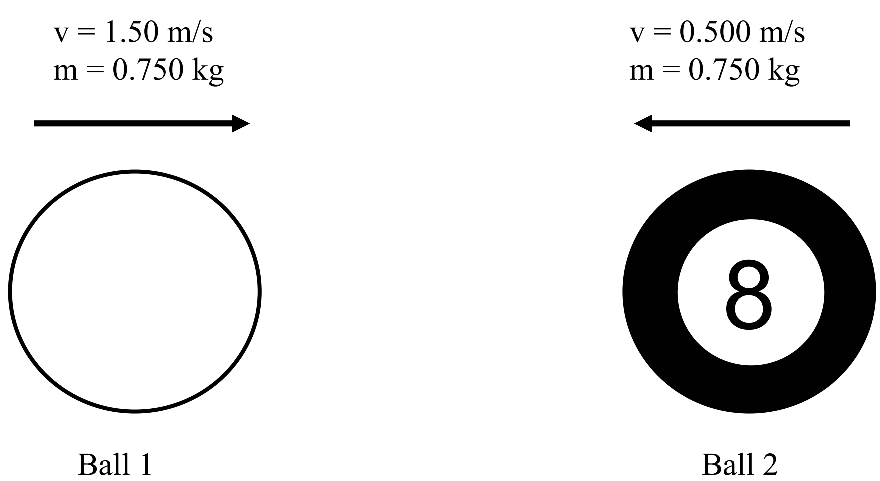
(ii) Calculate the magnitude of the tension in the connecting rope.

$$\begin{aligned}
&For\ 2.0\ kg\ block,\\
&T - mg = F_{net}\\
&T = mg + F_{net} \quad (1\,\text{mark})\\
&T = mg + ma\\
&T = (2.0kg)(9.80m/s^2) + (2.0kg)(4.2m/s^2) \quad (0.5\,\text{marks})\\
&T = 28N \quad (0.5\,\text{marks})
\end{aligned}$$

Or ,

$$\begin{aligned}
&For\ 5.0\ kg\ block,\\
&T - mg = -F_{net}\\
&T = mg - F_{net} \quad (1\,\text{mark})\\
&T = mg - ma\\
&T = (5.0kg)(9.80m/s^2) - (5.0kg)(4.2m/s^2) \quad (0.5\,\text{marks})\\
&T = 28N \quad (0.5\,\text{marks})
\end{aligned}$$

4 c) Two pool balls each having a mass of 0.750 kg are approaching each other as shown. Ball 1 is initially traveling at 1.50 m/s to the right while ball 2 is traveling at 0.500 m/s to the left. After the collision, ball 1 is traveling to the right at a speed of 0.35 m/s. Calculate the velocity of ball 2 after the collision.



$$p = p'$$

$$m_1v_1 + m_2v_2 = m_1'v_1' + m_2'v_2' \quad (1\text{ mark})$$

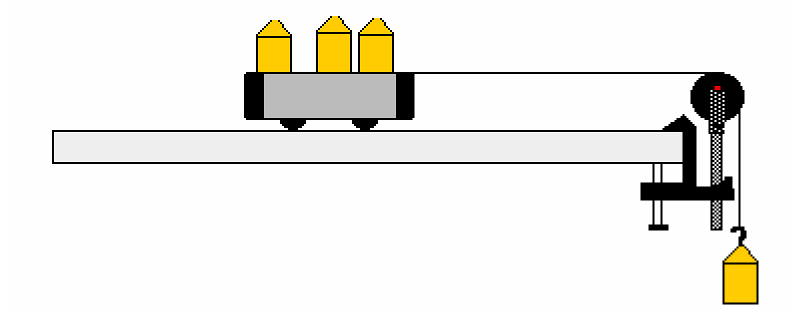
$$(0.750kg)(1.50m/s) + (0.750kg)(-0.500m/s) = (0.750kg)(0.35m/s) + (0.750kg)v_2'$$

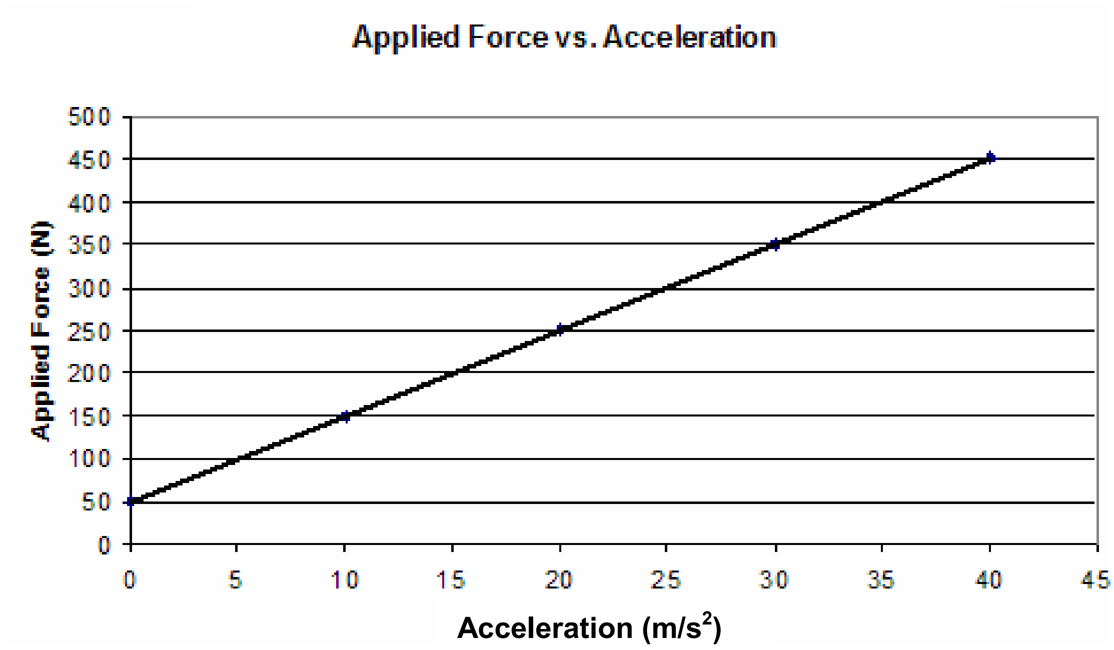
(2 marks)

$$\begin{aligned}
&0.75 = 0.263 + (0.750)v_2'\\
&0.487 = (0.750)v_2'
\end{aligned} \quad (0.5\text{ marks})$$

$$\therefore v_2' = 0.65m/s \text{ (right)} \quad (0.5\text{ marks})$$

4 d) A mass is attached to a cart as shown, and an experiment is performed to determine the relationship between force, mass and acceleration. For each trial, a mass is taken off the cart and attached to the hanging mass, keeping the total mass of the system constant. A graph of *Applied Force vs. Acceleration* for this experiment is shown below.





(i) Calculate the total mass of the system.

$$Slope = \frac{F}{a} = total\ mass \quad \text{(1 mark)}$$

$$\frac{rise}{run} = \frac{450-50}{40-0} = 10kg \quad \text{(1 mark)}$$

(ii) Determine the frictional force acting on the system.

$$\begin{aligned} F_{Net} &= ma \\ F_{Applied} - F_f &= m_T a \\ F_{Applied} &= m_T a + F_f \\ y &= m x + b \end{aligned} \quad \text{(1 mark)}$$

Frictional Force = *y-intercept* = 50N (1 mark)

3 43. a) A force of 85 N is applied to a lawn mower at an angle of 60.0° above the horizontal. Calculate the distance the mower must be pushed to do 2000.0 J of work.

$$W = Fd\cos\theta \quad \text{(0.5 marks)}$$

$$2000.0J = (85N)d\cos(60.0) \quad \text{(1 mark)}$$

$$\frac{2000.0J}{(85N)\cos(60.0)} = d \quad \text{(1 mark)}$$

$$d = 47m \quad \text{(0.5 marks)}$$

3 b) A 2.0×10^3 W winch is used to raise a 1200 kg car vertically from a ditch. Calculate how high the car is raised if the winch operates for 72 s.

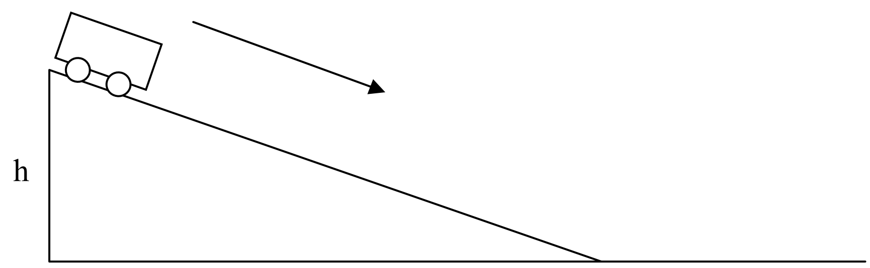
$$P = \frac{W}{t} \quad \text{(0.5 marks)}$$

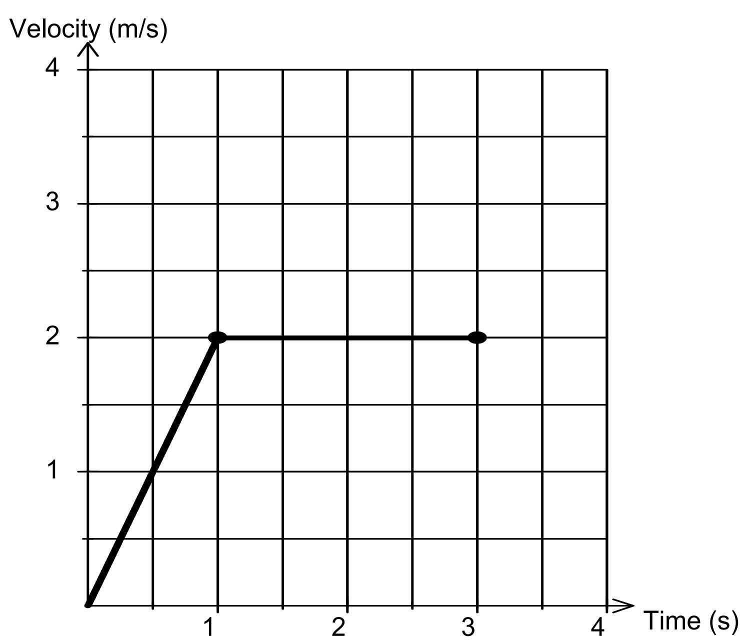
$$P = \frac{mgd}{t} \quad \text{(1 marks)}$$

$$2000W = \frac{(1200kg)(9.8m/s^2)d}{72s} \quad \text{(1 mark)}$$

$$d = 12m \quad \text{(0.5 marks)}$$

4 c) A 0.500 kg cart is released from rest at the top of a ramp and allowed to roll down the ramp and across a level floor as shown. Data are collected and plotted on the velocity vs. time graph below. Calculate the original height, h, of the ramp.





Velocity at bottom of ramp = highest velocity = 2 m/s (read from graph) (1 mark)

$$E_{k_{Bot}} = \frac{1}{2}mv^2 \quad \text{(0.5 marks)}$$

$$E_{k_{Bot}} = \frac{1}{2}(0.500kg)(2m/s)^2 \quad \text{(0.5 marks)}$$

$$E_{k_{Bot}} = 1J \quad \text{(0.5 marks)}$$

$$E_{k_{Bot}} = E_{g_{Top}} \quad \text{(0.5 marks)}$$

$$1J = mgh \quad \text{(0.5 marks)}$$

$$1J = (0.500kg)(9.8m/s^2)h$$

$$h = 0.2m \quad \text{(0.5 marks)}$$

4 d) A spring with a spring constant of 350 N/m is compressed a certain distance by a 3.0 kg mass. If the maximum speed of the mass after it is released is 2.0 m/s, calculate the distance the spring was compressed.

$$E_e = E_k \quad (1\text{mark})$$
$$\frac{kx^2}{2} = \frac{mv^2}{2} \quad (1\text{mark})$$
$$kx^2 = mv^2$$
$$x^2 = \frac{mv^2}{k} \quad (1\text{mark})$$
$$x = \sqrt{\frac{(3.0kg)(2.0m/s)^2}{350N/m}}$$
$$x = 0.19m \quad (1\text{mark})$$

3 44. a) An air mattress floating on a lake bobs up and down 45 times in 5.0 minutes. Calculate the speed of the water waves produced if the distance between their crests is 4.0 m.

$$f = \frac{\#cycles}{time} = \frac{45}{300} = 0.15Hz \quad \text{(1.5 marks)}$$
$$v = \lambda f = (4.0m)(0.15Hz) \quad \text{(1 mark)}$$
$$v = 0.60m/s \quad \text{(0.5 marks)}$$

2 b) A single slit of width 1.0×10^{-5} m is illuminated by light of wavelength 6.21×10^{-7} m. Calculate the angle at which the second order minimum occurs.

$$n\lambda = w\sin\theta_n$$
$$\sin\theta_n = \frac{n\lambda}{w} \quad (0.5\text{marks})$$
$$\sin\theta_2 = \frac{(2)(6.21\times10^{-7}m)}{1.0\times10^{-5}m} \quad (0.5\text{marks})$$
$$\sin\theta_2 = 0.1242 \quad (0.5\text{marks})$$
$$\theta_2 = 7.1^\circ \quad (0.5\text{marks})$$

3 c) A police car has a speed trap set up on the highway. The radar gun emits a frequency of 9.0×10^9 Hz and detects waves differing by 1.4×10^3 Hz. Calculate whether the driver of this car will get a speeding ticket if the speed limit is 1.0×10^2 km/h.

$$v_r = \left(\frac{\Delta f}{2f_1}\right)c$$
$$v_r = \frac{1.4\times10^3 Hz}{2(9.0\times10^9 Hz)} x3.00\times10^8 m/s \quad (1\text{mark})$$
$$v_r = 23m/s \quad (0.5\text{marks})$$
$$v_r = 23m/s(3.6) = 84km/h \quad (0.5\text{marks})$$

Since this is below the speed limit, the driver would not get a ticket. (1 mark)

4 d) The index of refraction for diamond is 2.42.

(i) If light travels from air into diamond, calculate the speed of light in diamond.

$$n = \frac{c}{v} \quad \text{(0.5 marks)}$$

$$2.42 = \frac{3.00 \times 10^8}{v} \quad \text{(0.5 marks)}$$

$$v = \frac{3.00 \times 10^8}{2.42} = 1.24 \times 10^8 m/s \quad \text{(1 mark)}$$

(ii) Calculate the critical angle for diamond in air.

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \quad \text{(0.5 marks)}$$

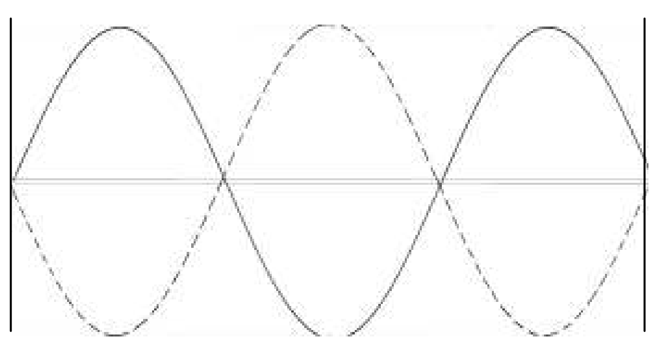
$$(2.42)\sin\theta_C = (1.00)\sin(90) \quad \text{(0.5 marks)}$$

$$\theta_C = \sin^{-1}\left(\frac{1.00}{2.42}\right) \quad \text{(0.5 marks)}$$

$$\theta_C = 24.4^0 \quad \text{(0.5 marks)}$$

4 e) A standing wave pattern containing three antinodes is produced on a 6.0 m rope.

(i) Sketch the standing wave pattern produced.



(1 mark)

(ii) Calculate the speed of the wave if the frequency of its source is 5.5 Hz.

$$6.0m = 1.5\lambda \quad \text{(1mark)}$$

$$\lambda = \frac{6.0}{1.5} = 4.0m \quad \text{(0.5marks)}$$

$$v = f\lambda = (5.5Hz)(4.0m) \quad \text{(1mark)}$$

$$v = 22m/s \quad \text{(0.5marks)}$$

End of Part II