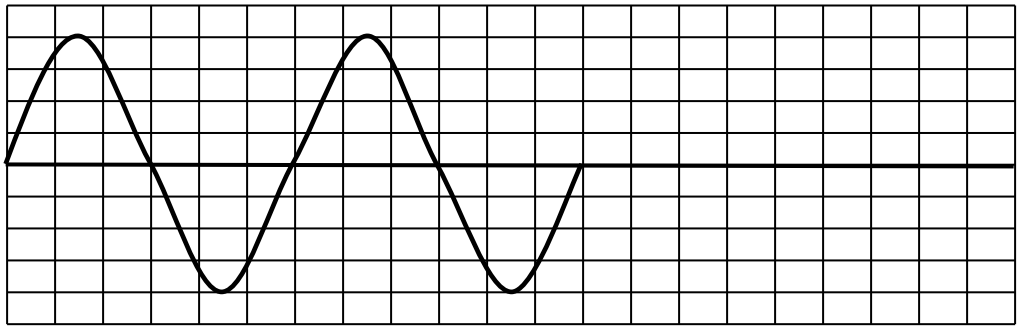
Physics 30s Exam Review Key

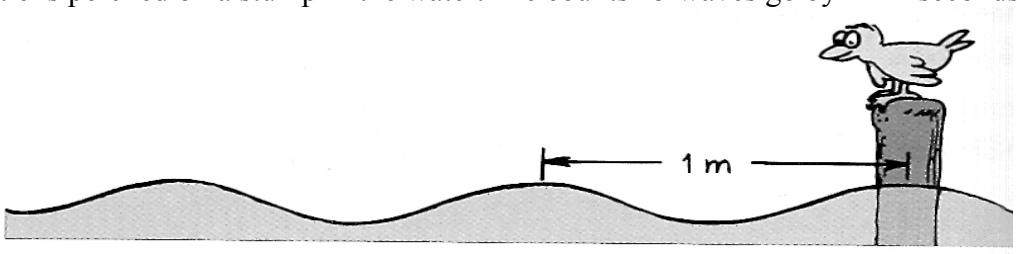
Extended Answer Key

I: Waves

1. On the grid below, each block represents **1 cm**. Sketch **two** wavelengths of a wave with the following characteristics
   a) wavelength of 6 cm
   b) amplitude of 4 cm



2. Tweetie is perched on a stump in the water. He counts 15 waves go by in 12 seconds.



a) What is the frequency and period of the waves?

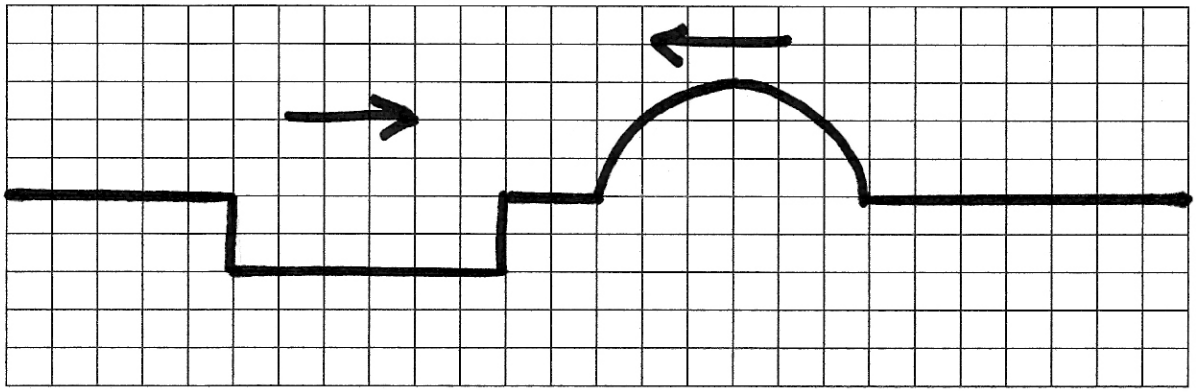
$$f = \frac{\#of\ waves}{time} = \frac{15}{12} = 1.25\ Hz$$

$$T = \frac{1}{f} = \frac{1}{1.25} = 0.8\ s$$

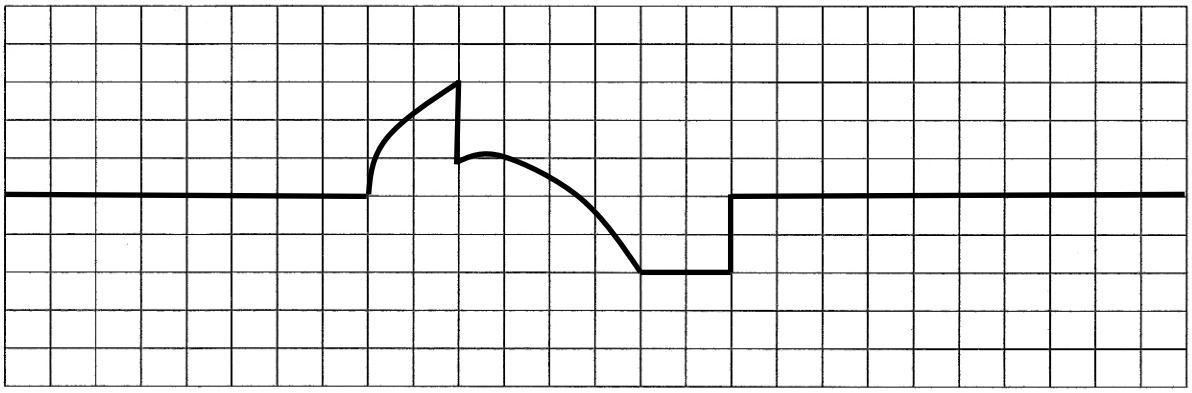
b) If Tweetie estimates the wavelength to be 1 m, what is the speed of the waves?

$$v = f\lambda = (1.25)(1) = 1.25\ m/s$$

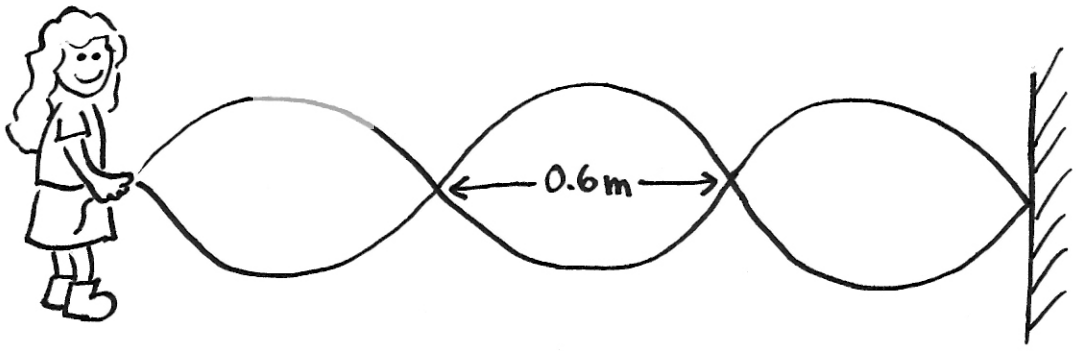
3. The waves shown below are moving toward each other at a rate of 1 space per second. Sketch the resultant wave pattern at t =5 s.



t = 5 s



4. A student makes a standing wave pattern with a skipping rope as shown. If the waves are moving at 7 m/s, with what frequency does the student move her hand up and down?



$\lambda = (2)(0.6) = 1.2\ m$ $\qquad f = \frac{v}{\lambda} = \frac{7}{1.2} = 5.8\ Hz$

5. A light beam from a sparkling diamond (n = 2.42) escapes into the air (n = 1.00).

   a) If the angle of incidence is 20°, what is the angle of refraction?

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$\sin\theta_2 = \frac{(2.42)(\sin 20^\circ)}{1.00}$$

$$\therefore \theta_2 = 56^\circ$$

   b) Calculate the speed of light in diamond.

$$n = \frac{c}{v}$$

$$\therefore v = \frac{c}{n} = \frac{3x10^8}{2.42} = 1.24x10^8 \ \ m/s$$

II: The Nature of Light

1. Identify and explain an experiment that proves light behaves as a particle.

   Photoelectric Effect

   One electron is emitted from a metal surface for every photon that hits it with enough energy (threshold frequency). Therefore, increasing the frequency of light causes electrons to be emitted with a greater velocity, but no more electrons will be emitted than before because it's a one to one interaction.

2. Identify and explain an experiment that proves light behaves as a wave.

   Young's Double-Slit Experiment.

   When coherent light is shone through two narrow slits, an interference patter is observed, the same way as it is seen for water waves passing through two openings in a barrier.

3. A viewing screen is separated from a double-slit source by 1.2 m. The distance between the two slits is 0.030 mm. The second-order bright fringe (n=2) is 4.5 cm from the center line.

   a) Determine the wavelength of the light.

$$\lambda = \frac{d\Delta x}{nL} = \frac{(3x10^{-5})(4.5x10^{-2})}{2(1.2)} = 5.6x10^{-7}\ m \quad or \quad 560\ nm$$

   b) Calculate the distance from one bright spot to the next.

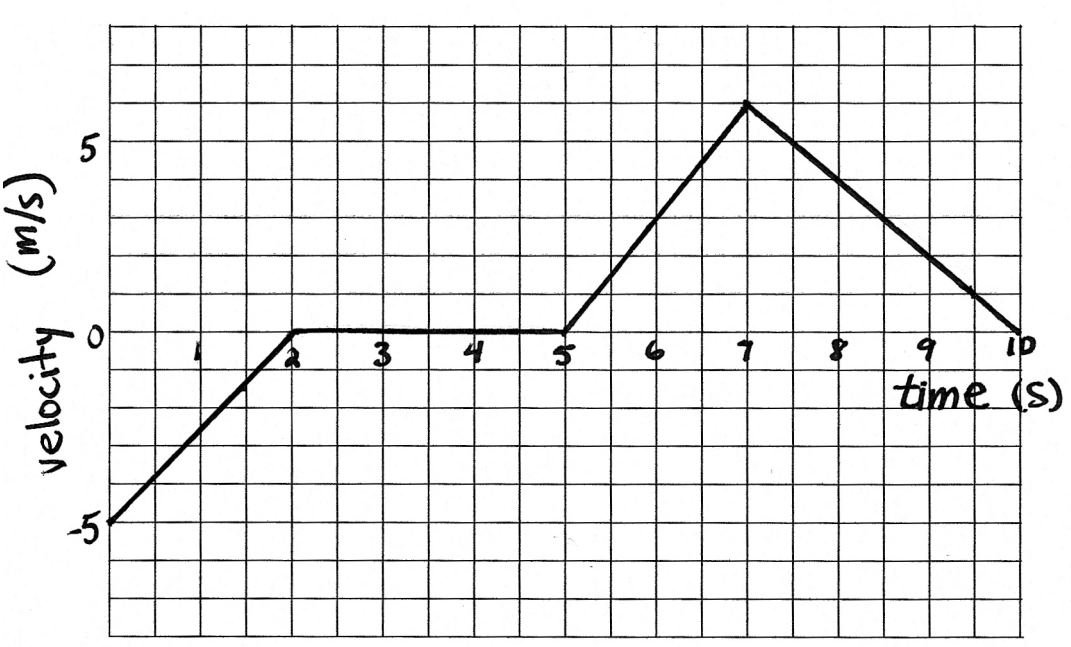
   4.5/2 = 2.25 cm

   c) If the screen is moved further away from the light, describe what would happen to the interference pattern as seen on the screen.

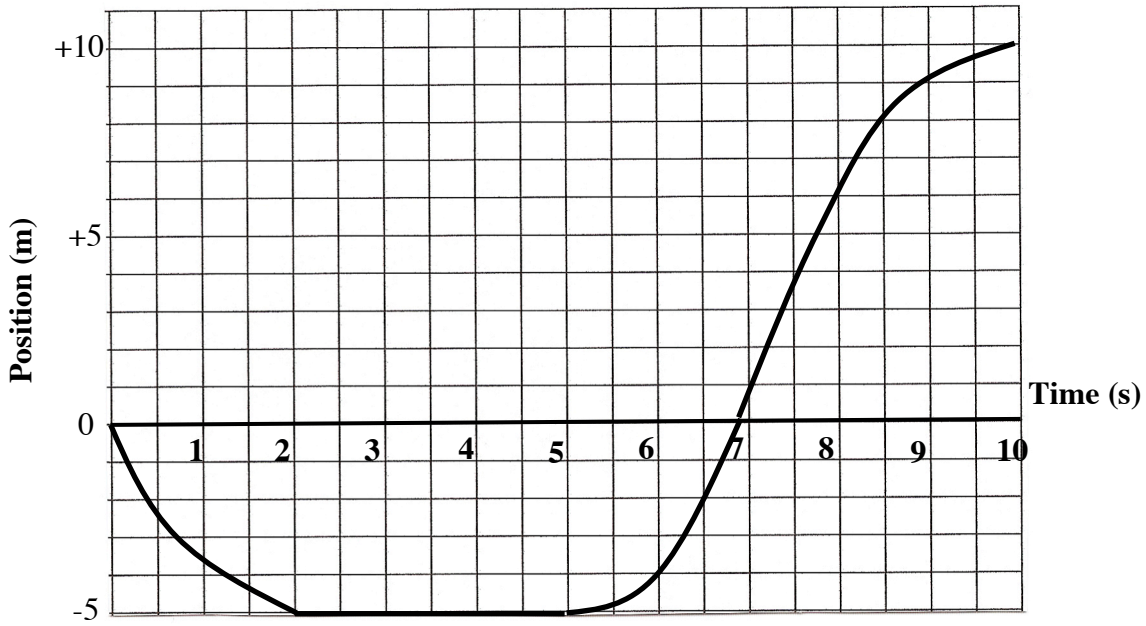
   The interference pattern would spread out.

III: Mechanics

1. The following graph shows the velocity of an object over a 10 s time interval.



Translate the velocity-time graph into a position-time graph in the space provided. Be sure to label your axes. You may assume the object starts at the origin.



2. As Rebecca is driving in her car, she speeds up from 10 km/h to 50 km/h in 5.5 seconds.

   a) What is her acceleration in m/s^2?

   v_1 = 10 km/h = 2.78 m/s
   v_2 = 50 km/h = 13.89 m/s

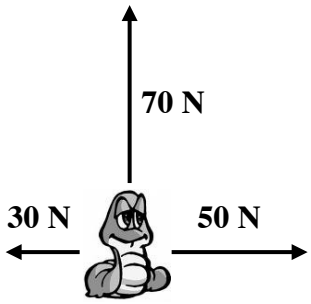
   $$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{13.89 - 2.78}{5.5} = +2 \ m/s^2$$

   b) What is the total distance she traveled during this time?

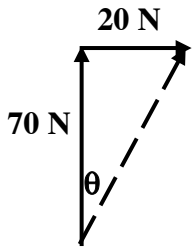
   $$d = \left(\frac{v_1 + v_2}{2} \right) t = \left(\frac{2.78 + 13.89}{2} \right) 5.5 = 46 \ m$$

3. Three early-birds are fighting for the same worm. Blue Jay pulls with a force of 70 N to the North, Robin pulls with a force of 50 N East, and Sparrow pulls with a force of 30 N West.

   a) Draw a free body diagram showing all the forces acting on the worm.



   b) Determine the net force acting on the worm.



$$\Sigma F = \sqrt{70^2 + 20^2} = 73$$

$$\tan \theta = \frac{20}{70}$$

$$\therefore \theta = 16^\circ$$

$$\Sigma F = 73 \ N, 16^\circ \ E \ of \ N$$

4. As Tyler mows the lawn, he applies a force of 35 N at an angle of 25º down from the horizontal. The lawn mower is 25 kg, and a 20 N force of friction opposes the motion of the mower.

   a) Calculate the net force causing the mower to accelerate.

   $F_x = 35\cos 25^\circ = 31.7$ N

   $$\Sigma\vec{F} = \vec{F}_x - \vec{F}_f = 31.7 - 20 = 11.7\,N, \textit{in the direction of the applied net force}$$

   b) Determine the mower's acceleration.

   $$\vec{a} = \frac{\Sigma\vec{F}}{m} = \frac{11.7}{25} = 0.47\,m/s^2, \textit{in the direction of the applied net force}$$

IV: Fields

1. A 75 kg man stands on a scale in an elevator. What is the scale reading when the elevator is

   a) at rest.

   $$\vec{F}_{scale} = \vec{F}_g \quad (\vec{a} = 0\ m/s^2)$$

   $$\therefore \vec{F}_{scale} = m\vec{g} = (75)(9.8) = 735\ N$$

   b) accelerating upward at 2 m/s^2.

   $$\vec{F}_{scale} = \Sigma\vec{F} + \vec{F}_g = m\vec{a} + m\vec{g} = 75(2 + 9.8) = 885\,N$$

2. A waiter is sliding an 8 kg dish bin across a counter at a constant velocity.

a) If the waiter provides a 7 N force to keep the bin moving forwards, what is the frictional force acting on the bin?

7 N

b) What is the coefficient of kinetic friction between the bin and the counter?

$$\vec{F}_f = \mu \vec{F}_N$$

$$\therefore \mu = \frac{\vec{F}_f}{m\vec{g}} = \frac{7}{(8)(9.8)} = 0.09$$

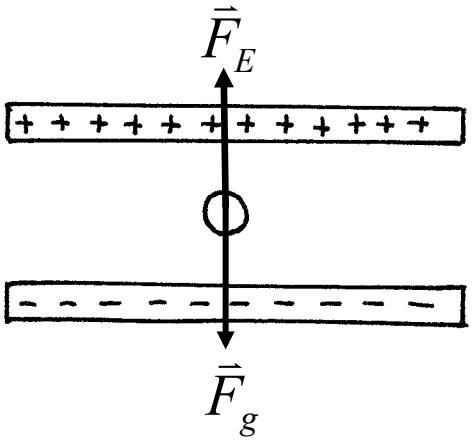
c) Would you expect the value obtained in part b to be greater or less than the coefficient of **static** friction between the bin and the counter? Why?

The value would be less than the coefficient of static friction.

It is more difficult to start an object moving than to keep it moving due to inertia.

3. An oil drop of mass 2.03×10^{-15} kg is suspended (not moving) between two parallel plates creating an electric field of 25 000 N/C down as shown.

a) Draw the force vectors acting on the drop.



b) Is the charge on the oil drop positive or negative?

Negative

c) Calculate the charge on the oil drop in Coulombs.

$$\Sigma \vec{F} = \vec{F}_E + (-\vec{F}_g)$$
$$m\vec{a} = \vec{F}_E - \vec{F}_g \quad (\vec{a} = 0 \ m/s^2)$$
$$0 = q\vec{E} - m\vec{g}$$
$$\therefore q = \frac{m\vec{g}}{\vec{E}} = \frac{(2.03x10^{-15})(9.8)}{(25{,}000)}$$
$$= 7.96x10^{-19} \ C$$

c) How many electrons did the drop gain or lose?

#electrons = $7.96 \times 10^{-19} / 1.6 \times 10^{-19}$ = 5 electrons gained

4. A 10 m length of wire carrying a current of 2.7 A North is placed in a magnetic field. If the wire experiences a force of 6.2 N into the page, what is the magnitude and direction of the magnetic field?

$$\vec{F}_M = \vec{B}IL$$

$$\therefore \vec{B} = \frac{\vec{F}}{IL} = \frac{6.2}{(2.7)(10)} = 0.23\ T, East$$

Multiple Choice Key

Question	Answer
1	C
2	B
3	A
4	D
5	C
6	A
7	C
8	D
9	B
10	D
11	A
12	D
13	B
14	C
15	A
16	A
17	B
18	D
19	C
20	B
21	A
22	C
23	D
24	A
25	B

Question	Answer
26	C
27	B
28	D
29	B
30	A
31	A
32	B
33	C
34	D
35	D
36	A
37	C
38	B
39	D
40	D
41	C
42	C
43	A
44	B
45	B
46	C
47	A
48	D
49	D
50	B