Kuwait University Department of Physics

جامعة الكويت
KUWAIT UNIVERSITY

General Physics I for Biological Sciences (Phy 121)
Midterm Examination
Spring Semester 2025-2026
April 18, 2026
Time: 12:00 PM to 13:30 PM

Instructors: **Dr. Al-Failakawi, Dr. Al-Otaibi, Dr. Al-Refai, Dr. Burahmah, Dr. Hadipour, Dr. Kokkalis and Dr. Razee**

Name:.. **Student ID:**..........................

Section:...................................... **Serial No.:**.............................

Instructions to the Students:

- Answer all the questions. Show all your working in this booklet.
- All communication devices must be switched off and placed in your bag or deposited with the invigilator in charge. Anyone found using a communication device will be disqualified.
- Programmable calculators, which can store equations, are not allowed. You may use a non-programmable calculator.
- Cheating incidents will be processed according to the University rules.
- **Use SI units**.
- **Take $g = 9.8$ m/s^2**.

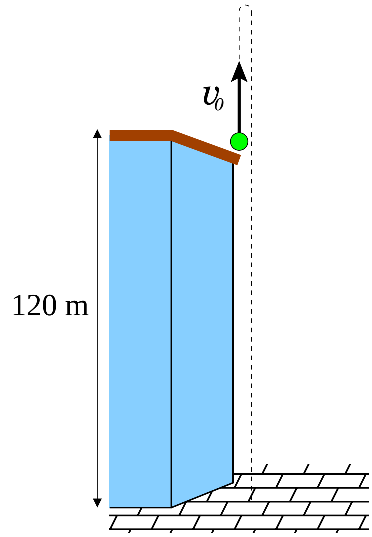
For use by instructors only

Problem #	P1	P2	P3	P4	P5	P6	P7	Total
Max. Marks	**4**	**4**	**3**	**4**	**3**	**3**	**5**	**26**
Marks								

1. A ball is thrown vertically upward from the top of a 120 m tall building. It reaches its maximum height after 1.5 s. Ignore air resistance.

   (a) Find the velocity of the ball just before it hits the ground. **3 points**

   (b) How long it takes for the ball to reach the ground? **1 point**



Solution: We choose the **ground level** as **zero position**, and **upward** direction as the **positive** direction for all quantities.

First we need to calculate the initial velocity v_0. We have $a = -9.8$ m/s^2, and at the maximum height $v = 0$. So

$$v = v_0 + at \implies v_0 = -at = 14.7 \text{ m/s}$$

Hitting the ground: We have $x_0 = 120$ m, $x = 0$, and we use

$$v^2 = v_0^2 + 2a(x - x_0) \implies v^2 = 2568$$

$$\implies v = -50.7 \text{ m/s} \;\; \text{[Negative, because it is falling down]}$$

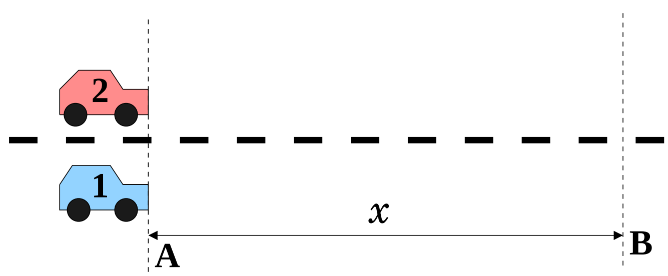
Then

$$t = \frac{v - v_0}{a} = 6.7 \text{ s}$$

2. On a horizontal straight road, the car number 1 travelling with constant speed of $v_1 = 30$ m/s passes car number 2 (at point **A**) at the instant (t=0) car number 2 starts from rest with a constant acceleration $a = 2.5$ m/s^2. After time t and travelling through a distance x, the two cars are together again (at point **B**).

   (a) Find the time t that the cars needed to reach **B**. **3 points**

   (b) Find the distance x between the points **A** and **B**. **1 point**



Solution: Both the cars have travelled the distance x in time t. For car **2** the initial speed is $v_0 = 0$. So

$$\left.\begin{aligned} &\text{For Car } \mathbf{1}: \quad && x = v_1 t \\ &\text{For Car } \mathbf{2}: \quad && x = \frac{1}{2}at^2 \end{aligned}\right\} \implies v_1 t = \frac{1}{2}at^2 \implies t = \frac{2v_1}{a} = 24 \text{ s}$$

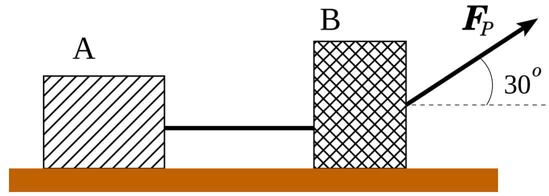
Then

$$x = v_1 t = 720 \text{ m}$$

3. The box A (mass $M_A = 10$ kg) and the box B (mass $M_B = 14$ kg) connected by a horizontal massless cord are on a frictionless horizontal surface. When a force $\boldsymbol{F_P}$ is applied to box B as shown, the boxes accelerate at $a = 2.8$ m/s^2.

   (a) Find the tension in the cord connecting the two boxes. **1 point**

   (b) Find the magnitude of the applied force $\boldsymbol{F_P}$. **2 points**



Solution: Looking at the free-body diagram, and applying Newton's second law to the boxes, we have

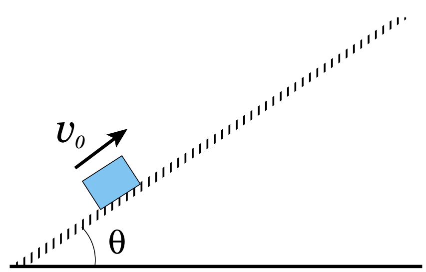
Box A: $F_T = M_A a \implies F_T = 28$ N

Box B: $F_P \cos 30^o - F_T = M_B a \implies F_P = \dfrac{M_B a + F_T}{\cos 30^o} = 78$ N

4. A block is given an initial speed of $v_0 = 8$ m/s up the rough incline ($\theta = 25^o$) as shown. The coefficient of kinetic friction between the incline and the block is $\mu_k = 0.17$. Find the time it takes the block to come momentarily to rest. **4 points**

Solution: We have drawn the free-body diagram.

We choose the positive $x-$axis down the incline and the positive $y-$axis perpendicular to the incline.



Then, Newton's second law in the $y-$direction reads

$$F_N - Mg\ \cos\theta = 0 \implies F_N = Mg\ \cos\theta$$

Newton's second law along the $x-$direction reads

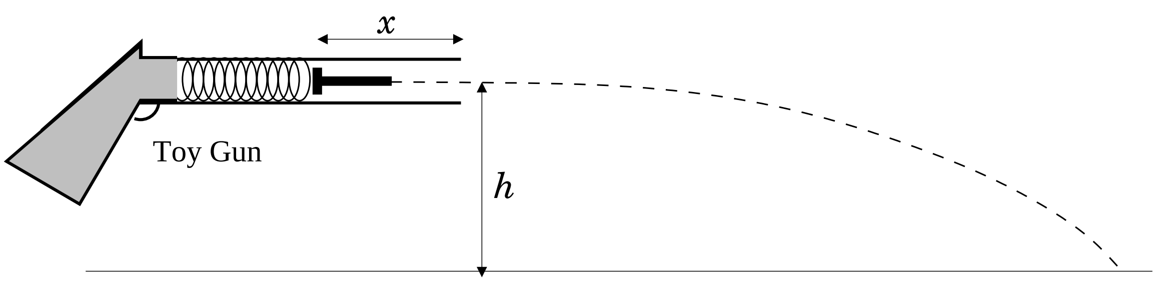
$$Mg\ \sin\theta + F_{fr} = Ma \implies Mg\ \sin\theta + \mu_k Mg\ \cos\theta = Ma$$

$$\implies a = g(\sin\theta + \mu_k\cos\theta) = 5.65 \text{ m/s}^2$$

Accoding to our sign convention, $v_0 = -8$ m/s, and $v = 0$. So

$$v = v_0 + at \implies t = \frac{v - v_0}{a} = 1.4 \text{ s}$$

5. A toy gun is fitted with a spring of spring constant $k = 200$ N/m. It is held horizontal at a height of $h = 1.2$ m from the ground. The spring is compressed by $x = 4$ cm by a dart of mass $M = 0.017$ kg, and then it is released. Find the speed of the dart when it lands on the ground. Ignore air resistance. **3 points**



Solution: The work-energy principle from start to finish is

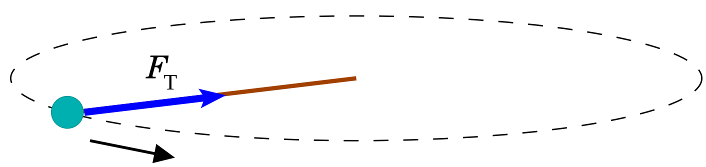
$$\text{KE}_i + \text{PE}_i = \text{KE}_f + \text{PE}_f$$

$$\implies 0 + \frac{1}{2}kx^2 + Mgh = \frac{1}{2}Mv^2 + 0 + 0$$

$$\implies 0.16 + 0.20 = \frac{1}{2}Mv^2$$

$$\implies v = 6.5 \text{ m/s}$$

6. A small ball of mass $M = 0.15$ kg is connected to a cord. When the ball is in a horizontal uniform circular motion of radius $R = 0.12$ m, the magnitude of the tension in the cord is $F_T = 3$ N. Find the frequency of the ball's circular motion. **3 points**



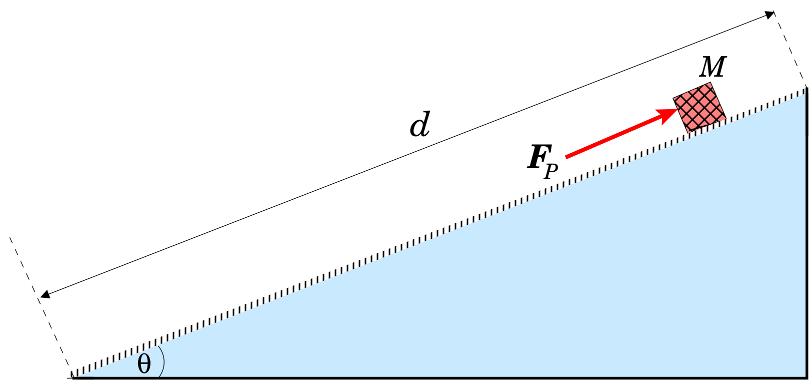
Solution: The Newton's law for the radial direction is

$$F_T = M\frac{v^2}{R} \implies v = \sqrt{\frac{F_T R}{M}} = 1.55 \text{ m/s}$$

Then

$$v = 2\pi R f \implies f = \frac{v}{2\pi R} = 2.06 \text{ Hz}$$

7. In a warehouse, boxes of mass $M = 50$ kg slide down the rough incline ($\theta = 15^o$) of length $d = 6$ m. The coefficient of kinetic friction between the boxes and the incline is $\mu_k = 0.12$. The boxes start from rest at the top. For safety reasons, their maximum speed should be 2 m/s. A constant force of magnitude F_P applied parallel to the incline controls the speed of the boxes (see the figure). Find the minimum value of F_P. **5 points**



Solution: The maximum height of the incline is

$$h = d\ \sin\theta = 1.55 \text{ m}$$

The work-energy principle from start to finish implies

$$\text{KE}_i + \text{PE}_i + W_{NC} = \text{KE}_f + \text{PE}_f$$

$$\Longrightarrow\ 0 + Mgh - \mu_k Mg\cos\theta \times d - F_P\ d = \frac{1}{2}Mv^2 + 0$$

$$\Longrightarrow\ 419 - F_P\ d = 100$$

$$\Longrightarrow\ F_P = 53 \text{ N}$$