Bermuda College

Sample Exam

2 hrs

There are 7 questions on the following topics.

1. Thermal Physics
2. Magnetism
3. Electricity
4. Astrophysics
5. Energy
6. Waves and Sound
7. Optics

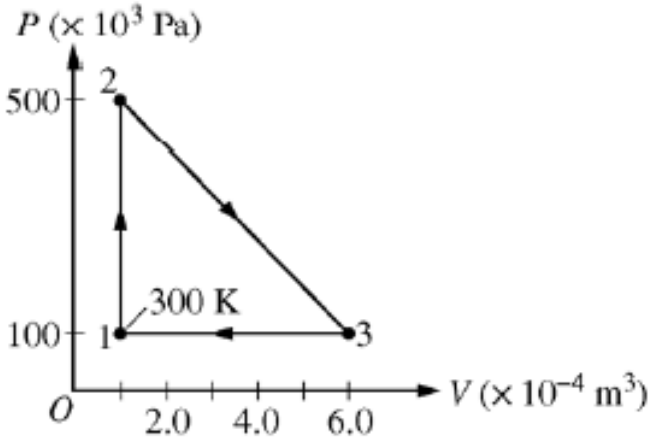
Choose any 5 questions.

Each question worth 10 marks.

Budget 20 mins per question.

Open book

1 – Thermal Physics



A 0.0040 mol sample of a monatomic gas is taken through the cycle shown above. The temperature T_1 of state 1 is 300 K.

a) Calculate T_2 and T_3. (3)

b) Calculate the amount of work done on the gas in one cycle (3)

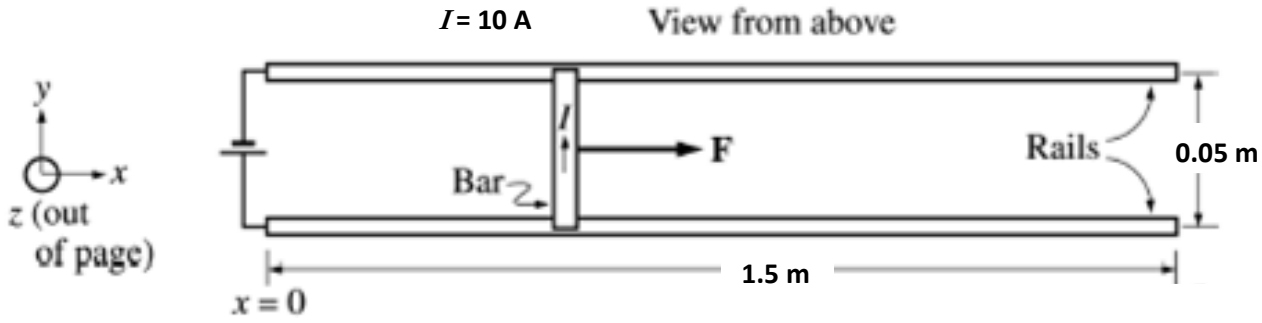
c) Is the net work done on the gas in one complete cycle positive, negative, or zero? (2)

_____Positive _____Negative _____Zero

Justify your answer

d) Calculate the heat added to the gas during process 1 → 2. (2)

2 - Magnetism



A rail gun is a device that propels a projectile using a magnetic force. A simplified diagram of this device is shown above. The projectile in the picture is a bar of mass 0.1 kg and length 0.05 m, which has a constant current of 10 A flowing through it in the +*y* direction, as shown. The space between the thin frictionless rails contains a uniform magnetic field 0.1 T, perpendicular to the plane of the page. The magnetic field and rails extend for a distance 1.5 m.

The magnetic field exerts a constant force *F* on the projectile, as shown.

a) What effect causes the force shown? (2)

b) What is the direction of the magnetic field? (1)

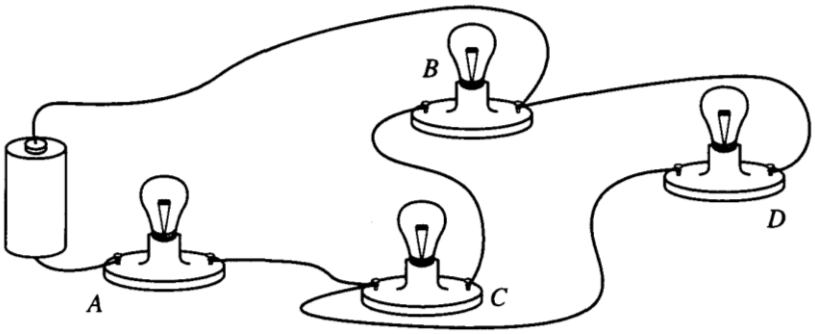
c) Calculate the force applied to the bar by this effect (2)

d) Calculate the acceleration of the bar due to this applied force (2)

e) What speed does the bar leave the rail gun? (2)

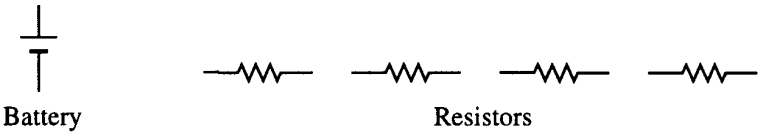
f) In reality the bar will not achieve this speed. Discounting friction - explain why. (1)

3 - Electricity



In the circuit shown above, A, B, C, and D are identical lightbulbs. Assume that the battery maintains a constant voltage between its terminals (i.e., the internal resistance of the battery is assumed to be negligible) and the resistance of each lightbulb remains constant.

a) Draw a diagram of the circuit in the box below, using the following symbols to represent the components in your diagram. Label the resistors A, B. C, and D to refer to the corresponding lightbulbs. (4)



b) List the bulbs in order of their brightness, from brightest to least bright. If any two or more bulbs have the same brightness, state which ones. Justify your answer. (2)

Bulb D is then removed from its socket.

c) Describe the change in the brightness, if any, of bulb A when bulb D is removed from its socket. Justify your answer. (2)

d) Describe the change in the brightness, if any, of bulb B when bulb D is removed from its socket. Justify your answer. (2)

4 - Astrophysics

In March 1999 the Mars Global Surveyor space probe entered its final orbit about Mars, sending data back to Earth. Assume a circular orbit with a period of 1.18×10^2 minutes = 7.08×10^3 s and orbital speed of 3.40×10^3 m/s . The mass of the Global Surveyor is 930 kg and the radius of Mars is 3.43×10^6 m.

a) calculate the radius of the GS orbit. (2)

b) Calculate the mass of Mars. (3)

c) If the probe was to be placed in a lower circular orbit (closer to the surface of Mars), would the new orbital period of the probe be greater than or less than the given period? (2)

_____Greater than _____ Less than

Justify your answer.

d) In fact, the orbit the Global Surveyor entered was slightly elliptical with its closest approach to Mars at 3.71×10^5 m above the surface and its furthest distance at 4.36×10^5 m above the surface. Explain how and why the speed of the probe varies during this orbit. (3)

5 - Energy Resources

There are numerous energy resources that can be used to generate electricity.

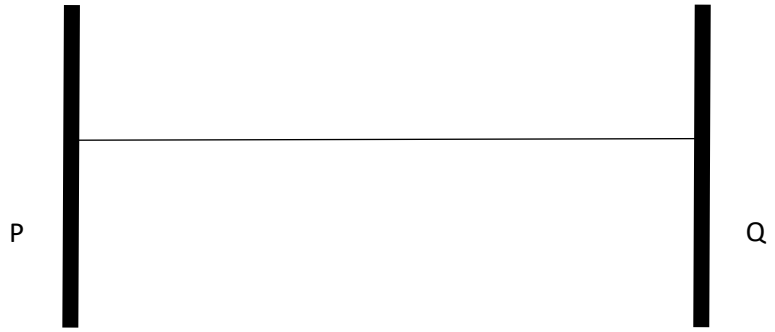
a) Explain the basic concept of how electricity is produced by a generator. (4)

b) Describe 2 methods of spinning this generator, outlining a major advantage and disadvantage of each system.

Method 1 (3)
Method 2 (3)

6 – Waves and Sound

A rope is stretched between two vertical supports. The points where it is attached (P and Q) are fixed. The linear density of the rope, μ, is 0.4 kg/m, and the speed of the transverse wave on the rope is 12 m/s.



a) What is the tension in the rope? (2)

b) With what frequency must the rope vibrate to create a travelling wave with a wavelength of 2 m? (2)

The experiment is redone with the same rope but the length is now set to 4 m. The tension is the same.

c) Calculate the frequency of the harmonics:

i) First (2)

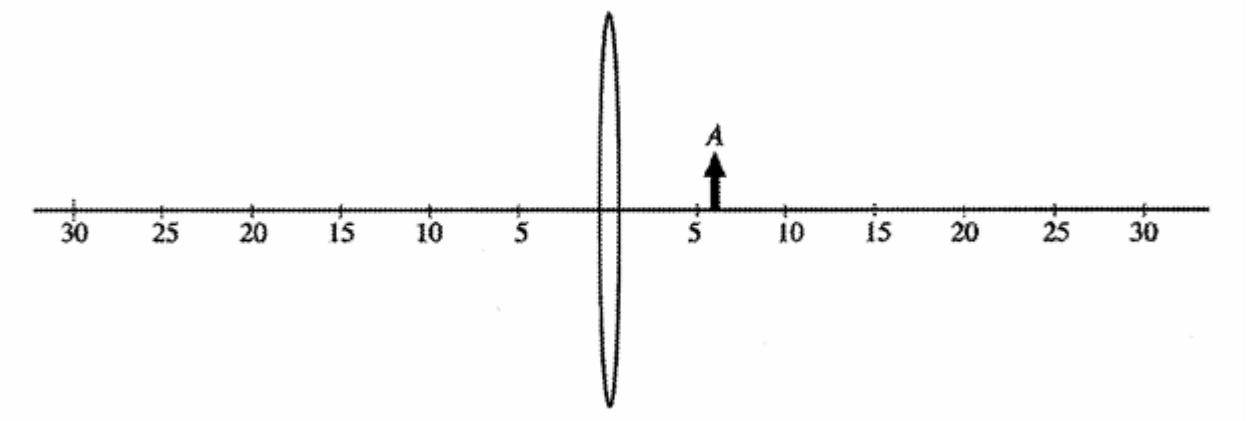
ii) Second (2)

iii) Fourth (2)

7 - Optics

A thin converging lens of focal length 10 cm is used as a simple magnifier to examine an object *A* that is held 6 cm from the lens.

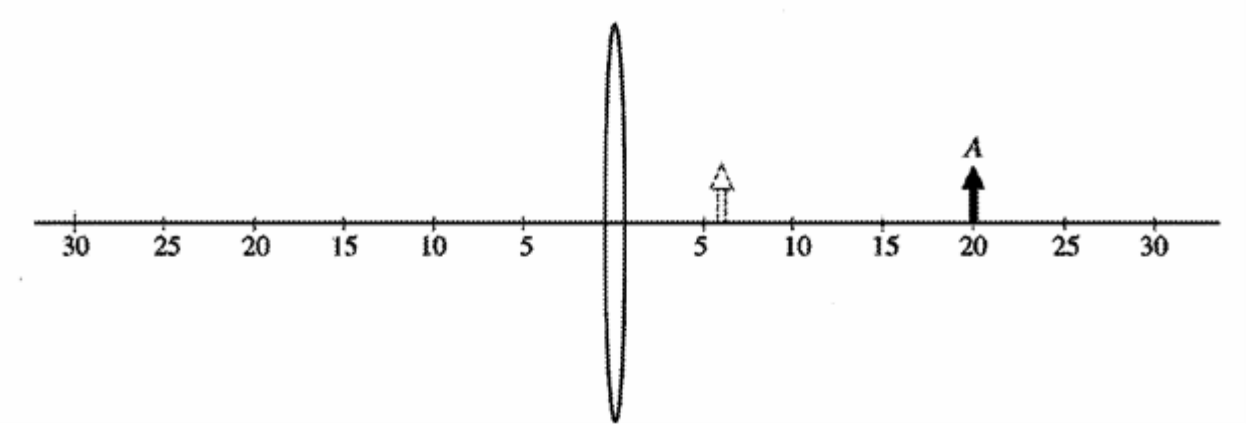
a) On the figure below, draw a ray diagram showing the position and size of the image formed. (2)



b) State whether the image is real or virtual. Explain your reasoning. (1)

c) Calculate the distance of the image from the center of the lens. (2)

d) Calculate the ratio of the image size to the object size. (2)



e) The object *A* is now moved to the right from x = 6 cm to a position of x = 20 cm, as shown above. Describe the image position, size, and orientation when the object is at x = 20 cm. (3)